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Editor
Kristin L. Kraus

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Utah Academy of Sciences, Arts, and Letters

History: Founded 3 April 1908, the Utah Academy of Sciences was organized “to promote investigations and diffuse knowledge in all areas of science.” Beginning in 1923, the Academy started publishing the papers presented in its annual meetings in *Proceedings*. In June 1933 at the annual meeting, the Academy was enlarged to include arts and letters, and the name was changed to the Utah Academy of Sciences, Arts, and Letters. Articles of incorporation and non-profit organization status were accepted by the Academy membership at the spring meeting in April 1959. In 1977, the name of the journal of the Academy was changed from *Proceedings* to *Encyclia*. It became a refereed journal at this time. In the mid 1980s, the scope of the Academy was expanded further to include (1) business, (2) education, (3) engineering, (4) library information and instruction, and (5) health, physical education, and recreation. Beginning with the 1998 issue, the journal became *The Journal of the Utah Academy of Sciences, Arts, and Letters*.

Annual Meeting: The Academy’s annual meetings are normally held in the spring on one of the Utah campuses of higher education. The plenary session is called the Tanner Lecture, endowed by Mr. O.C. Tanner in 1986.

Best Paper Awards: A best paper and a best poster presented in each division may be selected for cash award, which is presented at the Academy's “Awards Evening” held the following fall.

Distinguished Service Awards: The Academy recognizes outstanding contributions to teaching and scholarship by means of annual Distinguished Service Awards, alternating every other year between disciplines.

Membership: When the Academy was founded in 1908, membership was by nomination, ratified by the Council, and elected by a “three-fourths votes of members present.” Today, the Academy's membership is available by application.

Institutional Members: All Utah institutions of higher education are members of the Utah Academy. The Academy appreciates their patronage.

Publication Policy

Each year the Academy publishes *The Journal of the Utah Academy of Sciences, Arts, and Letters*. All abstracts presented at the yearly conference, as talks or posters, are published in the journal. Additionally, all presenters are invited to submit a paper to be considered for publication in the journal based on their presentation. From among the papers submitted for review, a number are selected for publication. Each academic division may select a “best paper” from among the papers selected for publication.

If you presented a paper at the most recent UASAL conference, you are invited to submit an article to be considered for publication in the journal. Submissions should be sent to the Section Chair responsible for your division by June 1. Please review the Instructions for Authors prior to submission.

The UASAL supports the highest standards of research through its academic publishing. Papers submitted to the *Journal of the Utah Academy of Sciences, Arts, and Letters* will be based on the material presented at the annual conference. These papers must be unique submissions that are not substantially similar to previous work and are not under consideration for publication in another journal. Any material that has been previously published or that is under consideration for publication elsewhere (whether it has been formally accepted or not) may not be submitted for publication in the journal. Submissions must be the original work of all authors listed on the manuscript. References made in a manuscript or article to another person’s work or idea must be credited appropriately. All research submitted for publication in the journal should follow the ethical guidelines for research in their respective field.

The journal is a double-blind, peer-reviewed scholarly publication. It is part of both the Wilson and EBSCO database systems. This allows research published in the journal worldwide exposure and access.

The Academy includes divisions especially designated for Arts, Biological Science, Business, Education, Engineering, Humanities/Philosophy/Foreign Language, Kinesiology and Health Sciences, Languages/Literature, Physical Sciences, and the Social Sciences.

The Utah Academy of Sciences, Arts, and Letters broad academic focus is rare among state academic associations. Utah is one of only four states (joining Michigan, Wisconsin, and Virginia) that include a complete academic structure for all disciplines.

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JAMES H. WOLFE AWARD

The James H. Wolfe Prize is designated as a lifetime achievement award. Recipients are selected based on their lifetime work as Utah academics.

Doran J. Baker

Space Dynamics Lab, Utah State University

Doran Baker was born in Salt Lake City. He and his two brothers loved science from childhood forward; they completed many projects in the shop behind the family home, including building one of the first working television sets in Salt Lake. Doran raised chickens to help pay tuition at the University of Utah, earning a PhD in electrical engineering. He completed post-doctoral study at Harvard University and the Armed Forces Technical Institute. While stationed at the Air Force Geophysics Lab in Massachusetts, he met and married Agnes “Kathy” Rivard. Their honeymoon was a drive across the United States to settle in Logan, Utah, where Doran had been hired at Utah State University as a professor of Electrical Engineering. Teaching and working with students became his lifelong passion. Early in his career, he helped establish the Electro-Dynamics Lab, which later became the Space Dynamics Laboratory (SDL) at Utah State. He was also instrumental in developing the SDL’s involvement with the NASA Space Grant Consortium. He received numerous honors for his upper-atmospheric research, including the Utah Governor’s Medal for Science and Technology. He transitioned from teaching to emeritus status at USU after 62 years.

Kay D. Baker

Space Dynamics Lab, Utah State University

Like his older brother Doran, Kay grew up in Salt Lake City with a deep love for science and space. And like Doran, he also attended Granite High and then the University of Utah, also earning undergraduate and graduate degrees in electrical engineering and physics. He fell in love with and married Carolyn Smith while still an undergraduate at the U; she later followed him to Logan, which they quickly claimed as their real home. Kay and his brother Doran were cofounders of what eventually became the Space Dynamics Laboratory (SDL) at Utah State University. Kay was a pioneer in the fields of atmospheric science and space engineering. While at The University of Utah, he played a key role in the development of novel space-based techniques to measure atmospheric

conditions. Kay and his team at the Upper Air Research Laboratory at the U developed the Standing Wave Impedance Probe, which could directly measure the local electron density. For 30 years, Kay was a dedicated teacher and faculty member at Utah State, serving as head of the Electrical Engineering Department, tenured professor of electrical engineering, professor of physics, and director of the Center for Research in Aeronomy—in addition to his work with the SDL.

Allan Steed

Space Dynamics Lab, Utah State University

Allan Steed was reared on a dairy farm in Syracuse, Utah, graduating from Davis High. He received, BS, MS, and PhD degrees in electrical engineering from Utah State University, where he was mentored by Doran and Kay Baker and where he did graduate work in their Electro-Dynamics Laboratory. He helped with the transition of the EDL to the Space Dynamics Laboratory (SDL) in 1982, becoming its president in 1986. He held that position until his retirement in 2003, always considering it an enormously beautiful assignment that occasioned close friendships with his respected coworkers as well as fulfilling associations with state, national, and global leaders. When he wasn't busy with SDL work and travel responsibilities or helping his neighbors in Logan, Allan enjoyed spending time outdoors—camping, hiking, fishing, and stargazing—and he cherished hours with Kaye at their Bear Lake cabin. Regardless of where he was, he always carried a camera to capture nature's beauty. He left lasting imprints on his family and friends, his students, and on the mission and structure of his beloved SDL.

DISTINGUISHED SERVICE AWARD

The Distinguished Service Award is given to honor an individual for exceptional service to education or academic service to citizens in Utah.

Kathryn Bond Stockton

University of Utah

Kathryn Bond Stockton is the Dean of the School of Social and Cultural Transformation, or Transform, at the University of Utah, where she is also a Distinguished Professor of English. She was integral to the creation of Transform in response to the needs of students and faculty in Disability Studies, Ethnic Studies, Gender Studies, and Pacific Island Studies at the university. In the wake of Utah HB-261 and the shuttering of the university's Women's Center, LGBTQ Resource Center, and Black Cultural Center, Bond Stockton has been tireless in securing inclusion and support for marginalized students within the parameters of this new law. Bond Stockton also works to educate the general public through her inclusive and compassionate outreach on behalf of queer people and other minoritized groups. She has appeared on the Ezra Klein Show for *The New York Times*, has presented on RadioWest here in Utah, and has participated in dozens of invited podcasts, panels, and talks. In academia, she impacts research and pedagogy in her fields of interest through books and scholarly articles and through secured grants. Her works have in turn inspired local and national art exhibits and film festivals.

WILLARD AND VIOLA GARDNER PRIZE

The Gardner Prize is awarded annually for exceptional achievement by an academic professional in Utah.

Shannon Hale

New York Times best selling author Shannon Hale started writing books at age ten and never stopped, eventually earning an MFA in Creative Writing. After 19 years of writing and many rejections, she published *The Goose Girl*, the first book in her award-winning Books of Bayern series. Her other books for young adults include the acclaimed fantasy *Book of a Thousand Days*, the sci-fi adventure *Dangerous*, and genre-bending comedy *Kind of a Big Deal*. Her books for middle grade readers include the Newbery Honor winner *Princess Academy* and sequels, and the USA Today best-selling *Ever After High* series. With Caldecott-honoree LeUyen Pham, she created her award-winning graphic novel memoirs *Real Friends*, *Best Friends*, and *Friends Forever* and the bestselling *Itty-Bitty Kitty-Corn* picture books. With director Jerusha Hess, Shannon co-wrote the screenplay for the film adaptation of her novel *Austenland*. With her husband Dean Hale, Shannon co-wrote: Eisner-nominee *Rapunzel's Revenge* and *Calamity Jack* (with Nathan Hale), two books about Marvel's unbeatable super hero Squirrel Girl, DC's Diana, Princess of the Amazons series (with Victoria Ying) and *Amethyst, Princess of Gemworld* (with Asiah Fulmore), and the popular early chapter book series *The Princess in Black* (with LeUyen Pham). Shannon's books have been translated into more than 25 languages and studied in classrooms from elementary schools to universities. She is a renowned public speaker and advocate for gender equality. She and Dean live with their four children near Salt Lake City, Utah.

O.C. TANNER LECTURE 2025

The plenary session of the Annual Conference is called the Tanner Lecture, endowed by Mr. O.C. Tanner in 1986.

“I Was a Queer Child: What that Might Mean for You”

Dr. Kathryn Bond Stockton

University of Utah

Kathryn Bond Stockton is Distinguished Professor of English, former Associate Vice President for Equity and Diversity, and former inaugural Dean of the School for Cultural & Social Transformation at the University of Utah. Two of her books—*Beautiful Bottom, Beautiful Shame: Where “Black” Meets “Queer”* and *The Queer Child* (Duke University Press)—were national finalists for the Lambda Literary Award in LGBT Studies and her book *Making Out* (NYU Press) was a 2020 finalist for the Next Generation Indie Book Award for memoir. Her newest book (with MIT Press) is *Gender(s)* and she has also authored *God Between Their Lips* (Stanford University Press). Along with her university’s top teaching award, she has received the NOW Lifetime Achievement Award, the YWCA Outstanding Achievement Award in Arts and Communication, the Crompton Noll Prize from the Modern Language Association, and the Rosenblatt Prize for Excellence, the highest honor granted by the University of Utah.

ACADEMY FELLOW

“Fellow” is the title used to honor individuals who have, or have had, substantial involvement as members of the Academy and who have gained distinction through meritorious original research, scholarship, creative work, or extraordinary teaching within their academic field.

Rachel Keller

Snow College

Rachel Keller served as division chair and president of the Utah Academy of Sciences, Arts, and Letters in 2018-2020. She graduated with a Ph.D. from the University of New Mexico, specializing in modern American literature, composition, and secondary education. She passed comprehensive exams with distinction in poetry, modern American literature, and 19th-century American literature. She earned her New Mexico State Secondary Teaching License and has extensive teaching experience at the college level, secondary level, and abroad in West Africa. After completing a two-year Peace Corps Volunteer service term in Cape Verde, West Africa, she and her husband moved to Ephraim, where she teaches a variety of classes in the English department at Snow College.

HONORARY MEMBER

Any person who has given long service and gained unusual prominence and distinction in the sciences, arts or letters may be conferred honorary membership in the Academy by the Board of Directors.

Liliana Olvera-Arbon

Liliana Olvera-Arbon embarked on her transformative journey with the Utah Coalition Against Sexual Assault in July 2019, assuming the role of Advocacy Manager. Her appointment as Executive Director marked a pivotal moment in the organization's evolution, reflecting her steadfast dedication to advancing the rights of survivors of sexual violence. Liliana is deeply committed to centering and amplifying the voices of survivors, advocating tirelessly for justice and empowerment. Her leadership at UCASA is characterized by a passionate pursuit of equity and a staunch commitment to dismantling systemic injustices that perpetuate sexual violence. Believing fervently in collective action, Liliana champions collaborative efforts to foster safer communities and drive societal change. She envisions a future where every voice is heard, every survivor is supported, and together, we can eliminate sexual violence. Through her advocacy work and personal pursuits, Liliana continues to inspire and empower others, leaving an indelible impact on those she serves and the broader community.

2025 BEST PAPER/POSTER AWARDS

ARTS

Best Paper

Touching Loss: The Language of Hands in Käthe Kollwitz's Maternal Mourning

Lily Greenwood
Utah Valley University

Best Poster

Finding Beauty in Balance and Cost: Analyzing the Evolution of Mobile Homes

Hayden Fleming
Utah Valley University

BIOLOGICAL SCIENCES

Best Paper

Identifying Cranial Specimens of Utah Species of *Lepus*

Arianna Harrington, Ethan Rowland
Southern Utah University

Best Poster

A Look into Frugivorous Interactions with *Psychotria* and *Palicourea* Genera on Barro Colorado Island, Panama

Madison Smart, Elsa Jos
Utah State University

BUSINESS

Best Paper

The Oyster Is Your World: A Revied Look at International Diversification

Robert Dubil
University of Utah

ENGINEERING

Best Paper

Slab of Ice Melting Rate Due to Natural Convection and Thermal Radiation

Tim Amodt
Southern Utah University

HUMANITIES, PHILOSOPHY, & FOREIGN LANGUAGES

Best Paper

Scroll, Click, Mitigate: Unmasking and Taming the Social Media Mental Health Concerns Haunting Utah's Kids

Aggrey Otieno
Utah State University

“Then I Remembered”: Joan Didion on Grief and its Replication: Minimalism and Phenomenology

George Dibble
Brigham Young University

Best Poster

Body Worlds: Issues of Corpses & Human Dignity, Insights from Rome

Miranda Slusser, Savanna Thompson
Snow College

KINESIOLOGY AND HEALTH SCIENCES

Best Paper

Musical (Department) Chairs: The Health Impacts of Serving as a Rotating Department Chair

James Bemel
Utah Valley University

Best Poster

Eating Disorders: Treating the Underlying Mental Illness

Darci Barker
Salt Lake Community College

PHYSICAL SCIENCES

Best Paper

Quantifying Cadmium and Lead Concentrations in Cocoa Beans

Hannah J. Verhaal, Lydia E. Felix, Harrison R. Yates, J. Andreas
Lippert, Charles Davidson
Weber State University

Best Poster

**Effects of Heavy Metal Uptake in the Growth and Development of
*Lactuca sativa L.***

Elisa Johnson, Audrey O'Donnal, Riley Jackson, Braden Robinson
Utah Valley University

SOCIAL SCIENCES

Best Paper

**Wellbeing, Experiential Learning, and Food Justice: A Mixed
Methods Case Study of a University Campus Garden**

Elisa L. Diaz, CoCo M. James, and Gabrielle M. James
University of Utah

Best Poster

**Gaps in Gun Safety: A Dual Lens Approach to Addressing Gun
Safety in Utah through Policy and Community Action**

Jamie McFall, Kaisha McFall
Utah Valley University

Female Creators in Mexican Surrealism: The Psychological Effects of Exile on the Art of Remedios Varo and Leonora Carrington

Aubrey Gallafent

Utah Valley University

Abstract

The experience of exile had a profound effect on many of the Mexican female surrealists, specifically Remedios Varo and Leonora Carrington. Together, these artists create overlapping artistic worlds, and a bond, through which they explore identity, androgyny, and creation. Their exile created an opportunity for collaboration and metaphysical exploration that would not have been possible otherwise. Within their metaphysical exploration comes this uniquely female surrealist identity crisis based on their relegation to being solely mother–maiden–muse. Varo and Carrington’s psychological and spiritual developments are visible in the subject matter and symbolism of their art, allowing us to understand how their ideas of feminine identity were developed during their exile. Themes of transformation and mysticism are common in the work of Remedios Varo and Leonora Carrington. Their paintings often mix alchemy and witchcraft with distorted or hybrid female forms. This

essay discusses the symbolism and metaphors found in Remedios Varo's Nacer de Nuevo (Born Again) and Creacion de las Aves (Creation of the Birds) as well as Leonora Carrington's The Feast of Samhain and The Kitchen Garden on the Eyot. Through an analysis of these four works, we can reach a better understanding of how Varo and Carrington's artistic journeys were shaped by their relationship and exile.

Exile, both physical and psychological, profoundly reshaped the creative and personal lives of artists. Once broken away from the larger movement of Surrealism in painting, Remedios Varo and Leonora Carrington formed a close emotional and artistic relationship in Mexico City. Surreal subjects were the perfect vessel for exploring the complex emotions left behind when separated from family, country, and peers. Together, they searched for identity and belonging through a world of alchemy, witchcraft, and hybrid female forms. Through mystical scenes and androgynous figures, these female surrealists provide a glimpse into the transformative effects of their exile on understanding femininity and identity. The works they created in Mexico City reveal how they coped with the relocation, rediscovery, and reclamation caused by exile—through an exploration of the creative powers within feminine identity that led to a subversion of gender binaries and patriarchal Surrealist views.

In experiencing a state of exile, an artist's psyche is reshaped. This transformation through forced emigration is a layered psychological event anchored in recurring states of fear and helplessness. In "Art and the conditions of exile," Linda Nochlin explores this relationship with artists. Though an overall negative force, exile has proven to be a catalyst for artistic growth. The works of Varo and Carrington after they settled in Mexico City demonstrate the loss in sense of self cause by being forced from their home. With creative exploration as a tool, their dislocation left room for their self-discovery and reinvention.¹ With years spent in physical and emotional exile, these artists retreated into their own minds to a space of psychological self-analysis.²

Leonora Carrington's experiences of exile in her early twenties sent her on a path of self discovery through her art. Although she did not receive artistic training during her schooling, she entered the art world as a 19-year-old through a relationship with Max Ernst—a German artist

¹ Linda Nochlin, "Art and the conditions of exile: men/women, emigration/expatriation," *Poetics Today* 17, no. 3 (1996): 317-337, <https://doi.org/10.2307/1773412>.

² Jacqueline Chénieux-Gendron and Andrew Eastman, "Surrealists in exile: another kind of resistance," *Poetics Today* 17, no. 3 (1996): 437-52, <https://doi.org/10.2307/1773417>.

who helped establish the Surrealist movement.³ After following him to Paris, the invasion of Nazis—and Ernst’s arrest—left her isolated. She suffered a slow descent into madness, ending with being institutionalized. Her treatment included heavy sedation, which caused a psychological journey that is visible in her art. When released, Carrington fled Europe through a marriage of necessity. Once in Mexico—not her intended destination of New York—she divorced her husband and started a new artistic journey.⁴

Remedios Varo’s art reflects the events of her early adult life, when she was cut off from her home and family. Her introduction to art was through her father, a hydraulic engineer, who trained her in drafting. She enrolled in a prestigious art school in Madrid at the Academia, before following the avant-garde to Paris.⁵ She had many open relationships with Surrealists as she travelled back and forth, most notably, the poet Benjamin Peret. In following him to France during a Spanish civil war, she was labelled a traitor and barred from re-entering the country. As foreigners, both Peret and Varo ended up imprisoned in French internment camps.⁶ Her time in this camp is something she never willingly discussed and likely had a massive psychological effect. She eventually gained refugee status in Mexico, where she spent the rest of her life.⁷

Because Surrealism often devalued women in romantic roles, Carrington and Varo instead forged a close artistic friendship rooted in mutual exploration and reinvention in Mexico. Impactful artistic relationships define the Surrealism movement, especially among women.

Surrealist men often viewed traditional marriage and family arrangements negatively and did not have a desire to pursue them. This forced women of this movement to create a new form of partnership within their female friendships.⁸ Many of these relationships formed in Paris and have a strong presence in the study of this period. Escaping war drove both Varo and Carrington to exile in Mexico, but exile created

³ Werner Spies, Karin von Maur, Sigrid Metken, Uwe M. Schneede, and Sarah Wilson. *Max Ernst: A Retrospective; [on the Occasion of the Exhibition Max Ernst, a Retrospective, the Tate Gallery, London, 13 February–21 April 1991; Also Shown at the Staatsgalerie, Stuttgart (18 May–4 August 1991), and the Kunstsammlung Nordrhein-Westfalen, Düsseldorf (24 August–3 November 1991)]* (Munich: Prestel, 1991), XVI.

⁴ Whitney Chadwick, *Farewell to the Muse: Love, War and the Women of Surrealism* (Thames & Hudson, 2017), 6171.

⁵ Janet A. Kaplan, *Remedios Varo* (Abbeville Press, 2000), 11-27.

⁶ Kaplan, *Remedios Varo*, 53-71.

⁷ Kaplan, *Remedios Varo*, 81.

⁸ Chadwick, *Farewell to the Muse*, 11.

a strangeness within their own consciousness. Their friendship was an opportunity to explore this experience within their art.

The profound friendship between Remedios Varo and Leonora Carrington became the foundation for a distinctive artistic language rooted in parallel experiences and a shared vision. Their time together is underexplored, despite the full intertwining of the lives of these artists. Carrington labelled this the most important friendship of her life—even saying Varo’s presence saved her life.⁹ There was no separation between the two, who lived together for a short time and shared every thought, dream, and idea. While their intimate discussions have no written record, we can understand many of their ideas based on the similar themes and motifs that appear in their work.¹⁰ They adopted similar communicative devices, stylistic details, and a shared world of knowledge and stories. Although the broader Surrealist movement has been extensively studied, the creative space forged by female surrealists in exile deserves greater recognition as its own movement.

Both artists explored their own themes and ideas, but they shared an interest in the creative nature of femininity. Their individual bodies of work carry an intricate psychological journey, intersecting in the middle of the 20th century through a joint development of iconography and alchemical lore. Remedios Varo focuses on a deconstruction of creation, femininity, and rebirth in *Nacer de Nuevo (Born Again)* and *Creacion de las Aves (Creation of the Birds)*. The work of Leonora Carrington is more overtly feminist, while still exploring domesticity and creation, as seen in *The Feast of Samhain* and *The Kitchen Garden on the Eyot*. Through disconnection from their understanding of the world, these works acknowledge feminine creative power and attempt to make sense of the new consciousness they found in Mexico.

An important aspect of exile explored in their work is the concept of rebirth and relocation. There is a version of the artist who is left behind, unable to live in the new world. This idea appears in Carrington’s *The Feast of Samhain* and Varo’s painting *Nacer de Nuevo (Born Again)*. Both paintings draw from Celtic lore, a common element of Carrington’s work.¹¹ *The Feast of Samhain* is based on the holiday Samhain, or All Souls’ Eve, where the boundaries between the afterlife and our own are

⁹ Whitney Chadwick, “Leonora Carrington: evolution of a feminist consciousness,” *Woman’s Art Journal* 7, no. 1 (1986): 40, <https://doi.org/10.2307/1358235>.

¹⁰ Clare Kunny, “Leonora Carrington’s Mexican vision,” *Art Institute of Chicago Museum Studies* 22, no. 2 (1996): 172, <https://doi.org/10.2307/4104320>;

Courtney Lee Weida, “Frida Kahlo, Remedios Varo, Leonora Carrington, and Leonor Fini: feminist lessons in chimerism, corporeality, cuisine, and craft,” *Visual Culture & Gender* 11 (October 1, 2016): 47.

¹¹ Chadwick, *Farewell to the Muse*, 9.

blurred. This celebration is another metaphor for rebirth, as the festival signifies the Celtic new year.¹²

Each of these works mirrors the artist's own experience of finding herself stuck in an unfamiliar place. The main figure in *The Feast of Samhain* is taking the lead in the festival and seems to be an invented personification of Samhain from Carrington's mind. This large white female form is exiting a doorway with a second female figure, presumably passing out of her native realm. Leaving behind familiarity is the basis of her own experience, as well as the beginning of the exploration of exile within both hers and Varo's work.¹³ The figure in Varo's *Born Again* similarly plunges into a new realm, but through a vaginal portal rather than a doorway. She references her own rebirth into Mexico by depicting a stylized self-portrait. The scene her figure stumbles upon is filled with symbols tied to female creation.¹⁴

In *Born Again*, Varo sets a scene rich with Celtic imagery that connects rebirth and the power of creation. The figure is confronted with a full scrying bowl, showing the reflection of the moon. The bowl is a representation of the holy grail, which is tied to the Celtic cauldron of fertility.¹⁵ This comes from Carrington's book, *Down Below*, where the water is an elixir of life and youth.¹⁶ The cauldron of fertility belonged to 'the good god,' Dagda, a force of fertility and consort to the deity of abundance.¹⁷ Rather than elixir, the cauldron was associated with brewing food as well as life, symbolizing both rebirth and wisdom.¹⁸ This figure pushes her way into a small, occult room where she is confronted with Varo's symbolism.¹⁹ Her rebirth is accompanied by the discovery of the power of fertility and creation. Coming through a vulvar portal implies the innately feminine nature of this power. To cement this comparison, the overflowing vessel reflects the moon, a symbol Varo associates with women and their power. In linking the overflowing vessel with the moon's cyclical death and renewal, Varo asserts the

¹² Tatiana Bužeková, "Commemoration of the dead in the context of alternative spirituality: collective and solitary rituals," *Religions* 15, no. 5 (May 20, 2024): 626, <https://doi.org/10.3390/rel15050626>.

¹³ Janice Valerie Helland, "Daughter of the Minotaur: Leonora Carrington and the surrealist image." MA thesis, University of Victoria (1984), 154.

¹⁴ Zamora, Lois Parkinson. "The Magical Tables of Isabel Allende and Remedios Varo." *Comparative Literature* 44, no. 2 (1992): 119. <https://doi.org/10.2307/1770341>.

¹⁵ Chadwick, "Evolution of a feminist consciousness," 41.

¹⁶ Ailsa Cox, James Hewison, Michelle Man, and Roger Shannon. *Leonora Carrington: Living Legacies* (Wilmington, Delaware: Vernon Press, 2020), 53.

¹⁷ Patricia Monaghan, *The Encyclopedia of Celtic Mythology and Folklore* (New York: Checkmark Books, 2008), 113–14.

¹⁸ Monaghan, *Celtic Mythology and Folklore*, 79, 226.

¹⁹ Weida, "Feminist lessons in chimerism," 45.

feminine body as a site of creative and transformative power and challenges Surrealism's patriarchal tendencies.²⁰

Although the narrative of Carrington's work comes from Celtic lore, her symbolism focuses on the moon and the feminine divine. She incorporates a double moon motif in *The Feast of Samhain*, echoing Varo's *Born Again*. In the sky, she depicts a full moon as well as an eclipsed moon. Although Varo may have influenced her lunar symbolism, Carrington also developed her own associations between the moon and women during her time in the asylum, as she recounts in her book *Down Below*.²¹ At the very least she associated the moon with freedom, like that given to her in relocating to Mexico City.²² Exposure to archaeological sites in Mexico, like Teotihuacan and the Pyramid of the Moon, influenced her beliefs about the moon. She created a physical representation of the feminine divine, drawing upon the moon, curving forms, the rainbow, and the wisdom of a spotted dog.²³ This imagery is all visible in *The Feast of Samhain*, as the focal figure has a head almost resembling a crescent moon. On the bottom left is another white, curved form, equipped with a forlorn, feminine face. To her right is a spotted dog, with others running in the background. Each small detail of this painting ties back to her personal representations of the feminine divine.

The last recurring motif that alludes to feminine creation in this work is seen in the white figure's arms that curve around her torso—drawing attention to her womb. From her arms slips a silver egg of creation. The egg is a personal symbol developed by Carrington in *Down Below* and is a reference to her quest for truth within her psychological exile. Like the cauldron, it represents rebirth and the changing of cycles seen with the moon. In other works, she uses it as an alchemical symbol of the knowledge found in women. This figure is a guardian of this egg, like a mother protecting a child.²⁴ In this image, women are a source of creation, an idea that was difficult to develop when steeped in the stereotypes and infantilization of women in the Surrealism movement.

Varo and Carrington's interest in a feminine creator was in part a reaction to the popularity of the *femme-enfant*. This creative model was popular among male surrealists and was not adopted by most female surrealists.²⁵ The idea of a naïve woman with child-like innocence was

²⁰ Estella Lauter, "The creative woman and the female quest: the paintings of Remedios Varo," *Soundings: An Interdisciplinary Journal* 63, no. 2 (1980): 118-127, <https://www.jstor.org/stable/41178147>.

²¹ Cox et al., *Leonora Carrington: Living Legacies*, 34.

²² Chadwick, "Evolution of a feminist consciousness," 40.

²³ Cox et al., *Leonora Carrington: Living Legacies*, 54-55.

²⁴ Cox et al., *Leonora Carrington: Living Legacies*, 167.

²⁵ Chadwick, "Evolution of a feminist consciousness," 40.

seen as the ideal access to the unconscious. This leaves no room for women to mature or for motherhood, restricting them to ideas of virginity and an untainted view of the world. In aging, women were seen as a weaker creative force.²⁶ Varo and Carrington used their time as exiles to rediscover the identity of a mature female creator through the idea of the White Goddess introduced by Robert Graves. We see hints at this Goddess in the main figure in *The Feast of Samhain*, which is enriched by the writings on this topic.

Graves's concept of the White Goddess claims her presence in every culture, religion, and poet. She has many different names and is the power of creation and destruction, 'the Mother of all Living' who inspires the deepest fear.²⁷ From a lost age of matriarchy, she transfixes the minds of men and is tied to the moon, trees, owls, and every goddess created.²⁸ She was eventually relegated to being a muse or goddess under an all-powerful god. Graves's work describes the power and fear that has been lost from our knowledge. With the seasons, she changes from a girl with spring, to a woman with summer, and a hag with fall—cycling alongside the New, Full, and Old Moons.²⁹ It is easy to see why artists like Varo and Carrington latched onto this concept. While fighting their own relegation to mother–maiden–muse, the White Goddess is the perfect personification of the struggle of women artists.³⁰

In reclaiming feminine creation, Varo and Carrington explored the feminine divine in relation to hybridity and androgyny. The reclamation of feminine creation meant exploring the nature of femininity and masculinity and of unity and harmony within all things.³¹ The constraints of female sexuality and rigid binaries blocked their quest for understanding. Hybrid forms and androgyny helped overcome these boundaries by de-emphasizing feminine stereotypes.³² Varo used this as a method to reject all stereotypes and ideas linked to femininity, strengthened by references to alchemy.³³ Carrington uses hybridity and androgyny to examine creation outside of the preconceived ideas about

²⁶ Weida, "Feminist lessons in chimerism," 46.

²⁷ Robert Graves, *The White Goddess: A Historical Grammar of Poetic Myth*, 16th ed. (1966; repr., Toronto: McGraw-Hill Ryerson Ltd., 1983), 24.

²⁸ Graves, *The White Goddess*, 448.

²⁹ Harold Bloom, *Robert Graves* (New York: Chelsea House, 1987), 21.

³⁰ Weida, "Feminist lessons in chimerism," 46.

³¹ Chadwick, "Evolution of a feminist consciousness," 40.

³² Tara Plunkett, "'Melusina after the Scream': surrealism and the hybrid bodies of Leonora Carrington and Remedios Varo," *Bulletin of Spanish Studies* 95, no. 5 (May 28, 2018): 494, <https://doi.org/10.1080/14753820.2018.1497341>.

³³ Deborah J. Haynes, "The art of Remedios Varo: issues of gender ambiguity and religious meaning," *Woman's Art Journal* 16, no. 1 (1995): 31, <https://doi.org/10.2307/1358627>.

women, allowing the female subject to escape the mother–maiden–muse restriction.³⁴

The use of hybrid forms as a symbol for freedom and authenticity can be understood through the play cowritten by these two artists, *El santo cuerpo grasoso*. In this story, a man goes through a metamorphosis by grafting various skins to his body and the application of oil. Once completed, he changes into the true form of his soul, becoming a butterfly.³⁵ Hybrid forms are a way to make the exterior appearance reflect the transformations of the soul, similarly to the transformations Varo and Carrington experienced through exile. Both women were finally free from the restrictions of object and found unlimited potential in what they could do. By dismissing typical imagery for the female muse, they found feminine creative power. Hybrid beings were popular throughout the whole Surrealist movement. Based around the creation of male and female, the one androgynous was a perfect fusion between the two. It was a union between opposites that unlocked the power of creation.³⁶ Despite being a fusion of genders, both artists invoked this idea by reducing the stereotypical feminine features of their women.

Varo's central figure in *Creacion des las Aves* is a perfect fusion of the concept of the White Goddess and the free expression of hybridity. The figure—who Graves believed to have the creative powers of women and the moon—has been transformed into a bird-woman. In dropping the stereotypical feminine features creator, her identity as a woman is only clear from the posing of the figure and our understanding of Varo's style. There is no physical indicator that this is a female figure. Varo and Carrington came to believe that creative powers were natural and innate to women, but the balance and unity of the masculine and feminine was a necessary aspect.³⁷ By leaning into androgyny, these artists separate female creation from the lens of male surrealists. The objectification of women dissipates with the indicators of gender. Finding more power in their female identity allowed them to thrive once separated from the leading Surrealist group. Varo's painting is a form of self-analysis as she looked for spiritual answers, with the goal of understanding how she fits into the universe. Her separation from home and family left a need for these answers to ground her in her new life. Rather than creation from nothing, she explored her own mental transformation through the transformation of starlight into birds.³⁸

³⁴ Cox et al., *Leonora Carrington: Living Legacies*, 58.

³⁵ Cox et al., *Leonora Carrington: Living Legacies*, 45.

³⁶ Chadwick, "Evolution of a feminist consciousness," 38.

³⁷ Parkinson Zamora, "The magical tables," 134.

³⁸ Weida, "Feminist lessons in chimerism," 44.

Rather than simply creation out of nothing, Varo and Carrington explored creation as transformation, like that in *El santo cuerpo grasoso*. In this work, she uses alchemical symbols to suggest a rediscovery of self and alchemical transformation as a metaphor for creation. Just to the left of her central figure, we see two egg vessels that supply the creator with color. Here, she adopts the personal imagery of Carrington to add to the metaphor of transformation.

Alchemical symbolism allowed Carrington and Varo to reclaim the kitchen as a creative space. While discussing dreams and philosophical ideas, they shopped for groceries and cooked for each other.³⁹ The kitchen was a special place for many female surrealists but took on greater meaning for Varo and Carrington.⁴⁰ They saw the kitchen as steeped in alchemical symbolism, reclaiming a domestic space for their exploration of creation and transformation. This coincided with the next step in their journey through exile, a reclamation of themselves and their identities. Domestic responsibilities were not obstacles to their creative development. The kitchen instead housed their conversations of gender and culture, taking on more power when merged with the traditions in Mexico surrounding food in relationship with religion. Blending ethnicities, cultures, and art in kitchen discussions made space for powerful metaphors.⁴¹

Rather than an intimate kitchen setting—or an alchemical lab—Carrington reclaims cooking and domestic spaces with the garden in *The Kitchen Garden on the Eyot*. Varo and Carrington evolved their idea of a woman creator by having her creation come through domestic and alchemical activities, like cooking. They believed that women had an important role in protecting and tending the cauldron of fertility. In a stylized self-portrait, Carrington places a circle of three figures, two of which are likely her and Varo. The women may be those very women protecting the ingredients for the cauldron.⁴² She recalls all her symbols of feminine creation on the right side of this painting. An iteration of the White Goddess is suspended in a tree—presumably a tree of life—clutching a silver egg. The majority of the painting is the circular garden with radiating arms. The many circles we see in these, and their previous works, may be the artists representing the alchemical circle or the circle of the cauldron referenced in Carrington's writings.⁴³

³⁹ Noehlin, "Art and the conditions of exile," 318–19.

⁴⁰ Weida, "Feminist lessons in chimerism," 47.

⁴¹ Weida, "Feminist lessons in chimerism," 48.

⁴² Chadwick, "Evolution of a feminist consciousness," 41.

⁴³ Cox et al., *Leonora Carrington: Living Legacies*, 181.

Exile was an internal journey that changed how these artists understood themselves, the world, and creation. Through severing their ties to their home and family, Varo and Carrington craved a greater understanding of their place in the universe. Their separation from Paris Surrealism allowed them to explore the unity within feminine creative power, and the occult came to be a vehicle through which they could explore these ideas. Combining concepts of alchemy, domesticity, and hybrid forms, they deconstructed binaries and found unity between humans, nature, and animals. The shared visual vocabulary and mythological lore of these two artists allowed them to grapple with creation and the innate power of femininity that was absent in the greater movement of Surrealism.

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Touching Loss: The Language of Hands in Käthe Kollwitz's Maternal Mourning

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Abstract

*German Expressionist artist Käthe Kollwitz (1867-1945) is known for her depictions of hardship, loss, and grief. Kollwitz was talented in expressing hardship, but she was especially skilled in depicting a specific type of sadness: maternal mourning. Her experience of losing her son in the First World War and her grandson in the Second World War taught her the true nature of a mother's grief, pain that she then transferred to her artwork. Although Kollwitz expresses the hardships associated with sacrifice through a multitude of visual elements, her depiction of hands and their language serves as a major channel to communicate grief. This paper specifically investigates how Käthe Kollwitz uses her depiction of hands as the primary vehicle to communicate the hardship behind motherly loss and grief. Through examining *The Battlefield* (1907), *The Mothers* (1921), and *Lamentation* (1938-41), this study seeks to explore how her use of gestures, hand positioning, and hand emphasis work to articulate maternal emotions. Although previous research has thoroughly touched on the emotional portrayal of mothers in Kollwitz's prints, this research goes a step further by exploring this emotion through the lens of hands and their gestures. By analyzing gestural*

studies and examining specific hand emphasis in Kollwitz's work, this research addresses the central role of hands in Kollwitz's work and expands our understanding of the outlets through which Kollwitz portrays maternal mourning.

German Expressionist artist Käthe Kollwitz is known for her depictions of hardship, loss, and grief. Having lived through two world wars, Kollwitz was a firsthand witness to the sights that dealt with the pain and devastation of these heavy subjects; she was able to embed these uncomfortable emotions into every line, shape, and shadow of her artwork, thus transferring the grief from the subjects in the prints to the emotions of the viewer.¹ While Kollwitz was talented in expressing hardship, she was especially skilled in depicting a specific type of sadness: maternal mourning. When looking at Kollwitz's work, she capitalizes not only on the emotional capability of hands but also on the use of gestures as she portrays mourning mothers, making hands the primary vehicle to communicate the hardship behind motherly loss and grief.

During the First World War, Kollwitz lost her son, and in the Second, she lost her grandson. These experiences helped her understand the true nature of a mother's grief, pain that she then transferred to her artwork.² While Kollwitz expresses the hardships associated with sacrifice through many visual aspects—such as the stooped postures in the figures, strategic highlighting, and sorrowful facial expressions—her specific focus on hands elevates the emotional impact of her work. Across ages and cultures, hands have been used in art as a medium to communicate information about cultural interactions and to provide an indication of visual narrative systems in different societies.³ Anthropologist Ethel J. Alpenfels explores the social significance of the human hand in art, expressing, “The hands point or lead or command; the hands cry out in agony or they lie quietly sleeping; the hands have moods, character, and in a wider sense, their own particular beauty. From prehistoric times to our own day, in every society known to science, the

¹ Angela Moorjani, “Käthe Kollwitz on sacrifice, mourning, and reparation: an essay in psychoaesthetics,” *MLN* 101, no. 5 (1986): 1110, <https://doi.org/10.2307/2905713>.

² Stewart Buettner, “Images of modern motherhood in the art of Morisot, Cassatt, Modersohn-Becker, Kollwitz,” *Woman's Art Journal* 7, no. 2 (1986): 19, <https://doi.org/10.2307/1358300>.

³ Valentine Bernasconi, Eva Cetinić, and Leonardo Impett, “A computational approach to hand pose recognition in early modern paintings,” *Journal of Imaging* 9, no. 6 (June 1, 2023), doi:10.3390/jimaging9060120.

hands symbolize cultural behaviors, values, and beliefs.”⁴ Alpenfels’s sentiment can be used as a building block when looking at the hands in Kollwitz’s work; as she created her work, she was clearly aware of the communicative and emotional power of hands that Alpenfels explores.

Not only do the hands in art have the power to create an immediate emotional reaction, but viewers also subconsciously associate the figures’ hand gestures with meaning. These gestural movements, whether intended or involuntary, convey some sort of social or emotional meaning to the people observing.⁵ Historian François Caradec, with Philippe Cousin as his illustrator, compiled a list of over 850 gestures, acknowledging that while the meaning of each movement likely changes from region to region and culture to culture, the human brain still subconsciously assigns meaning to them.⁶ When exploring hands in Kollwitz’s work, looking at them in conjunction with Caradec’s identified gestures gives a greater insight into their meaning as well as their use as a vehicle to portray mourning mothers. With this idea of gesture in mind, Kollwitz was able to use hands as she “...fervently and eloquently remind[s] us that it is our actions, the gestures we make as individuals, that define us as a society.”⁷ Her focus on hands can be traced back to the early 20th century, in which she began more heavily experimenting with lighting and emphasis to evoke the expressive qualities held by hands.⁸

Kollwitz’s use of hands as an outlet to express maternal grief is significantly seen in her etching, *The Battlefield* (Fig. 1), made in 1907. When she created this print, Käthe Kollwitz had been married to her husband, Karl Kollwitz, for nearly twenty years and had two young sons. Because of her husband’s socialist beliefs, he was supportive of her independence and artistic pursuits, meaning Kollwitz was able to continue progressing in her career in addition to her role as a mother.⁹

⁴ Ethel J. Alpenfels, “The anthropology and social significance of the human hand,” *Artificial Limbs* 2, no. 2 (1955): 14.

⁵ Keith Thomas, “Introduction,” in *A Cultural History of Gesture*, eds. Jan Bremmer and Herman Roodenburg (Ithaca, NY: Cornell University Press, 1992), 1.

⁶ François Caradec, *Dictionary of Gestures: Expressive Comportments and Movements in Use around the World*, trans. Chris Clarke (Cambridge, Massachusetts: The MIT Press, 2018), 1-2.

⁷ Starr Figura, “Gesture,” in *Body Language*, ed. Joanne Greenspun (New York: Museum of Modern Art, 1999), 55.

⁸ Ernest Schonfield, “Body language in the prints of Käthe Kollwitz,” in *The German Revolution: Expressionist Prints*, ed. Peter Black (Glasgow: The Hunterian, University of Glasgow, 2019), 9. <https://eprints.gla.ac.uk/181182/1/181182.pdf>.

⁹ LouAnn Faris Culley, “Käthe Kollwitz,” Salem Press Biographical Encyclopedia, April 30, 2023.



Fig. 1. Käthe Kollwitz, *The Battlefield* from the portfolio “*Peasant War*,” 1907, etching, 16 ¼” × 20 ⅞”, public domain, via Wikimedia Commons.

Karl Kollwitz’s work as a physician in middle- and lower-class neighborhoods exposed Kollwitz to the hardships of poverty. As she began engaging with these economically disadvantaged communities, she became particularly interested in the roles, positions, and sacrifices of lower-class women, which she explores in this etching.¹⁰

The Battlefield is part of Kollwitz’s *Peasant Wars* series and depicts a woman, likely a lower-class mother, searching for a man, likely her son, amongst a sea of dead corpses.¹¹ As the woman searches, her body is completely cast in shadow along with the blurred landscape and bodies behind her. Kollwitz’s choice of black for the majority of the print was an intentional choice “to convey an oppressive nocturnal mistiness,” which adds an overall solemn ambiance to the print.¹² The woman holds a lantern that is aimed at and pools light towards the only two elements of the print that are not lost in the darkness: the dead boy’s face and the

¹⁰ Culley, “Käthe Kollwitz.”

¹¹ “The Battlefield, 1907,” from the portfolio “*Peasant War*,” 1907, etching, 16 ¼” × 20 ⅞”, public domain, via Wikimedia Commons.

¹² Elizabeth Prelinger, “Annotated checklist,” in *Käthe Kollwitz* (Washington: National Gallery of Art, 1992), 158.

mother's hand. This etching was created seven years before the start of the First World War, which was seven years before her 18-year-old son, Peter, was killed on the battlefield.¹³ Although she had not yet lost a child when she created this work, Kollwitz still manages to embed the raw emotions of maternal grief into the image.

While it is clear that there is emotional weight present in this image, this research expands on that weight by looking at it through the lens of Kollwitz's use of hands. Through compositional choices, the hands in *The Battlefield* work to emphasize the emotional sense of maternal grief. In this etching, the line created by the dead bodies of the soldiers, which runs parallel to the faint horizon line in the background, stresses the horizontal nature of the image. The standing woman's body, however, breaks this horizontality; even though she is hunched over, creating a curved line, the straightness of her arm that extends through her hand and fingers and to the boy's chin starkly interrupts the horizontal focus, immediately capturing viewers' attention. Along with this, the woman's hand and the contact that it makes with the boy's chin are the only lit aspects of the print, instantly drawing viewers' eyes to this connection. This touch emphasizes the tenderness of their relationship, making the loss and grief experienced by the mother all the more apparent and heavy.

Kollwitz's specific emphasis on the woman's hand in *The Battlefield* further reiterates the mother's intense grief. It allows viewers to see the wrinkled and gnarled nature of the woman's hand in contrast with the soft and smooth curves of the limp head, emphasizing her age and representing the beauty and hardship that she has already faced in life—hardship that Kollwitz frequently depicts in her images of working-class women.¹⁴ This gives viewers a sense of compassion and added sorrow toward the woman, as they can imagine the difficulties she has endured on top of now losing her son. The focus on the hand also allows viewers to notice the exaggeration of its veiny nature. These veins and wrinkles give the hands a sense of three-dimensionality that the rest of the image lacks; this was often done by Kollwitz to allow the hands to “pulsate with energy” and to give them a “powerful presence.”¹⁵ In this print, doing so gives the mother's hand a sort of energy that provides a starker contrast to the dead figure, further emphasizing the message of death and loss that adds to the mother's emotion of grief.

In *The Battlefield*, Kollwitz's use of hand gestures serves as an additional aspect of her expression of maternal grief. In Caradec's

¹³ Buettner, “Images of modern motherhood,” 18.

¹⁴ Moorjani, “Käthe Kollwitz on sacrifice,” 1111.

¹⁵ Schonfield, “Body language in the prints of Käthe Kollwitz,” 10.

exploration of gestures, he identifies a gesture similar to the one done by the woman, where a person's hand is lowered toward the ground with their palm flat. He describes this as a gesture that "designates the supposed size of the interlocutor's children," almost like a person reaching down to grab their child's hand.¹⁶ This seems to further emphasize the relationship between the mother and child, almost like the woman is reaching down to hold the boy's hand as she would have done when he was a young child. An additional gesture identified by Caradec that resembles the mother's hand in *The Battlefield* is a person placing their hand on a casket, signifying, "Homage to the deceased. Final farewell."¹⁷ While the mother in Kollwitz's print is not placing her hands flat on a casket, she has her hand oriented in a similar manner with her fingers stretched and pointed towards the ground, stressing the deceased nature of her son and further emphasizing a sense of loss.

While images like *The Battlefield* represent Kollwitz's depiction of maternal mourning through a literal death, other images reflect the grief by showing the anxiety that surrounds loss. *The Mothers* (Fig. 2), created after the death of her son from 1922-23, focuses more on this unease behind motherly loss and sacrifice that came as a result of the war. This print was created as part of the series, *Krieg (War)*, which was a depiction of the difficulties brought about by World War I. In this series, however, rather than focusing on the difficulties of the men fighting, as was so often done, Kollwitz chose to focus on the people who were on the sidelines of the war—the mothers and children.¹⁸ She particularly wanted to express their fears about the possibility of having to face life alone, a feeling she felt all too familiar with after losing her son. While Kollwitz previously had a spirit for sacrifice, her perspectives changed as she struggled with her position as a wife and mother who was forced to sacrifice her loved ones to the war.¹⁹ When *The Mothers* was created, she was still mourning the loss of her son, and this external emotional force was guiding her artistic depictions of sacrifice.²⁰ Building off of this information, this research looks specifically at how Kollwitz's hands in *The Mothers* reflect the grief and anxiety she was feeling at this time. The woodblock print depicts a number of women who are pressed

¹⁶ Caradec, *Dictionary of Gestures*, 186.

¹⁷ Caradec, *Dictionary of Gestures*, 178.

¹⁸ Heather Hess, "*The Mothers (Die Mütter)* (plate 6) from *War (Krieg)*," German Expressionism: Works from the Collection, MoMA, 2011, https://www.moma.org/s/ge/collection_ge/object/object_objid-69687.html.

¹⁹ Moorjani, "Käthe Kollwitz on Sacrifice," 1113.

²⁰ Buettner, "Images of Modern Motherhood," 19.



Fig. 2. Käthe Kollwitz, *The Mothers*, 1921-22, Woodcut on paper, 13 ½" × 15 ¾", public domain, via Wikimedia Commons.

together in a protective mass around their children.²¹ The arms, bodies, heads, and hands of the women band together to prevent any threats from reaching the children.²²

In *The Mothers*, Kollwitz's use of hands accentuates her depiction of the fear and grief associated with loss. This series, as well as the majority of Kollwitz's work, is black and white, which Prelinger explores, remarking, "...Kollwitz adopted a stark black and white language of signs that would be universally understood. [The viewers] are unencumbered by particulars that would restrict them to a specific time or place."²³ In addition to making the prints universal, the choice of a black-and-white composition causes the highlighted elements to stand out greatly from their black counterparts; among the blur of women pressed together, the elements that stand out the most include a few select faces, the hidden child's garment, and the multitude of hands, all of

²¹ Käthe Kollwitz, *The Mothers*, 1921-22, Woodcut on paper, 13 ½" × 15 ¾", public domain, via Wikimedia Commons.

²² Prelinger, "Annotated checklist," 163.

²³ Prelinger, "Kollwitz reconsidered," 59.

which are the only white features of the print. Within these elements, the hands seem to be the most prominent, spreading across backs, covering faces, and resting on top of heads. By highlighting the hands and placing them strategically throughout the composition, Kollwitz is able to move the viewer's eyes in a swirling motion as they travel from hand to hand throughout the clump, generating a feeling of the endless swirl of grief and anxiety.

Along with this swirling emotion, the emphasis on connection created by these hands highlights the togetherness of the community of women, further stressing their shared emotions of grief and fear. As was typical in the prints of Kollwitz, the mothers' hands do not stretch out into space but instead connect to the limbs of the other figures in the composition;²⁴ amidst the blur of women, their hands reach out to cover the faces of children, rest on top of the other figures' heads, and rest on the shoulders next to them. Many of these connections allude to recognizable gestures. The central hand, for example, is placed in a gesture that Caradec characterizes as "one's hand resting on the shoulder (the scapula) of one's interlocutor..."²⁵ Caradec recognizes this as a "gesture of protection," and in this image, the hand serves as protection by creating a physical barrier between the group of mothers and the outside world. This barrier increases the sense of motherly anxiety as viewers can almost feel the panic of the women as they physically attempt to protect their children. Other gestures, such as the hands that the mothers place over and on top of their children's faces, are recognized by Caradec as theatrical gestures of anxiety or profound despair, thus heightening the print's emotion.²⁶

The only hands that appear disconnected from the mass of figures belong to the woman on the far left of the print. One way to interpret these hands is in a prayer gesture, which is identified by Caradec as "palms laid flat, similar fingers touching, [and] forearms raised skyward."²⁷ When considering this gesture, the hands could emphasize the distressed call for help made by these mothers, thus magnifying their emotions of desperation. However, when considering this woman from a side angle, it could be argued that both of her palms are facing outward. When pairing the outward-facing palms with the downturned head above them, this gesture could align with a more subtle version of what Caradec characterizes as "to raise both arms in the air," which is a gesture of

²⁴ Schonfield, "Body language," 14.

²⁵ Caradec, *Dictionary of Gestures*, 127.

²⁶ Caradec, *Dictionary of Gestures*, 44.

²⁷ Caradec, *Dictionary of Gestures*, 218.

surrender.²⁸ Interpreting these hands as signifying surrender adds a sense of defeat to the print; despite the women's efforts to protect their children, they are still forced to surrender to sacrifice. This message of surrender adds to the sense of grief as it emphasizes the unwilling sacrifice made by the mothers and their futile efforts to stop it.

Although the majority of Käthe Kollwitz's success comes from her prints, she spent much of her later career exploring sculpture, specifically memorial pieces.²⁹ In comparison with her prints, the hands in these sculptures may be less distinguishable, but their meanings and emotions are still largely present. One of these sculptures is *Lamentation* (Fig. 3), which was created towards the end of her life from 1938 through 1941.



Fig. 3. Käthe Kollwitz, *Lamentation*, 1938-41, Bronze, 10 9/16" × 3 7/8", public domain.

This sculpture was created after the death of her close friend and fellow sculptor, Ernst Barlach. It pictures a woman pressing her face into her hands, and when looking at the portion of the face that is exposed, it

²⁸ Caradec, *Dictionary of Gestures*, 136.

²⁹ Stephanie Gehring, "Attention to suffering in the work of Simone Weil and Käthe Kollwitz," (master's thesis, Duke University, 2018), 199.

becomes clear that the woman resembles Kollwitz herself.³⁰ While this sculpture seemingly strays away from a literal depiction of a mother, as Kollwitz was merely a close friend to Barlach, the work's title, *Lamentation*, situates it within the theme of female and motherly mourning. The term "lamentation" or "to lament" refers to the fervent expression of grief, and it is frequently associated with artistic depictions of Mary's emotional response to her son's death; it is often tied to "[Mary's] ultimate love, resulting in deep compassion with the suffering Christ."³¹ Keeping this association with Mary in mind, along with Kollwitz's close relationship with Barlach, this sculpture can be looked at through the lens of motherly grief. Along with this, the sculpture was created around the time when Kollwitz's husband died and her grandson was sent to war, meaning she had ideas of motherly loss and sacrifice in mind as she was creating the sculpture.

In *Lamentation*, Kollwitz's visual emphasis on hands accentuates the intense emotional aspect of the sculpture. Both of the woman's hands are pressed to her face; one is resting vertically over the right side of her face, and the other is placed horizontally over her mouth. Together, these hands cover over half of the woman's face, becoming the primary focus of the composition. Along with that, the rest of the composition is relatively flat, as the woman's face lacks three-dimensionality and instead almost sinks in. The hands, in contrast, protrude from the sculpture, with each finger clearly defined. The way in which Kollwitz pushes the hands out into space allows them to be highlighted at a greater level than the other elements of the sculpture, similar to how she strategically highlights hands in her black-and-white prints.³² Many of Kollwitz's sculptures were intended to be seen from multiple angles, and when looking at this sculpture from the back, the hands are similarly seen pushing out into space, immediately drawing attention.³³ While it may be assumed, based on the title of the image and its context as a memorial sculpture, that the principal focus of the sculpture would be Kollwitz's mournful expression, the prominence placed on the hands almost turns them into the subject of the sculpture. Because of this, it is the hands more than anything that become the outlet through which Kollwitz can express maternal mourning.

³⁰ Käthe Kollwitz, *Lamentation*, 1938-41, Bronze, 10 9/16" × 3 7/8", public domain.

³¹ Eliška Kubartová Poláčková, *Medieval Laments of the Virgin Mary: Text, Music, Performance, and Genre Liminality* (Leeds: Arc Humanities Press, 2023), 2.

³² Schonfield, "Body language in the prints of Käthe Kollwitz," 9.

³³ Shulamith Behr, "Käthe Kollwitz, the Expressionist milieu, and the making of her career," in *Women Artists in Expressionism: From Empire to Emancipation* (Princeton: Princeton University Press, 2022), 74.

Because of the rough texture of the sculpture, the hands are not smooth and dainty but instead have a coarse and rustic quality. This creates an effect similar to one seen in *The Battlefield* in which the rough hands emphasize the hardships that Kollwitz has faced in her own life on top of now losing a close loved one, thus adding a sense of heaviness to her grief.³⁴ Along with their roughness, the hands are not gently placed on the woman's face but are instead holding her weight as she leans into them. This weight and pressure adds a feeling of physical heaviness as viewers can literally feel the weight that she places into her hands; this, in turn, creates a feeling of emotional heaviness regarding Kollwitz's mourning, further communicating her intense grief.

When considering the gestures in *Lamentation*, viewers may first notice the hand that is placed horizontally across Kollwitz's mouth. This can be tied to a gesture characterized by Caradec as "[t]o quickly cover one's mouth with one's hand," which he identifies as a gesture done to prevent an individual from saying anything further.³⁵ Because of their progressive beliefs, both Kollwitz and Barlach were censored by Nazi authorities.³⁶ Along with that, the Nazi regime caused Kollwitz to lose nearly everything she had worked so hard for, including her right to exhibit, her teaching position, and her studio, meaning that her work was literally silenced as well.³⁷ Looking at this censorship of Kollwitz and Barlach, the hand's placement over the mouth could be a representation of the way in which both artists were forced into silence by the government. However, this gesture of silence could also be alluding to a quiet kind of mourning, almost like Kollwitz is physically stifling her cry. When pairing the hand placement with the mournful expression held on the exposed part of Kollwitz's face, she seems as if she is almost trying to conceal her sadness, which draws even more compassion from viewers as they can see her vulnerability.

An additional notable gesture employed by Kollwitz in *Lamentation* is the hand that is placed vertically over the left side of her face. This draws ties to a similar gesture that Kollwitz utilizes in *The Mothers* in which the hands are placed over the head, which Caradec identifies as representing a moment of profound despair.³⁸ In the case of *Lamentation*, this strategic placement of the hand over Kollwitz's face serves a similar purpose, as it emphasizes her despair. In addition to this gesture, there is significance in Kollwitz's choice to place both the right

³⁴ Moorjani, "Käthe Kollwitz on sacrifice," 1111.

³⁵ Caradec, *Dictionary of Gestures*, 92.

³⁶ "Lamentation."

³⁷ Culley, "Käthe Kollwitz."

³⁸ Caradec, *Dictionary of Gestures*, 44.

and left hands on the face. In a study on emotional recognition in gestures, research found that with gestures representing sadness and fear, the elbows and hands tend to come closer to the body.”³⁹ With this reasoning, Kollwitz’s choice to place both hands directly on the face could be a way for her to reinforce this closeness of the hands to the body, allowing her to further tie the work to the recurring sadness and fear she felt with her continuous sacrifice of loved ones.

After looking at the artwork of Käthe Kollwitz, particularly *The Battlefield*, *The Mothers*, and *Lamentation*, it is clear that Kollwitz was incredibly skilled at capturing great emotions of maternal grief in her works. Although previous research has thoroughly touched on the emotional portrayal of mothers in Kollwitz’s prints, this research goes a step further by exploring this emotion through the lens of hands and their gestures. By analyzing gestural studies and examining specific hand emphasis in Kollwitz’s work, this research addresses the central role of hands in Kollwitz’s work and expands our understanding of the outlets through which Kollwitz portrays maternal mourning. Whether she strategically highlights the hand or uses hand gestures to communicate messages of protection, anxiety, or silence, her conscious focus on hands in her exploration of loss and sacrifice emphasizes the grief of the mother. As I have continued to explore the vast collection of Kollwitz’s work that focuses on mothers and women, my eyes are consistently drawn to her use of hands. Only upon further research into Kollwitz’s strategic depiction of hands can we fully understand the true meaning of her grieving mothers.

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³⁹ Sriparna Saha, et al., “A study on emotion recognition from body gestures using Kinect Sensor,” (paper presented at International Conference on Communication and Signal Processing, India, April 2014), 58, doi:10.1109/ICCSP.2014.6949798.

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Identifying Cranial Specimens of Utah Species of *Lepus*

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Abstract

Three species of Lepus (Mammalia, Lagomorpha, Leporidae) are native to Utah: L. americanus (snowshoe hare), L. californicus (black-tailed jackrabbit), and L. townsendii (white-tailed jackrabbit). Identifying the crania of these three species is challenging in isolation of other information. This is particularly true for L. californicus and L. townsendii, which broadly overlap in cranial measurements. To better classify Utah Lepus crania, 15 cranial measurements were collected from 38 L. americanus, 130 L. californicus, and 118 L. townsendii specimens. While the crania of L. americanus was found to be shorter than those of the other two species ($p < 0.00001$), L. californicus and L. townsendii specimens were differentiated using linear discriminant analysis (LDA). Measurements that explained the highest variance in the model included those that characterized the rostrum and basicranium. A jackknife validation test was performed to evaluate the LDA and resulted in 95% accuracy. These results suggest that LDA of cranial metrics may be used to distinguish crania of L. californicus and L. townsendii with a high degree of accuracy. The LDA model was applied to 10 poorly identified specimens from Southern Utah University's mammalogy teaching collection, which were predicted to belong to L. californicus.

Introduction

Three species of *Lepus* (Mammalia, Lagomorpha, Leporidae) are native to Utah: *L. americanus* (snowshoe hare), *L. californicus* (black-tailed jackrabbit), and *L. townsendii* (white-tailed jackrabbit). The snowshoe hare is more commonly found in the boreal forests of northern North America and is limited to high-elevation coniferous forest habitats within Utah (Durrant, 1952; Hall, 1981; Krebs & Murray, 2018). The subspecies of the snowshoe hare found in Utah is *L. americanus bairdii*. The white-tailed jackrabbit is largely distributed in a variety of grassy, shrubby, and forested habitats across the North Central United States, and within Utah, is more commonly found in elevations between 1500 and 3350 m (5000-11000 ft; Beever et al., 2018a; Durrant, 1952; Lim, 1987). Two subspecies of white-tailed jackrabbits are recognized, separated by the Continental Divide. The subspecies that occurs in Utah is the western subspecies, *L. townsendii townsendii*. The black-tailed jackrabbit is commonly found in more low-elevation, arid habitats of the Western and Southwestern United States and Northern Mexico. In Utah, the black-tailed jackrabbit is found across much of the state except in the Uinta and Wasatch mountain ranges (Beever et al., 2018b; Best, 1996; Durrant, 1952). Two subspecies of black-tailed jackrabbits exist in Utah: *L. californicus deserticola*, found west of the Colorado River, and *Lepus californicus texianus*, found to the east of the river (Fig. 1).

In the wild, these three species of hares are easily distinguished by their habitat preferences and external characteristics (Fig. 1). Black-tailed jackrabbits and snowshoe hares have not been reported to occupy the same localities, but black-tailed jackrabbits and white-tailed jackrabbits may occur sympatrically (Beever et al., 2018a). The snowshoe hare and white-tailed jackrabbits are adapted to colder habitats and their pelages turn white in winter (Krebs & Murray, 2018; Lim, 1987), whereas the black-tailed jackrabbit does not. The snowshoe hare is generally smaller and has shorter ears than the white-tailed jackrabbit (Hall, 1981). The black-tailed jackrabbit overlaps in size with the white-tailed jackrabbit, but, as the common name suggests, the black-tailed jackrabbit is distinguished by its tail, which is black on the dorsal surface, in comparison with the all white tail of white-tailed jackrabbit (Beever et al., 2018; Best, 1996). The black-tailed jackrabbit also has proportionately long ears that are related to their role in environmental heat exchange.

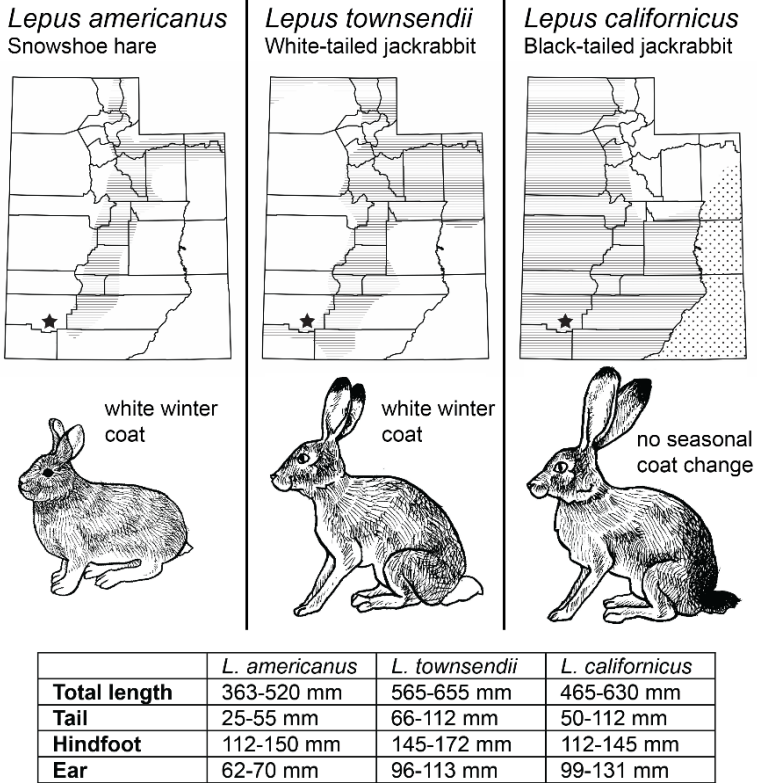


Figure 1: Range maps (adapted from Durant, 1952) and external characteristics of the (left) snowshoe hare (*L. americanus bairdii*, striped area), (middle) white-tailed jackrabbit (*L. townsendii townsendii*, striped area), and (right) black-tailed jackrabbit (*L. californicus deserticola*, striped area, and *L. californicus texianus*, dotted area) of Utah. The black star represents the approximate location of Southern Utah University. Measurements for each species are from Hall (1981).

In comparison to living specimens, the skulls of these three *Lepus* species are not easily distinguished from one another in isolation from their skins and locality information. Leporid skulls show relatively low variation within the family compared to other mammal groups (Ge et al., 2015) and relatively few detailed studies have been conducted on their cranial osteology (Scott, 2018). Nelson (1909) described North American leporids and included several qualitative comparisons and quantitative measurements of the crania of *L. americanus*, *L. townsendii*, and *L. californicus* subspecies. His data suggested that *L. americanus*

crania are generally smaller than those of *L. townsendii* and *L. californicus*, but the latter two species are broadly overlapping in the reported cranial metrics. Hall (1951) also noted the difficulty of distinguishing white-tailed jackrabbit skulls from those of black-tailed jackrabbits, particularly those subspecies found in the Great Basin region. Evidently, these two species can be distinguished east of the Rocky Mountains by the number of enamel folds seen on the first incisor, such that *L. townsendii* presents with “a simple groove” whereas *L. californicus* “has a bifurcation, or even trifurcation, of the infold that can be readily seen by examining the occlusal surface of the incisor” (p. 182). Hall’s observation was repeated in several subsequent publications (Best, 1996; Hall, 1981; Lim, 1987), and a way to easily classify these species’ skulls remains undetermined, although some workers have used dental characters to devise a method. For example, Grayson (1977) used the averages of mandibular tooththrow length and Fox et al. (2019) used the dimensions and degree of enamel folding of the lower third premolars to classify unknown specimens to *L. californicus* and *L. townsendii*. These methods of identification are limited, however, to specimens that preserve the teeth and mandibles.

The objective of this study is to further characterize the cranial anatomy of the three species of *Lepus* that occur in Utah and determine a way to more reliably classify them to species. A major motivation for conducting this study was the presence of poorly documented specimens of *Lepus* in the mammalogy teaching collection at Southern Utah University (SUU) that we wished to identify with more certainty. Specimens in this collection have been inconsistently maintained through the years, causing several instances of misidentification. Although it is probable that many of the *Lepus* specimens in the SUU collection belong to *L. californicus*, given the high likelihood that most specimens were locally collected by past mammalogy classes and the observation that the natural habitats near campus are favored by the black-tailed jackrabbits, the current work will more thoroughly test this hypothesis.

Materials & Methods

Fifteen cranial measurements were taken using digital calipers from 38 *L. americanus*, 130 *L. californicus*, and 118 *L. townsendii* specimens housed in the mammalogy and vertebrate zoology collections at the Natural History Museum of Utah (NHMU), the University of Colorado Museum of Natural History (UCM), and the Denver Museum of Nature and Science (DMNS). Only adult specimens, defined by the fusion of the supraoccipital and exoccipital bones (Hoffmeister &

Zimmerman, 1967; Kraatz et al., 2015), were selected. The number of specimens measured from each collection is summarized in Table 1.

Table 1. Number of specimens measured from each collection				
Species	NHMU	UCM	DMNS	Total
<i>Lepus americanus bairdii</i>	16	9	13	38
<i>Lepus californicus</i>	67 (48)	28 (21)	35 (28)	130 (97)
<i>L. californicus deserticola</i>	62 (47)	(0)	(0)	62 (47)
<i>L. californicus melanotis</i>	0 (0)	23 (17)	28 (22)	51 (39)
<i>L. californicus texianus</i>	5 (1)	5 (4)	7 (6)	17 (11)
<i>Lepus townsendii</i>	37 (25)	40 (27)	41 (31)	118 (83)
<i>L. townsendii campanius</i>	2 (1)	19 (12)	32 (26)	53 (39)
<i>L. townsendii townsendii</i>	35 (24)	21 (15)	9 (5)	65 (44)
Total	120	77	89	286

Numbers in parentheses represent the number of specimens with all 15 measurements present and thus included in the linear discriminant analysis models. NHMU = Natural History Museum of Utah; UCM = University of Colorado Museum of Natural History; DMNS = Denver Museum of Nature and Science

All measured specimens were associated with locality information. Most specimens examined in this study originated in Utah or Colorado; in fact, all *L. townsendii* examined were collected in these two states. Three, one, and four specimens each of *L. californicus* were collected in California, Idaho, and New Mexico, respectively. One specimen of *L. americanus* was collected in California. All other *L. californicus* and *L. americanus* specimens were collected in Utah or Colorado.

Cranial measurements that were collected from each specimen are defined in Table 2 and illustrated in Figure 2.

A one-way ANOVA test was conducted on greatest skull length (GSKL) to determine that *L. americanus* crania are, on average, shorter than those of *L. californicus* and *L. townsendii* ($p < 1 \times 10^{-15}$). Figure 3 demonstrates that the greatest skull length of the snowshoe hare does not overlap with that of the black-tailed or white-tailed jackrabbit. Based on these results that strongly suggest that GSKL is sufficient for differentiating this species from the other two, *L. americanus* was eliminated from further analysis.

To develop a model to classify *L. californicus* and *L. townsendii* cranial specimens, a linear discriminant analysis (LDA) was performed. Also known as canonical variates analysis, LDA produces a combination of linear equations that best explains the separation between groups or categories of data (Zelditch et al., 2012). An LDA model was constructed using the 15 cranial measurements collected from 97 *L. californicus* and

Table 2. Measurements collected from each specimen		
No.*	Measurement	Description
1	Greatest skull length (GSKL)	Anterior face of 1 st upper incisors to posterior point of the supraoccipital bone (external occipital protuberance)
2	Maxillary toothrow length (MXTL)	Alveolar length of toothrow from upper premolar 2 to molar 3
3	Maxillary toothrow breadth (MXTB)	Breadth across both toothrows from the labial sides of the alveoli of the upper premolar 3
4	Postdental breadth (PostDB)	Least breadth across the pterygoid process posterior to the maxillary tooth rows
5	Postorbital constriction (POC)	Breadth of the constriction posterior to the orbital processes
6	Upper diastema length (UDias)	Length from the anterior face of the first upper incisor to the anterior alveolar border of the upper premolar 2
7	Nasal length (NasL)	Greatest length of one nasal bone from the most anterior to most posterior points
8	Nasal breadth (NasB)	Greatest breadth across both nasal bones
9	Choana width (ChoaW)	Greatest width of the choanal opening
10	Zygomatic breadth (GZB)	Greatest breadth across both zygomatic arches
11	Braincase breadth (BrainCB)	Greatest breadth of braincase
12	Basioccipital length (BaOCL)	Midsagittal length of the basioccipital, measured ventrally
13	Basioccipital breadth (BaOCB)	Greatest breadth across the basioccipital, measured ventrally
14	Rostrum depth (RostD)	Most ventral surface of the nasal to most dorsal point of the maxilla anterior to the upper premolars
15	Bulla length (BulL)	Greatest anterior-posterior length of the auditory bulla

*See Figure 2 for a visual representation of the measurements by number.

83 *L. townsendii* specimens as a predictor of species identity. A jackknife validation test of accuracy was performed by sequentially removing one specimen from the sample, performing an LDA, and plugging in the removed specimen back into the model to determine the proportion of correctly classified individuals.

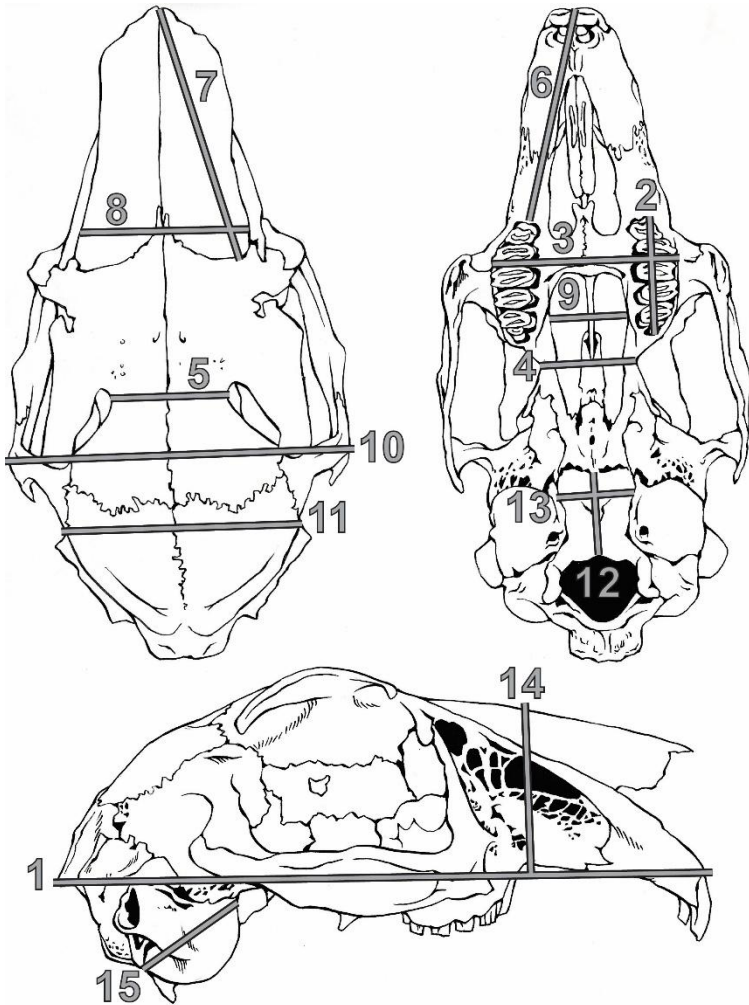


Figure 2: Cranial measurements used in the linear discriminant analysis, illustrated on a cranium of *Lepus* in (clockwise from upper left) dorsal, ventral, and lateral views. Measurements 1-15 are defined in Table 2.

Lastly, 10 crania of *Lepus* belonging to the SUU mammalogy teaching collection were measured. These 10 *Lepus* specimens were dissociated from their skins and precise locality information, but were identified to genus following a dichotomous key (Thies, 2016). An assumption was made that all 10 specimens likely belong to a *Lepus*

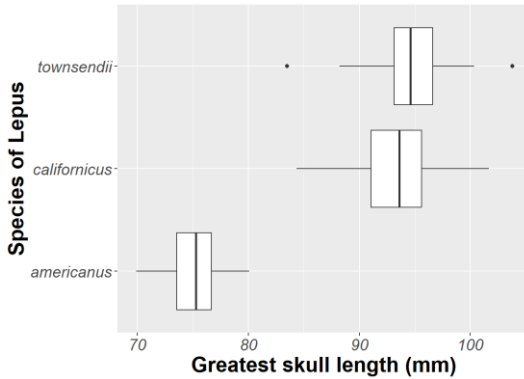


Figure 3: Box plot representing the distribution of greatest skull lengths of adult specimens of *L. americanus*, *L. californicus*, and *L. townsendii* measured for this study.

species found in Utah. This determination was based on two factors: 1) the vast majority of specimens in the SUU mammalogy teaching collections are Utah native species, including *Lepus* skins that may have been (at one point) associated with the crania, and 2) the specimens in the collection that do possess associated locality information indicate that most were collected in Iron County (where SUU is located) and its immediate surrounding counties. GSkL was used to determine whether the specimen could be *L. americanus* before using the LDA model to predict whether the specimen is best classified as *L. townsendii* or *L. californicus*.

All statistical analyses were completed using R (R Core Team, 2025).

Results

Cranial measurements are summarized in Table 3. Generally, *L. americanus* is smaller than *L. townsendii* and *L. californicus* in all measurements. On average, *L. americanus* has a GSkL of 75 mm, with a range of 69.9 to 80.1 mm. *L. townsendii* had a mean GSkL of 94.6 mm, with a range of 83.5 to 103.77 mm, whereas *L. californicus* had a mean GSkL of 93.4 mm, with a range of 84.3 to 101.7 mm, showing that the two jackrabbit species broadly overlap in cranial size. However, while overlapping, mean measurements of *L. californicus* crania are slightly smaller than those of *L. townsendii*.

Table 3. Mean (\pm standard deviation) and n of cranial measurements of species			
Measurement	<i>Lepus americanus</i>	<i>Lepus californicus</i>	<i>Lepus townsendii</i>
1. GSkL	75.0 (± 2.5) (n=38)	93.4 (± 3.5) (n=126)	94.6 (± 2.8) (n=112)
2. MXTL	13.8 (± 0.8) (n=37)	16.7 (± 0.9) (n=130)	17.4 (± 0.7) (n=117)
3. MXTB	21.1 (± 0.7) (n=37)	24.9 (± 1.5) (n=130)	26.4 (± 0.9) (n=117)
4. PostDB	10.1 (± 0.5) (n=37)	11.9 (± 0.8) (n=126)	11.8 (± 1.0) (n=110)
5. POC	11.3 (± 0.8) (n=37)	12.6 (± 1.5) (n=126)	13.4 (± 1.0) (n=118)
6. UDiasL	24.9 (± 0.8) (n=37)	30.4 (± 1.8) (n=127)	32.2 (± 1.3) (n=113)
7. NasL	30.0 (± 2.3) (n=34)	38.9 (± 2.4) (n=121)	40.0 (± 2.0) (n=112)
8. NasB	15.6 (± 1.1) (n=36)	18.8 (± 1.5) (n=120)	20.7 (± 1.3) (n=114)
9. ChoaW	7.6 (± 0.4) (n=38)	8.5 (± 0.8) (n=128)	10.6 (± 0.8) (n=118)
10. GZB	37.2 (± 1.8) (n=33)	42.6 (± 1.9) (n=125)	44.7 (± 1.2) (n=112)
11. BrainCB	27.7 (± 1.0) (n=36)	31.1 (± 1.2) (n=129)	32.0 (± 1.0) (n=116)
12. BaOCL	9.9 (± 1.0) (n=37)	11.8 (± 0.7) (n=129)	12.1 (± 0.8) (n=115)
13. BaOCB	9.0 (± 0.6) (n=37)	9.8 (± 0.9) (n=130)	11.3 (± 0.8) (n=115)
14. RosD	15.1 (± 1.0) (n=36)	19.8 (± 1.5) (n=122)	21.7 (± 1.2) (n=113)
15. Bull	10.7 (± 0.6) (n=36)	13.2 (± 0.7) (n=124)	12.7 (± 0.7) (n=109)

All measurements in millimeters. See Table 2 for measurement abbreviations.

The coefficient of each variable in the LDA model is reported in Table 4. The three variables with the greatest weight in the model were choana width, basioccipital breadth, and postdental breadth, followed by four variables with similar loadings: rostral depth, greatest skull length, bulla length, and zygomatic breadth. Variables with the lowest weights in the model included nasal length, postorbital constriction breadth, and maxillary length and breadth. The jackknife validation test correctly classified 92 of 97 *L. californicus* crania and 79 out of 83 *L. townsendii* crania, resulting in a prediction accuracy of 95% for this sample.

Table 4. The coefficient or weight of each variable in the LDA model	
Variable	Coefficient
ChoaW	0.70
BaOcB	0.41
PostDB	0.38
RostD	0.32
BrainCB	0.25
UdiasL	0.24
NasB	0.20
MXTL	0.11
POC	0.06
NasL	0.00
MXTB	-0.08
BaOcL	-0.11
GZB	-0.28
GSkL	-0.30
BullL	-0.30

See Table 2 for abbreviations.

The distribution of the linear discriminant (LD) scores calculated for each specimen included in the model are illustrated in Figure 4.

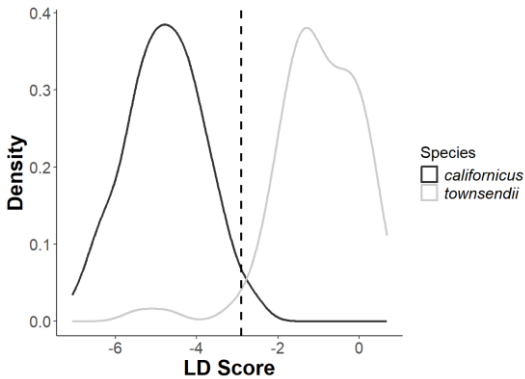


Figure 4: Density plot representing the distribution of linear discriminant (LD) scores calculated by the linear discriminant analysis model for all specimens in the sample. The dashed line represents a practical cutoff point for classifying unknown specimens using each model, which was calculated as $[(\text{mean LD score of species 1}) + (\text{mean LD score of species 2})]/2$. The resulting cutoff score for *L. californicus* versus *L. townsendii* is -2.9.

Based on greatest skull length, all 10 unknown *Lepus* crania from the SUU mammalogy teaching collection were precluded from belonging to *L. americanus* (Table 5). The LDA model classified all 10 specimens to *L. californicus*, each with a posterior probability >99%.

Table 5. Greatest skull length (GSkL) of SUU <i>Lepus</i> specimens and posterior probability of classification			
Specimen	GSkL (mm)	Posterior probability	
		<i>L. californicus</i>	<i>L. townsendii</i>
SUU M 0098	87.7	1	0
SUU M 0120	87.9	0.992	0.008
SUU M 0156	89.9	1	0
SUU M 0068	90.3	1	0
SUU M HF108	90.5	0.998	0.002
SUU M 158	90.8	0.999	0.001
SUU M 0077	91.4	0.998	0.002
SUU M 0108	91.6	0.999	0.001
SUU M 0130	92.6	1	0
SUU M LA16	96.1	1	0

Discussion & Conclusion

The results of the jackknife accuracy test on the LDA model showed that black-tailed and white-tailed jackrabbits in the sample can be differentiated reasonably well by the 15 cranial measurements (Fig. 4). The four variables with the highest loadings included choana width, basioccipital breadth, postdental breadth, and rostral depth (Table 4), suggesting that the proportions of the rostrum and ventral features of cranium are particularly useful for differentiating between black-tailed jackrabbits and white-tailed jackrabbit skulls found in Utah and Colorado. While handling the specimens, the authors qualitatively observed that white-tailed jackrabbits (*L. townsendii*) seemingly possessed proportionately more robust snouts and wider cranial bases compared with black-tailed jackrabbits (*L. californicus*), which could correspond with the relatively high positive loadings of these variables in the LDA model. The model also suggests that differences found between these species are not well captured by dimensions of the maxillary region, nasal length, or breadth of the postorbital constriction. Further morphometric study of the crania of these rabbits could elucidate more specific shape differences between the skulls of these two species.

Practically, this study provides a tool (Table 6) by which an unknown *Lepus* skull from Utah may be classified. The snowshoe hare is smaller than the white-tailed or black-tailed jackrabbits; any adult *Lepus* skull found in Utah that is ≤ 80 mm in length is likely to belong

to the snowshoe hare. If ≥ 83 mm in length, the cranium is likely to belong to a jackrabbit species. Calculating an LD score for the specimen can differentiate between the white-tailed and black-tailed jackrabbits. An LD score < -2.9 suggests the specimen is likely *L. californicus*, and a score > -2.9 indicates that the specimen is likely *L. townsendii* (Fig. 4). Any specimens with an LD score of -2.9 could be either species according to this methodology and species assignment would require additional information.

Table 6. Dichotomous key for diagnosing the crania of adult specimens of Utah species of *Lepus*.

1. Measure the greatest skull length (as defined in Table 2) of the specimen Greatest skull length is ≤ 80 mm <i>Lepus americanus</i> Greatest skull length is > 83 mm Go to 2
2. Calculate linear discriminant score (LD score) of the specimen by collecting the 15 cranial measurements (defined in Table 2) and multiplying each measurement by its coefficient (Table 4). The sum of the products, or $\sum(\text{measurement} * \text{coefficient})$, is the LD score. LD score < -2.9 <i>Lepus californicus</i> LD score > -2.9 <i>Lepus townsendii</i>

It is important to note the limitations of the findings of this study. The classification method described above is best used to identify unknown specimens of *Lepus* found in Utah and Colorado, as it was modeled on a sample of specimens largely collected in these states. Regional variation in cranial anatomy exists within each of the three *Lepus* species, sometimes to the extent that skulls alone may appear to be divergent enough to belong to different species rather than subspecies (Nelson, 1909). Durrant (1952) also noted that *L. californicus deserticola*, the subspecies found in much of Utah (and the Great Basin region), tends to measure smaller than other subspecies of the black-tailed jackrabbit. Therefore, without further detailed study of subspecies-level variation, the LDA model presented here may not adequately capture population differences observed at a larger geographical scale, such as across the entire range of the two jackrabbit species. The models may also do a poor job distinguishing between these species on a temporal scale, as species morphology is expected to evolve through time. Therefore, caution is warranted when applying the LDA model to samples from the deep past. Specimen locality information, if available, should be used to further support any predicted identifications, although caution is again warranted when samples from the past are assessed as species ranges may have changed with climate across time (as documented for jackrabbits in the Great Basin by Grayson, 1977). Lastly, the model is limited by the requirement for all variables to be present to

calculate an LD score, so a relatively complete specimen is necessary to use the model presented here.

The probable assignment of the 10 unknown SUU *Lepus* crania to *L. californicus* was not entirely unexpected given that the species are frequently observed in the natural areas near the SUU campus. Although the original collection information is lost, this study provided a means to reclaim a probable species identity and further these specimens' utility as a teaching tool in the mammalogy classroom.

Acknowledgments

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An Examination of the Chloroplast *petD* Intron among Eusporangiate Ferns

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Abstract

*The chloroplast *petD* gene consists of two exons separated by a group II intron with 6 stem-loop domains (DI–DVI). This study examines the *petD* intron of taxa representing the major eusporangiate lineages from downloaded GenBank sequences. For the eusporangiate ferns examined here, the intron length varied from 591 to 712 bp. As expected for the 6 group II introns, DI was the largest and accounted, on average, for approximately 52% of the overall intron length, although intron length variation among taxa was observed. Additionally, there did not appear to be a directly proportional relationship between DI and intron lengths. For example, the *Equisetum* species had the smallest introns (591–597 bp) with a DI (343–345 bp) representing approximately 58% of the overall length. In contrast, the taxa in the genus *Ophioglossum* all had introns of 712 bp, with their DI (347 bp) making up about 49% of the total length. Length variation between eusporangiate taxa was observed not only for the *petD* intron itself but also among the domains. Among the eusporangiate ferns, DI did not exhibit the greatest degree of*

variation (only 324 to 347 bp). Instead, this was observed for DIV (63 to 172 bp). The lowest level of observed length variation was for DV (34 to 35 bp). Also included for comparison were members of the Osmundaceae, a group of ferns considered intermediate between eusporangiate and leptosporangiate ferns and/or as basal leptosporangiate ferns. Intron and domain values for osmundaceous ferns were, in general, comparable with the eusporangiate ferns. Secondary structures were generated, and a phylogenetic analysis was also conducted.

Introduction

Ferns, or monilophytes, are sometimes divided into two groups called eusporangiate and leptosporangiate ferns (Pryer et al. 1995, Schuettpelz and Pryer 2007). As the two names suggest, these groups differ with respect to sporangial development. Each eusporangium develops from several epidermal cells while each leptosporangium develops from a single epidermal cell and are, therefore, smaller (Sofiyanti et al. 2019). While leptosporangiate ferns form a monophyletic group, the eusporangiate ferns do not but are considered to be a paraphyletic assemblage (Pryer et al. 2004, Kim et al. 2014).

This paper follows the systematic treatment of Smith et al. (2006) for eusporangiate ferns. Briefly, this classification puts all eusporangiate ferns in one of three taxonomic classes and four orders: Class Psilotopsida (consisting of Order Psilotales and Order Ophioglossales), Class Equisetopsida (Order Equisetales), and Class Marattiopsida (Order Marattiales) (Smith et al. 2006). Under this system, each order is represented by a single family, respectively, Psilotaceae, Ophioglossaceae, Equisetaceae, and Marattiaceae (Smith et al. 2006).

Family Psilotaceae is usually treated as having 2 genera and approximately 12 species (Christenhusz and Byng 2016). Classification treatments of the Ophioglossaceae are contentious, with 4 to 15 genera (Kuo et al. 2024) and 80 or more species (Xu and Deng 2017) recognized. The Equisetaceae are represented by a single genus, *Equisetum*, consisting of 3 subgenera and about 18 species (Christenhusz et al. 2019). There are 6 genera and approximately 100 species recognized in the Marattiaceae (Murdock 2008b, Lehtonen et al. 2020).

Many phylogenetic relationships among eusporangiate ferns are, to some extent, in dispute. While most relatively recent studies (e.g., Pryer et al. 2004, Kuo et al. 2011, Kim and Kim 2018) agree in placing the whisk ferns (Psilotales) and ophioglossoid ferns (Ophioglossales) in a clade together, usually represented taxonomically as Class Psilotopsida,

the relationships of the marattioid ferns (Marattiales) and, especially, the horsetails/scouring rushes (Equisetales) vary between studies. For example, horsetails and marattioid ferns formed a clade together with leptosporangiate ferns, although with low support, in the study by Pryer and Schuettpelz (2009). In contrast, Rai and Graham (2010) and Kuo et al. (2011) placed marattioid ferns in a sister relationship with leptosporangiate ferns, while the horsetail genus *Equisetum* was found to be a sister group to all ferns. Lehtonen (2011) reported that the position of the horsetails depended on the optimality criterion used, with maximum parsimony (MP) placing it as a sister group to a marattioid/leptosporangiate clade, as did Wikström and Pryer (2005), or with maximum likelihood (ML) placing it in a sister position to leptosporangiates only, but not marattioid ferns. While the orders Psilotales and Ophioglossales were united in a clade, as expected, Sen et al. (2012) reported that the horsetails had a close phylogenetic affiliation with basal leptosporangiate ferns in the Osmundales while the marattioid fern were united with the not-so-basal leptosporangiate Order Hymenophyllales. On the other hand, the horsetails were put in a sister position to the whisk ferns/ophioglossoid clade while the marattioid ferns were found to be in a sister position to leptosporangiate ferns in the Osmundales by Nitta et al. (2022).

This study evaluates phylogenetic relationships among eusporangiate ferns using *petD* intron sequences. The *petD* gene is part of an operon that includes 4 other genes involved in the photosynthetic light reactions, *psbB*, *psbT*, *psbH*, and *petB*, and is located in the large single copy (LSC) of the chloroplast genome (Westhoff and Herrmann 1988). It encodes subunit IV of the cytochrome b6/f complex and is required for proper functioning of photosynthetic electron transport (hence “pet”) during linear electron flow (Chen et al. 1993). The *petD* intron is a group II intron (Löhne and Borsch 2005). Group II introns have a secondary structure that is characterized by 6 stem loop domains (DI–DVI) radiating off a central hub, with DI divided into four subdomains (Ia–Id) and usually accounting for approximately 50%, more or less, of the overall intron length (Michel et al. 1989, Kelchner 2002, Zimmerly and Semper 2015), as is also shown in Figure 1 for the *petD* intron for *Equisetum pratense*.

Length variation of the *petD* intron due to numerous indels has been reported for various seed plant groups, particularly angiosperms. For example, Worberg et al. (2007) reported a range of intron lengths of 639–799 bp for eudicots, with at least 257 indels of various sizes. For taxa in the Malpighiales, intron lengths of 713–970 bp were found by Korotkova et al. (2009), with a minimum of 244 indels. Furthermore, the numbers of indels are not evenly distributed among domains. For example, Löhne

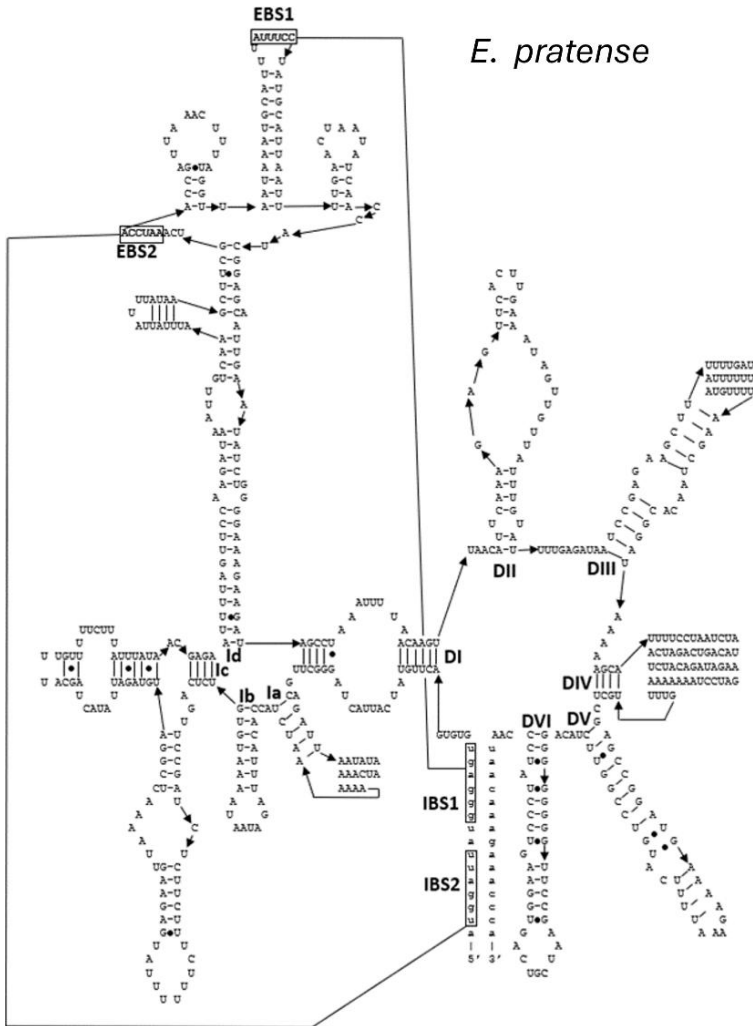


Figure 1. The *petD* intron secondary for *E. pratense*. Position of the 6 domains (DI–DVI) is indicated in the central hub. The subdomains of DI (Ia–Id) are indicated within that domain. The internal binding sites (IBS1 & IBS2) in the 5' exon and the corresponding external binding sites (EBS1 & EBS2) in DI are also indicated. Secondary structure format shown here follows that presented through the “Secondary Structure Diagram Retrieval” page at the Comparative RNA Web Site Project (<https://crw-site.chemistry.gatech.edu/DAT/3C/Structure/index.php>).

and Borsch (2005) observed that DIV tended to have the highest number of indels among the angiosperms and gymnosperms evaluated in that study, followed by DI and then DII, while DV and DVI each had a single indel.

The use of *petD* intron sequences, either alone or in conjunction with other types of sequences, for phylogenetic analysis of different plant taxa has been previously performed. Such studies have looked at seed plant relationships, mostly angiosperms. These have included basal angiosperms with a small number of gymnosperms (Löhne and Borsch 2005), the Rubiaceae (Kårehed et al. 2008), the Campanulaceae (Borsch et al. 2009), eudicots (Barniske et al. 2012), and the genus *Asparagus* (Tian et al. 2023).

This study is part of ongoing research to evaluate the phylogenetic usefulness of noncoding chloroplast DNA, and especially group I and group II introns, with respect to various fern taxa. The aims of the study include evaluation of the utility of *petD* intron nucleotide and secondary structure prediction models for inferring relationships among eusporangiate fern taxa. This study further attempts to compare and evaluate aspects of intron secondary structure among eusporangiate ferns.

Materials and Methods

Selection of taxa

All sequences were downloaded from GenBank. For further sequence details, including sequence authorship, please use the GenBank accession number listed in the Appendix. Fern sequences were selected primarily so as to provide representation of the major eusporangiate fern lineages. As part of the focus on this group of ferns, a small number of sequences were included also that represented the Osmundaceae, a family of ferns considered to be intermediate in certain morphological and genetic respects to both eusporangiate and higher leptosporangiate ferns (Hasebe et al. 1994, Du et al. 2022) and/or as the most basal group of leptosporangiate ferns (Hasebe et al. 1995, Pryer et al. 2004). This includes aspects of chloroplast genome structure that are distinctly eusporangiate and not leptosporangiate (Quandt et al. 2004, Kim et al. 2014). For this reason, Osmundaceous ferns were used as outgroup taxa to the eusporangiate ferns, as has been the case other phylogenies of eusporangiate taxa, such as Lehtonen et al. (2020). For the phylogenetic analyses (see below) of this study, there were a total of 25 sequences, which breakdown to 21 eusporangiate ferns and 4 osmundaceous ferns. Names of taxa used in this study follow the taxonomic information for

the sequences as shown in GenBank, although, as indicated in the Discussion, the generic affiliation of a few taxa have since been revised.

Sequence alignment

Prior to both the phylogenetic and secondary structure (see below) analyses, the downloaded sequences were aligned using the program MAFFT (Kato and Standley 2013), which is available online at the EMBL-EBI website (Madeira et al. 2024, <https://www.ebi.ac.uk/jdispatcher/msa/mafft/>). For phylogenetic analysis, alignment of nucleotide sequences is standard practice and is commonly understood as necessary, among other things, to identify regions of similarity/homology between sequences.

Secondary structure analysis

To identify the locations of the *petD* intron domains, fern sequences were aligned initially with 2 seed plant taxa, *Campanula trachelium* (Campanulaceae) and *Malpighia glabra* (Malpighiaceae). Work on the secondary structures for members of the Campanulaceae (Borsch et al. 2009) and for the Malpighiaceae (Korotkova et al. 2009) has been previously conducted. Small portions (12-15 nt) of the 5' and 3' exons were included in the alignment to properly identify exon/intron boundaries and to identify the positions of the 2 internal binding sites (IBS1 and IBS2) in the 5' exon and 2 corresponding external binding sites (EBS1 and EBS2) located in the intron's DI region. Once the individual domains were identified for each taxon, the respective lengths for each domain were determined for each taxon. These were then expressed as a percentage of the over intron length for that taxon. These data were averaged. Because the presence of indels affects the length of introns as a whole, as well as for individual domains, the numbers of indels and their respective sizes were also determined and recorded.

Secondary structures for individual domains were determined using mFold (Zuker, 2003; <https://www.unafold.org>). Domain sequence data were entered in the RNA folding form v2.3 of mFold. A temperature setting of 25°C was used, but default settings were otherwise used. In some cases, constraints were specified, but these were mainly employed to ensure correct formation (base pairing) of the basal stem structure for each domain and each DI subdomain following the alignment and comparison with the seed plant secondary structures. Constraints were also employed to show the position in the secondary structure of EBS1 and EBS2, which are located in subdomain Id of DI. Once individual domain structures were determined, the complete intron structure was assembled and manually drawn.

Phylogenetic analyses

Both (MP and maximum likelihood ML analyses were conducted using MEGA11, ver. 11.0.13, (Tamura et al. 2021). These were performed using the complete deletion option for gaps and missing data (i.e., all positions with gaps or missing data were eliminated). Evaluation of branch support for each analysis involved bootstrapping with 500 replicates and collapsing branches with less than 50% bootstrap (BS) support. Optimal tree searching algorithms were the Tree Bisection and Reconnection (TBR) algorithm (Swofford et al. 1996) for MP and the Nearest-Neighbor-Interchange (NNI) algorithm (Robinson 1971, Waterman and Smith 1978, Penny and Hendy 1985) for ML. Initial trees for the MP analysis were obtained by MEGA11 by the random addition of sequences (10 replicates). Statistics obtained for MP are tree length (steps), consistency index (CI), retention index (RI), and the composite index. Prior to the execution of the ML analysis, the “Find Best DNA/Protein Models (ML)” option (under the “Model” tab) was used to determine the best nucleotide substitution model. The Tamura 3-parameter model (Tamura 1992) with gamma distribution (i.e., T92+G model) was selected with $G = 0.8172$. For the ML analysis, initial trees for were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Tamura 3 parameter model, and then selecting the topology with highest log likelihood value.

As already noted, the phylogenetic relationships among the eusporangiate fern lineages are mostly contentious. The sole possible exception to this is a clade representing the Class Psilotopsida (Order Psilotales plus Order Ophioglossales) of Smith et al. (2006), which has been obtained previously by several researchers (e.g., Pryer et al. 2004). It was, therefore, considered useful to attempt to quantify the divergence between these different fern lineages in terms of the *petD* intron. To do this, taxa were placed in one of the following five groups: Equisetaceae, Psilotaceae, Ophioglossaceae, Marattiaceae, and Osmundaceae in MEGA11. Following this, between group mean distances and net between group mean distances were determined using the “Distance” tab, also in MEGA11, for all 5 groups using the T92+G model. As implemented in MEGA11, a between-group mean distance is the arithmetic average of all pairwise distances, based on the number of nucleotide substitutions, between 2 taxon groups. A net between-group mean distance is similarly utilized in MEGA11, except that it adjusts for within group distances.

Results

Secondary structure analysis, intron length, and domain variability

Intron lengths are summarized in Table 1, with domain length results summarized in Table 2. Identification of the 5' and 3' ends of each domain in the alignment was a relatively straightforward task, though there was sometimes minor nucleotide variation affecting the formation of the basal stem region for some domains. Overall mean intron length was 647.52 ± 35.23 (range 591-712). There was some noticeable variation in intron length among the eusporangiate ferns included in this study

	Equisetopsida	Psilotopsida	Marattiopsida	Osmundales
Range	591-597	614-712	632-634	641-643
Mean	594.25	679.89	640.63	641.75
Std dev	2.50	30.99	10.57	0.96

(mean intron length 648.62 ± 38.48 , which ranged from 591 bp (*Equisetum sylvaticum*) to 712 bp (all *Ophioglossum* taxa). Although there was a small amount of length variation, the shortest intron lengths observed were for the 4 included *Equisetum* taxa. For the osmundaceous ferns (Osmundales), introns ranged from 641 bp (*Plenasium vachellii* and *Osmundastrum cinnamomeum*) to 643 bp (*Todea barbara*). The petD intron secondary structure for *E. pratense* is shown in Figure 1.

As expected, DI was the largest domain. For the eusporangiate ferns, it ranged from 324 (*Psilotum nudum*) to 347 bp (again, all *Ophioglossum* taxa) and accounted for 48.51% (*Mankyua chejuense*) to 58.04% (*E. sylvaticum*) of the overall intron length. It should be perhaps noted here that there was not a precise correlation between overall intron length and the length of a particular domain. For the osmundaceous ferns, all taxa had a DI with a length of 323 bp, accounting for 50.23% (*T. barbara*) to 50.39% (*P. vachellii* and *O. cinnamomeum*) of the overall length. Among both the eusporangiate and osmundaceous ferns, DI length variation was relatively small, especially when considering DIV. While DIV was the second most length-variable domain overall, it was also the most variable among all ferns examined. For eusporangiate ferns alone, its length ranged from 63 bp (*E. sylvaticum*) to 172 bp (*O. thermale* and *O. vulgatum*), which, respectively, correspond to the lowest (10.66%) and highest (24.16%) percentage of the intron length covered by DIV. The smallest values obtained for DIV in the study were for the genus *Equisetum*. Among the osmundaceous ferns, there was a narrow

Table 2. <i>petD</i> intron domain lengths (bp)						
	DI	DII	DIII	DIV	DV	DVI
Overall						
Range	323–347	37–66	32–58	63–172	34–35	21–36
Mean	333.16	50.68	45.52	126.88	34.44	25.92
Std dev	8.88	11.40	5.79	31.28	0.51	5.43
% of intron	48.51–58.04	6.08–9.82	5.21–8.98	10.66–24.16	4.92–5.75	3.00–6.09
Eusporangiate ferns						
Range	324–347	37–66	32–58	63–172	34–35	21–36
Mean	335.10	49.67	46.19	125.14	34.52	26.86
Std dev	8.37	12.20	6.10	33.97	0.51	5.44
% of intron	48.51–58.04	6.08–9.82	5.21–8.98	10.66–24.16	4.92–5.75	3.00–6.09
Osmundaceous ferns						
Range	323	55–59	42	135–137	34	21
Mean	323.00	56.00	42.00	136.00	34.00	21.00
Std dev	0.00	2.00	0.00	0.82	0.00	0.00
% of intron	50.23–50.39	8.57–9.18	6.53–6.55	21.00–21.34	5.29–5.30	3.27–3.28

range of 135 bp to 137 bp, representing 21.00% to 21.34% of the intron length of those taxa. Generally, it was the second longest domain among all ferns examined. Among all plants groups examined, the least variable domain in terms of length was DV, which had an extremely narrow range of 34 bp to 35 bp. In this study, it accounted for 4.92% (all *Ophioglossum* taxa) to 5.75% (*E. sylvaticum*) of intron length. DV and DVI were the least variable domains among ferns in this study. While considerable structural variation was observed in the DIV for eusporangiate ferns (Figure 2), DV, in contrast, appeared to be the most structurally conserved and showed minimal variation (Figure 3).

At least 124 indels of varying lengths were found throughout the intron, which were, in many cases, contiguous. These ranged in size from 1 to 20 nucleotides (nt) in length. Of these, 55 (the largest category) were a single nucleotide in length. Only 4 were 10 nt or more in length. With the exception of a single nucleotide indel in the interhelical region between DII and DIII, all indels were in domain stem-loop structures. In descending order, there were 59 indels found in DI, 33 in DIV, 17 in DII, 8 in DVI, 5 in DIII, and 1 in DV. Indel information is summarized in Table 3.

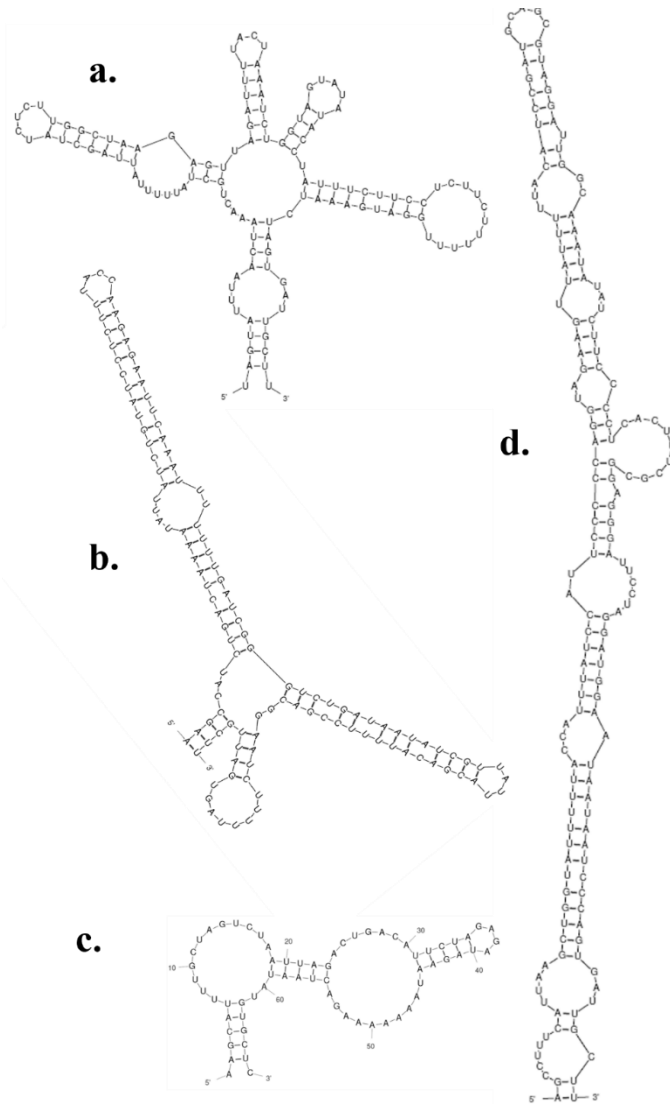


Figure 2. The considerable structural variability of the DIV region of the *petD* intron among eusporangiate ferns. Structures were obtained using the online mFold server (Zuker 2003). Shown are **a.** *Psilotum nudum*, **b.** *Marattia laxa*, **c.** *Equisetum xylochaetum*, and **d.** *Japanobotrychium lanuginosum*.

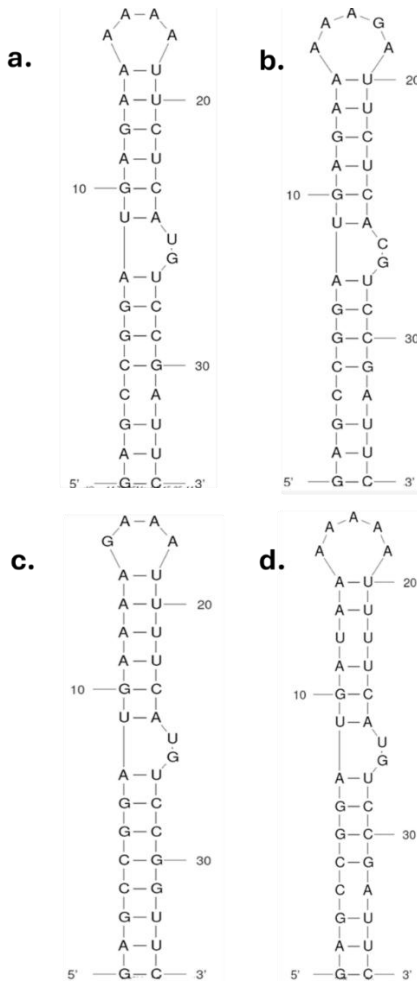


Figure 3. The conserved secondary structure of the DV region of the *petD* intron among eusporangiate ferns. Structures were obtained using the online mFold server (Zuker 2003). Shown are: **a.** *Psilotum nudum*, **b.** *Ophioglossum thermale*, **c.** *Equisetum pratense*, and **d.** *Angiopteris angustifolia*.

Phylogenetic analyses

The MP analysis generated three equally parsimonious trees of length = 761 steps, with CI = 0.648, and RI = 0.851, and a composite

Table 3. Number of indels in <i>petD</i> intron by size (nt)											
Domain	1	2	3	4	5	6	7	8	9	≥10	Total
DI	28	13	8	2	1	4	1	0	1	1	59
DII	7	2	4	2	1	0	1	0	0	0	17
DII-DIII interhelical	1	0	0	0	0	0	0	0	0	0	1
DIII	1	1	0	0	0	0	1	1	1	0	5
DIV	14	5	3	2	2	1	1	1	1	3	33
DV	1	0	0	0	0	0	0	0	0	0	1
DVI	3	3	0	2	0	0	0	0	0	0	8
Total	55	24	15	8	4	5	4	2	3	4	124

index of 0.551. The MP bootstrap consensus tree is shown in Figure 4. Bootstrap branch support was robust for the Ophioglossaceae (99%), Equisetaceae (100%), Marattiaceae (100%), and Osmundaceae (100%). However, some groupings within each of the Ophioglossaceae, Marattiaceae, and Osmundaceae were not well supported. It should also be noted that relationships in the Marattiaceae are mostly unresolved. Furthermore, it should be noted that there is low support (68%) here for Class Psilotopsida (Order Psilotales plus Order Ophioglossales) of Smith et al. (2006). Within the eusporangiate ferns, the Marattiaceae formed a clade distinct from all other ferns.

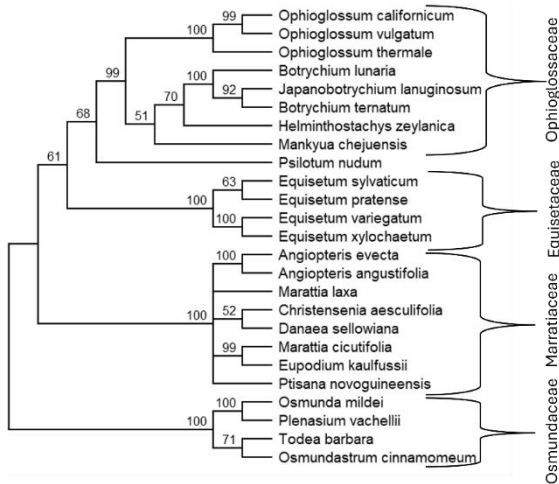


Figure 4. MP bootstrap consensus tree for eusporangiate ferns using *petD* intron sequences. The numbers above the branches are the bootstrap support values. Taxa belonging to the fern families Ophioglossaceae, Equisetaceae, Marattiaceae, and Osmundaceae grouped together as shown. *P. nudum* was the only included representative of the Psilotaceae.

For the ML analysis, the optimal tree obtained using the T92+G model had a log likelihood of -3648.57. The ML tree is shown in Figure 5. Branch support was in many respects similar to MP, with the Ophioglossaceae, Equisetaceae, Marattiaceae, and Osmundaceae each strongly supported at 100%. Resolution within the Marattiaceae was poor, but, as with MP, formed a distinct group from the other eusporangiate ferns. Unlike MP, the *Ophioglossum* species were united in a trichotomy. Additionally, while MP had *Helminthostachys zeylanica* in a sister position with the genera *Botrychium* and *Japanobotrychium*, ML placed it in a sister position to the genus *Ophioglossum*. Unlike the MP analysis, branch support for Class Psilotopsida was a more moderate 76%. The ML analysis has *T. barbara* and *O. cinnamomeum* in a different phylogenetic relationship from what was obtained for MP.

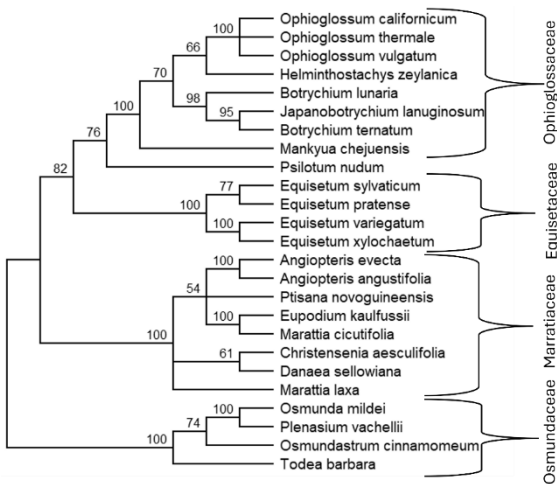


Figure 5. ML bootstrap consensus tree for eusporangiate ferns using petD intron sequences. The ML analysis used the T92+G nucleotide substitution model. The numbers above the branches are the bootstrap support values. Taxa belonging to the fern families Ophioglossaceae, Equisetaceae, Marattiaceae, and Osmundaceae grouped together as shown. *P. nudum* was the only included representative of the Psilotaceae.

Although the pairwise between-group mean distance and the net between-group mean distance values obtained had different ranges, both were relatively high and are suggestive of considerable evolutionary divergence between the fern groups examined here. Both sets of distances are presented in Table 4. Pairwise between-group mean

Table 4. Pairwise T92+G evolutionary distances between fern groups					
	1.	2.	3.	4.	5.
1. Equisetaceae	-----	0.629	0.702	0.615	0.661
2. Psilotaceae	0.660	-----	0.471	0.579	0.615
3. Ophioglossaceae	0.868	0.606	-----	0.533	0.547
4. Marattiaceae	0.680	0.613	0.701	-----	0.447
5. Osmundaceae	0.718	0.641	0.708	0.507	-----

Between-group mean distances are below the diagonal and net between-group mean distances are above the diagonal.

distances ranged from 0.507 (Marattiaceae–Osmundaceae) to 0.868 (Equisetaceae–Ophioglossaceae). Net between-group mean distances were generally smaller and ranged from 0.447 (Marattiaceae–Osmundaceae) to 0.702 (Equisetaceae–Ophioglossaceae). Interestingly, the next lowest pairwise distances for both measures were for Psilotaceae–Ophioglossaceae at 0.606 (between-group mean distance) and 0.471 (net between-group mean distance), although this is noted cautiously, as only a single Psilotaceous specimen was used in this study. Although the Marattiaceae–Osmundaceae and Equisetaceae–Ophioglossaceae pairwise relationships represented the lower and upper bounds, respectively, for both set of distances, pairwise relationships did not always correlate between the two. For example, the between-group mean distance for Ophioglossaceae–Osmundaceae was 0.708, which was the third highest distance. However, the net between-group mean distance for this taxon pair was 0.547, which was the seventh highest of 11 comparisons. This is, no doubt, because of the difference in how these distances are calculated.

Discussion

Secondary structure of the petD intron of ferns

Alignment of *petD* intron sequences facilitated reliable determination of the intron's 6 domains, as well as identification of the 4 subdomains of DI. The intron secondary structure presented in this study for *E. pratense* is consistent with the general structure of group II introns (Michel et al. 1989, Kelchner 2002, Zimmerly and Semper 2015), and plants in particular (Löhne and Borsch 2005, Borsch et al. 2009, Korotkova et al. 2009). Nevertheless, *in silico* predictions of RNA secondary structure, although used widely, do have limits, which have been previously commented on by others (e.g., Mathews et al. 2004, Andronescu et al. 2014, Leamy et al. 2016). It should be kept in mind that RNA secondary structure is a result of many different factors, which

means that the prediction of secondary structures by computer programs may not necessarily represent the actual RNA structure (Gottschling and Plötner 2004). Additionally, some RNAs may appear *in vivo* with more than one secondary structure (Ritz et al. 2013). Regardless, such approaches, as presented here, provide testable hypotheses about RNA secondary structure and present a background for evaluating and interpreting experimental investigations (Gottschling and Plötner 2004, Leamy et al. 2016). Finally, predicted RNA secondary structures may sometimes provide information useful for phylogenetic inference (e.g., Korotkova et al. 2009).

Consistent with previous studies of the chloroplast *petD* intron, as well as group II introns in general, (e.g., Lehmann and Schmidt 2003, Löhne and Borsch 2005, Borsch et al. 2009, Zimmerly and Semper 2015), DI is the largest domain and accounts for about half of the overall intron length for the plants examined here. Except for DIV, length variation for the *petD* intron was minimal (≤ 29 nucleotides) for all domains among the ferns examined here. In contrast, the observed variation for DIV was as much as 109 nucleotides. Slightly higher variation was reported among basal angiosperms for DIV by Löhne and Borsch (2005) with a length range of 72–197 nucleotides, while even higher DIV variation was reported by Korotkova et al. (2009) in a range of 98–284 nucleotides for the Malpighiales. Whether considering nucleotide, secondary structural, or length variation, DV was the least variable domain among ferns examined in this study. This finding is comparable to the angiosperm studies of Löhne and Borsch (2005) and Korotkova et al. (2009), which reported little or no length variation for the conserved DV in those taxa, which are comparable with what was seen with ferns. Löhne and Borsch (2005) reported an average length \pm standard deviation of 34 ± 0.2 among basal angiosperms, while Korotkova et al. (2009) reported a consistent length of 37 among members of the order Malpighiales. Secondary structures obtained for ferns in this study were very similar to the consensus structure presented for DV for Malpighiales (see Fig. 7 in Korotkova et al. 2009). What structural variation was observed appeared to be confined mainly in or near the terminal loop. Although there was some nucleotide variation seen in the helical stem, the mFold results indicate that it did not greatly affect the secondary structure or, some cases, that there were compensatory base changes, consistent with the conserved secondary structure of the *petD* DV.

Although length mutations due to the presence of indels were found throughout the sequence alignment, most of this indel variation (74.2%) was localized, perhaps not surprisingly, in just 2 domain regions, DI and DIV. However, considering its considerable length, as compared with

the other shorter domains, DI is, in this sense, more conserved than DIV. The considerable observed length variation in the shorter DIV among the eusporangiate ferns evaluated, on the other hand, seems to suggest that its phylogenetic utility is, at best, limited.

Small indels were most frequent. For example, of the 124 identified indels, 55 (40.3%) were a single nucleotide in length and 24 (19.4%) were only two nucleotides. Not unexpectedly, as shown in Table 3, the majority of these are found in DI and DIV. In contrast to the shorted indels, there were only four indels that were 10 or more nucleotides long, with three of these located in DIV and one in DI. Although not directly examined in the present study, intron and domain length variation for the *petD* intron due to the presence of mutational hotspots has been previously investigated by Löhne and Borsch (2005), Korotkova et al. (2009), and Borsch et al. (2009) for several angiosperm taxa. Further evaluation of the *petD* intron among eusporangiate ferns, and the highly variable DI and DIV in particular, is recommended.

Phylogenetic relationships of eusporangiate ferns

Monilophytes, or ferns, consist of four orders of eusporangiate ferns and seven orders of leptosporangiate ferns (Smith et al. 2006). Although the four main lineages, plus the osmundaceous lineage, were recovered and well supported, both the MP and ML analyses appeared to bifurcate eusporangiate ferns into two major groups with the Equisetaceae, Psilotaceae, and Ophioglossaceae in one and with the Marattiaceae by itself in a separate group. The *petD* intron results obtained here by both the MP and ML trees, as well as the obtained evolutionary distances, would seem to be consistent with Pryer et al. (2004) and Kuo et al. (2011) in placing *Psilotum* and the ophioglossoid ferns together in a clade together. Nevertheless, many of the evolutionary affiliations among the four eusporangiate fern groups have long been considered unclear, particularly those involving the horsetails (*Equisetum*) and the marattioid ferns, as well the relationship of these groups with the leptosporangiate ferns (Pryer et al. 2004, Murdock 2008a). However, recent data tend to suggest that eusporangiate ferns represent a paraphyletic assemblage (Pryer et al. 2004, Kim et al. 2014).

The relationship of the Equisetales with other fern groups has varied between phylogenetic studies and is usually considered to unresolved (Pryer et al. 2001, Karol et al. 2010). The phylogenetic analyses presented in this study placed the horsetail genus *Equisetum* in a sister relationship to the *Psilotum* plus the Ophioglossaceae clade, though weakly supported. Notwithstanding, this particular phylogenetic relationship has been reported elsewhere (Kim and Kim 2018, Du et al.

2022). While only four *Equisetum* species (out of 15 to 18 generally recognized species) were included in the present study, the addition of more *Equisetum* species and, perhaps, the inclusion of species from the genus *Tmesipteris*, another member of the Psilotaceae, may help to further resolve these relationships. Regardless, both the phylogenetic analyses, as well as the obtained evolutionary distances, clearly do not support the placement of the Equisetaceae in a sister relationship with leptosporangiate ferns, one phylogenetic possibility that was discussed by Lehtonen (2011). Based on the *petD* sequence data, the horsetails were quite distinct and do not appear to have any phylogenetic relationship with the basal leptosporangiate Osmundaceae. At the same time, however, it should be pointed out that the four *Equisetum* sequences were resolved correctly into subg. *Hippochaete* (*E. variegatum* and *E. xylochaetum*) and subg. *Equisetum* (*E. sylvaticum* and *E. pratense*).

The six marattioid genera of Murdock (2008b) were represented in this analysis. Both the MP and ML analyses united *Marattia cicutifolia* with *Eupodium kaulfussii*, but not with its apparent congener *M. laxa*. However, Lehtonen et al. (2020) placed this taxon in the genus *Eupodium* and treated *M. cicutifolia* as a synonym for *E. cicutifolium*. Several previous fern phylogenetic studies have suggested a close relationship between the Marattiaceae and leptosporangiate ferns, particularly with the Osmundaceae, and often hypothesized a sister relationship for it with leptosporangiate ferns (e.g., Murdock 2008a, Knie et al. 2015, Du et al. 2022). Normally considered as basal leptosporangiate ferns, the Osmundaceae do nevertheless have many eusporangiate-like features as well as features intermediate between eusporangiate and leptosporangiate ferns. These include both anatomical and genetic attributes (Bierhorst 1971, Hasebe et al. 1994, Metzgar et al. 2008, Shen et al. 2018, Lehtonen et al. 2020). In this study, it should be cautiously noted that the lowest evolutionary distances obtained were between the Marattiaceae and the Osmundaceae. Regardless, neither the MP nor ML phylogenetic analyses placed the Marattiaceae in a sister position with the Osmundaceae in this study.

Usefulness of petD intron sequences for phylogenetic studies of eusporangiate ferns

Phylogenetic analysis of the *petD* intron sequences used in this study recovered the major eusporangiate lineages, as well as the osmundaceous lineage. In the case of the genus *Equisetum*, and as already noted, analyses were able to distinguish correctly the subgenera represented in the sequences examined. Species belonging to the same

genus were united, although the generic affiliations of some taxa have been revised since their sequences were deposited in GenBank. For example, the taxa shown in this study as *M. laxa* and *M. cicutifolia* were not grouped together, with the latter taxon grouping with *E. kaulfussii*. As previously pointed out, however, *M. cicutifolia* is now recognized as *E. cicutifolium* (Lehtonen et al. 2020). Likewise, in the Ophioglossaceae, *Botrychium lunaria* and *B. ternatum* were separated, with the latter taxon united with *Japanobotrychium lanuginosum*. However, many recent treatments place *B. ternatum* in the genus *Sceptridium* as *S. ternatum* (Lee and Kim 2012, Cao and Hauk 2022). The genera *Sceptridium* and *Japanobotrychium* are joined in a clade in the phylogeny of Zhang et al. (2020), which, therefore, would account for the placement seen in the present study's MP and ML results. It should be noted, however, that the position of *H. zeylanica* was inconsistent between the MP and ML. In MP, it was in a sister position to the genera *Botrychium* and *Japanobotrychium* (and *Sceptridium*). This basically is in agreement with the placement of the genus *Helminthostachys* in Zhang et al. (2020). However, its position in the ML was anomalous by being united with the genus *Ophioglossum*. While taxa in the Marattiaceae were united in both MP and ML, many relationships were either largely unresolved or often incongruous with previous phylogenies, such as Murdock (2008b) and Lehtonen et al. (2020).

Based on these results, it is concluded that *petD* intron sequences are generally useful for phylogenetic analyses of eusporangiate ferns, certainly at the family level and above. They also seem useful for identification at the generic level, although not necessarily always resolving relationships between different genera. Furthermore, it may be prudent to use *petD* intron sequences with other sequence regions and/or with morphological data. Additional evaluations of the relationships between eusporangiate ferns and also with leptosporangiate ferns using *petD* intron sequences are needed. Moreover, these should also include sequences from nonfern taxa as well.

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Appendix: nucleotide sequences used in this study

All sequences are grouped first by whether a eusporangiate or osmundaceous fern and then by family. Within each family, sequences are listed by species (and GenBank accession number). Species names are as listed in GenBank. For further information, please consult the sequence date and description recorded in the GenBank record.

Eusporangiate ferns

Equisetaceae: *E. pratense* (NC_088039), *E. sylvaticum* (NC_088054), *E. variegatum* (NC_088040), *E. xylochaetum* (NC_065985)

Marattiaceae: *A. angustifolia* (NC_026300), *A. evecta* (NC_008829), *C. aesculifolia* (MN412587), *D. sellowiana* (NC_051976), *E. kaulfussii* (NC_051977), *M. cicutifolia* (NC_051978), *M. laxa* (NC_051979), *P. novoguineensis* (NC_051980)

Ophioglossaceae: *B. lunaria* (NC_048457), *B. ternatum* (NC_060644), *H. zeylanica* (KM817788), *J. lanuginosum* (NC_066645), *M. chejuensis* (JF343520), *O. californicum* (NC_020147), *O. thermale* (NC_088530), *O. vulgatum* (MZ066610)

Psilotaceae: *P. nudum* (KC117179)

Osmundaceous ferns

Osmundaceae: *O. mildei* (MZ292715), *O. cinnamomeum* (NC_024157), *P. vachellii* (PQ300106), *T. barbara* (NC_072274)

Is TikTok Affecting the Mental Health of Your Employees? Examining the Link Between Compulsive TikTok Use and Mental Health

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Abstract

This study investigates the potential relationship between compulsive TikTok use and mental health. A survey of 603 men and women was conducted to examine their TikTok usage patterns, and the Mood Disorder Questionnaire was utilized to assess the presence of mood disorders. Results revealed that 26% of participants exhibited signs of mood disorders, a rate significantly higher than the general population's 10%. Results of hypothesis testing show that compulsive TikTok use is positively associated with craving. Furthermore, time spent on TikTok and craving are positively associated with mental health problems. Happiness and relationship satisfaction are negatively associated with mental health problems. Notable limitations include the reliance on a student sample of self-reported data and the exclusion of non-TikTok

users. The findings suggest that compulsive use of TikTok may have a more pronounced negative effect on mental health than previously recognized. This is particularly concerning for employers, because the mental health consequences of social media use may extend into the workplace, affecting employee well-being and productivity. Although the study specifically looked at TikTok, understanding this link could help businesses implement policies and support systems that promote healthier technology use overall. Such policies could foster a more positive and productive work environment for both employees and organizations.

Introduction

Social media platforms have become an inseparable part of daily life. Millions of users engage with them daily for entertainment, communication, and information. TikTok, one of the most popular platforms, has captured a global audience with its short-form videos and algorithm-driven content. Although TikTok provides entertainment and a sense of connection, growing concerns have emerged regarding its potential impact on users' mental health. The addictive nature of TikTok is alarming. It boasts an endless scroll of personalized content designed to capture and hold attention. This has raised concerns about its role in worsening mood disorders, anxiety, and other psychological issues. As more people turn to TikTok for daily engagement, the question arises: Could the compulsive use of this platform be undermining the mental well-being of its users? Should businesses pay attention to this because it has the potential to affect their employees?

The implications of compulsive TikTok use extend far beyond personal life; they have the potential to significantly affect workplace dynamics and employee productivity. With the average worker spending hours on their smartphones, businesses may soon face a new set of challenges in managing their workforce's mental health. The effects of compulsive social media use on cognitive function, emotional regulation, and overall job performance are not fully understood. However, the link between mental health and workplace productivity is clear. This study seeks to explore the relationship between compulsive TikTok use and the mental health of employees. This is important as valuable insights into the psychological toll that may accompany an overreliance on this digital platform can be discussed. By understanding these effects, businesses can take proactive steps to promote healthier technology use and safeguard the well-being of their workforce. Table 1 shows the hypotheses used in this study.

Table 1: Hypotheses	
Hypothesis number	Hypothesis summary
H1	Time spent on TikTok will be positively associated with mental health problems.
H2	Compulsive TikTok use will be positively associated with craving.
H3	Craving will be positively associated with mental health problems.
H4	Happiness will be negatively associated with mental health problems.
H5	Relationship satisfaction will be negatively associated with mental health problems.

Literature Review

Social Media—TikTok

The widespread adoption of TikTok has spurred research into its psychological and behavioral effects. Recent studies have examined various dimensions of this phenomenon. Excessive use of social media has been linked to anxiety, depression, and loneliness (Primack et al., 2017). Social media platforms are designed to engage users with a constant stream of content, often leading to compulsive use patterns and a cycle of emotional distress (Kross et al., 2013). Research highlights that prolonged exposure to social media can lead to poor self-esteem, body image concerns, and increased social anxiety (Twenge et al., 2018; Clements & Boyle, 2018). Users frequently compare their lives to the idealized portrayals presented on platforms like TikTok. Comparison like this can lead to feelings of inadequacy and dissatisfaction. The pressure to maintain an online persona might further exacerbate anxiety and depressive symptoms among employees, which can impact overall job performance.

The short video nature of social media is troublesome. Xu et al. (2024) found that individuals with higher levels of short video addiction exhibit lower working memory and cognitive function. This suggests that compulsive TikTok consumption may alter both the brain's reward system and its capacity for attention and emotional control. Research has shown that more screen time is associated with a range of mental health symptoms (Nagata et al., 2024). Platforms such as TikTok, with their rapid content delivery mechanisms, may lead to attention difficulties and contribute to an increased need for instant gratification.

Studies show that prolonged use of electronic media is linked to disrupted sleep patterns (Cain & Gradisar, 2010), decreased

concentration (Roshan et al., 2024), and increased symptoms of anxiety and depression (Wegmann et al., 2018). Social media's short-form content delivery system can reduce users' attention spans and contribute to difficulties in cognitive functioning (Clements, 2021). Social media-induced stress can increase emotional exhaustion, affecting employees' ability to work effectively (Sonnentag et al., 2018).

Social Media Use and Employee Well-Being

The impact of compulsive social media use extends beyond individual mental health. Excessive social media use can also have significant consequences for employee well-being and productivity in the workplace. The integration of digital technology into work life has blurred the lines between professional and personal activities. Employees are now expected to be constantly connected to work-related technology, while also engaging with personal platforms like TikTok.

Research on "technostress," which is defined as the stress induced by the use of digital technologies in the workplace, highlights the psychological toll of being constantly connected. Employees who experience high levels of technostress are more likely to report feelings of burnout, anxiety, and emotional exhaustion (Tarafdar et al., 2011). When compulsive social media use is added to this equation, the consequences can be even more pronounced. Studies suggest that employees who engage in excessive social media use during work hours are more likely to experience decreased productivity, lower job satisfaction, and higher levels of stress (Ayyagari et al., 2011).

In the case of TikTok, the brief and engaging videos often lead to a "quick distraction" pattern. This is characterized by employees finding themselves spending minutes or even hours scrolling through content. This habit can reduce cognitive engagement with work tasks and create a fragmented workday. This can impair both individual performance and team dynamics. Employees who engage excessively with TikTok may experience cognitive distractions and difficulties in social interactions within the workplace which may impact mental health.

Research has shown that excessive use of social media can lead to increased feelings of anxiety, depression, and loneliness (Primack et al., 2017), often leading to a sense of emotional distress, social comparison, and decreased well-being (Kross et al., 2013). Individuals who experience difficulty regulating their online activities are more likely to experience these negative mental health outcomes (Kuss and Griffiths, 2017). This is especially concerning with platforms like TikTok, where the consumption of content is fast-paced and often reinforces unhealthy

social comparisons, leading to further psychological distress (Fardouly et al., 2015).

Time Spent on Social Media

Social media is not all bad news. On the one hand, platforms like TikTok provide a space for social interaction, creative expression, and entertainment. On the other hand, too much time spent on these platforms can lead to negative outcomes. The psychological impact of social media is complex, often varying depending on the type of interaction, the amount of time spent on the platform, and individual differences in users' personalities and needs.

Increased time spent on social media platforms has been consistently associated with negative mental health outcomes across a wide range of studies. Prolonged exposure to idealized portrayals of other people's lives on social media fosters harmful social comparisons. These comparisons lead individuals to feel inadequate or dissatisfied with their own lives. The more time users spend scrolling through curated content, the greater the risk of experiencing loneliness and a sense of isolation as online interactions cannot replace meaningful face-to-face connections (Keles et al., 2020; Twenge et al., 2018).

The constant barrage of notifications and digital interactions leads to heightened stress levels that overwhelm the brain's ability to process emotions effectively. These cumulative effects underscore how excessive time on social media contributes to a broader decline in mental health, highlighting the need for boundaries and healthier habits to mitigate these risks (Alonzo et al., 2021).

Hypothesis 1: Increased time spent on TikTok will be positively associated with mental health problems.

Compulsive Technology Use

Compulsive technology use is defined as spontaneous interaction with social media that is unintentional, uncontrollable, effortless, and efficient (Clements and Boyle, 2018). It is often referred to as "technology addiction" and shares characteristics with other forms of behavioral addiction (Griffiths, 2005). Studies have shown that algorithm-driven platforms like TikTok exploit psychological vulnerabilities, increasing engagement through intermittent reinforcement mechanisms (Montag et al., 2019). This can result in compulsive usage patterns that disrupt daily life (Andreassen et al., 2012; Clements, 2021). These psychological consequences can extend into the workplace, affecting employees' emotional and cognitive functioning, job satisfaction, and overall well-being (Clements, 2024).

The psychological mechanism behind compulsive technology use is similar to that of other addictive behaviors. According to the “variable reward theory,” social media platforms like TikTok utilize random reinforcement to keep users engaged. This type of reinforcement, where users are unsure when or what type of content will appear next, is particularly effective at increasing user engagement. This model mirrors behaviors seen in gambling addiction, where individuals continue engaging in a behavior because of the cravings for rewards, thereby reinforcing compulsive use.

Hypothesis 2: Compulsive TikTok use will be positively associated with craving.

Psychological Effects of Compulsive TikTok Use: Cravings

TikTok, with its emphasis on short, catchy videos, offers users a sense of instant gratification. However, this form of gratification can lead to addictive patterns of use, where users feel a constant need to check the app and engage with new content (Clements and Boyle, 2018). This engagement is often driven by the desire for social validation, whether through likes, comments, or shares, leading to a heightened focus on external validation and self-presentation. TikTok is thus a place for social comparison. Social comparison theory (Festinger, 1957) suggests that individuals have an inherent drive to compare themselves with others to evaluate their own worth. On TikTok, where curated and often idealized content is prevalent, users are exposed to unrealistic portrayals of others’ lives. This can lead to feelings of inadequacy, lower self-esteem, and a distorted sense of self-worth (Fardouly et al., 2015). These negative emotional states are compounded by the platform’s design, one that encourages users to continually scroll through content without meaningful engagement or interaction. This can foster a sense of emptiness and dissatisfaction. Adolescents and young adults, in particular, are at heightened risk from social comparison because it impacts their self-esteem and emotional well-being. This cycle continues as cravings for validation of social comparison become more pronounced with increased use.

Craving is defined as an intense desire or urge to obtain an appetitive target (Clements, 2021). A growing body of research has linked cravings for social media to mood disorders such as depression and anxiety. Kross et al. (2013) found that Facebook use decreases subjective well-being. This finding is consistent with similar studies on various social media platforms (Clements, 2024). Compulsive social media use and the cravings to engage with it disrupts emotional

regulation, thereby intensifying mood instability and worsening symptoms of pre-existing mood disorders (Kircaburun et al., 2020).

In addition to mood disorders, compulsive social media use has been shown to contribute to sleep disturbances. The constant exposure to stimulating content, particularly before bedtime, can interfere with sleep patterns, leading to insufficient rest and a negative impact on cognitive functioning (Eeftens et al., 2023). The negative effects of sleep deprivation, in turn, can further exacerbate feelings of stress, anxiety, and irritability, creating a vicious cycle of emotional distress.

The physiological and psychological consequences of excessive social media cravings further compound negative mental health outcomes. Constant notifications and updates from platforms like TikTok create a persistent state of hypervigilance. This contributes to heightened stress levels and an increased desire to relieve cravings. Additionally, the addictive nature of such cravings often results in reduced face-to-face interaction and increased social isolation, key predictors of depression and anxiety. This combination of factors underscores the urgent need for targeted interventions to address the detrimental effects of social media use on mental health, particularly among vulnerable groups (Keles et al., 2020).

Hypothesis 3: Craving will be positively associated with mental health problems.

General Happiness and Mood Disorders

Happiness is most commonly defined as a state of well-being and contentment—a feeling of joy, satisfaction, or pleasure that reflects how positively someone evaluates their life. General happiness levels have been found to be inversely associated with mood disorders such as depression and bipolar disorder. Higher levels of happiness are associated with enhanced emotional resilience. Emotional resilience reduces susceptibility to mood dysregulation. Conversely, individuals with low levels of happiness often experience feelings of hopelessness, and a diminished ability to manage stress. These problems exacerbate symptoms of mood disorders. Individuals who are unhappy have been found to have dysregulation of serotonin and dopamine. These neurotransmitters play a critical role in maintaining emotional stability (Layous et al., 2014; Pressman et al., 2019). These findings highlight the importance of general happiness as a protective factor against mood disorders.

Increasing happiness has also been shown to alleviate a range of mental health problems. Engaging in positive activities such as gratitude practices, regular physical exercise, and fostering social connections not

only enhances happiness levels but also improves emotional regulation and reduces stress. Happiness triggers the release of neurochemicals like endorphins and oxytocin, which act as natural mood stabilizers and stress reducers (Diener et al., 2017). Additionally, interventions aimed at promoting happiness, such as mindfulness programs and cognitive-behavioral strategies, have been shown to reduce symptoms of depression and anxiety while improving overall well-being (Howell et al., 2007). These insights underscore the critical role of cultivating happiness as a preventive and therapeutic approach to addressing mood disorders and enhancing mental health. The happier you are, the fewer mental health problems you will have.

Hypothesis 4: Happiness will be negatively associated with mental health problems.

Relationship Satisfaction and Mood Disorders

Relationship satisfaction is typically defined as a subjective evaluation of the quality and health of a relationship. It reflects how positively an individual feels about their relationship based on emotional, cognitive, and behavioral factors. It has also been defined as the subjective sense of relational quality arising from evaluations of the positive and negative dimensions of one's romantic relationship (Lawrance and Byers, 1995).

High relationship satisfaction has been consistently linked to positive mental health. Research suggests that individuals in satisfying relationships experience greater emotional support. This acts as a buffer against stress and psychological distress. Studies have shown that high levels of relationship satisfaction are associated with lower levels of depressive symptoms, because partners provide a sense of security and validation that fosters emotional well-being (Røsand et al., 2012). The quality of intimate relationships has been found to positively influence the regulation of stress hormones. These regulated hormones can mitigate the physiological impacts of chronic stress and thus reduce the risk of developing mood disorders.

Relationship satisfaction helps contextualize the broader mental health implications of compulsive social media use. Relationship satisfaction also plays a critical role in enhancing resilience to life stressors. Satisfying relationships promote open communication and mutual problem-solving. This relationship dynamic reduces feelings of isolation and helplessness. Furthermore, high relationship satisfaction has been linked to increased levels of positive affect and life satisfaction—both of which are protective factors against mental health issues (Downward et al., 2022). These findings underscore the

importance of fostering healthy and fulfilling relationships as a means of promoting mental health and preventing the onset of mood disorders. The better your relationships are the fewer mental health problems you will experience.

Hypothesis 5: Relationship satisfaction will be negatively associated with mental health problems.

Figure 1 shows the proposed research model for this study.

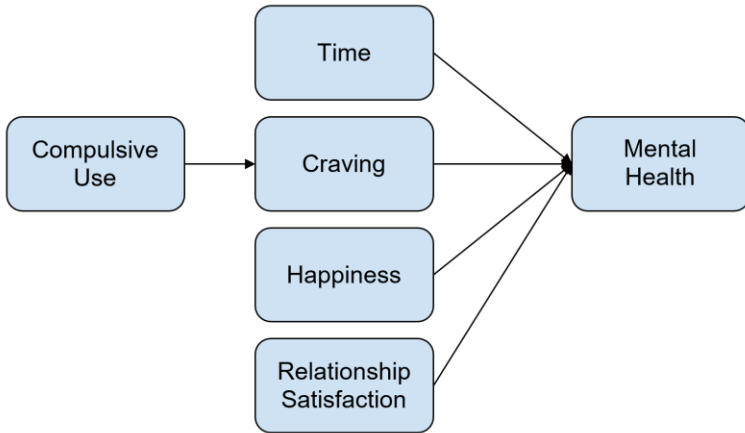


Figure 1: Research model.

Research Methodology

This study employs a survey research design for three primary reasons. First, the survey method facilitates the investigation of perceptual variables of interest. By quantifying these constructs, it enables comparisons and the derivation of inferences regarding the relationships between variables within the study and the broader population. Previous research on psychological constructs has demonstrated the utility of survey instruments in assessing behaviors that are inherently difficult to observe.

Second, the survey design supports the exploration of attributes thought to exist within a large population by sampling a subset of individuals (Fowler, 2002). The fundamental objective of a survey is to generalize findings from a representative sample to the larger population, thereby enabling inferences about specific behaviors (Babbie, 1990). Consequently, this study leverages survey data to better understand the antecedents and outcomes of compulsive social media use across the general population.

Third, the survey design provides the advantage of standardized measurement. Such consistency across respondents ensures the collection of comparable data, allowing for the generation of meaningful statistics. These statistics are critical for assessing the extent to which variations in withdrawal and craving are associated with compulsive use, as well as the extent to which variations in compulsive social media use influence general happiness. Without standardized measures, it would be impossible to produce statistically meaningful results (Fowler, 2002), and any observed relationships between variables at the individual level would lack comparability across respondents. This approach ensures robust, generalizable insights into the variables under investigation.

Data for this study were collected through a web-based survey, targeting participants from a United States-based university. Those that did not use TikTok were excluded from the study. A total of 603 college students participated and completed the survey. A limitation to this sample was using university students as a proxy for employees. Although the sample comprises college students, a substantial body of research supports the relevance of workplace-related terminology when studying this population. Many college students are employed while enrolled and their dual identity as both students and workers has been documented in higher education literature. According to the Trellis Strategies report (Taylor, 2025), 68% of undergraduate students work for pay, with a significant portion identifying as “workers who go to school” rather than “students who work.” This distinction reflects how employment is not merely incidental but central to their lived experience. Similarly, Perna and Odle (2020) argued that the financial and structural realities of college life have made employment a normative part of the student experience. Working during college is associated with long-term earnings benefits and are consequential for students’ future workplace outcomes (Douglas and Attewell, 2025). These findings justify the use of workplace-oriented language and focus even if the sample is drawn from a student population.

Additionally, demographic data were not collected. This was done in an attempt to focus on understanding patterns of behavior without introducing assumptions based on race, gender, or socioeconomic status. This helps avoid stereotype reinforcement. Furthermore, because the Mood Disorder Questionnaire (MDQ) is a clinical tool used to assess mental health deficiencies, care was taken to not collect demographic data that might inadvertently identify individuals.

Mood disorders, encompassing conditions such as major depressive disorder and bipolar disorder, are among the most prevalent and debilitating mental health challenges worldwide. These disorders are characterized by significant disruptions in mood, energy levels, and

cognitive functioning, which can lead to impaired social and occupational performance. Research has highlighted the complex interplay of genetic, neurobiological, and environmental factors in the understanding of mood disorders. Accurate and early identification is necessary to improve treatment outcomes (Fava & Kendler, 2000). Screening tools, such as the MDQ, have become instrumental in identifying individuals at risk for bipolar spectrum disorders. The MDQ, a brief self-report instrument, is designed to assess symptoms of mania and hypomania, as well as their impact on daily functioning. The MDQ provides a preliminary step toward diagnosis (Hirschfeld et al., 2000).

The MDQ has demonstrated utility in both clinical and general population settings. Studies report its effectiveness in screening for general mood disorders such as bipolar I disorder. However, its sensitivity for bipolar II and related conditions is comparatively lower (Hirschfeld et al., 2000; Miller et al., 2009). Its psychometric properties, including high specificity, make it a valuable tool for ruling out bipolar disorder in individuals presenting with depressive symptoms. Clinicians warn the MDQ should not be used as a standalone diagnostic tool but rather as part of a comprehensive clinical evaluation. Adding such screening instruments into routine mental health assessments can facilitate early intervention, which is key to potentially mitigating the long-term impact of mood disorders on individuals and society (Fornaro et al., 2015).

To assess mental health challenges present in our population of interest, this study employed the MDQ as a tool to help rigorously identify deficiencies in mental health. The MDQ consists of three parts. First, it has 13 yes/no symptom questions based on a person's experiences. For example, questions ask things like "Have you ever had a period when you were not your usual self and you were so irritable that you shouted at people or started fights or arguments?" and "Have you ever had a period when you were not your usual self and thoughts raced through your head or you couldn't slow your mind down?" In the second part of the MDQ, people are asked whether multiple symptoms from part 1 occurred during the same time period. The third part assesses the level of functional impairment caused by these symptoms. The results are then scored. To screen positive for a mood disorder, all three of the following must be met: 1) 7 or more "yes" responses out of the 13 symptom items; 2) a "yes" to the question about symptoms occurring at the same time; and 3) a response of "moderate" or "serious" problem to the question about functional impairment.

To test the measurement and structural model, the study utilized a partial least squares (PLS)-structural equation modeling approach. This method was chosen for its ability to maximize the explained variance in

dependent variables while simultaneously evaluating data quality based on the characteristics of the measurement model.

Results

Initial descriptive statistics were examined to gain insight into some of the phenomena of interest. Results showed that 32.3% of individuals used TikTok for 4 or more hours per day, with some using it up to 10 hours in a 24-hour period. Figure 2 shows the breakdown of time spent by individuals.

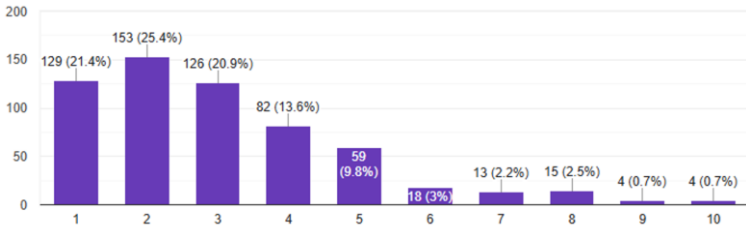


Figure 2: How many hours a day do you spend on TikTok?

The MDQ results indicated that 26.4% of respondents could be classified as having a mood disorder. This is much higher than the general population in which only 10% of individuals are classified as having a mood disorder. Scores from 3 to 5 are an indication of a possible mood disorder. Figure 3 shows the breakdown of scores.

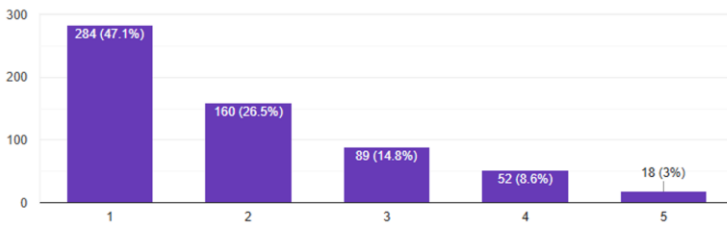


Figure 3: MDQ scores in the current study

Prior to testing the structural model, construct dimensionality and factorial validity of latent constructs were rigorously examined in two phases. The first phase applied principal components analysis using SPSS to evaluate construct dimensionality, which PLS assumes a priori but cannot measure directly (Gefen, 2003; Gerbing & Anderson, 1988).

In the second phase, Smart PLS software was used to assess convergent and discriminant validity, both of which are essential components of construct validity (Straub et al., 2004). These procedures ensured a robust validation of the measures as recommended by Gefen and Straub (2005).

The measurement model was further tested using PLS confirmatory factor analysis. This step evaluated factorial validity by specifying the loading patterns of measurement items on latent constructs. Results confirmed that all measurement items loaded with statistically significant t-values on their corresponding constructs, supporting convergent validity (Gefen & Straub, 2005). Discriminant validity was assessed by examining latent variable correlations with measurement items, revealing that each item loaded strongly on its specified factor without overlapping onto other factors.

Additional discriminant validity assessment involved analyzing the average variance extracted (AVE) for each latent construct. Following Fornell and Larcker's (1981) criteria, the square root of the AVE for each construct was shown to exceed any correlation among pairs of latent constructs. Results met the threshold AVE value of .50 and consistently demonstrated stronger square root values than inter-construct correlations, providing further evidence of discriminant validity. This is shown in Table 2.

Table 2: Construct reliability and validity				
Variable	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Compulsive	0.870	0.894	0.911	0.722
Crave	0.883	0.885	0.920	0.741
Happiness	0.865	0.872	0.917	0.788
Satisfaction	0.908	0.925	0.931	0.732

Upon confirming the validity of the measurement model, I proceeded to evaluate the structural model using SmartPLS. The initial step in this evaluation involved calculating the R^2 values for the endogenous latent variables, followed by analyzing the path coefficients to determine the strength and significance of the relationships within the model. Figure 4 shows these results.

The R^2 values provide an assessment of the explanatory power of the model. Specifically, the R^2 value for craving was 0.466, indicating that 46.6% of the variance in this construct is explained by its predictors, demonstrating a moderately strong level of explanatory power.

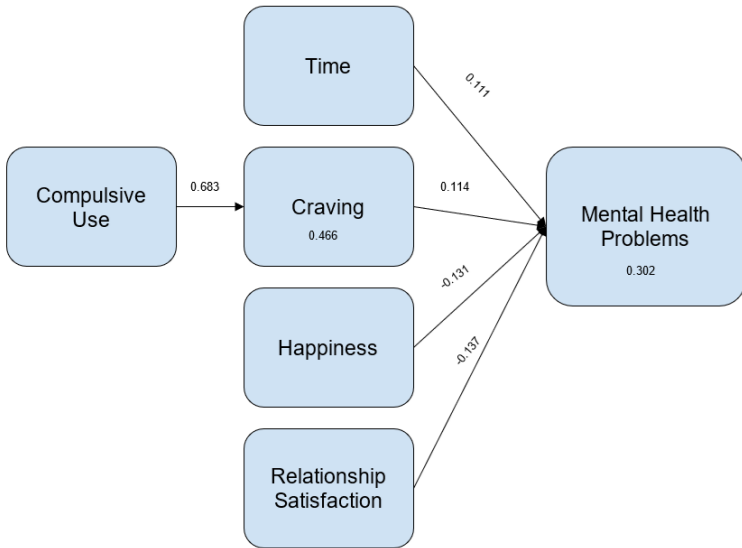


Figure 4: Model results

Similarly, the R^2 value for mental health problems was 0.302, suggesting that 30.2% of the variability in mental health problems can be attributed to its predictors, reflecting moderate predictive strength.

The analysis of path coefficients further highlights the strength and direction of relationships within the structural model. The path coefficient from compulsive use to craving was 0.683, suggesting a strong and significant positive association; higher levels of compulsive use are strongly predictive of increased craving. The path from time to mental health problems had a coefficient of 0.111, reflecting a weak but statistically significant positive relationship. Similarly, the path from craving to mental health problems also had a coefficient of 0.114, indicating that craving contributes to the development of mental health issues, albeit with a modest effect size.

Conversely, the relationships between happiness and mental health problems (path coefficient = -0.131) and relationship satisfaction and mental health problems (path coefficient = -0.137) were negative, indicating that both happiness and relationship satisfaction act as protective factors against mental health problems. Although the effect sizes are modest, the negative coefficients underscore their potential mitigating roles in reducing mental health issues.

These findings collectively support the hypotheses and underscore the dynamic interplay among the constructs. The strong positive association between compulsive use and craving highlights the centrality of compulsive behaviors in driving craving. At the same time, the protective effects of happiness and relationship satisfaction underscore their importance in mitigating mental health problems. The combination of these results contributes to a deeper understanding of the structural relationships and provides empirical evidence for theoretical propositions.

Discussion

This study aimed to investigate the potential relationship between compulsive TikTok use and mental health issues, with a focus on the implications for workplace productivity and well-being. By examining the intersection of compulsive social media use and mental health, particularly in the context of the workplace, this paper highlights the significant psychological risks associated with excessive TikTok use. The findings suggest that compulsive use of TikTok may have a more pronounced negative effect on mental health than previously recognized. This could have far-reaching consequences for employees' emotional well-being, job satisfaction, and overall productivity. Although a limitation of this study is that only TikTok use was assessed, it is likely that other social media use may also negatively impact mental health and contribute to work related outcomes such as absenteeism.

The research findings underscore the need for employers to acknowledge the psychological impact of social media platforms such as TikTok on employee mental health. As digital technology becomes increasingly ingrained in both personal and professional spheres, the risks associated with compulsive use must be addressed proactively. Future research should consider the direct effects of compulsive social media use on happiness and relationship satisfaction. The literature highlights that compulsive social media use can lead to a variety of negative outcomes, such as mood disorders, anxiety, sleep disturbances, and decreased workplace productivity. The findings stress the importance of fostering healthier technology use patterns, both for individual well-being and organizational success.

Interventions to Address Compulsive Technology Use in the Workplace

Organizations should consider strategies to help employees manage their digital habits and foster a healthier work environment. This is

especially true given the negative effects of personal social media overuse. One important step is to provide employees with education about the risks associated with excessive technology use and promote the importance of digital well-being. Companies could encourage employees to develop healthier usage patterns by offering workshops or training programs focused on the psychological effects of social media.

Another intervention is to promote work–life balance by encouraging employees to set boundaries between their professional responsibilities and personal technology use. This could include instituting guidelines that discourage excessive social media use during work hours or encouraging employees to engage in activities that promote relaxation and disconnection from digital devices. Providing employees with time to disconnect from screens, either through mandatory breaks or company-sponsored wellness activities, can reduce the temptation to engage in compulsive social media use and improve overall mental health.

Employers should also consider providing access to mental health resources and support services. Offering access to counseling, digital wellness programs, and stress-management workshops can help employees address the underlying causes of compulsive technology use and manage its psychological effects more effectively. A culture of openness around mental health, combined with proactive support systems, can help reduce the stigma surrounding mental health issues and encourage employees to seek help when needed (Nowland et al., 2018).

Companies that take a leadership role in addressing digital well-being and mental health could enhance their corporate reputation and thereby attract top talent who value employers that prioritize employee mental health. As mental health concerns continue to gain prominence in the corporate landscape, businesses that support their employees' mental and emotional health are likely to experience benefits in terms of reduced burnout, improved job satisfaction, and higher retention rates.

Research Implications and Future Research

This study contributes to the growing body of literature examining the relationship between social media use and mental health. The findings expand upon previous research and demonstrate that the compulsive use of platforms like TikTok may present unique challenges. Although the literature on compulsive social media use is robust, further research is needed to explore the specific mechanisms through which platforms like TikTok affect mental health in more granular detail. Future studies could investigate how various features of TikTok, such as

its algorithm-driven content feed, its use of visual and auditory stimuli, and its community-oriented nature, specifically influence users' psychological outcomes.

Additionally, longitudinal studies could help to better understand the causal relationship between compulsive social media use and mental health outcomes over time. Although this study found a correlation between compulsive TikTok use and mood disorders, future research should explore whether compulsive use directly leads to the development of mental health issues or whether pre-existing mental health conditions may predispose individuals to compulsive social media use. Furthermore, research could focus on examining the effects of compulsive social media use across different demographic groups, such as age, gender, and occupation. This may help identify whether certain populations are more vulnerable to the psychological effects of excessive TikTok use. Future research may also assess how this might affect work-related outcomes such as turnover and absenteeism.

Future work could also explore interventions that may mitigate the negative effects of compulsive social media use. For instance, future studies could evaluate the effectiveness of digital detox programs, time management strategies, or mindfulness-based interventions in reducing the psychological impact of excessive social media use among employees. Additionally, the role of organizational culture in shaping employees' technology use habits warrants further exploration. Research could examine whether workplaces that foster a culture of digital well-being see better outcomes in terms of employee health, engagement, and productivity.

Conclusion

In conclusion, this study emphasizes the growing concern over compulsive TikTok use and its potential impact on employee mental health and workplace productivity. As social media continues to play an integral role in both personal and professional spheres, businesses must recognize the risks associated with compulsive technology use and take proactive steps to address them. By implementing digital wellness programs, promoting work–life balance, and offering mental health resources, companies can mitigate the negative effects of compulsive social media use on their employees' well-being. Future research should continue to explore the relationship between technology use and mental health, particularly in the context of the workplace, to provide a deeper understanding of the mechanisms at play and inform interventions aimed at fostering healthier digital habits.

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Appendix: Measurement Instruments

Craving—An intense desire or urge to obtain an appetitive target (TikTok). Adapted from Clements (2024)

1. I often spontaneously think about TikTok
2. I sometimes feel an urge to use TikTok
3. I find myself thinking about TikTok
4. I have experienced feelings of craving associated with my use of TikTok

Compulsive Use of Social Media—Spontaneous interaction with social media that is unintentional, uncontrollable, effortless, and efficient. Adapted from Clements and Boyle (2018)

1. I choose TikTok without even being aware of making the choice
2. I unconsciously start using TikTok
3. Using TikTok is something I do without even being aware of it
4. I find myself checking in with TikTok without explicitly planning to do so
5. I often feel compelled to use TikTok
6. I often feel I spontaneously use TikTok

Subjective Happiness—An individual's personal assessment of how happy they feel. Adapted from Lyubomirsky and Lepper (1999).

7. In general, I consider myself:
not a very happy person 1 2 3 4 5 6 7 a very happy person
8. Compared to most of my peers, I consider myself:
less happy 1 2 3 4 5 6 7 more happy
9. Some people are generally very happy. They enjoy life regardless of what is going on, getting the most out of everything. To what extent does this characterization describe you?
not at all 1 2 3 4 5 6 7 a great deal
10. Some people are generally not very happy. Although they are not depressed, they never seem as happy as they might be. To what extent does this characterization describe you?
not at all 1 2 3 4 5 6 7 a great deal

Relationship Satisfaction—An individual's personal assessment of how satisfied they are with their relationships. Adapted from Hendrick (1988).

Think about your relationships with other people. Specifically, think about your closest relationship. This could be a friend, spouse, significant other, etc.

11. How well does your partner meet your needs?
12. In general, how satisfied are you with your relationship?
13. How good is your relationship compared to most?
14. How often do you wish you hadn't gotten into this relationship?
15. To what extent has your relationship met your original expectations?
16. How much do you love your partner?
17. How many problems are there in your relationship?

The Oyster is Your World: A Revised Look at International Diversification

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Executive Summary

Using new Wharton Research Database Services country index data, this study constructs mean–variance efficient frontiers for dollar returns on up to 37 country stock indices over 1995–2023 and subperiods to determine the empirical optimal global allocation. Contrary to recent studies showing rational overallocations to the U.S. market, the global tangent “market” portfolios are, if anything, underallocated to the U.S. They resemble nominal gross domestic product (GDP) or purchasing power parity (PPP)–adjusted GDP weights, much less market cap weights, and definitely not 100% U.S. Home-biased U.S. investors expose themselves to 0.4–0.7% higher monthly standard deviation of returns and experience 0.1–0.3% lower means than the optimal allocators. The optimal strategies contain allocations to non-eurozone European economies (e.g., Denmark, Norway, Switzerland) that exhibit high Sharpe ratios and are less U.S.-correlated as well as allocations to Southeast Asia and Oceania (e.g., Indonesia, Taiwan, Australia, and New Zealand). Allocations to India are smaller than, and to China

greater than, the GDP share of the world. Overall, the findings are that home bias is harmful and that nominal and PPP-adjusted GDP weightings tend to be the best guides to portfolio construction. Market cap weighting, which favors developed economies, also seems to harm investors' long-term mean–variance tradeoffs.

The rationale for international diversification is simple. If other markets are uncorrelated with ours, then holding a diversified portfolio across many international markets will reduce risk. In this case, risk is defined as the standard deviation or volatility of the overall portfolio's value or returns. This argument is strengthened by the fact that the diversifying investor does not need to experience any reduction in the long-term average return; the investor simply earns the average of the mean returns. A risk-averse investor, who can be roughly thought of as maximizing the Sharpe ratio (the ratio of the mean return to the volatility of the return) of their overall portfolio, thus gains through the denominator decreasing.

Yet across the world, we observe country-centric “home bias.” Sweden's investors own almost 50% of the Stockholm Stock Exchange equities, and Swedish investors allocate more than 0.5% of their retirement portfolios to Swedish equities. The country's contribution to the world's gross domestic product (GDP) is 0.5%. Most U.S. investors hold most of their stock portfolios in U.S. equities, well beyond the 25% share of the U.S. in the global GDP or 35% in the global market capitalization. One explanation can be a behavioral bias of regret avoidance, i.e., investors' irrational attempts to avoid regret, in the process limiting their own opportunity set and reward-to-risk ratio.

There are other rational explanations. Many of them were studied by Mukherjee et al. (2018). Long before that, Goetzmann et al. (2005) studied how the integration of global markets has led to the increased covariation of international indices and decreased benefits to diversification. Swedroe (2013) and Hunkar (2013) showed that the diversification benefits now only remain in small caps and frontier markets and only because of investment frictions and costs. Frictions can include difficulty of owning foreign brokerage accounts, restrictions on foreign equity ownership, limited float of shares, currency transaction on entry and exit, etc. Dobil (2020) performed mean–variance tangent portfolio optimizations similar to the ones in this study but using 28 country exchange-traded funds available at the time of the study to U.S. retail investors. These vehicles bear the friction costs directly and pass them to investors; they also invest only in very liquid foreign stocks. Not surprisingly, with the cost advantage of U.S. stocks, the study found as

optimal near-100% allocations to the U.S. Dubil (2023) improved the examination by using index and currency data for the U.S. plus 49 other countries over 1986–2019 and found that most optimal solutions do in fact significantly overallocate to the U.S. beyond any GDP or market cap weighting (with the exception of some period-specific large allocations to small markets). The study suggested that home bias appeared to be an optimal choice for the U.S. investor. However, the indices came from multiple sources without any information about reinvestment or percentage of the market coverage. This study follows the same line of inquiry using a new set of cum-dividend country index returns constructed by Compustat Global and available from Wharton Research Database Services. We find very different results. Pure 100% U.S. portfolios are very inefficient, as are stock market cap-weighted allocations. Purchasing power parity (PPP)-adjusted and nominal GDP weightings are better yet suboptimal, but the optimal tangent allocations do seem to resemble these weightings a lot more than portfolios with higher U.S. weights. This is a significant finding with important prescriptions for how U.S.-based investors should build their long-term retirement portfolios. S&P Global (2023) cited several trends in the current process of world deglobalization: increased trade barriers like tariffs and quotas; reduced foreign direct investment; localization of supply chains; increased regulation; and geopolitical tensions. These are only likely to contribute to the divergence of the performance of the equity markets around the globe.

Studies of International Diversification and Home Bias

Home country bias—a disproportional overallocation to domestic stocks—is usually explained in the literature by behavioral (irrational) biases or (rational, data-driven) changing correlations, frictions, and costs. On the behavioral side, home bias is a classic example of regret avoidance. It leads investors to avoid unfamiliar foreign choices. Fortunately, a lot of research on the home bias focuses not on the investors biases but provides data-driven evidence of how the very real informational asymmetry of U.S. traders relative to foreign traders and/or high transaction costs can cause underallocation to foreign equities. Huberman (2001) and Solnik and Zuo (2012) mixed the two aspects and build models in which regret-biased investors in equilibrium hold a smaller quantity of foreign equities. French and Poterba (1991) showed that U.S. investors perceive real return on Japanese or U.K. stocks 1–2% higher the domestic investors perceive. Glassman and Riddick (2001) showed that U.S. investors believe that the standard deviation of foreign equities is up to 3.5 times higher than the actual

standard deviation. Scott et al. (2019) examined the extent of the home bias, with investors in the U.S., U.K., Japan, Canada, and Australia overallocating domestically by 29%, 19%, 48%, 56%, and 64% over the world cap weighting. Levy and Levy (2014) argued that, as correlations rise, foreign investment cost declines in absolute terms but does not decline much in relative terms. In general, studies show the U-shaped dependence of the total risk on the allocation to foreign equities. Adding foreign stocks to portfolios at low allocations at first reduces, but at high allocation increases, the total standard deviation. Conover et al. (2002) showed that adding emerging markets to developed country allocations adds 1.5% per year to the mean, but this gain is traced exclusively to the restrictive Fed policy periods. Asness et al. (2011) focused on the length of the investment horizon and required over 50-year horizons to detect benefits of diversification. One complicating aspect of this discussion is that there is no established yardstick against which to measure the extent of “overallocation.” The candidates are GDP or market cap weighting. Solnik (May 1974 and August 1974), and later Adler and Dumas (1983) developed international versions of capital asset pricing model in which countries operate as separate currency, tax, and inflation zones. The standard representative agent assumption is replaced by that with multiple representative agents with their own risk-free rates and return-risk preferences. The result is not necessarily the cap weighting of the world index. Absent a uniform theory, the only approach left is an empirical identification of globally priced risk factors or empirical asset pricing. In the mean–variance context, one approach is an empirical determination of the tangent (Sharpe ratio-maximizing) portfolio.

Dubil (2020 and 2023) took precisely this approach. Given the local currency index returns over 1986–2019 translated into dollars, Dubil solved for optimal tangent portfolios from the perspective of a U.S. investor. In a two-fund separation sense, he found as optimal allocations into the U.S. of 65% and more. This finding casts doubt that home bias is irrational and suggests that it is the result of high correlations and low Sharpe ratios of many foreign equity markets over the study period. Those studies rely on exchange-traded funds rather than indices or on index data without knowing the composition of the indices or their built-in reinvestment assumptions. The current study follows the same approach of mean–variance optimization, using a new clearly identified index return data and finds very different results. The worst performers are pure U.S. allocations and market cap-based allocations with outsize weights for the U.S. and the developed world. The GDP-based allocations, while not optimal, perform much better.

The Data Set and Return Statistics of Dollar Returns

To perform tangent portfolio optimizations for the U.S.-based investor, the monthly data set contains international stock index discrete returns cum dividends from the Wharton Research Database Services and currency rates in foreign currency per dollar from OFX financial technology company. The monthly index and index constituent data come from Compustat Global. The analysis is cap-weighted, includes dividend reinvestments, and covers 40 countries. It starts in July 1995 but misses several important countries until later years. The data ends at February 2023. The FX (foreign exchange) data does not have pre-euro currencies and misses Colombia and Chile. For these reasons, the data in the study are grouped into three intervals: 18 countries over the total 28-year period July 1995 to February 2023, 33 countries over a shorter 23-year period of March 2000 to February 2023, and 37 countries over a 17-year period February 2006 to February 2023. The first interval covers 64% of the world's nominal GDP and 80% of the world's market capitalization; the last interval covers 82% of the world's nominal GDP and 90% of the world's market capitalization. The country nominal and PPP-adjusted GDP and market cap data come from the World Bank as of 2023. The weights of these three benchmark world portfolios are renormalized to reflect the composition of the available index and FX data set. For example, the U.S. constituted 25.3% of the nominal, 15.5% of the PPP GDP, and 44.3% of the world's market cap as of 2023, but in the study it shows as 31.0%, 20.7%, and 49.2%, respectively, of all the countries included in the 2000–2023 interval. The tables below show the exact weights.

With all exchange rates expressed in foreign currency per dollar, we computed the dollar returns experienced by a U.S. investor investing in a foreign index fund. In discrete terms, the gross return $1 + r_t^{US}$ for month t to a dollar investor on \$1 invested in the index of country I_t can be computed as

$$1 + r_t^{US} = \frac{X_t}{X_{t-1}} (1 + r_t^I)$$

where X_{t-1} and X_t are exchange rates at the end of months $t-1$ and t , and r_t^I is the return on index I_t , in its native currency over month t . To replicate a one-month return on the $I_t = \text{AUS}$ index, one buys Australian dollars at the beginning of the month, with Australian dollars one buys Australian stocks to earn a return r_t^{AUS} and sells the stocks and the proceeds in Australian dollars for U.S. dollars at the end of the month. The study then takes as sufficient statistics the arithmetic means and covariance matrices of the returns to run mean variance optimizations

Table 1. Return means and standard deviations ending February 2023 and starting on						
Country	Jul-95		Mar-00		Feb-06	
	Mean	StDev	Mean	StDev	Mean	StDev
USA	0.83	4.60	0.62	4.62	0.77	4.62
AUS	0.86	5.22	0.87	5.42	0.68	5.81
DKK	1.12	5.12	1.08	5.25	1.03	5.24
HKD	0.75	6.73	0.59	5.78	0.70	5.68
JPN	0.35	4.94	0.27	4.69	0.30	4.45
MAL	0.40	7.10	0.47	4.53	0.58	4.33
NOR	0.91	6.37	0.92	6.39	0.65	6.53
SGP	0.58	6.41	0.63	5.57	0.68	5.63
KOR	0.64	8.58	0.72	7.09	0.50	6.51
SWE	0.99	6.33	0.63	6.39	0.81	5.96
SWZ	0.74	4.60	0.69	4.29	0.67	4.22
TWN	0.95	12.18	1.01	12.77	1.40	13.89
THD	0.38	8.21	0.86	6.56	0.65	5.76
GBP	0.53	4.45	0.37	4.60	0.33	4.74
CHN	0.92	7.90	0.69	7.29	1.12	7.81
INDa	1.08	7.96	1.07	7.84	0.95	7.69
MEX	1.02	6.62	0.83	6.08	0.63	6.00
NZD	0.79	4.97	0.92	4.74	0.74	4.84
AUT			0.87	6.27	0.42	6.77
BEL			0.71	5.45	0.47	5.63
FIN			0.45	7.14	0.62	5.96
FRA			0.60	5.33	0.65	5.34
GER			0.47	5.84	0.56	5.69
INSa			1.01	7.38	0.97	6.68
IRE			0.66	6.22	0.44	6.39
ITA			0.34	6.08	0.30	6.30
NED			0.62	5.84	0.72	5.87
POR			0.28	5.64	0.32	5.81
ESP			0.51	6.00	0.41	6.14
BRZ			0.94	8.15	0.57	7.99
EGP			0.27	7.27	-0.27	6.93
PHL			0.78	5.89	0.88	5.57
PLN			0.53	7.65	0.36	7.59
GRE					-0.27	9.51
HUN					0.36	8.04
RSA					0.51	6.27
TUR					0.67	9.27

All values are reported as percentages.

solving for the highest Sharpe ratio portfolios (tangent) and a variety of maximum mean portfolios for different levels of standard deviations. All results are presented per month, not annualized.

Table 1 presents the means and standard deviations for monthly dollar returns to international investing. The U.S. is in the group of low-risk countries as Japan, Switzerland, the U.K., and New Zealand. Greece, Turkey, and Taiwan have the highest individual risks (standard deviations).

Table 2 shows the correlation matrix for the monthly dollar returns of international indices over the 1995–2023 and 2006–2023 periods. The correlations are practically the same over the two periods.

Table 2. Correlations of international indices' returns over																				
1995-2023 and 2006-2023																				
1995-2023																				
	USA	AUS	DKK	HKD	JPN	MAL	NOR	SGP	KOR	SWE	SWZ	TWN	THD	GBP	CHN	INDa	MEX	NZD		
USA	1.00	0.71	0.69	0.58	0.56	0.44	0.69	0.63	0.57	0.78	0.72	0.30	0.47	0.79	0.02	0.47	0.67	0.53		
AUS	0.71	1.00	0.65	0.57	0.55	0.48	0.73	0.69	0.60	0.68	0.66	0.30	0.58	0.74	0.11	0.55	0.62	0.76		
DKK	0.69	0.65	1.00	0.46	0.44	0.37	0.72	0.54	0.51	0.76	0.75	0.26	0.42	0.75	0.10	0.45	0.55	0.58		
HKD	0.58	0.57	0.46	1.00	0.45	0.57	0.54	0.78	0.51	0.53	0.47	0.34	0.57	0.56	0.06	0.47	0.57	0.48		
JPN	0.56	0.55	0.44	0.45	1.00	0.32	0.49	0.50	0.54	0.50	0.52	0.22	0.48	0.51	0.08	0.41	0.43	0.46		
MAL	0.44	0.48	0.37	0.37	0.32	1.00	0.40	0.67	0.45	0.42	0.33	0.29	0.61	0.39	0.12	0.41	0.46	0.46		
NOR	0.69	0.73	0.72	0.54	0.49	0.40	1.00	0.63	0.52	0.71	0.68	0.30	0.49	0.77	0.14	0.53	0.59	0.58		
SGP	0.63	0.69	0.54	0.78	0.50	0.67	0.63	1.00	0.59	0.59	0.57	0.36	0.71	0.63	0.07	0.53	0.64	0.62		
KOR	0.57	0.60	0.51	0.51	0.54	0.45	0.52	0.59	1.00	0.54	0.47	0.34	0.63	0.52	0.06	0.47	0.50	0.57		
SWE	0.78	0.68	0.76	0.53	0.50	0.42	0.71	0.59	0.54	1.00	0.74	0.29	0.42	0.78	0.11	0.49	0.58	0.57		
SWZ	0.72	0.66	0.75	0.47	0.52	0.33	0.68	0.57	0.47	0.74	1.00	0.22	0.43	0.78	0.10	0.37	0.54	0.60		
TWN	0.30	0.30	0.26	0.34	0.22	0.29	0.30	0.36	0.34	0.29	0.22	1.00	0.36	0.27	0.06	0.28	0.29	0.30		
THD	0.47	0.58	0.42	0.57	0.48	0.61	0.49	0.71	0.63	0.42	0.43	0.36	1.00	0.47	0.12	0.43	0.51	0.54		
GBP	0.79	0.74	0.75	0.56	0.51	0.39	0.77	0.63	0.52	0.78	0.78	0.27	0.47	1.00	0.09	0.47	0.62	0.58		
CHN	0.02	0.11	0.10	0.06	0.08	0.12	0.14	0.07	0.06	0.11	0.10	0.06	0.12	0.09	1.00	0.10	0.05	0.12		
INDa	0.47	0.55	0.45	0.47	0.41	0.41	0.53	0.53	0.47	0.49	0.37	0.28	0.43	0.47	0.10	1.00	0.49	0.45		
MEX	0.67	0.62	0.55	0.57	0.43	0.46	0.59	0.64	0.50	0.58	0.54	0.29	0.51	0.62	0.05	0.49	1.00	0.48		
NZD	0.53	0.76	0.58	0.46	0.46	0.46	0.58	0.62	0.57	0.57	0.60	0.30	0.54	0.58	0.12	0.45	0.48	1.00		
2006-2023																				
	USA	AUS	DKK	HKD	JPN	MAL	NOR	SGP	KOR	SWE	SWZ	TWN	THD	GBP	CHN	INDa	MEX	NZD		
USA	1.00	0.71	0.58	0.66	0.60	0.72	0.71	0.73	0.81	0.78	0.26	0.57	0.82	0.83	0.68	0.55	0.17	0.57	0.71	0.38
AUS	0.79	1.00	0.73	0.64	0.62	0.70	0.80	0.79	0.73	0.79	0.77	0.27	0.69	0.79	0.12	0.69	0.80	0.79	0.74	0.78
DKK	0.71	0.73	1.00	0.49	0.58	0.64	0.75	0.66	0.72	0.85	0.80	0.24	0.56	0.78	0.14	0.56	0.60	0.67	0.77	0.80
HKD	0.58	0.64	0.61	1.00	0.54	0.61	0.80	0.66	0.57	0.54	0.32	0.64	0.64	0.16	0.67	0.53	0.53	0.62	0.54	0.57
JPN	0.62	0.56	0.54	1.00	0.52	0.39	0.61	0.60	0.63	0.63	0.22	0.57	0.61	0.10	0.48	0.52	0.54	0.63	0.58	0.60
MAL	0.40	0.70	0.64	0.61	1.00	0.67	0.73	0.71	0.69	0.61	0.31	0.61	0.64	0.67	0.71	0.51	0.61	0.66	0.62	0.61
NOR	0.72	0.80	0.75	0.63	0.59	0.67	1.00	0.76	0.70	0.78	0.72	0.29	0.65	0.81	0.13	0.62	0.61	0.64	0.82	0.76
SGP	0.71	0.79	0.66	0.80	0.61	0.75	0.76	1.00	0.77	0.77	0.71	0.27	0.75	0.71	0.11	0.68	0.73	0.75	0.81	0.79
KOR	0.73	0.75	0.72	0.66	0.71	0.70	0.77	0.77	1.00	0.76	0.68	0.37	0.71	0.71	0.09	0.63	0.68	0.68	0.75	0.71
SWE	0.81	0.79	0.85	0.67	0.63	0.69	0.78	0.74	0.76	1.00	0.85	0.25	0.61	0.83	0.17	0.59	0.87	0.70	0.81	0.81
SWZ	0.78	0.77	0.80	0.58	0.61	0.61	0.72	0.68	0.68	0.85	1.00	0.18	0.54	0.82	0.12	0.56	0.65	0.70	0.83	0.83
TWN	0.26	0.27	0.24	0.32	0.22	0.25	0.29	0.35	0.37	0.25	0.28	1.00	0.30	0.25	0.28	0.24	0.23	0.28	0.24	0.23
THD	0.57	0.69	0.56	0.64	0.52	0.70	0.65	0.71	0.61	0.54	0.36	1.00	0.61	0.17	0.63	0.63	0.59	0.63	0.63	0.57
GBP	0.80	0.79	0.78	0.64	0.61	0.65	0.81	0.73	0.83	0.82	0.82	0.36	1.00	0.88	0.04	0.78	0.82	0.85	0.75	0.79
CHN	0.04	0.12	0.14	0.16	0.10	0.14	0.13	0.12	0.09	0.11	0.12	0.03	0.13	1.00	0.07	0.15	0.15	0.16	0.15	0.11
INDa	0.57	0.65	0.56	0.67	0.48	0.64	0.62	0.73	0.63	0.59	0.54	0.24	0.63	0.59	0.07	1.00	0.58	0.57	0.63	0.58
MEX	0.67	0.69	0.60	0.53	0.52	0.56	0.61	0.71	0.58	0.67	0.65	0.25	0.63	0.67	0.69	0.71	1.00	0.55	0.70	0.63
NZD	0.62	0.80	0.67	0.53	0.54	0.54	0.66	0.67	0.66	0.65	0.65	0.31	0.64	0.58	0.58	0.62	0.58	1.00	0.67	0.64
AUT	0.77	0.79	0.77	0.62	0.61	0.64	0.82	0.77	0.71	0.81	0.82	0.24	0.63	0.85	0.15	0.65	0.83	0.85	0.70	0.87
BRL	0.73	0.74	0.80	0.58	0.58	0.61	0.76	0.71	0.71	0.81	0.83	0.23	0.63	0.83	0.16	0.58	0.63	0.68	0.83	1.00
EUR	0.78	0.78	0.81	0.57	0.60	0.74	0.68	0.74	0.85	0.82	0.19	0.57	0.82	0.15	0.61	0.65	0.66	0.82	0.80	0.87
FIN	0.82	0.78	0.79	0.59	0.66	0.64	0.78	0.73	0.75	0.86	0.87	0.20	0.59	0.88	0.11	0.59	0.69	0.65	0.88	0.85
GER	0.83	0.78	0.80	0.67	0.67	0.67	0.75	0.74	0.86	0.82	0.24	0.62	0.81	0.63	0.71	0.65	0.66	0.82	0.85	0.93
HKD	0.58	0.57	0.59	1.00	0.56	0.41	0.71	0.63	0.67	0.63	0.55	0.29	0.77	0.60	0.10	0.66	0.64	0.64	0.64	0.62
IND	0.71	0.66	0.75	0.40	0.51	0.55	0.56	0.65	0.76	0.73	0.18	0.30	0.78	0.12	0.45	0.54	0.58	0.78	0.78	0.77
ITA	0.71	0.72	0.74	0.52	0.60	0.61	0.73	0.66	0.68	0.77	0.71	0.54	0.82	0.13	0.56	0.67	0.59	0.83	0.77	0.81
JPN	0.81	0.78	0.83	0.59	0.66	0.66	0.72	0.76	0.78	0.88	0.26	0.61	0.85	0.14	0.59	0.67	0.68	0.86	0.86	0.85
KOR	0.81	0.77	0.73	0.53	0.58	0.62	0.75	0.66	0.72	0.76	0.17	0.58	0.75	0.13	0.58	0.63	0.62	0.81	0.76	0.75
NZD	0.68	0.70	0.68	0.55	0.62	0.61	0.70	0.67	0.66	0.73	0.76	0.17	0.54	0.79	0.14	0.55	0.66	0.58	0.81	0.78
PER	0.53	0.71	0.50	0.58	0.47	0.67	0.71	0.62	0.57	0.54	0.52	0.25	0.55	0.53	0.57	0.61	0.46	0.53	0.57	0.61
RUS	0.57	0.62	0.58	0.39	0.46	0.55	0.67	0.59	0.57	0.59	0.51	0.29	0.57	0.56	0.55	0.50	0.53	0.57	0.61	0.44
SAR	0.71	0.71	0.78	0.53	0.53	0.66	0.69	0.77	0.75	0.73	0.63	0.27	0.75	0.69	0.31	0.67	0.80	0.81	0.81	0.80
SEK	0.85	0.81	0.84	0.38	0.35	0.36	0.45	0.44	0.41	0.48	0.11	0.37	0.43	0.16	0.37	0.38	0.55	0.45	0.47	0.51
TWN	0.61	0.62	0.59	1.00	0.53	0.61	0.70	0.67	0.68	0.69	0.31	0.55	0.70	0.10	0.62	0.62	0.79	0.66	0.71	0.67
USD	0.68	0.78	0.59	0.67	0.53	0.72	0.70	0.71	0.73	0.82	0.20	0.57	0.80	0.77	0.51	1.00	0.71	0.80	0.80	0.81
TUR	0.46	0.57	0.47	0.40	0.58	0.51	0.61	0.55	0.55	0.46	0.15	0.54	0.52	0.07	0.59	0.48	0.57	0.53	0.54	0.53

There are many studies that measure the ebb and flow of international correlations, such as Longin and Solnik (1995), Longin and Solnik (2001), and Goetzmann et al. (2005); most, like Campbell et al. (2002), demonstrate that correlations rise in bear markets and decline in economic expansions. Studies like that of Das et al. (2019) show that correlations spike and converge rapidly over short periods around global crises. Many studies document that the increase in correlations primarily between the U.S. and Europe, but less for Asian economies, is mostly attributable to the convergence in economic value fundamentals (e.g., Baele et al. (2010), Baele and Soriano (2010), and Barberis et al. (2005)).

Our correlation statistics reflect many of these trends: a slight increase of developed countries' correlations (USA-DKK 0.69 to 0.71, UAS-AUS 0.71 to 0.79), relatively low correlations within Asia (CHN-INDa 0.1, INDa-TWN 0.28), and also low correlations between Asia and Europe (THD-SWE 0.42) and the U.S. (USA-TWN 0.3) Some of these trends are likely to explain our results. For example, if the U.S. is increasingly more integrated with Europe, but not so much with Asia and Oceania, then if European peripheral economies can offer attractive means, then we would expect a substitution of an allocation to the U.S. for Norway and Switzerland, but not Germany or France, and to Australia or Taiwan. What is most remarkable in Table 2, however, is how stable the long-term correlation structure of the world is.

Mean-Variance Diversification with International Indices

To determine the mean-variance efficient frontier of risky assets, the quadratic optimizer solves a Lagrangian (optimization with constraints), maximizing the mean portfolio return subject to three conditions: the portfolio standard deviation is equal to a set level, the sum of the weights is one, and the weights are non-negative, i.e., the efficient portfolios are long-only. Given the restricted domain of weights, one is likely to obtain corner solutions with many zero weights. Intuitively, what that means is that some indices' means are so low and correlations so high that they are statistically dominated by other (better) choices. Only allowing short positions would lead to non-corner solutions being optimal with all weights non-zero. For tangent portfolio optimizations, we maximize the Sharpe ratio, i.e., the excess return (return minus the deposit rate) divided by the standard deviation or the slope in the mean–standard deviation space. The tangent maximization determines the one and only efficient portfolio that a U.S. investor should allocate to in the second step of a two-step wealth maximization

decision, first deciding between the risk-free and the risky allocation, and then determining the composition of the risky part.

Figure 1 shows three panels of the restricted (long-only) efficient frontiers over different subperiods of 1995–2023, each with different index universe corresponding to the availability of data. The means and standard deviations are non-annualized monthly. The graphs include the U.S.-only portfolio and three “logically” weighted world portfolios that mimic the relative sizes of countries in the world: nominal GDP, PPP GDP, and market caps of the individual equity markets. The other allocations marked are the minimum variance (for reference only) and the tangent (highest Sharpe ratio) portfolio (the optimal for the historical period).

Apart from the tangent, the different portfolios appear to be clustered together. There are several important findings here. First, the Sharpe ratios—the slopes in the standard deviation vs. mean space—for the tangent on one hand and the other clustered points on the other hand are very different. So, there is a benefit to constructing optimized portfolios relative to naïve GDP or cap market weighting. Second, among the naïve choices, the exact weighting, whether by GDP or market cap, does not make a huge difference, but GDP weighting seems to outperform market cap weighting, when looking at the slopes of the imaginary capital allocation lines connecting the origin and each point. This is an important action prescription. Investors should resist chasing relative valuations in the stock markets and focus on the global economic size of each geography. Third, the U.S.-biased portfolio is by far the worst, adding risk for zero gain in the long-term mean.

The graphs tell a lot of the story, but not all. The numbers in Tables 3–5 do it better.

Tables 3–5 show the outcomes—the means, standard deviations, Sharpe ratios, and composition (the weights of countries) for the minimum variance, the tangent “market,” the U.S.-only portfolio, and the efficient portfolio with the same standard deviation as the U.S., as well as nominal GDP, PPP GDP, and market cap-weighted portfolios.

Tables 3–5 prove that a U.S. investor should not build home-biased portfolios. We quantify the loss of efficiency by solving for the efficient portfolio with the same risk, shown side by side. The give-up in mean return is 0.15% for the whole 1995–2023 period and 0.27% per month for the 2006–2023 period, the data that has more countries available. That is approximately 3% per year.

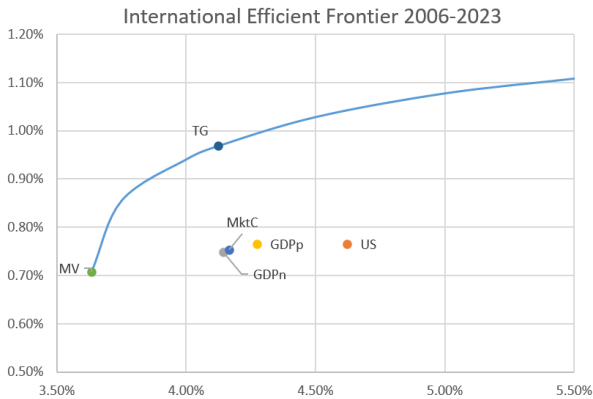
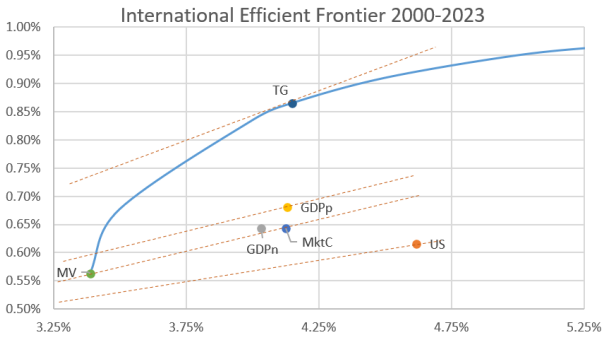
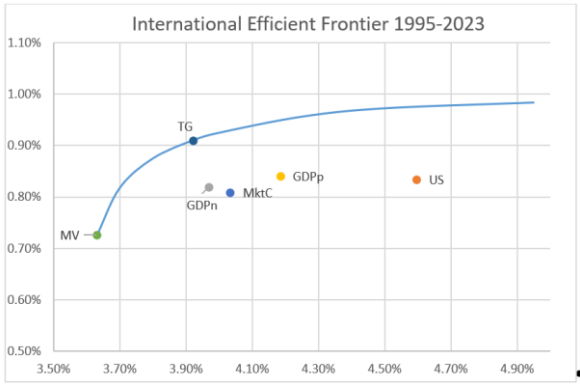


Figure 1. International frontiers for subperiods of 1995–2023. Dotted lines indicate capital allocation lines. MV, minimum variance; TG, tangent “market”; GDPn, nominal GDP; GDPp, PPP GDP; MktC, market-cap portfolio; US, U.S. only portfolio.

In Table 3, the tangent's allocations to the U.S., China, and India are similar to the nominal GDP weights (U.S. 0.3642 in TG vs. 0.3982 in GDPn, CHN 0.2258 vs. 0.2809, INDa 0.0814 vs. 0.0529), but the extra reward to risk premium comes from overallocations to Denmark (0.10), Switzerland (0.0348), Mexico (0.0837), and New Zealand (0.10). The exact countries are likely to be period-specific, but the message is clear: allocate proportionately to the U.S., China, but a little less, and use that to allocate to U.S. and European periphery economies. You gain a little risk reduction because of imperfect correlation but do not give up the mean because of the integration of the satellites.

	MV	TG	US	Eff	GDPn	GDPp	MktC
Mean	0.73%	0.91%	0.83%	0.98%	0.82%	0.84%	0.81%
StDev	3.63%	3.92%	4.60%	4.60%	3.97%	4.18%	4.03%
Sharpe	0.1724	0.2066	0.1596	0.1907	0.1811	0.1769	0.1758
USA	0.2804	0.3642	1.0000	0.0500	0.3982	0.2752	0.5532
AUS	0.0000	0.0000	0.0000	0.0170	0.0262	0.0198	0.0192
DKK	0.0446	0.1000	0.0000	0.1000	0.0062	0.0047	0.0075
HKD	0.0000	0.0000	0.0000	0.0000	0.0056	0.0055	0.0442
JPN	0.1500	0.0000	0.0000	0.0000	0.0662	0.0616	0.0610
MAL	0.0433	0.0000	0.0000	0.0000	0.0064	0.0123	0.0049
NOR	0.0000	0.0000	0.0000	0.1000	0.0091	0.0068	0.0033
SGP	0.0000	0.0000	0.0000	0.0000	0.0073	0.0081	0.0073
KOR	0.0000	0.0000	0.0000	0.0000	0.0260	0.0279	0.0242
SWE	0.0000	0.0000	0.0000	0.1000	0.0092	0.0073	0.0102
SWZ	0.1000	0.0348	0.0000	0.0000	0.0126	0.0079	0.0223
TWN	0.0000	0.0102	0.0000	0.0733	0.0114	0.0168	0.0224
THD	0.0000	0.0000	0.0000	0.0000	0.0077	0.0160	0.0061
GBP	0.1000	0.0000	0.0000	0.0000	0.0480	0.0418	0.0314
CHN	0.1817	0.2258	0.0000	0.3098	0.2809	0.3277	0.1213
INDa	0.0000	0.0814	0.0000	0.1500	0.0529	0.1283	0.0557
MEX	0.0000	0.0837	0.0000	0.1000	0.0221	0.0296	0.0045
NZD	0.1000	0.1000	0.0000	0.0000	0.0039	0.0026	0.0015

Weights shown as decimals.

Table 4's subperiod starts with the tech bubble bursting in 2000–2001, depressing the U.S. mean and therefore dropping the U.S. from the tangent altogether. The U.S. is not replaced by Continental Europe or the U.K., but rather by Australia, Denmark, Norway, Switzerland, Mexico, and New Zealand. The allocations to China and India are in line with their GDP weights; they are relatively much higher than Indonesia and

Table 4. Optimal portfolio allocations 2000-2023							
	MV	TG	US	Eff	GDPn	GDPp	MktC
Mean	0.56%	0.87%	0.62%	0.93%	0.64%	0.68%	0.64%
StDev	3.39%	4.15%	4.62%	4.62%	4.03%	4.13%	4.13%
Sharpe	0.1366	0.1844	0.1117	0.1787	0.1346	0.1406	0.1315
USA	0.1945	0.0000	1.0000	0.0000	0.3101	0.2067	0.4916
AUS	0.0000	0.1000	0.0000	0.1000	0.0204	0.0148	0.0170
DKK	0.0000	0.1000	0.0000	0.1000	0.0048	0.0035	0.0066
HKD	0.0000	0.0000	0.0000	0.0000	0.0044	0.0041	0.0393
JPN	0.1500	0.0000	0.0000	0.0000	0.0515	0.0463	0.0542
MAL	0.1000	0.0000	0.0000	0.0000	0.0049	0.0092	0.0043
NOR	0.0000	0.0229	0.0000	0.1000	0.0071	0.0051	0.0029
SGP	0.0000	0.0000	0.0000	0.0000	0.0057	0.0061	0.0065
KOR	0.0000	0.0000	0.0000	0.0000	0.0203	0.0210	0.0215
SWE	0.0000	0.0000	0.0000	0.0000	0.0071	0.0055	0.0090
SWZ	0.1000	0.1000	0.0000	0.0000	0.0098	0.0060	0.0198
TWN	0.0000	0.0388	0.0000	0.0839	0.0089	0.0126	0.0199
THD	0.0000	0.0000	0.0000	0.0000	0.0060	0.0120	0.0054
GBP	0.0415	0.0000	0.0000	0.0000	0.0374	0.0314	0.0279
CHN	0.1709	0.2166	0.0000	0.1671	0.2188	0.2462	0.1078
INDa	0.0000	0.0812	0.0000	0.1500	0.0412	0.0964	0.0495
MEX	0.0000	0.0845	0.0000	0.0904	0.0172	0.0223	0.0040
NZD	0.1000	0.1000	0.0000	0.1000	0.0030	0.0019	0.0013
AUT	0.0000	0.0000	0.0000	0.0087	0.0057	0.0050	0.0013
BEL	0.0000	0.0000	0.0000	0.0000	0.0070	0.0062	0.0032
FIN	0.0000	0.0000	0.0000	0.0000	0.0034	0.0027	0.0002
FRA	0.0000	0.0000	0.0000	0.0000	0.0339	0.0306	0.0280
GER	0.0000	0.0000	0.0000	0.0000	0.0496	0.0431	0.0226
INSa	0.0000	0.0828	0.0000	0.1000	0.0161	0.0328	0.0075
IRE	0.0000	0.0000	0.0000	0.0000	0.0064	0.0052	0.0011
ITA	0.0000	0.0000	0.0000	0.0000	0.0245	0.0248	0.0074
NED	0.0000	0.0000	0.0000	0.0000	0.0121	0.0100	0.0158
POR	0.0000	0.0000	0.0000	0.0000	0.0031	0.0035	0.0006
ESP	0.0000	0.0000	0.0000	0.0000	0.0170	0.0177	0.0090
BRZ	0.0000	0.0000	0.0000	0.0000	0.0234	0.0311	0.0098
EGP	0.1000	0.0000	0.0000	0.0000	0.0058	0.0136	0.0004
PHL	0.0430	0.0731	0.0000	0.0000	0.0049	0.0095	0.0027
PLN	0.0000	0.0000	0.0000	0.0000	0.0084	0.0132	0.0018

Weights shown as decimals.

the Philippines. One should not of course read that Indonesia, or the Philippines, are special bullets, but rather proxies for Southeast Asia

(perhaps over India). The GDP and market cap-weighted portfolios exhibit the same means as the U.S. portfolio, but they are less risky.

Table 5 is probably the most informative. It covers the most recent 17 years and has the most (37) countries represented. The allocation to the U.S. is almost identical to its nominal GDP weight (0.3377 vs. 0.3038) and the allocation to China is a bit higher than its PPP-GDP weight (0.3008 vs. 0.2143), both countries carrying approximately 30% allocations. Indonesia and the Philippines again appear with above GDP weights, jointly accounting for 17% while India's allocation is zero. Denmark, Switzerland, and Taiwan represent another 17%. In real life, this likely suggests that the U.S. investor should not look to increase the

Table 5. Optimal Portfolio Allocations 2006-2023							
Feb-06	MV	TG	US	Eff	GDPn	GDPp	MktC
Mean	0.71%	0.97%	0.77%	1.04%	0.75%	0.77%	0.75%
StDev	3.63%	4.12%	4.62%	4.62%	4.14%	4.27%	4.17%
Sharpe	0.1673	0.2106	0.1439	0.2039	0.1566	0.1557	0.1569
USA	0.3035	0.3377	1.0000	0.1374	0.3038	0.1981	0.4851
AUS	0.0000	0.0000	0.0000	0.0000	0.0200	0.0142	0.0168
DKK	0.0055	0.1000	0.0000	0.1000	0.0047	0.0034	0.0065
HKD	0.0372	0.0000	0.0000	0.0000	0.0043	0.0039	0.0388
JPN	0.1500	0.0000	0.0000	0.0000	0.0505	0.0444	0.0535
MAL	0.1000	0.0000	0.0000	0.0000	0.0048	0.0088	0.0043
NOR	0.0000	0.0000	0.0000	0.0000	0.0069	0.0049	0.0029
SGP	0.0000	0.0000	0.0000	0.0000	0.0056	0.0059	0.0064
KOR	0.0000	0.0000	0.0000	0.0000	0.0199	0.0201	0.0213
SWE	0.0000	0.0000	0.0000	0.0000	0.0070	0.0053	0.0089
SWZ	0.1000	0.0060	0.0000	0.0000	0.0096	0.0057	0.0196
TWN	0.0024	0.0681	0.0000	0.1000	0.0087	0.0121	0.0196
THD	0.0092	0.0000	0.0000	0.0000	0.0059	0.0115	0.0053
GBP	0.0573	0.0000	0.0000	0.0000	0.0366	0.0301	0.0276
CHN	0.1860	0.3008	0.0000	0.4026	0.2143	0.2359	0.1064
INDa	0.0000	0.0000	0.0000	0.0600	0.0404	0.0924	0.0488
MEX	0.0010	0.0000	0.0000	0.0000	0.0169	0.0213	0.0039
NZD	0.0048	0.0121	0.0000	0.0000	0.0029	0.0018	0.0013
AUT	0.0000	0.0000	0.0000	0.0000	0.0056	0.0048	0.0013
BEL	0.0000	0.0000	0.0000	0.0000	0.0069	0.0059	0.0031
FIN	0.0000	0.0001	0.0000	0.0000	0.0034	0.0026	0.0002
FRA	0.0000	0.0000	0.0000	0.0000	0.0332	0.0293	0.0276
GER	0.0000	0.0000	0.0000	0.0000	0.0486	0.0413	0.0223
INSa	0.0000	0.0753	0.0000	0.1000	0.0157	0.0314	0.0074
IRE	0.0000	0.0000	0.0000	0.0000	0.0063	0.0050	0.0011

ITA	0.0000	0.0000	0.0000	0.0000	0.0240	0.0237	0.0073
NED	0.0000	0.0000	0.0000	0.0000	0.0118	0.0096	0.0156
POR	0.0014	0.0000	0.0000	0.0000	0.0030	0.0033	0.0006
ESP	0.0000	0.0000	0.0000	0.0000	0.0167	0.0170	0.0089
BRZ	0.0000	0.0000	0.0000	0.0000	0.0229	0.0298	0.0097
EGP	0.0030	0.0000	0.0000	0.0000	0.0057	0.0130	0.0004
PHL	0.0388	0.1000	0.0000	0.1000	0.0048	0.0091	0.0027
PLN	0.0000	0.0000	0.0000	0.0000	0.0082	0.0126	0.0017
GRE	0.0000	0.0000	0.0000	0.0000	0.0026	0.0030	0.0005
HUN	0.0000	0.0000	0.0000	0.0000	0.0021	0.0032	0.0003
RSA	0.0000	0.0000	0.0000	0.0000	0.0048	0.0074	0.0103
TUR	0.0000	0.0000	0.0000	0.0000	0.0108	0.0281	0.0023

Weights shown as decimals.

domestic allocation but should perhaps look to the smaller, very open, developed, peripheral European economies, not necessarily the more integrated eurozone. It also demonstrates the benefits of exposure to Southeast Asia, and the lack of benefits of exposure to India.

Main Themes and Implications for Investors and Advisors

This study is clearly bound by the available index data and is backward looking in time. Its country allocation results are surely period specific. Yet there are very clear lessons for how to think about international portfolio allocation.

The first and foremost is that the U.S. home bias is harmful. It lowers the long-term mean and increases the standard deviation of the return relative to all international allocations. The U.S.-only portfolio performs the worst, and the U.S.-biased portfolio based on market caps performs worse than based on GDP weighting.

The second theme is the importance of China and emerging Southeast Asia over India. The tangent and the minimum-variance portfolios over 2006–2023 have an overweight in China and Indonesia, or, if not in China then in Malaysia, Japan, and Taiwan. India does not show in either. One can only speculate about the causes: investability; state control; supply chain power. The global decoupling from China, and the opening of India could potentially exacerbate the effect even more.

The third theme is perhaps that the U.S. investor instead of overallocating to the U.S. should consider developed non-eurozone economies like Denmark and Switzerland, as well as Australia and New

Zealand. Their openness and relative nonintegration with other blocs may account for their complementary risk–reward attractiveness.

Until the Covid-19 pandemic, the world was integrating. The Economist (2019) cited 41 economies with identical inflation-targeting responses post-2008. As evidenced by Ha et al. (2019), many emerging markets joined the developed world in overcoming inflation, and 13 emerging-market countries' central banks followed the U.S. Fed policy in lockstep in 2016–2019. Prices in the global economy were sticky, the price formation process was global, and the cyclicity was gone, with producer firms adjusting margins to absorb shocks. Costs passing through cross-border supply chains accounted for 50% of producer–price inflation, according to Auer et al. (2017). As of 2024, the integrating globalization forces have gone away as the S&P Global (2023) survey outlines. We are now in a period of tech rivalry, declining cross-border investment, competing monetary blocs, supply chains separating, and political strife. This will likely translate into a decline in stock market correlations and perhaps lower return means. The role of diversification across geographies is only likely to grow.

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Deployment and Analysis of High-Altitude Pico Balloon

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ABSTRACT

As part of a Mechanical Engineering Capstone project at Southern Utah University (SUU), we successfully launched three pico helium balloons from Cedar City, Utah. The mission goal was to analyze and predict the static and dynamic behavior of the balloon throughout its ascent. Using one-dimensional theoretical models, we predicted parameters such as temperature, pressure, altitude, ascending velocity, floating altitude, and buoyancy force. Weak signal propagation reporter tracking methods were used to monitor the balloon's location and showed that the balloon reached a maximum altitude of 40,000 feet, closely matching our predicted values. The strong correlation between our theoretical analysis and launch data validated our models, demonstrating the effectiveness of our approach. The procedure for balloon preparation and launch has been developed and documented. This project serves as a foundation for future high-altitude balloon research and engineering applications at SUU.

NOMENCLATURE

$a_t = \frac{d^2y}{dt^2}$	Instantaneous vertical acceleration at t (m/s ²)
A_c	Cross-sectional area (m ²)
C_d	Drag coefficient
F_b	Buoyancy force (kg)
F_d	Drag force (N)
F_L	Free lift (kg)
g	Gravitational acceleration (m/s ²)
h	Altitude (m)
m_b	Mass of balloon (kg)
m_p	Mass of payload (kg)
m_{He}	Mass of helium (kg)
N_L	Neck lift (kg)
P_{af}	Air pressure at float altitude (kPa)
P_{bf}	Helium pressure at float altitude (kPa)
P_{b0}	Helium pressure at launch altitude (kPa)
R	Ideal gas constant (kPa·m ³ /kg·K)
Re	Reynold's number
T_f	Temperature at float altitude (K)
T_o	Temperature at launch altitude (K)
V_{bf}	Volume of the balloon at float altitude (m ³)
V_{b0}	Volume of the balloon at launch altitude (m ³)
V_{b-h}	Volume of the balloon at h altitude (m ³)
$Vel_t = \frac{dy}{dt}$	Instantaneous ascending velocity at t (m/s)
$V_{full} = V_f$	Balloon's fully inflated volume (m ³)
ρ	Density (kg/m ³)
ρ_{a0}	Air density at launch altitude (kg/m ³)
ρ_{a-f}	Air density at float altitude (kg/m ³)
ρ_{He0}	Helium density at launch altitude (kg/m ³)
μ	Dynamic viscosity (Pa.s)
ν	Kinematic viscosity of air (m ² /s).
ΔP	Pressure difference needed to maintain a stable altitude or superpressure due to free lift (kPa)

INTRODUCTION

Pico ballooning is the practice of flying balloons using small and light payloads. Typical weather balloons burst at their float altitude, meaning that they provide data for only a short period of time. However, in pico ballooning, balloons are usually superpressure balloons that expand while rising to float altitude and can resist the differential pressure at float altitude. These balloons fly for longer time than

traditional weather balloons. As a result, they can achieve extended flight durations, enabling long-term data acquisition.

The literature is rich in technical information on ballooning. This section discusses the most relevant articles. Lally [1] provides the comprehensive status of superpressure balloon technology. His notes include balloon shapes, stresses, free lift, balloon stability, testing techniques, and equations for balloon design and performance. McKinney et al. [2] launched 8 pico balloons from Neumayer Station III, yielding valuable insights into the Antarctic stratospheric wind structure. They explored the pressure-testing process and deployment techniques for pico balloons, showcasing their transformation from inexpensive party balloons (costing less than \$20) into efficient superpressure balloons to promote the application of pico balloons to a wider scientific community by demonstrating their usefulness. Voss et al. [3] compared theoretical data with several balloon flights, starting from the basic equations of motion in a viscous fluid. Differential heat transfer and drag were also taken into account, and they utilized a dynamic Excel database to evaluate the lift force and the payload mass. NASA has done much research on the Earth's atmosphere and produced the standard atmosphere, which includes equations defining various parameters (density, atmospheric pressure, and temperature) as a function of altitude [4]. Morrison [5] determined the drag coefficient as a function of Reynold's number for a sphere in uniform flow (details in Appendix A).

The Cedar Stratos balloon project at Southern Utah University (SUU) had two primary objectives. The first goal was to accurately create a one-dimensional (1D) model of the balloon's static and dynamic behavior and calculate parameters such as float altitude, float pressure differential, superpressure altitude, and ascending rate. The second objective was to systematically document the entire process for launching the pico balloon, including preparation, testing, and launch procedures. To validate the theoretical models, 3 identical pico balloons were launched.

THEORY AND MODELING

Static Analysis

Many parameters need to be considered to have a successful balloon launch. The two main parameters are the float altitude, where the balloon is at neutral buoyancy, and the float pressure, which is the gauge pressure inside the balloon when it is at float altitude. Determining the float pressure allows the balloon to be pressure tested before launch. The float gauge pressure for a pico balloon is typically ~ 0.3 psig, so most

balloons are pressure tested to 0.4 psig. This is discussed further in the Procedure section below.

Neutral buoyancy occurs when the density of the air is equal to the overall density of the balloon and its payload. To determine the overall balloon density, the amount of helium in the balloon must be determined. This is calculated using a parameter called free lift.

Free lift is the net lift a balloon has available at launch altitude beyond what is needed to maintain neutral buoyancy. It is essentially, at the launch altitude, the excess buoyancy of the balloon, caused by the difference between the weight of the displaced air and the combined weight of the balloon system (combining the masses of the balloon, the lifting gas, and the payload). It should be noted that because all of the forces in this system are functions of the gravitational acceleration g (m/s^2), this constant is divided out of the static sum-of-forces equation for the balloon at launch. Therefore, the units of free lift, F_L , are typically given in kilograms. F_L may be expressed as [2, p. 8]

$$F_L = (\rho_{a0} - \rho_{He0})V_{b0} - (m_b + m_p) \quad (1)$$

where m_b is the mass of the balloon (kg), m_p is the mass of payload (kg), ρ_{a0} is the air density at the launch altitude (kg/m^3), ρ_{He0} is the helium density at the launch altitude (kg/m^3), and V_{b0} is the volume of balloon at the launch altitude (m^3). For a pico balloon, F_L is typically 6-7 grams [2, p. 10]. Given all other parameters, V_{b0} can be calculated by solving Eq. (1) for V_{b0} , as

$$V_{b0} = \frac{F_L + m_b + m_p}{\rho_{a0} - \rho_{He0}} \quad (2)$$

Once V_{b0} is evaluated, the total density of the balloon at float can be evaluated as [2, p. 8]

$$\rho = \frac{m_b + m_p + V_{b0}\rho_{He0}}{V_f} \quad (3)$$

Once the total system density is known, the NASA atmosphere model [4] can be used to determine ρ_{a-f} the altitude where the atmosphere is at the same density as the balloon, which is the float altitude. The temperature and pressure of the atmosphere at this altitude can also be determined using data provided by NASA.

To determine the float gauge pressure, the internal pressure of the buoyancy gas (in our case helium) in the balloon must be determined. The ideal gas (IG) law may be used [6, p. 456]

$$\frac{P_{b0}V_{b0}}{T_0} = \frac{P_{bf}V_{bf}}{T_f} \quad (4)$$

where P_{b0} is the atmospheric pressure at launch [kPa], T_0 is the temperature at launch (K), V_{bf} is the balloon volume at float altitude (m^3), and T_f is the temperature at float altitude (K).

Once the internal pressure of the helium is evaluated, the float gauge pressure is simply calculated as the difference between the balloon float pressure and the atmospheric pressure (represented as P_{af}) at that altitude.

$$\Delta P_f = P_{bf} - P_{af} \quad (5)$$

The final calculated parameter of the static analysis is the superpressure altitude. This is the altitude where the balloon reaches its maximum volume and the ascending rate slows significantly. The balloon stops expanding because the pressure inside the balloon is equal to the atmospheric pressure, so the superpressure altitude can be evaluated by determining the altitude where the atmospheric pressure is equal to the balloon float pressure, using the NASA atmospheric model.

The balloon must contain enough helium to create the desired free lift. Because it is easiest to fill the balloon without the payload attached, a parameter called neck lift (N_L), is defined as [2, p. 20]

$$N_L = F_L + m_p \quad (4)$$

Once the desired neck lift is evaluated, the balloon can be filled to the desired neck lift as described in the procedure. It should be noted that if the amount of buoyant gas is not sufficient to match the neck lift, the balloon will not reach the float altitude, because the altitude where air density and balloon system density match will be lower. If the amount of buoyant gas provides more lifting force than the neck lift, the balloon will overshoot the desired float altitude and experience a higher differential pressure at the new float altitude.

Dynamic Analysis

To perform the dynamic analysis of a balloon, all the forces on the balloon must be considered. Free-body diagrams of the balloon are shown in Figure 1.

By applying Newton's second law of motion ($F = ma$), the dynamic motion of the balloon is expressed as (a second-order ordinary differential equation) [2, p. 7]

$$\begin{aligned}
 (m_b + m_p + m_{He}) \frac{d^2 y}{dt^2} &= -(m_b + m_p + m_{He})g + F_b \\
 &\quad - F_d
 \end{aligned}
 \tag{7}$$

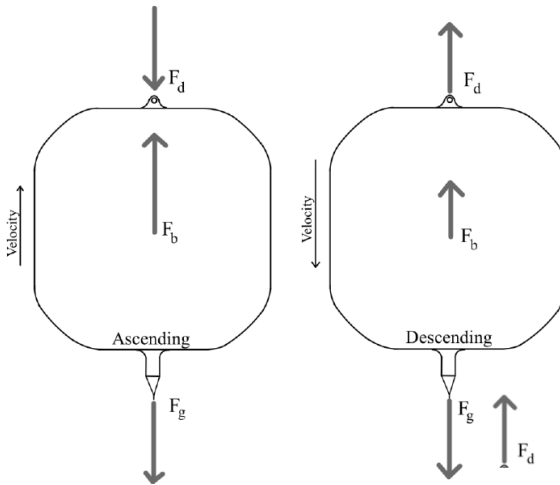


Figure 1. Free-body diagrams of ascending and descending balloons (not to scale).

where $\frac{d^2 y}{dt^2}$ is the vertical acceleration (m/s^2), and F_d is the drag force (N). It should be noted that Eq. (7) will be numerically solved in the dynamics analysis of the pico balloon. Next, the drag force is defined as [6, p. 434]

$$F_d = \frac{1}{2} C_d \rho_{a-h} A_c V_{b-h}^2 \tag{8}$$

where C_d is the drag coefficient, A_c is the balloon cross-section area (m^2), and V_{b-h} is the instantaneous ascending velocity (m/s). Note that we assumed the balloon is a sphere; therefore, the calculation is an approximation. Note that the ρ_{a-h} is evaluated from NASA data for a given h , and ρ_{He-h} from the IG law [6, p. 456]. At the h altitude, the buoyancy force is defined as [6, p. 95]

$$F_b = \rho_{a-h} g V_{b-h} \tag{9}$$

Note that V_{b-h} is a function of altitude, and may be calculated using the IG law. If we can assume constant acceleration over a short time step,

Δt (s), the changes in elevation Δh_t and velocity $\Delta Vel_t = \frac{dy}{dt}$ over Δt may be expressed as

$$\Delta h_t = Vel_t \Delta t + \frac{1}{2} a_t (\Delta t)^2 \quad (9)$$

$$\Delta Vel_t = a_t \Delta t \quad (10)$$

where a_t is $\frac{d^2y}{dt^2}$ (m/s²). Therefore, for any h_t and V_t ,

$$h_{new} = h_{old} + \Delta h_t \quad (11)$$

$$Vel_{new} = V_{old} + \Delta Vel_t \quad (12)$$

$$t_{new} = t_{old} + \Delta t \quad (13)$$

Now, we can march through time to reach zero ascending velocity at the float altitude.

In Eq (7), the only constant force is the force of gravity. The buoyancy force increases as the balloon expands, and the drag force changes as the balloon expands as the air properties change, and as the balloon accelerates.

The steps below are followed for each time step Δt to evaluate the dynamic motion of the balloon.

1. The density, temperature and pressure of the atmosphere at the balloon's current altitude are determined using the NASA model [4].
2. The volume of the balloon is calculated using the IG law. If using the IG law yields a volume greater than V_{full} , the balloon's volume is assumed to be the constant (maximum) volume. Balloon diameter and cross-sectional area are also evaluated.
3. The acceleration of the balloon is determined using Eq. (7).
4. The velocity and position at the end of the time step are determined using Eqs. (11) and (12).
5. The kinematic viscosity of the air is calculated using Sutherland's Law and the air density [7].
6. Reynolds number is calculated using kinematic viscosity, velocity, and balloon diameter.
7. Drag coefficient is calculated using the 2013 Morrison equation [5].
8. The time is incremented using Eq. (13).
9. Steps 1-8 are repeated until the balloon reaches float altitude.

MATERIALS

Table 1 presents the materials used in the balloon project.

Table 1. Required materials list				
Item	Qty	Brand	Model/Type	Vendor
Mylar balloon	3	PartyWoo	50-in aluminized mylar	Amazon.com
Fill tube	1	Evergreen	5/32 EVG225	Amazon.com
Fishing line	1	-	-	-
Fishing swivel clip	1	-	-	-
Traquito tracker board	2	Raspberry Pi	RP2040	Amazon.com
Solar panels	2	PowerFilm	MPT3.6-75	Mouser.com
Antenna wire	1	-	-	-
97% helium bottle	1	Party Factory	7 ft ³	Amazon.com
Pump	1	Etekcity	110-120V	Amazon.com
Scale	1	-	-	-
Paperclips	1	-	-	-
50g hooked weight	1	-	-	-
Flat clamp, rubber jaws	1	-	-	-
String	1	-	-	-
Aquarium air tubing	1	Aqua-life	Penn-Plax Standard	Amazon.com
Aquarium T connector and valve	1	Pawfly	2-way with T-shape connectors	Amazon.com
Small plastic bag	1	-	-	-
Polyamide tape	1	Bertech	1-mm thick	Amazon.com

PROCEDURE

In this section, the procedure for the pico balloon launching is discussed. The pressure testing, launch preparation, and launch parameters were determined based on experimenting with many pico balloons to determine the correct parameters such as maximum pressure, helium fill rate, and neck lift. For detailed information on the procedure, contact the authors.

Pressure Testing

Balloon is pressure tested to 0.4 psig. This pressure is slightly higher than the expected differential pressure at float (0.3 psig) previously calculated by Eq. (5). To pass this pressure test, the balloon must hold 0.4 psig \pm 0.1 psig for at least 2 hours. The pressure testing was performed following these steps:

1. Insert the fill tube. Ensure that the fill tube has cleared the end of the long internal section of the valve sleeve.
2. Inflate the balloon with air using the fill configuration of the pump (Fig. 2). Filling should be done at a reasonably slow rate to prevent stresses on the balloon. Continue until the pressure monitor reads the desired pressure.

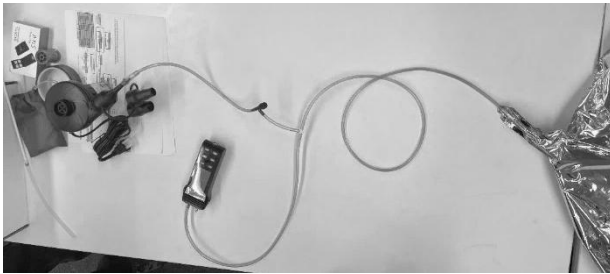


Figure 2. Fill apparatus in fill configuration.

3. Quickly remove the fill tube. Fold the neck of the balloon over itself so the valve opening is covered. Use a binder clip to hold the neck in the folded position.
4. Allow two hours for the balloon to hold the pressure.
5. Unfold the neck and reinsert the fill tube of the fill apparatus. Make sure the valve going to the pump is closed, and turn on the digital pressure gauge before inserting the fill tube. If the pressure in the balloon is above 0.2 psig, the balloon may be certified for flight.

Preparation and Filling

1. Evacuate the balloon of air using the evacuation configuration of the pump as instructed by the manufacturer of the pump. This evacuation is essential to prevent dilution of the helium in the balloon.

2. Prepare a bag of small masses that is approximately equal to the neck lift as determined by Eq. (4).
3. Clip the small bag of masses to the balloon, and fill the balloon with helium until it reaches approximately neutral buoyancy. This is indicated by the bag of masses attached to the balloon lifting slightly away from the workbench.
4. To more finely measure the balloon's neck lift, place a 50-g weight with a hook on the scale, along with the clip and string that used to be attached to the paperclip bag; then, tare the scale.
5. Reattach the clip to the balloon, and loop the string around the hook on the weight. The negative value read on the scale is equal to the current neck lift of the balloon. Slowly add or remove small amounts of helium, allowing the balloon to settle back into a stable position above the scale before reading the scale, as shown in Figure 3. Continue until the absolute value of the scale's reading is equal to the desired neck lift.



Figure 3. Precise neck lift measurement.

6. The flexible one-way valve sleeve is designed such that once the balloon is pressurized, the valve collapses, sealing the balloon. However, for additional protection from leaks, seal the valve with polyamide tape as shown in Figure 4.



Figure 4. Valve sealing.

7. Attach the balloon harness to the balloon, and secure with Kapton tape as shown in Figure 5.



Figure 5. Balloon harness attachment.

8. Affix the safety line to the balloon harness.

Launch

The launch location and activities should comply with local Federal Aviation Administration regulatory practices. The launch location and time should be selected to ensure minimal surface winds and precipitation. The launching was performed following these steps:

1. Holding the balloon stem and utilizing the safety line, take the balloon into the clear area at the launch site.
2. Lay out the payload on a tarp so that no lines are crossed or entangled. Carefully unspool the two dipole antennas to minimize sideways forces on the connection points.
3. Hold the tracker facing the sun. A small green LED on the tracker board will undergo a complex series of blinks as the tracker detects its current position and enters flight mode. Once the LED is blinking steadily, the tracker is ready for flight. If the tracker loses access to the sun, the startup sequence will automatically be repeated.
4. Attach the swivel on the payload to the swivel on the balloon.
5. Holding the payload and the balloon by the stem, detach the safety line.
6. Feed out the line a foot at a time, pausing if the balloon moves downward and resuming when the balloon recovers buoyancy. Continue until the line is completely deployed so only the tracker is being held.
7. Once the line is deployed, walk or run at approximately the wind speed towards the balloon so that the tracker is closer to vertically beneath the balloon.
8. At the point at which the balloon is lifting upward, release the line and allow the balloon to freely lift, as shown in Figure 6.



Figure 6. Balloon near point of release.

RESULTS AND DISCUSSION

During the SUU spring semester of 2025, three pico balloons were launched. These flights provided positional and altitude data over the course of each flight. The first balloon remained airborne for approximately 1 month, completing more than 2 full circumnavigations of the Earth before communication was lost. The second balloon flew for approximately 3 weeks and followed a similar trajectory to the first. The third balloon flew for approximately 9 days. See Appendix B for more information on SUU flights.

The first balloon followed a path near the equator for the majority of its flight. After initially moving south and spending some time in an eddy near South America, the balloon followed a tropical jet stream moving east. Balloon location was tracked and represented using Sondehub Amateur [8]. This map is shown in Figure 7.

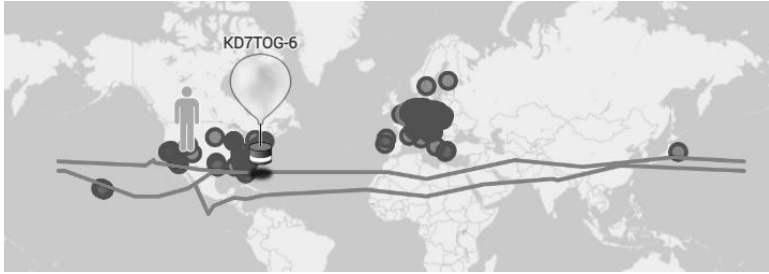


Figure 7. First balloon's flight path.

The first recorded altitudes and predicted altitudes for each balloon are shown in Table 2.

Table 2. Predicted and experimental flight altitudes			
Flight no.	Predicted altitude (ft)	Actual flight altitude (ft)	Percent error
1	37720	37270	1.2%
2	34573	34974	1.2%
3	34585	34646	0.2%

As the balloons were exposed to solar heating and cooling cycles over several days, they began to weaken, which allowed them to expand more than initially anticipated. This allowed the first balloon to reach an eventual maximum altitude of 40617 feet, 18 days after launch. The altitude of the first balloon throughout its journey is shown in Figure. Figure 8 was generated automatically as part of the weak signal

propagation reporter tracking software available from the Traquito group [9].

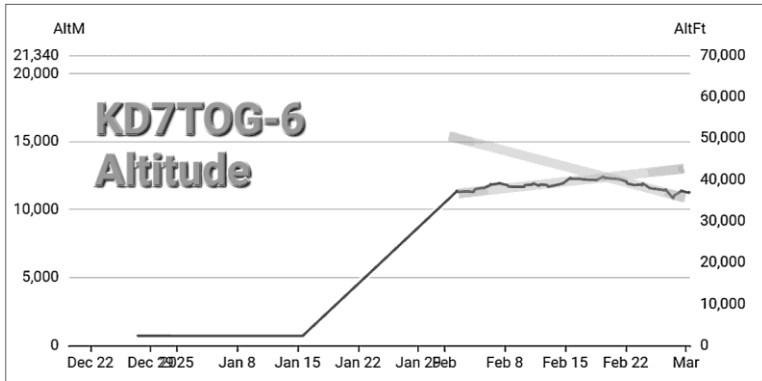


Figure 8. First balloon altitude over time.

As can be seen in Figure 8, the balloon's expansion leads to an increase in altitude over the first 18 days of the flight. The maximum altitude, 40617 ft, corresponds to a balloon volume of 0.277 m^3 . For reference, the original float volume was 0.209 m^3 . The balloon began losing helium at some point around this time, because the altitude began decreasing after this point. It is unclear what exactly caused the balloon to begin losing helium, but it is likely to be the same weakening of the balloon that led to the initial expansion.

Because the solar panels on the tracker face upwards, they work only when the sun is approximately above the balloon. This means that during the early spring of 2025, data was only received between the solar hours of approximately 10 a.m. and 2 p.m. During spring and summer, the balloons can transmit for longer, because there is more daylight.

Additionally, flight data revealed an apparent latitude boundary beyond which no transmissions were received. This boundary exists because of the decreasing solar angle at high latitudes. At these low angles, insufficient solar irradiance prevents the horizontally mounted onboard solar panels from generating enough power for the tracker to transmit signals. This transmission barrier is expected to move further north as the year progresses. The apparent transmission boundary for February 2025 is shown in Figure 9.

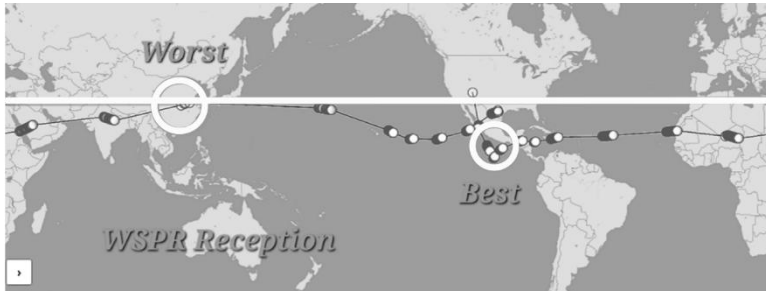


Figure 9. February transmission boundary.

The transmission boundary was not calculated exactly but is rather determined by observing when transmissions become sparse or stop occurring entirely. For example, the circle labeled “Worst” in Figure 9 contains relatively few transmissions during the typical transmission hours as compared with the number of transmissions in the circle labeled “Best.” As in Figure 8, the original map was generated by Sondehub Amateur.

The static analysis results are presented in Table 3. The balloon and payload masses were measured, and the mass of helium, float altitude, free lift, neck lift, superpressure onset altitude, and differential pressure at float were evaluated using the equations provided in the static analysis section.

The last calculated parameter of the static analysis is the superpressure altitude. This is the altitude at which the balloon reaches its maximum volume and the ascending rate slows significantly. The balloon stops expanding because the pressure inside the balloon is equal to the atmospheric pressure.

Table 1. SUU first flight static analysis results							
m_b (g)	m_p (g)	m_{He} (g)	Float altitude in m (ft)	F_L (g)	N_L (g)	Super- pressure onset alt. (m)	Differential P at float in kPa (psi)
47	15.24	8.5	11500 (37720)	6.7	21.94	10880	2.045 (0.297)

Figures 10, 11, and 12 show the results of the dynamic analysis. Figure 10 shows that the predicted float altitude of the static analysis is the same as the dynamic analysis (11,500 m). It also shows that the SUU balloon reached the float altitude in approximately 142 minutes, and the superpressure altitude was 10,880 m (in approximately 127 minutes).

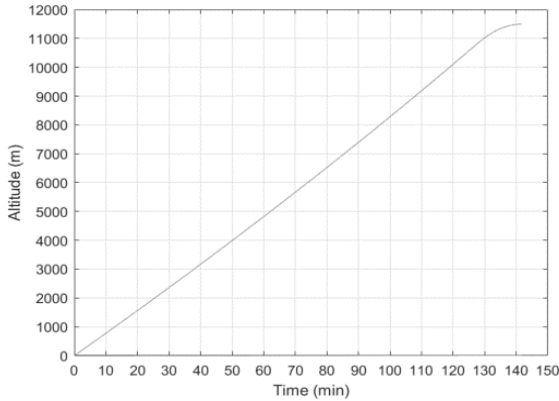


Figure 10. Altitude vs. time for SUU first flight

A typical time for a pico balloon to reach the floating altitude is approximately 2 to 2.5 hours [2]. Figure 11 confirms the predicted float time (approximately 142 minutes). In approximately 127 minutes, the balloon reached the maximum volume (superpressure altitude) and its ascending rate decreased significantly. It is worth noting that the ascending rate increased slightly from time of release to superpressure altitude. The volume of the balloon increased as the altitude increased (up to the superpressure altitude).

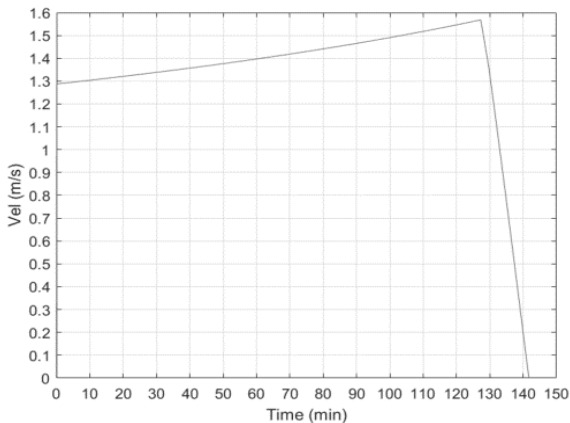


Figure 11. Ascending velocity of SUU first flight.

Figure 12 shows the volume of the first SUU balloon as a function of time. The static analysis predicted the minimum volume of the balloon at launch was 0.0632 m^3 and the maximum volume at the float altitude was 0.209 m^3 . The dynamic analysis validated the static analysis volume change. Figure 12 also shows the constant volume of the balloon as it reached the superpressure altitude at approximately 127 minutes.

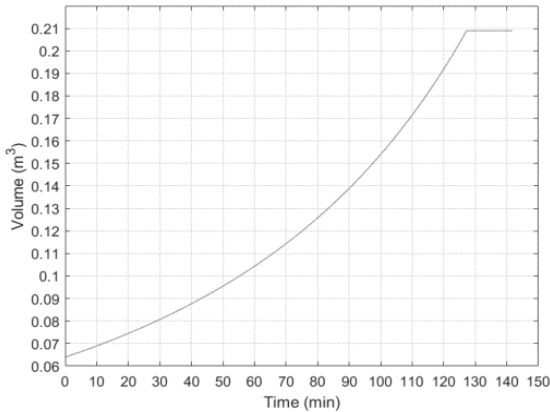


Figure 12. Balloon volume during ascending for SUU first flight.

CONCLUSIONS AND RECOMMENDATIONS

The Cedar Stratos SUU Balloon Project successfully launched and tracked 3 pico balloons. Observed float altitudes deviated by maximum of 1.2% from predictions, which reasonably validated the model. All 3 balloons demonstrated extended flight capability. The first balloon completed over 2 circumnavigations over the course of a month. The next 2 balloons also completed extended flights. The balloon was modeled both statically and dynamically. Static parameters such as float altitude, float pressure, and superpressure altitude were calculated, and dynamic parameters such as ascending rate, drag coefficient, and balloon diameter were evaluated numerically. Balloons were pressure tested and filled with the required amount of helium, which was measured using the neck lift.

Through trial and error, this project provided a detailed procedure for launching high-altitude pico balloons. Information regarding the Federal Aviation Administration as well as weather patterns was compiled. This knowledge provides a solid foundation for future SUU balloon projects.

We recommend future flights use higher-frequency tracking, such as automatic packet reporting system, to validate ascent rate predictions. Also, future flights could take place during the summer, which could raise the latitude boundary for powering a tracking signal, giving a wider range from which data could be gathered.

ACKNOWLEDGMENTS

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APPENDIX A

Drag Coefficient Evaluation

The drag coefficient is a dimensionless number that considers several factors influencing drag force. It is typically determined experimentally by testing a model in a wind tunnel with the velocity, density, and size of the model known. By measuring the drag force, the drag coefficient can be calculated using the drag equation. Once the drag coefficient is determined, it can be used to estimate the drag on a similarly shaped object under different flow conditions.

The Reynolds number, Re , is a dimensionless parameter that represents the ratio of inertial forces to viscous forces in a fluid flow as [6, p. 181]

$$Re = \frac{V_{b-h} D \rho_{a-h}}{\mu_{a-h}} \quad (\text{A.1})$$

where μ is the absolute viscosity of air (Pa.s).

Dynamic viscosity of air at h altitude, μ_{a-h} (Pa.s), depends on the temperature. Sutherland’s law is an approximation for this relationship as [6]

$$\frac{\mu_{a-h}}{\mu_o} = \left(\frac{T_h}{T_o}\right)^{3/2} \frac{T_o + S_\mu}{T_h + S_\mu} \quad (\text{A.2})$$

where constants are presented in Table A.1.

Table A.1. Constants of Sutherland's law			
Gas	μ_0 (Pa.s)	T_0 (K)	S_μ (K)
Air	$1.716 (10^{-5})$	273.15	111

Morrison [5] presented a data correlation for uniform flow around a smooth sphere that spans the entire range of Reynolds number, from creeping flow, and reaching the highest values of Reynolds number in turbulent flows. For this purpose, he developed a data correlation, one that is explicit in drag coefficient as

$$C_d = \frac{24}{Re} + \frac{2.6 \left(\frac{Re}{5}\right)}{1 + \left(\frac{Re}{5}\right)^{1.52}} + \left(\frac{0.411 \left(\frac{Re}{2.36 \times 10^5}\right)^{-7.94}}{1 + \left(\frac{Re}{2.36 \times 10^5}\right)^{-8}} \right) + \left(\frac{0.25 \left(\frac{Re}{10^6}\right)}{1 + \left(\frac{Re}{10^6}\right)} \right) \quad (\text{A.3})$$

Equation (A.3) defines drag coefficient as a function of Reynolds number over the entire Reynolds number range of the available experimental data. He recommended not to use this equation beyond $Re = 10^6$; for $Re < 2$, Eq. (A.3) follows the creeping-flow result ($C_d = 24/Re$). It should be noted that for $10^3 < Re < 10^5$, the drag coefficient reaches a nearly constant value of about 0.5.

APPENDIX B

Appendix B provides information about 3 SUU balloons in Table B1. All 3 balloons were PartyWoo 50 silver “foil” balloons (mass = 54 g, maximum volume = 0.209 m³). Figure B1 shows the SUU capstone team and SUU balloons’ path around the Earth.

Table B1. SUU balloons				
Flight (launch date)	Tracker mass (g)	FL (g)	First reported flight altitude in m (ft)	General information
KD7TOG-6/ SUU-1 (Feb. 1, 2025)	15.24	6.7	11360 (37270)	This mission lasted 27 days and covered 48,000 miles, at an average altitude of 36,500 feet. It made two global circumnavigations.

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KD7TOG-7/ SUU-2 (March 1, 2025)	15.08	7	10660 (34974)	This mission lasted 20 days and covered 38,000 miles, at an average altitude of 39,000 feet. It made 1.75 global circumnavigations.
KD7TOG-8/ SUU-3 (Apr. 15, 2025)	15.08	6.56	10560 (34646)	This mission lasted 9 days, and covered 13,000 miles, at an average altitude of 36,000 feet. It made 0.7 global circumnavigations.



Figure B1. SUU capstone team and SUU balloons' paths around the Earth.

Southern Utah University Pico Balloon Launch Procedure

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and Ali Syyed Siahpush**

Southern Utah University

ABSTRACT

The Cedar Stratos Southern Utah University balloon project had two fundamental goals: first, to accurately model the static and dynamic behavior of the balloon in one dimension and calculate parameters such as float altitude, float pressure differential, superpressure altitude, terminal velocity, and ascending rate; and second, to accurately and thoroughly document the process of preparing, testing, and launching a pico balloon. We successfully launched 3 identical aluminized mylar balloons. The analytical evaluations (statics and dynamics) predicted correctly the experimental results. This paper focuses on the physical aspects of the launch procedure and balloon's characteristics.

BACKGROUND

The Cedar Stratos Southern Utah University (SUU) balloon project has two fundamental goals. The first is to accurately model the static and dynamic behavior of the balloon in one dimension and calculate parameters such as float altitude, float pressure differential, superpressure altitude, terminal velocity, and ascending rate. The second purpose of the project is to accurately and thoroughly document the process of preparing, testing, and launching a pico balloon. It should be noted that the term “pico” is not an abbreviation but rather a prefix derived from the International System of Units. “Pico” represents a factor of 10^{-12} . Although the prefix is typically used in scientific contexts to denote extremely small quantities (e.g., picoseconds or picograms), in ballooning, it implies that the balloon is small.

There are two common options in pico ballooning. The first option is an aluminized mylar balloon. The second option is a balloon made of nylon and polyethylene, such as the Yokohama balloon [1]. At SUU, we have successfully launched 3 identical aluminized mylar balloons. The Appendix provides more details of the SUU balloons.

When launching a pico balloon, an important consideration is the burst condition (pressure). If the balloon is overpressurized, it will burst at its seams. For the aluminized mylar, the maximum circumference of the fully expanded balloon is approximately 90 inches, and the burst pressure is between 0.4 and 0.6 psig [1].

The Yokohama balloon stretches further upon reaching the float altitude. This property may be desirable, because it can increase the volume of the balloon and allow it to float at higher altitude. However, the expansion could also cause weakening of the seams, causing a helium leak and balloon descent.

Both balloon types have a flexible one-way valve sleeve. This sleeve is designed such that once the balloon is pressurized, the valve collapses, avoiding any gas leak from the valve sleeve. Initially, when the balloon is not filled with gas (helium), the valve is relaxed, and helium gas can enter the balloon. It is important to ensure that the fill tube completely clears the entrance valve so that the valve will not collapse before the balloon is appropriately filled. The fill tube itself should be as tight a fit to the entrance valve as possible without ripping the valve sleeve to ensure there are no leaks. Figure 1 shows the valve sleeve and the fill tube.

The tracking electronics (payload) are beyond the scope of this project.

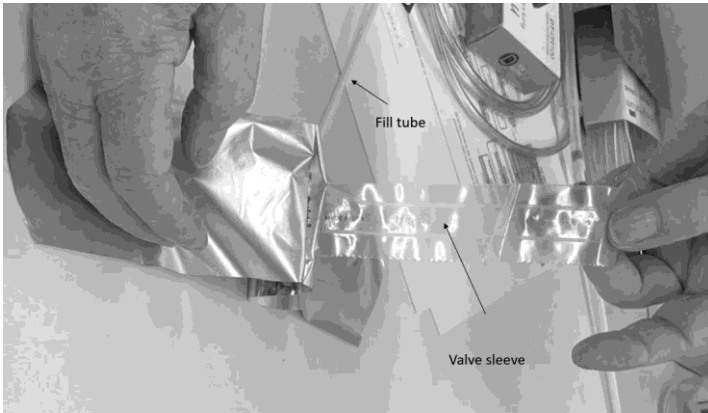


Figure 1. Valve sleeve and fill tube.

PROCEDURE (Aluminized Mylar Balloon)

Pressure Testing

The 5/32-in outside-diameter (OD) fill tube is inserted into the fill valve, ensuring the fill tube reaches past the end of the valve and into the balloon. Once in the fill position, the pump is turned on to inflate the balloon, continuing until the pressure monitor reads the desired gauge pressure. For a 50-in mylar balloon, the experimentally evaluated float pressure is approximately 0.3 psig. This calculation is performed in more detail in the accompanying paper [2]. In short, the float pressure inside the balloon is determined using the ideal gas law, and the pressure of the atmosphere at that altitude is determined using the NASA Atmosphere Model [3]. The float gauge pressure is the difference between these two values. To ensure the balloon can withstand the float pressure (0.3 psig) with some safety considerations (to avoid balloon burst), the balloon is inflated to approximately 0.4 psig for the pressure test. Once the balloon reaches 0.4 psig, the fill tube is removed quickly and the neck of the balloon is folded over itself so the valve opening is covered. A binder clip is used to hold the neck in the folded position. The inflation apparatus, including the pump, manometer (pressure sensor), and fill tube, are shown in Figure 2.

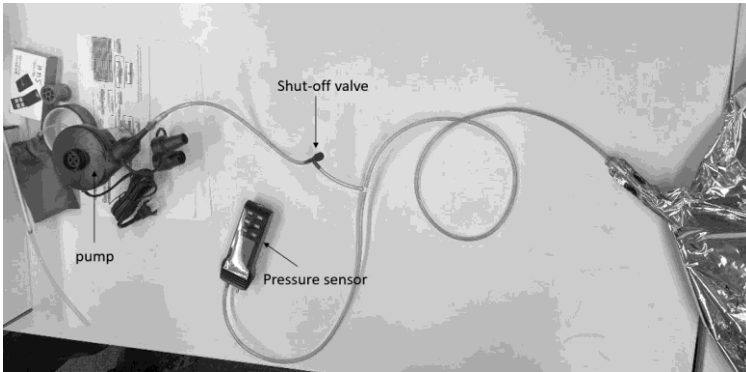


Figure 2. Balloon inflation apparatus (pressure testing).

The circumference of the balloon is measured several times while the balloon is fully inflated, and the average diameter is used to evaluate the balloon's cross-sectional area. In the Cedar Stratos SUU balloon project, the circumference of the balloon was approximately 90 inches.

Once the balloon has been sealed at 0.4 psig for at least 2 hours, the neck is unfolded. With the valve controlling the pump flow closed, the manometer (pressure sensor) is turned on and then the fill tube is inserted. Experimentally, it was determined that if the pressure in the balloon is above 0.2 psig, the balloon may be certified for flight (passed the pressure test). It is worth noting that the pump used for pressure testing the SUU balloons was relatively small and prone to overheating. As a result, the process had to be paused every 10 to 15 minutes to allow the pump to cool down. Consequently, the pressure testing took approximately 6 hours to complete. For future SUU flights, a more suitable pump will be considered to improve efficiency and avoid overheating.

Balloon Evacuating

It is important to remove any air trapped in the balloon before filling the balloon with helium. The balloon's floating altitude significantly decreases if the helium has impurities. To do this the fill tube is inserted into the entrance valve. With the pump in the evacuation configuration (Fig. 3), the pump is turned on and the air is evacuated until the balloon is completely deflated (no air in the balloon).

Before helium is added to the balloon, a small plastic bag is attached to the balloon using a very light alligator clip. The goal is to approximate the neck lift by adding small weights (e.g., paper clips, small washers) to the bag. The balloon should be neutrally buoyant if a weight equivalent to its neck lift is hung from it, so the balloon will be filled with enough helium to give it approximately neutral buoyancy. It is better for the approximate neck lift initially to be less than the required neck lift than over it, because helium can be more easily added than removed when fine-tuning the neck lift.

A short length of string is attached in a loop to the clip and a hole large enough for the string is poked in the small plastic bag. The other end of the string is used to tie the clip to the bag. The string, fill line, bag, and clip are placed onto the scale, as shown in Figure 5, and small masses are added until the total mass is approximately equal to the neck lift of the balloon (approximately 22 g).



Figure 5. Neck lift bag and scale.

When the neck lift is reached, the fill tube is attached to the helium tank and the neck lift bag is clamped to the side of the balloon neck, as shown in Figure 6, so the balloon valve can still be accessed. Helium is slowly added to the balloon until the bag of weights begins to lift from the table, as shown in Figure 7. Once the bag of weights begins to lift, the balloon has enough helium to begin the second phase of neck lift measurement.



Figure 6. Filling balloon with approximate neck lift attached.

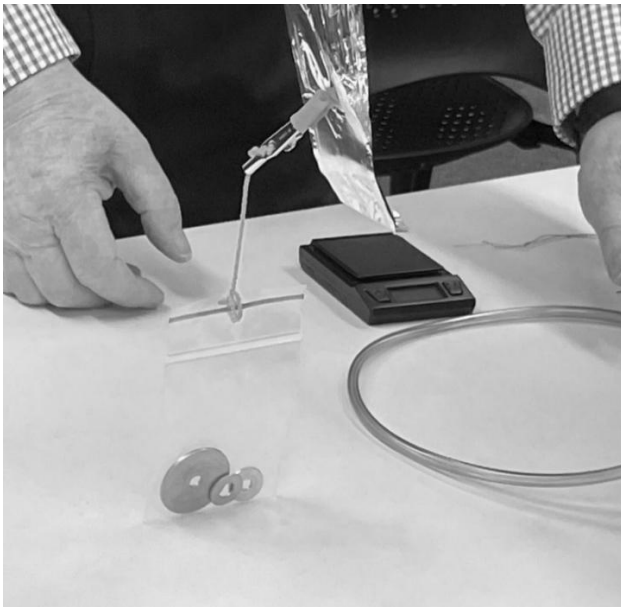


Figure 7. Coarse neck lift measurement.

To finetune the balloon's neck lift, a 50-g mass with a hook is placed on the scale, along with the clip and string that were attached to the plastic bag. Once these items are on the scale, the scale is tared (Fig. 8, left). Next, the clip is reattached to the balloon, and the string is looped around the hook on the 50-g mass. The scale will begin to read a negative value as the balloon pulls upwards on the 50-g mass. This negative value is equal to the current neck lift of the balloon, which should be fairly close to the desired final value. Small amounts of helium are slowly added or removed to allow the balloon to settle back into a stable position above the scale before reading the scale (Fig. 8, right). Once the absolute value of the scale's reading is equal to the desired neck lift, assuming there are no updrafts in the area, the highest absolute reading is the correct current neck lift measurement. Lower readings are the result of air currents applying additional forces to the balloon.



Figure 8. (Left) Taring the system. (Right) Precise neck lift measurement.

Sealing the Balloon

Once the balloon is filled to the accurate neck lift, the fill tube is removed from the balloon, and the valve is sealed by carefully placing an ~3-inch-long section of Kapton tape over the fill tube entrance in the balloon's neck, such that about an inch of the tape extends past the end of the neck (Fig. 9).

Finally, the fishing line loop is prepared, with a small swivel clip passed through the loop. The loop is approximately 5 inches in diameter and consists of 2 strands. A double overhand knot is used to tie the loop closed. The neck of the balloon is passed through the loop of the fishing line, and the neck is folded over, and the remaining section of tape is used to hold the neck in place. Another section of Kapton tape is wrapped at least once fully around the neck of the

balloon in the horizontal direction, and the sealing of the balloon is complete, as shown in Figure 10.



Figure 9. Preliminary valve sealing.



Figure 10. Sealed balloon with harness.

Releasing the Balloon

While holding the balloon stem and utilizing the safety line, the balloon is taken to the launch site. It is useful to clip the safety line with a carabiner to a belt loop or other grounded object to avoid accidental release of the balloon. Because care should be taken that the payload is not dragged across the ground, one person should carry the payload while the other holds the balloon.

The tracker and payload are laid on a tarp so that no lines are crossed or tangled. The tracker is held facing the sun, as shown in Figure 11. A small green light-emitting diode (LED) on the tracker board will undergo a series of blinks as the tracker detects its current position and enters flight mode. Once the LED is blinking steadily, the tracker is ready for flight. If the tracker loses access to the sun, the startup sequence will automatically be repeated.



Figure 11. Tracker initialization sequence

The two dipole antennas are unspooled in a way that keeps them straight and minimizes sideways forces on the connection points. One of the dipoles has a fishing swivel attached to the end, with the connection point painted over. The swivel on the payload is hooked into the swivel on the balloon, as shown in Figure 12.

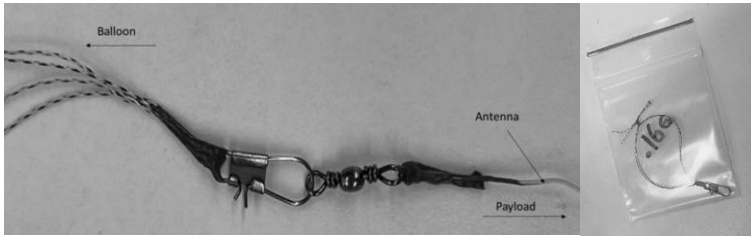


Figure 12. Harness-antenna connection.

To launch the balloon, the payload is lifted and held a short distance from the individual holding the balloon. With the lines cleanly separated, the safety line is removed, the balloon stem is held while the line is released gradually (about one foot at a time). If the balloon moves downward, the release should be paused and only resumed once the balloon ascends or stabilizes. This process is continued until the line is completely deployed and only the tracker is held (Fig. 13).



Figure 13. Balloon near point of release.

Once the line is deployed, the individual holding the balloon should move towards the balloon at approximately the wind speed until the tracker is closer to vertically beneath the balloon. At the point the balloon is lifting upward, the line is released and the balloon is allowed to lift freely.

Solar Cell Orientation

Solar cell orientation is a subject of some debate currently in the pico balloon community. Because the solar panels only work when facing the sun (correct solar angle), depending on the season and

latitude of the launch, there may be only a few hours of the day when the balloon can transmit. This is exacerbated when the balloon is further from the equator or during the winter months when the solar angle is less. To improve the solar panels' angle, many prototypes of different solar cell orientations have been discussed and manufactured. The most common version remains one where the solar cells are facing straight up when the balloon is in flight, with one on each side of the tracker. This orientation is one of the easiest and lightest to build and is fairly effective. Although less effective in winter because of the lower solar angle, this configuration operates efficiently between 10 AM and 2 PM. It even works while the sun is directly overhead, because the balloon spins while it is in motion, which throws the tracker out from underneath the balloon's shadow. Figure 2 shows the solar panels and the tracker used for the SUU balloon experiment.



Figure 2. Solar panels and tracker.

In the early days of pico ballooning, tracking was performed using HAM radio protocol, APRS (Automatic Packet Reporting System), which transmits data every 2 minutes and contains all data in a single packet. This protocol is generally desirable when doing shorter-range transmissions or when tracking balloons in areas with a high number of APRS receivers. Unfortunately, there are many places on Earth where APRS tracking is not feasible, particularly over oceans or areas of low population density.

Recently, many pico balloons have begun using Weak Signal Propagation Reporter (WSPR). WSPR trackers are incredibly long-range, which means that it is nearly impossible to transmit from a location and not be heard by at least one WSPR receiver. This protocol only transmits data every 10 minutes and transmits data as 2 packets, with the second packet transmitting 2 minutes after the first one. This is risky, because if only the first packet is received, just the coarse positional data is known. However, these disadvantages are worth the massive gains in the transmitter range.

Because most tracking systems are designed for APRS data, WSPR pico balloons often transmit in WSPR and use Python scripts to convert data to APRS format for compatibility with existing trackers such as Aprs.fi, SondeHub, or Lu7aa.

REGULATORY CONSTRAINTS

All flight activities should comply with U.S. Federal Aviation Administration requirements. The Unmanned Free Balloon requirements are given in Table 14, Chapter I, Subchapter F, Part 101, Subpart D of the Code of Federal Regulations [4]. These regulations specify that “These procedures apply to unmanned free balloons that carry payloads as described in 14 CFR Section 101.1(a)(4),” which states: “This part prescribes rules governing the operation in the United States, of the following: Except as provided for in § 101.7, any unmanned free balloon that—

- Carries a payload package that weighs more than four pounds and has a weight/size ratio of more than three ounces per square inch on any surface of the package, determined by dividing the total weight in ounces of the payload package by the area in square inches of its smallest surface;
- Carries a payload package that weighs more than six pounds;
- Carries a payload, of two or more packages, that weigh more than 12 pounds; or
- Uses a rope or other device for suspension of the payload that requires an impact force of more than 50 pounds to separate the suspended payload from the balloon.” [4]

Because the payload is well below the threshold weight of 4 pounds, pico balloons are exempt from these regulations. However, in part 101.5, the specification is made that, “No person may operate a moored balloon, kite, amateur rocket, or unmanned free balloon in a prohibited or restricted area unless he has permission from the using or controlling agency, as appropriate.”

This regulation implies that airspace restrictions near the launch area should be studied prior to launch. An aeronautical chart for the Cedar City (CDC) Airport is included in Figure 15 [5].

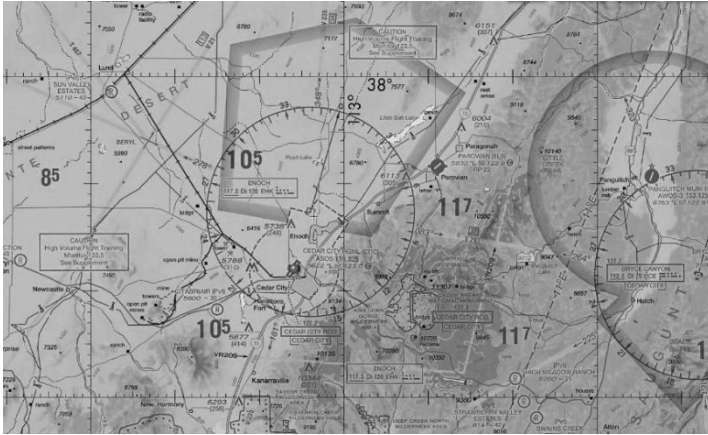


Figure 15. Aeronautical chart of Cedar City greater area.

The area surrounding the CDC airport is class E airspace, which is uncontrolled. Because the aeronautical chart provides notices of high-volume flight training, some special precautions could be taken to give notice to airport users. Efforts to notify the airport manager of balloon flight activities should be made.

MATERIALS

- 50-in Mylar balloon (as measured from the top of the balloon to the neck while deflated) (mass = 54 g, and 0.210 m³ volume) (<https://www.amazon.com/PartyWoo-Balloons-Birthday-Decorations-Wedding/dp/B0CJB5H7YH>)
- Fill tube
 - For mylar balloon: 4-mm (5/32 in) OD (“Evergreen scale models round tubing,” <https://www.amazon.com/Evergreen-Scale-Models-Round-Tubing/dp/B0006O5FF0>)
 - For Yokohama balloon: 4.76-mm (3/16-in) OD (<https://www.amazon.com/Evergreen-scale-models-tubing-EVG226/dp/B0006O5FFA>)
- Fishing line, 0.26-mm D (<https://www.amazon.com/Dorisea-Fluorescent-109Yards-2187Yards-Incredible-Superline/dp/B07V45B2KR>).

- Small metal clip (fishing swivel clip) (<https://www.amazon.com/AMYSports-Stainless-Saltwater-Interlock-Connector/dp/B0899H1JXS>).
- Tracker board (Traquito V1.0–10 meter WSPR–Litz dipoles/2-panel solar beam/no supercaps) (<https://www.amazon.com/Raspberry-Pi-Pico-Development-Integrated/dp/B0BDLHM9C/>
- Solar panels (3.6 v × 75 ma) (<https://www.mouser.com/ProductDetail/PowerFilm/MPT3.6-75?qs=BJlw7L4Cy79PADpX3LN7rA%3D%3D>)
- Wire (tracker assembly)
- 97% purity helium or higher (This information was not listed on our tank, so we assumed 97% purity.)
- Pump with capacity to fill and evacuate (<https://www.amazon.com/Etekcicy-Mattress-Inflatable-Exercise-Quick-Fill/dp/B074N2DCG5>)
- Scale capable of reading 1/10 g
- Small weights or paperclips
- 50-g weight with hook
- Flat clamp with rubber fittings on the jaws
- String, any kind
- Oxygen or aquarium tubing
- Tubing connectors (<https://www.amazon.com/Pawfly-Aquarium-Straight-Distributor-Splitter/dp/B08RYBWCRC>) (These valves are for standard 4-mm inner-diameter aquarium tubing, oxygen tubing is also 4-mm inner diameter)
- Small plastic bag
- Polyamide (KAPTON) tape (<https://www.amazon.com/Ber-tech-Kapton-Tape-Wide-Yards/dp/B009KB6DA6>)

ACKNOWLEDGMENTS

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APPENDIX

Table A provides information about 3 SUU balloons, which were PartyWoo 50 silver “foil” balloons (mass = 54 g, volume = 0.210 m³). The SUU balloons’ paths around the Earth are shown in [2, Figure B1].

Table A. SUU balloons			
Flight	Tracker mass (g)	Free lift (g)	General information
KD7TOG-6/ SUU-1	15.24	6.7	This mission lasted 27 days, covered 48,000 miles, at an average altitude of 36,500 feet. It made two global circumnavigations.
KD7TOG-7/ SUU-2	15.08	7	This mission lasted 20 days, covered 38,000 miles, at an average altitude of 39,000 feet. It made 1.75 global circumnavigations.
KD7TOG-8/ SUU-3	15.08	6.56	This mission lasted 9 days, covered 13,000 miles, at an average altitude of 36,000 feet. It made 0.7 global circumnavigations.

Slab of Ice Melting Rate due to Natural Convection and Thermal Radiation

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ABSTRACT

This paper discusses the effects of natural convection and thermal radiation on the melting rate of ice. It aims to validate the results of a previously conducted experiment performed at Southern Utah University, improve the experiment by considering radiation effects, and create a model that can accurately predict melting rates for vertical and horizontal orientations. The vertical setup had an experimental melting rate of 280 g/hr. The theoretical results from natural convection plus two different cases of thermal radiation heat transfer were 285 g/hr for a large enclosure and 281 g/hr for a two-surface enclosure. The horizontal setup had the melting experimental result of 287 g/hr, with theoretical melting results of 282 g/hr for a large enclosure and 277 g/hr for a two-surface enclosure. A sensitivity analysis was performed for the heat transfer coefficient and temperature deviations from experimental values. The heat transfer coefficient linearly changes with the mass flow rate. Increasing temperature deviations increased the mass flow rate

error by approximately 4% per one-degree deviation. Sources of error were considered, and the greatest melting rate error sources were from using a heat gun to extract the ice and human error while recording data.

INTRODUCTION

Ice melting is a common phenomenon observed when a solid transitions to a liquid because of the absorption of heat. This process, known as melting, is influenced by various factors such as temperature, pressure, humidity, and the presence of impurities like salt and air bubbles. Understanding the factors that affect the rate of melting is important in fields ranging from environmental science to engineering [1]. An important part of melting is related to the concept of natural convection. Huang et al. [2] developed a mathematical model to explain the melting process of phase change material affected by natural convection.

Natural convection causes movement of air, which either heats up or cools off the surface of an object. In the case of ice, natural convection of warm air causes the ice to melt. This melting provides a means to test and predict the effect of natural convection on the melting rate. The heating, ventilation, and air conditioning (HVAC) industry uses natural and forced convection to determine how much heat a system is losing and how its efficiency may be improved [3]. For many decades, the ice industry investigated the effect of natural convection on ice melting rates [4]. On the global scale, natural convection also affects the melting rates of glaciers, causing the sea level to rise [5]. Further experimentation and research on natural convection and how it affects ice melting can have a positive impact on understanding the effects of glacier and snow melt.

Many different experiments have been performed to analyze how natural convection affects the melting rate of ice. Dizadji and Entezar [6] calculated the Nusselt and Grashof numbers and heat transfer coefficient as different shapes of ice were suspended vertically and subjected to a controlled flow of air. Bejan and Zhang [7] studied a simplified and inexpensive experimental setup to observe the melting rate of a rectangular sheet of ice in an enclosure. In a previous experiment performed at Southern Utah University (SUU), a group of undergraduate students measured and predicted the melting rate of ice due to natural convection in an enclosure [8]. In the previous study, the discrepancy between the analytical prediction and the experimental results was 67% due to neglecting the effects of radiation and other sources of errors.

Thermal radiation may have a significant effect on the rate at which ice melts by contributing to the transfer of heat from a warmer

surrounding to the ice [9]. Thermal radiation is the emission of electromagnetic waves from all objects with a temperature above absolute zero [10]. When combined with natural convection, thermal radiation can have a significant impact on the total heat transferred. Unlike conduction or convection, thermal radiation does not require a medium and can transfer heat through a vacuum. When an object absorbs thermal radiation, its temperature increases, leading to changes in its physical state, such as the melting of ice.

The purpose of this experiment is to validate the results of the previous experiment conducted at SUU, expand and improve their results by including the effects of radiation, and create an accurate model to predict the mass flow rate of ice melting. Three melting test iterations were performed, considering vertical and horizontal orientations. The theoretical results from natural convection plus two different cases of thermal radiation heat transfer were considered. A sensitivity analysis was performed for the heat transfer coefficient and temperature deviations from theoretical evaluations.

THEORY

Convection Heat Transfer

To evaluate the natural convection heat transfer for air, the convection heat transfer coefficient (h) needs to be evaluated. It is defined as [10, p. 541]

$$h = \frac{Nuk_{air}}{L_c} \quad (1)$$

where Nu is the Nusselt number, k_{air} is the thermal conductivity of the air (W/m·K), and L_c is the characteristic length, in this study, the height H of the ice slab (m). From Table 9.1 in reference [10], the Nusselt number can be estimated as [10, p. 542]

$$Nu = \left\{ 0.825 + \frac{0.387Ra^{\frac{1}{4}}}{\left[1 + \left(\frac{0.492}{Pr_{air}} \right)^{\frac{9}{16}} \right]^{\frac{8}{27}}} \right\}^2 \quad (2)$$

where Ra is the Rayleigh number and Pr_{air} is the Prandtl number for air. The Rayleigh number is defined as [10, p. 541]

$$Ra = \frac{g\beta\Delta TH^3}{\alpha_{air}\nu_{air}} \quad (3)$$

where g is the acceleration due to gravity (m/s^2), β is the coefficient of volume expansion ($1/\text{K}$), ΔT is the steady state difference in temperatures of the surface and the ambient air ($^{\circ}\text{C}$), α_{air} is the thermal diffusivity of air (m^2/s), and ν_{air} is the kinematic viscosity of the air (m^2/s).

Once the h value is calculated, Newton's law of cooling can be used to evaluate the convection heat flux, \dot{q}_{conv} (W/m^2) as [10, p. 541]

$$\dot{q}_{conv} = h(T_{amb} - T_s) \quad (4)$$

where T_{amb} is the ambient temperature ($^{\circ}\text{C}$), and T_s is the uniform wall temperature of the slab ($^{\circ}\text{C}$). From the first law of thermodynamics (energy balance), the heat flux from convection heat transfer balances the heat flux because of latent heat. The result is [8]

$$\dot{q} = \rho\Delta h_f \frac{1}{2} \frac{dL}{dt} \quad (5)$$

where ρ is the density of water (kg/m^3), Δh_f is the latent heat of fusion (J/kg), dL is the change in thickness of half the slab (m), and dt is the change in time (s). The mass flow rate of melting ice is defined as [8]

$$\dot{m} = \rho WH \frac{dL}{dt} \quad (6)$$

where W is the width of the slab (m) (Fig. 1).

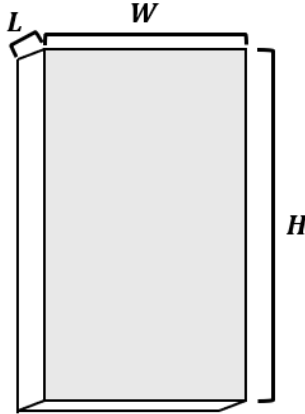


Figure 3. Designated dimensions of the slab ($H \times W$)

From Eq. (4), \dot{q}_{conv} may be evaluated, then substituting dL/dt from Eq. (5) into Eq. (6) results in the mass flow rate (\dot{m} , kg/s) as

$$\dot{m} = WH \frac{2\dot{q}_{conv}}{\Delta h_f} \quad (7)$$

Equation (7) is used to evaluate the melting rate as the function of the heat transfer rate (\dot{q}_{conv}) due to natural convection heat transfer.

Thermal Radiation Heat Transfer

Small Area in Large Enclosure (Cavity)

Heat transfer due to radiation also needs to be considered because it could have a significant impact on the melting rate of the ice. The heat transferred from the surrounding radiation in the room (\dot{Q}_{rad}) can be evaluated as [10, p. 789]

$$\dot{Q}_{rad} = F_{1-2}WH\varepsilon_1\sigma(T_{surr}^4 - T_s^4) \quad (8)$$

where F_{1-2} is the view factor of the slab to the walls surrounding the slab, ε_1 is the emissivity of the small object in the cavity (ice slab), σ is the Boltzmann constant ($\text{W/m}^2\text{K}^4$), and T_{surr} is the temperature of the surroundings ($^{\circ}\text{C}$). If the slab of ice is surrounded by identical walls, all at the same surrounding temperature and thermal properties, it forms a large enclosure (cavity), and the view factor can be assumed to be one. This can be assumed because it is a small slab compared with a large room. Note that the slab has two surface areas (A) exposed to radiation; thus, both the front and back surface areas must be considered.

Two-Surface Enclosure

The view factor can also change in the case of a two-surface enclosure. The two surfaces are one side of the slab and a box-like projection of the slab onto the apparatus walls. The effective emissivity is then used to estimate the heat transferred from radiation, and it is expressed as [10, p. 788]

$$\dot{Q}_{rad} = \frac{\sigma(T_{surr}^4 - T_s^4)}{\frac{1 - \varepsilon_1}{A_1\varepsilon_1} + \frac{1}{A_1F_{1-2}} + \frac{1 - \varepsilon_2}{A_2\varepsilon_2}} \quad (9)$$

where A_1 and A_2 are the area of the slab and the box-like projection (front, top, bottom, and sides surfaces facing the ice slab), respectively, and ε_2 is the emissivity of the surroundings. The view factor of a plane to the enclosure is considered to be one. Thus, the total heat transferred to one

side of the ice slab by convection and radiation heat transfer is defined as [10, p. 556]

$$\dot{Q}_{tot} = A_1 \dot{q}_{conv} + \dot{Q}_{rad} \quad (10)$$

where \dot{q}_{conv} and \dot{Q}_{rad} are evaluated from Eqs. (4), and (8 or 9), respectively. Substituting Eq. (10) into Eq. (7) results in the mass flow (melting) rate due to both sides of the plate (in our case, slab of ice) as

$$\dot{m} = \frac{2\dot{Q}_{tot}}{\Delta h_f} \quad (11)$$

EQUIPMENT AND MATERIALS

The materials used in the experiment are the same as the previous one. These materials were:

- ABS pipe (3-in diameter) with pipe supports
- String
- Baking pan (<https://www.amazon.sg/Fat-Daddios-POB-10153-Anodized-Aluminum/dp/B001332TBG?th=1>)
- Data logger (<https://www.az-instrument.com.tw/en/product-616361/4-Channel-K-Thermocouple-SD-Card-Logger-88598-AZ-EB.html>)
- Thermocouples (TC) (<https://trutechtools.com/ATB1>)
- Freezer
- Two 250-mL graduated cylinders (<https://www.amazon.com/Measuring-Cylinder-250ml-Polypropylene-Autoclavable/dp/B00JKRBRQA>)
- Digital force gauge (<https://www.amazon.com/gp/aw/d/B08YK6PDZ3?th=1>)

PROCEDURES

The same procedures and apparatus were used for this experiment as the previous experiment performed at SUU [8]. In the previous experiment, the testing apparatus was built out of a wooden frame with clear acrylic side panels, creating an enclosure. Inside the testing apparatus, there were two half-pipes held up at an angle of 55 degrees to collect water in a graduated cylinder.

Freezing of the ice slab followed the same steps as the previous experiment. Those steps were:

- Pour approximately 0.5 cm of water (488 mL) into the container.

- Freeze the water for 24 hours.
- Place the string and TCs at the location shown in **Error! Reference source not found.**

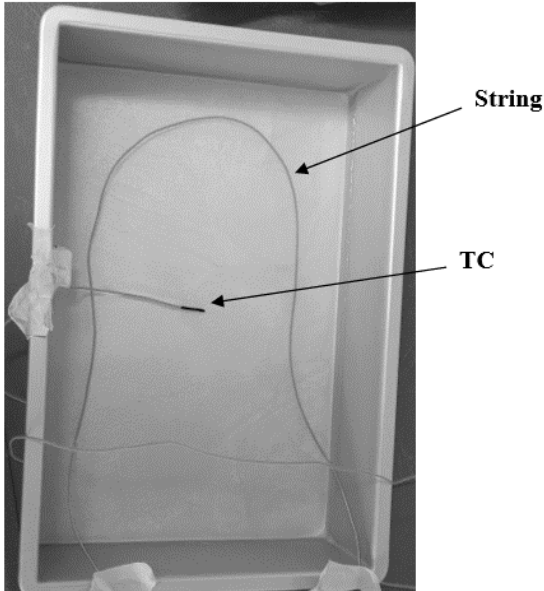


Figure 4. Setup of TC and string in ice slab

- Add another 0.5 cm of water and complete the freezing process.
- Use a low-heat gun to extract the ice slab without cracking and breaking the slab.
- Hang the ice slab in the enclosure, and record the volume of melted ice every 5 minutes.

In this experiment, to provide more accuracy, two 250-mL graduated cylinders were used to measure the melting rate instead of one 500-mL cylinder, as it was used previously.

To more accurately measure the ice temperature, the experiment was performed once more with 3 TCs evenly spaced along the long length of the slab (H). Next, an alternate way to measure the melting rate was used. In this approach, only 1 TC was used as before, and a digital force gauge was used to measure the mass of the ice slab along with the volume of melted ice in the graduated cylinder. In the final experiment, the height and width of the slab were switched (rotated by 90 degrees).

The last experiment was performed with more TCs in between the slab and the wall to measure the ambient temperature accurately.

RESULTS & DISCUSSION

Vertical Setup ($H \times W$)

In this experiment, H is the vertical dimension, and W is the horizontal dimension. The results of the vertical setup experiment are shown in Figure 3. In this figure, time is presented on the x-axis, and the total volume of melted water is presented on the y-axis. As expected, the steady-state slope of this figure was constant. Because the mass of water compared with the volume of water is 1 g to 1 mL, the rate of change of the data, determined by the slope of the trend line, provides the mass flow rate in g/min. Converting from g/min to g/hr gives a mass flow rate of 280 g/hr. Once the mass flow rate was determined, the heat transferred from natural convection was calculated by Eq. (7), and h was then calculated from Eq. (4). Because of the linearity of the data collected, the R^2 (coefficient of determination) value of the trend line was nearly 1. This validates that a steady state was reached during the experiment. Note that by the time the experiment was placed in the apparatus, the ice was at the steady-state melting rate.

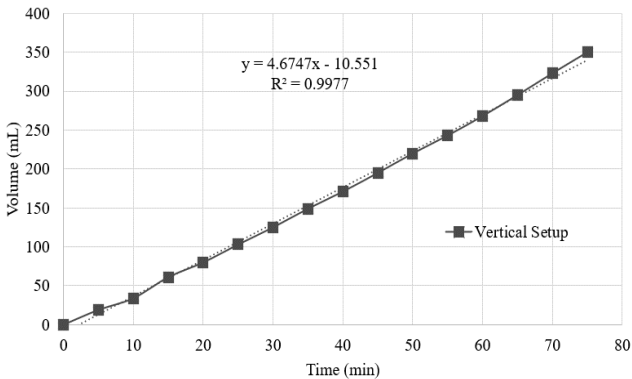


Figure 3. Experimental data for volume of water vs. time ($H \times W$).

The results of the previous experiment conducted at SUU were compared with this experiment to verify their results. Once their results were verified, improvements to the experiment were considered to yield better and more accurate results. In this evaluation ($H \times W$), it was assumed that air was at 1 atmospheric pressure, and the properties of air

were at the film temperature. Those values, given in Table A-15 from reference [10, p. 926], are presented in Table 1 along with the values for the emissivity of ice and acrylic, and the heat of fusion from ice to water.

Table 1. Properties of air, ice, and water						
Pr_{air}	k_{air} (W/m·K)	α_{air} (m ² /s)	ν_{air} (m ² /s)	ϵ_1	ϵ_2	Δh_f (J/kg)
0.7336	0.02439	1.944×10^{-5}	1.426×10^{-5}	0.92	0.94	333.4×10^3

The results of both the previous and vertical experiments ($H \times W$) are shown in Figure 4. The mass flow rate for this experiment was measured to be 280 g/hr, and the mass flow rate for the previous experiment was measured to be 281 g/hr. Even with a more precise measuring device (using a 250-mL graduated cylinder to measure the volume of melted ice), the values for the mass flow rate were quite the same.

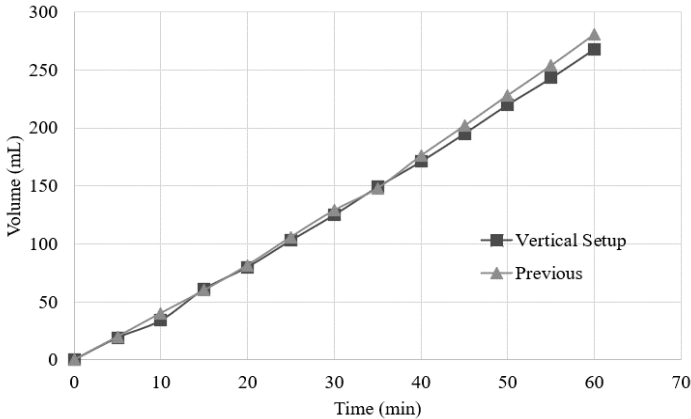


Figure 5. Comparison between two experiments.

Three TC Setup ($H \times W$)

The second iteration of the experiment was conducted with 3 TCs evenly spaced between 2 layers of ice along the height of the slab to accurately measure the ice temperature. Because TC wires are better at conducting heat than ice, adding more TCs to the slab increased the average mass flow rate to 315 g/hr. For this reason, the mass flow rate from this experiment was not used.

In this experiment, 4 other TCs were placed on the inside walls of the enclosure to measure the surrounding air temperature. As expected by the temperature recorded from these 4 TCs, the convection currents

only have a significant effect on the front and back faces of the slab. The average temperature was 16.9°C for T_{surr} used in Eq. (8) or (9) to solve for the effects of radiation. Another TC measured the air temperature between the slab and the wall ($T_{amb} = 16.2^{\circ}\text{C}$), used in Eq. (4) to evaluate the effects of convection. The average temperature from the 3 TCs in the slab was 0.86°C for T_s . These 3 temperatures were used in the theoretical calculations for the vertical setup to provide a more accurate mass flow rate.

The experimental and theoretical mass flow rate and average h value for the vertical setup ($H \times W$) and previous experiment are presented in Table 2. This table shows the relationship between values obtained from the experiments and the theoretical analysis. For the experimental values, the mass flow rate was evaluated from the data. The theoretical values were determined by using Eqs. (1-3) for h and Eq. (7) for the mass flow rate. The theoretical values for the effects of thermal radiation were evaluated from Eqs. (8-11). The temperatures used in these calculations were the 3 TC setup measurements. Considering only natural convection, from Eq. (4) and (7), the theoretical mass flow rate was 128 g/hr. The mass flow rate from the vertical setup ($H \times W$) was 280 gr/hr. The percent difference between these two values was 54%, signifying that the effect of thermal radiation (cavity) in the analysis, was not considered. When radiation in an enclosure was added to convection in the theoretical analysis, using Eq. (8) and Eq. (11), the predicted combined mass flow rate became 285 g/hr. The resulting percent difference compared with the vertical setup ($H \times W$) was 1.8%. This was repeated for the case of a two-surface enclosure. The melting rate was measured to be 281 g/hr and the percent error was 0.1%. The experimental values were compared with the theoretical values to determine the effectiveness of the experiment and to identify possible sources of error.

Table 2. Mass flow rates and average h values for (I) vertical test ($H \times W$)

Method	\dot{m} (g/hr)	h ($\text{W}/\text{m}^2\cdot\text{K}$)	\dot{m} error (%)
Previously published experiment	281	–	–
Experimental results	280	–	–
Analytical (only natural convection)	128	4.00	54.3
Large enclosure (cavity) (\dot{Q}_{tot})	285	8.69	1.75
Two-surface enclosure (\dot{Q}_{tot})	281	8.56	0.10

(III) Horizontal Setup ($W \times H$)

The last iteration of the experiment was performed to accurately measure the ambient temperature in the testing apparatus and measure the mass when the ice slab was rotated 90 degrees and the force gauge was used to measure the mass of ice slab. The graduated cylinder was also used, and the results were compared with each other. A total of 4 TCs, 2 on each side, were placed between the ice slab and the wall of the apparatus. On each side, 1 TC was roughly midway up the slab and the other TC was placed at the bottom of the slab. These temperatures recorded were averaged and used in the theoretical calculation. Figure 5 shows the total ice melting volume over time for this iteration. As expected, approximately, the total melting volume linearly changed with time.

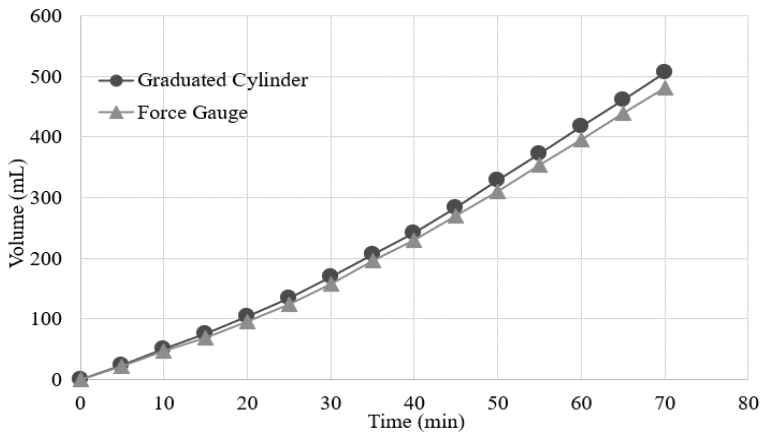


Figure 6. Results from the last iteration.

The force gauge measurements provided more accurate data than the graduated cylinder measurements. In the volumetric measurements, the volume was measured by visually recording the water level in the graduated cylinder, but the force gauge digitally showed the ice mass up to three significant digits. Figure 6 shows that the 2 measurements are linear within the first 5 data points. This linear section of the experiment was determined to be the steady-state condition for the ice melting. After the first 5 data points, data for both measurements slightly deviated from being linear. The R^2 value is very close to 1, and therefore, this linear section (steady state) was used to compare with the analytical prediction.

The same calculations and steps as presented in Table 2 were considered for the horizontal setup ($W \times H$). These parameters are shown in Table 3. The temperature values used in the calculations were those measured during the experiment. Only the steady-state mass flow rate data determined from the force gauge was used because of its accuracy.

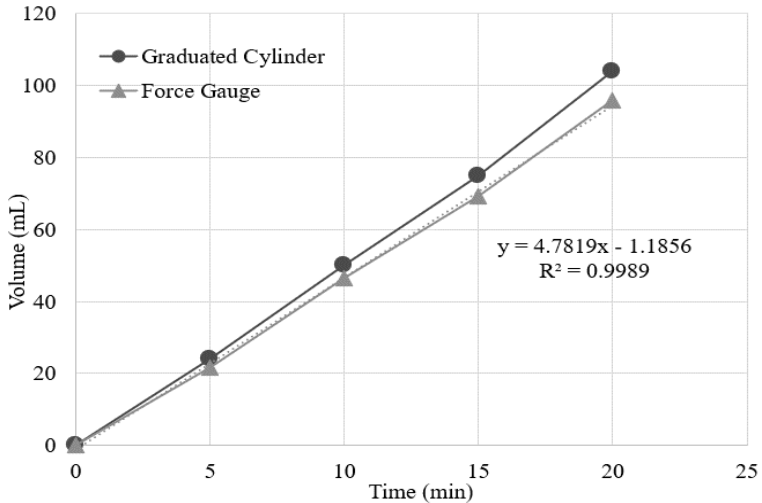


Figure 7. Linear portion of the last iteration ($W \times H$).

The theoretical mass flow rate values were compared with the experimental results. From the first 5 data points, the experimental mass flow rate was calculated to be 287 g/hr. When considering only natural convection, the mass flow rate was calculated as 132 g/hr. This resulted in a 54% error compared with the experimental results. When radiation from a large enclosure is added to natural convection, the combined mass flow rate was 282 g/hr, with an error of 1.8% compared with the experimental results (287 g/hr). The mass flow rate from a two-surface enclosure gave 277 g/hr, with a 3.32% error. This shows that the combination of natural convection and thermal radiation aligns more closely with the experimental results.

Table 3. Mass flow rates and average h values for (III) horizontal setup ($W \times H$)			
Method	\dot{m} (g/hr)	h ($W/m^2 \cdot K$)	\dot{m} error (%)
Experimental results	287	—	—
Analytical (only natural convection)	132	4.17	54.0

Large enclosure (\dot{Q}_{tot})	282	8.58	1.80
Two-surface enclosure (\dot{Q}_{tot})	277	8.45	3.32

Sensitivity Analysis

(I) Heat Transfer Coefficient (h)

The ice melting experiment is sensitive to changes in the combined convection and radiation h values. For the experimental vertical setup ($H \times W$), the h value was $8.55 \text{ W/m}^2\cdot\text{K}$. The theoretical h value, only considering convection heat transfer, based on Eq. (1) was $4.00 \text{ W/m}^2\cdot\text{K}$. Radiation also affects the final h value, and the total h value considers the combination of convection and radiation effects. Figure 7 shows the variation in melting rate compared with the different h values calculated in the theoretical analysis. This figure shows a linear relationship between the mass flow rate and the h values. This figure also shows that the experimental h value is a combination of both convection and radiation. The solid line shows the mass flow rate given a range of h values and the temperature measured from the experiment. Only considering natural convection, the mass flow rate was 128 g/hr . Radiation from a large enclosure and radiation from a two-surface enclosure resulted in 157 g/hr and 153 g/hr , respectively. Adding natural convection to radiation from a large enclosure resulted in a combined mass flow rate of 285 g/hr , which is approximately the same as the experimental result from the vertical setup.

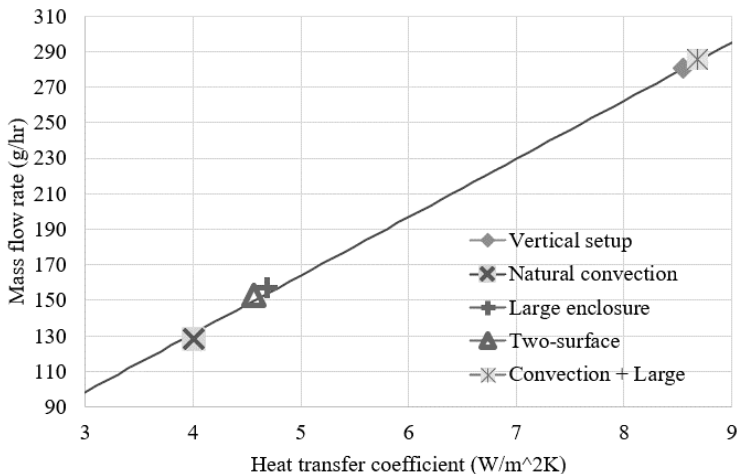


Figure 7. Mass flow rate vs. convection heat transfer coefficient

Figure 8 is another approach to show how sensitive the melting rate is compared to the h value. It shows 3 different h values and what the mass flow rate for each would be with the same boundary conditions. As expected, the higher the value of h , the higher the total volume of melted ice.

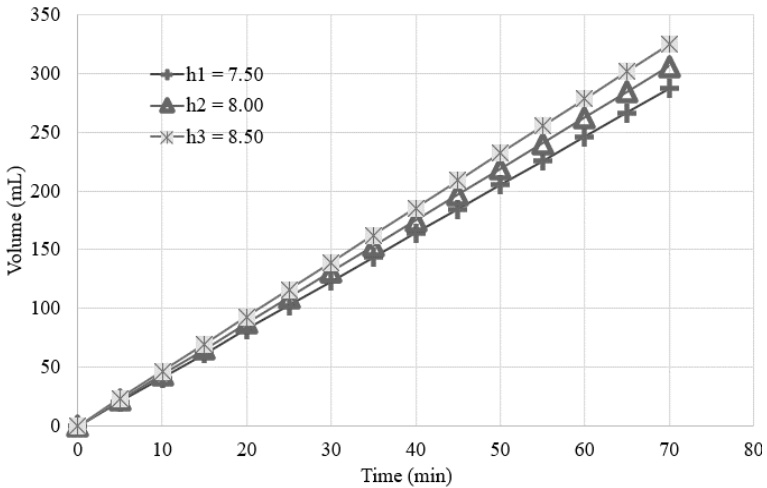


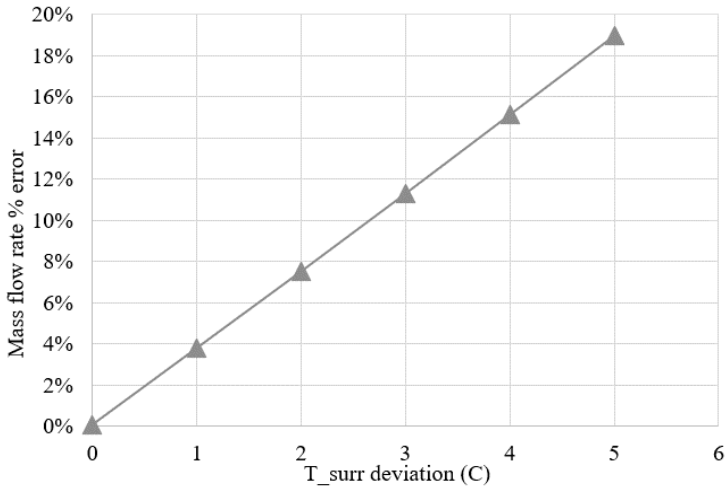
Figure 8. Volume of melted ice vs. time for 3 h values.

(II) Temperature Changes

As explained earlier, the measured temperature of the T_{amb} and T_{surr} were used in the theoretical calculations. A sensitivity analysis was performed by raising the temperature by 1 degree for T_{surr} or T_{amb} in the three TC setup ($H \times W$), evaluating the theoretical mass flow rates, and then comparing the effect of this deviation with the experimental results.

Figure 9A shows the change in the mass flow rate percent error when T_{surr} is changed by 1°C increments, and T_{amb} is considered constant. The deviation from the measured temperature is presented on the x-axis, and the mass flow rate percent error is on the y-axis. The measured value for T_{surr} was 16.9°C , and each deviation of 1°C was evaluated to find a new percent error. Zero percent error means that there was no temperature deviation and that the theoretical and experimental mass flow rates were the same. If the temperature is increased by 1°C , the mass flow rate percentage error increases by approximately 3.8%. This shows that the measured temperature value for T_{surr} was more accurate in the evaluation than the room temperature of 21°C . This also shows that the experiment is very sensitive to changes in temperature.

(A)



(B)

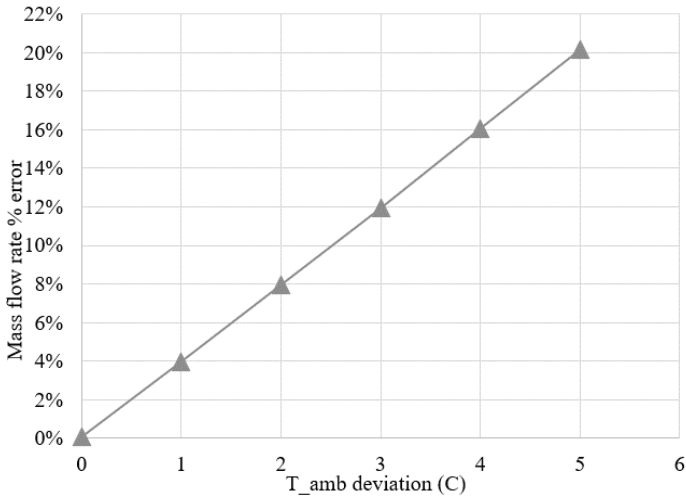


Figure 8. (A) Change in % error when T_{surr} is changed. (B) Change in % error when T_{amb} is changed.

Figure 9B shows when T_{amb} changes and T_{surr} stays the same. The measured value for T_{amb} was 16.2°C. The deviation from the measured ambient temperature is presented on the x-axis, and the mass flow rate percent error is on the y-axis. The results of this analysis show that when the ambient temperature deviates by 1°C, the mass flow rate percentage error increases by 4%. When the temperature deviated to 21.2°C, the error increased to 20% from the experimental value. Using the temperature measured inside the enclosure for T_{amb} was therefore more accurate than using the room temperature of 21°C.

SOURCES OF ERROR

A potential source of error is due to the heat introduced into the system from the heat gun used to extract the ice slab from the container. The heat gun melted some ice and partially impacted the overall temperature of the slab, thus affecting the melting rate. Airflow from the air conditioning unit could also affect the mass flow rate. However, since the experiment was in an enclosure, the contribution from the HVAC system was minimal. Another possible error that may have affected the mass flow rate was the presence of air bubbles in the ice. The air bubbles may have affected the melting rate because there is no phase change for the trapped air and the thermal properties of air are significantly different from water/ice. A possible solution to extract air bubbles from water is to freeze the ice in a vacuum chamber. Also, if the two halves of the ice slab were not intimately in contact, air bubbles could start to form at the interface of water and ice, and affect the melting rate. This problem may also be minimized if the ice was frozen in a vacuum chamber. Human error in reading the temperature, mass, or volume during the experiment is likely to have the leading effect on the error. While the temperature and mass were both shown digitally, the volume had to be recorded visually. Also, the 5-minute time intervals were visually estimated with a stopwatch and could result in an extra 10-30 seconds of melting while recording all the data.

Another source of error to consider is the accuracy of the data logger, TCs, and force gauge. These errors are presented in Table 4. The data logger and multiple TCs were tested to verify that they were within the accuracy range. The accuracy error in the force gauge was reported to be 0.4% of readings [15], but further investigation of the force gauge showed that the actual accuracy error was 1.2%. Therefore, the corrected mass measurements were 1.2% below the readings.

One assumption made was to use 10°C as the film temperature for the properties of air. Using the properties of air at 5 and 15°C compared to the assumed temperature showed that the possible error from this

assumption was less than $\pm 0.5\%$. Therefore, using 10°C as the film temperature has no major impact on the experiment.

Equipment	Range	Accuracy ($^{\circ}\text{C}$)	Accuracy (%)
K-type TC [13]	-50 to 400°C	± 0.002	± 0.5
Data logger [12]	-200 to 1370°C	± 0.1	± 0.3
Force gauge [15]	0-10 kg	-	+1.2
K-type TC [13]	-50 to 400°C	± 0.002	± 0.5

The final factor that can contribute to the error in the melting rate of the ice is the humidity in the air. Humidity increases the melting rate of the ice because the water particles in the air can transfer the heat more easily and can cause condensation to form on the ice. Although this calculation can be accomplished with the correct equipment and will lead to a more accurate model for the melting rate of the ice, it was not the purpose of this experiment.

CONCLUSION & RECOMMENDATION

The purpose of this experiment was to validate the results of the previous experiment conducted at SUU, improve their results by including thermal radiation, and consider an accurate model to predict the melting rate of ice for two orientations. Because of the ambient and surrounding temperatures, melting of ice can be a combination of natural convection and thermal radiation. The experiment was performed in three iterations to evaluate the melting rate of ice in vertical ($H \times W$) and horizontal ($W \times H$) orientations and predict the melting rate of ice. In the vertical setup, the theoretical melting rate had an error of 0.1% for the two-surface enclosure and 1.75% for the large enclosure. In the horizontal setup, the theoretical melting rate had an error of 3.32% for the two-surface enclosure and 1.8% for the large enclosure. The experiments verified that the melting rate was due to the combination of natural convection and thermal radiation. A sensitivity analysis was performed on the heat transfer coefficient and temperature deviations. The total heat transfer coefficient is a combination of convection and radiation and has a linear relationship to the mass flow rate. Temperature deviations also have a significant effect on the mass flow rate. A deviation of 1 degree causes the mass flow rate percent error to increase by 4%. Several sources of error were considered, and the leading errors were due to using the heat gun to extract the ice slab from the container and human error while reading data.

Recommendations

Keep the experiment simple. Use one TC for each measurement but carefully select the location. Be sure the top is covered to have a full enclosure and avoid warmer ambient air from seeping in. Make sure the ice slab is not touching the enclosure or pipes. Keep the testing apparatus away from the room air conditioning unit. Freeze the slab in an insulated container to minimize the amount of trapped air bubbles in the ice. To minimize the heat added to the ice, in future tests, it is recommended to use a tray that will allow the ice slab to be extracted without the use of a heat gun. Another recommendation is to measure the relative humidity inside and outside the apparatus to calculate the amount of water that condenses on the ice during the experiment. The final recommendation is to have two people recording data during the experiment. This will minimize the errors created by recording the data. With these recommendations and future testing, understanding of factors relating to ice melting can improve efficiency in many industries and help combat the effects global warming has on glaciers and snow melt.

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Musical (Department) Chairs: The Health Impacts of Serving as a Rotating Department Chair

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Abstract

The university department chair position is extremely important. Studies have identified potential problems associated with this position when it is based on a rotating system rather than being established as a permanent position. This study examined negative physical, psychological, and social consequences at a university in the western United States. Results indicate there can be associated with serving in a department chair position on a rotating basis, including serious physical health changes such as weight gain and sleeplessness, dangerous psychological changes such as anxiety and stress, and life-altering changes to personal and professional relationships. Although this study is not intended to discourage anyone from serving as department chair, the author recommends potential department chairs understand the negative impact it may have on their lives before pursuing the position.

Introduction

Serving as a department chair in higher education has been called “probably the most important, least appreciated, and toughest administrative position in higher education” (Buller, 2012). According to Federick “Fritz” Redlich, Dean of Yale Medical School in the 1960s and 1970s, “only a psychopath can believe himself to have all the qualifications for the [department chair] job” (Albert and Bartley 2018). Gmelch & Burns (1994) add to this by stating “chairs come to the position without leadership training; without prior administrative experience; without a clear understanding of the ambiguity and complexity of their role; and without recognition of the stresses inherent from the Janus-like position.” (p. 9).

Department chairs are tasked with a myriad of duties and responsibilities, including those related to department governance, instructional leadership, student affairs, external communication, budget and resources, office management, professional development, and faculty affairs (Berdrow, 2010; Bowman, 2002; Buller, 2012; Cipriano, 2011; Gmelch & Buller, 2015; Gunsalus, 2021; Powers & Schloss, 2023; Schmidt & Tucker, 1983; Taggert, 2015). Schmidt & Tucker (1983) detailed 54 tasks and duties of department chairs. The main category of interest in this article is that of “faculty affairs.” This category includes recruiting and selecting faculty members; assigning faculty responsibilities (e.g., teaching, research, committee work); monitoring faculty service contributions; evaluating faculty performance; initiating promotion and tenure recommendations; participating in grievance hearings; making merit recommendations; dealing with unsatisfactory faculty and staff performance; initiating termination of a faculty member; keeping faculty members informed of department, college, and institutional plans, activities, and expectations; maintaining morale; reducing, resolving, and preventing conflict among faculty members; and encouraging faculty participation (Schmidt & Tucker, 1983). According to Albert & Bartley (2018), “being chair remains a complex and challenging job with important responsibilities, but in many organizations, the [chair] has been reduced to middle management.” (p. 150).

Within academia, there are primarily two methods by which a department chair/head (herein referred to as “department chair”) is selected. The first method is through the election of a department chair from the current department faculty (herein referred to as the “rotating chair” system). That individual serves for a specific period of time (as outlined in university policy) and is then either re-elected or replaced by another department faculty member. The second method is through the

hiring of a full-time department chair, from inside or outside the department, who serves in the position until he/she is released from employment or chooses to move to another position. Most universities choose to use the “rotating chair” system, promoting from within the department and rotating the role among faculty. Each faculty member fills an approximately three- or four-year appointment with the intent of returning to the rank of faculty after their term expires (Kruse, 2020).

Because many universities select department chairs from current department faculty, the potential exists for negative impacts on the chair’s physical, psychological, and social health as he/she transitions into the department chair role, fulfills those duties, and then transitions back to faculty status as another colleague assumes the role of department chair. The literature suggests department chairs are highly unprepared to balance the duties associated with this leadership role, receiving very little formal training before or after they move into the position (Gmelch & Schuh, 2004; Wilson, 2001). According to Aziz et. al. (2005), most incoming chairs have little understanding of role expectations, task complexities, time demands, and the potential negative impact the role will have on their professional and personal relationships and identities.

Literature Review

The position of department chair is fraught with political considerations. Colleagues who once were friends find themselves in a very different relationship since one now serves the task of evaluating the other (Gmelch & Schuh, 2004). This change in relationship causes chairs to struggle with their new position in relation to colleagues and friends (Creaton & Heard-Lauréote, 2019).

Armstrong and Woloshyn (2017) found that a chair’s access to confidential information regarding his/her colleagues shifted those longstanding relationships, leading to ethical tensions regarding the dissemination of information, and that “the requirement to return to the faculty ranks at the end of their tenure tempers chairs’ willingness to address resistant colleagues and establish stable professional identities as scholars, managers or leaders.” (p. 108) That same study indicated an exacerbated discomfort with assuming the various roles fulfilled by a department chair by knowing their term as chair was limited. According to one participant in the study,

“One of the things I’m conscious of is that you are chair for a limited time and then you return as a regular faculty member... So whatever you have done as chair in terms of the relationships

that you have forged with your colleagues, you're mindful of that because you want to make sure that you remain colleagues. As a chair you're always mindful that it is a temporary position and that fundamentally you are still colleagues with the people that you work with" (p. 104).

Lees (2007) found that "change is...painful to some, and temporary rotating chairs may be hesitant to make faculty members or others uncomfortable since their term will end and someone else, possibly an aggrieved faculty member, will take over the helm" (p. 308).

As department chairs experience tension related to the variety of administrative duties they must accomplish, that tension is complicated by the fact that the position is temporary (Kruse, 2020). One participant in that study indicated "I will have to go back...I don't want to make enemies." According to Buller (2012), having authority over your peers complicates some of the relationships you had (particularly if you're in a situation where the chair rotates and someday soon they will end up having line authority over you), causing you to provide comments a bit more carefully than you would if you weren't the chair. The role of the department chair is to carry out the administration's orders without offending faculty members (Wilson, 2001). The question then becomes, "How do you do your job as department chair and require a faculty member to take on a course of action when that person is unwilling and may be likely to serve as the department chair someday in the near future?" (Buller, 2012). These are significant considerations because the average chair serves six years and 75% of chairs self-report a desire to return to faculty status when their term as department chair ends (Cipriano, 2011). On average, 20% of department chairs move out of that position and back to faculty status annually (Cipriano, 2011). Liang et al. (2022) found that "subordinates who are abused by a supervisor tend to experience violated perceptions of interpersonal justice and deteriorated well-being. One way in which they may seek to cope with these consequences is by engaging in retaliatory behaviors intended to 'get back' at their supervisor and even the score" (p. 37). Although "abused" is a rather subjective term, the point is made that feelings and actions of retaliation may come to fruition if the subordinate believes they have been abused, so department chairs may not do anything that could be perceived as "abusive" in order to prevent future retaliation.

Chairs are tasked with making decisions that impact the career trajectories of faculty (Taggart, 2015), and, consequently, they may end up making enemies of previous colleagues along the way (Wilson, 2001). In a study by Kruse (2020), one participant stated "It's just so lonely. I've learned not to trust people, some of whom I thought were

friends” (p. 753). Chairs don’t only experience loneliness in the position, they also may consider how they (1) appear to others, (2) may be seen more favorably, (3) may win, dominate, impress, or escape punishment, and (4) may avoid or mitigate a perceived or anticipated attack (Gibb, 1961). Disputes are easy to begin but almost impossible to end. Those internal divisions may continue for decades, even after the originators are long gone (Wildavsky, 1992).

Weaver et al. (2019) identified the challenges of serving as department chair, including dealing with bureaucracy, lack of time for individual research, job-related stress, dealing with noncollegial faculty, and excessive workload, and, while department chairs must balance intradepartmental politics impacting their social health, they also seem to be impacted negatively regarding their physical and psychological health. According to Gmelch & Buller (2015), a department chair’s work is personally stressful, and Weaver et al. (2019) expands on that point stating that faculty who take on the role as department chair undergo major changes in their work life, adding to the stresses of their academic career. According to the Centers for Disease Control (2023), occupational stress is defined as “the harmful physical and emotional responses that occur when the requirements of a job do not match the capabilities, resources, or needs of the worker.” The occupational stress experienced by a department chair may also be magnified because of the ambiguity of the chair’s role, which influences his/her interactions with subordinates (Aziz et al., 2005). According to Gmelch & Schuh (2004), 80% of department chairs admitted that the lack of balance between their private and professional life caused them moderate to severe stress.

Department chairs experience a large amount of stress during their time in the position. Those stresses tend to originate from the conflict-mediating role of the chair as well as time constraints due to the need for chairs to participate in a wide variety of meetings while constantly being interrupted and carrying heavy workloads (Gmelch & Burns, 1994). According to Gmelch & Burns (1994), the stresses experienced by department chairs are not influenced by the chair’s gender, age, discipline, or orientation toward faculty or administration.

Physical and emotional problems also occur within the department chair role. The following comments were received by Armstrong & Woloshyn (2017) regarding the long-term negative physical and emotional impacts of being department chair:

“I just felt so disenchanting. I felt so alienated from my colleagues, from these friends, these people I’d worked with. I didn’t even want to be there. I was so exhausted... I didn’t recognize myself” (p. 107).

“It’s not good for your wellbeing... Everybody complains about being the chair. Everybody does” (p. 107).

Many chairs report having to intentionally find time to exercise, eat properly, and decompress from work (Kruse, 2020). Support for a department chair leaving that role is essential, especially considering the potentially detrimental emotional effects associated with that position (Armstrong & Woloshyn, 2017).

Albert & Bartley (2018) presented the advantages of filling a department chair position with a full-time permanent chair. These include a broader choice of candidates, potential for new direction/ideas/policies/culture, potential for talented faculty to follow the new chair to the university, the ability to assess department strengths/weaknesses/opportunities/threats, ability to hire a charismatic fundraiser for the department, and the ability to improve a weak/struggling department. On the other hand, this process comes with significant disadvantages, including increased cost and time, performance may not live up to expectations, favorable culture and traditions may be lost, the potential for a steep learning curve, unsuccessful internal candidates may feel ill will toward the new hire and possibly resign, a long term of service may be expected causing a concern regarding burnout, and the vacancy created in the department from which the new chair came. One could also argue that the advantages and disadvantages of a rotating chair position are the opposite of the advantages and disadvantages described above.

The literature regarding department chairs suggests they experience a variety of stress-inducing issues such as intradepartmental politics and lack of training. Additional literature indicates the effects go beyond the psychological realm, impacting department chairs physically. According to Wilson (2001), many faculty within a department have watched others fail in the role of department chair and now avoid the position at all costs. Wildavsky (1992) expounds on this by stating “the departmental interest requires that faculty members not look at the chairmanship as something to be sought but rather as a duty to be endured.” (p. 83). This shouldn’t be the way the department chair position is viewed. As a department chair’s term nears its end, faculty shouldn’t be worried that they may have to sacrifice themselves for the good of the department. There must be another way.

This study is the first phase of the “Department Chair Health and Interrelationship Repercussions” (D-CHAIR) project. The purpose of this study was to examine several issues previously discussed as being faced by department chairs as well as exploring faculty perceptions around the idea of doing away with the rotating chair system and instead

hiring a full-time department chair. This study attempts to answer the following research question:

“Have current (or former) department chairs experienced physical, psychological or social health changes attributed to their position as department chair?”

Methodology

The electronic survey (delivered via Qualtrics) utilized for this study included the informed consent statement, which was the first question allowing participants to indicate their desire to participate in the study. Although the entire survey was designed to answer additional research questions, the research question posed required participants to complete one survey measuring the negative physical, psychological, and social changes experienced while serving as department chair.

An email was sent to all current Utah Valley University (UVU) department chairs asking them to forward it to their full-time faculty. The email included a link to a Qualtrics survey consisting of 22 questions (9 yes/no, 2 Likert scales, and 11 text responses). No participant answered all 22 questions because of the skip logic built into the survey, and participants were expected to spend no more than approximately 15 minutes completing the survey. This exploratory study consisted of a cross-sectional analysis of faculty (including department chairs) at UVU. Part-time faculty, adjunct faculty, and staff/administrators who teach an occasional class were not included in the study. To incentivize participation, all participants who completed the survey were entered into a drawing for one of twenty \$50 Amazon gift cards. Funding for the incentives was obtained through a grant from the UVU College of Health and Public Service Scholarly Activities Committee.

Data were analyzed quantitatively and qualitatively. Descriptive statistics (frequencies, averages, etc.) were used to describe quantitative data (through the use of the SPSS statistical software package) while qualitative data was analyzed by reviewing the responses to each question, collapsing responses in similar categories and looking for common themes. Because this study was qualitative and no statistical tests were conducted, no alpha level was established beforehand.

Results

Seventy-one faculty members completed the study, with 46 (64.8%) having been or currently serving as a department chair and 25 (35.2%) who had not served in that position.

Results Related to New Negative Physical Health Changes

Thirty-seven (80.4%) current or former department chairs experienced new negative physical changes and 9 (19.6%) did not. The negative physical health changes identified by the participants are summarized in Table 1.

Negative physical health change	Percent reporting
Weight gain	61.8
Sleeplessness	41.2
Hypertension	23.5
Headaches/migraines	11.8
Gastrointestinal issues	11.8
Fatigue/exhaustion	10.8
Jaw issues	5.9
Eye twitching	5.9
Chest pains	5.9
Panic attacks	5.9

Thirty-five (94.6%) current or former department chairs reporting new negative changes to their physical health believed those changes were attributable to their experiences as department chair whereas only 2 (5.4%) did not. Comments related to these results included:

- “[I experienced] weight gain, high blood pressure, shaking, sick stomach, and headaches. Teeth grinding led to dental and jaw problems and I was addicted to sleeping pills to get any sort of sleep.”
- “[I experienced] weight gain, hypertension, gastrointestinal issues, and chronic pain.”

Results Related to New Negative Psychological Health Changes

Forty-three (93.5%) current or former department chairs experienced new negative psychological changes, whereas 3 (6.5%) did not have these experiences. The identified negative psychological health changes are summarized in Table 2.

Forty (97.6%) of the current or former department chairs who reported new negative psychological changes believed those changes were attributable to their experiences as department chair and 1 (2.4%) did not. Comments received included:

Table 2. New negative psychological health changes (n=43)	
Negative psychological health change	Percent reporting
Anxiety	69.0
Stress	45.2
Depression	26.2
Decreased self-confidence/decreased self-esteem/increased self-doubt	9.5
Isolation	4.8
Emotional worry	4.8
Burnout	4.8
Crying	4.8
Anger	4.8

- “Anxiety and stress were at an all-time high while I was serving as department chair. I am typically not an anxious or stressed person; however, during my time as department chair, these things were off the charts high. I could not figure out a way to manage them, with all the stresses of the job. So I simply had to endure them until my time was finished as department chair. I only did one 3-year term as chair, simply because of the psychological impact the job had on me. I am still dealing with these issues today, because of my role as chair.”
- “[I experienced] stress, anxiety to the point of fear to come to work, nightmares, familial relationships strained because of the pressure and stress of the job, lack of interest in usually enjoyable activities, lack of motivation to care for self because there was too much else to do, lack of attention to family and personal responsibilities, crying, intimate relationship dysfunction, trust issues, a lot of fear and trepidation. In addition, it took me intensive self-care, yoga, meditation, and counseling to be able to go back to work after serving without getting literally sick when I had to go to work and would anticipate/fear seeing some faculty or administrators. It took me a good 6 years to get to this point. I had to disengage in order to preserve my health.”

Results Related to Negative Impacts to Personal and Professional Relationships

Twenty-nine (63.0%) current or former department chairs experienced negative impacts to personal and/or professional relationships whereas 17 (37.0%) did not have this experience. The negative impacts to those relationships are summarized in Table 3.

Table 3. Negative impacts to personal and professional relationships (n=29)	
Negative personal/professional impacts	Percent reporting
Altered and/or destroyed relationships	38.5
Negative impact on social interactions	26.9
Difficulty evaluating or holding accountable previous friends	26.9
Lack of support, trust and/or respect	19.2
Difficulty fitting in with department faculty after serving	11.5
Borderline or outright illegal events	7.7

According to two study participants:

- “Colleagues treated me differently, particularly those who I was holding accountable when they weren't meeting expectations.”
- “Every relationship I had in the department was ruined, with the exception of one faculty member. Before I was department chair, I had good relationships with 95% of the faculty and staff. Once finished with my role as chair, I have a good relationship with just one faculty member and zero staff. I held people accountable during my time as department chair. This did not work in my favor, in regards to keeping a good relationship with everyone. Now that I am no longer the department chair, I don't feel like I fit in with the department. I keep to myself, complete my job responsibilities, but there are zero interactions with faculty and staff other than mandatory meetings and, even then, I do not participate unless I have to. It's sad really. I had a great deal of pride and enthusiasm for my department prior to being the department chair, that pride and enthusiasm has been extinguished.”

Conclusions

This study brought to light many far-reaching issues with a rotating department chair position including (1) negative physical health changes, (2) negative psychological health changes, and (3) negative impacts to personal and professional relationships.

An overwhelming majority (80.4%) of department chairs reported experiencing new negative physical health changes during their time as department chair. The majority of respondents reported weight gain. Significant proportions of respondents also reported sleeplessness and hypertension. These findings are consistent with the findings of Gmelch & Buller (2015) and Weaver et al. (2019). A strong majority (94.6%) of

those who reported new negative physical health changes believed those changes were attributable to their experiences as department chair.

A tremendous majority (93.5%) of department chairs reported experiencing new negative psychological health changes during their time as department chair. Anxiety was the most reported psychological health issue, with 69% reporting its existence; stress was second most frequently reported, with just under half (45.2%) of respondents reporting the issue. These findings are consistent with the findings of Wilson (2001) and Wildavsky (1992). Almost all (97.6%) respondents who reported new negative psychological health changes believed those changes were attributable to their experiences as department chair.

A large majority (63.0%) of department chairs reported experiencing negative impacts to their personal and professional relationships during their time as department chair. Almost two-fifths (38.5%) reported experiencing altered and/or destroyed relationships and almost one-third reported negative impacts on social interactions and/or difficulty evaluating or holding accountable previous friends. These findings are consistent with the findings of Gmelch & Schuh (2004); Creaton & Heard-Lauréote (2019); Armstrong and Woloshyn (2017); Kruse (2020); Buller (2012); and Wilson (2001).

Future Research

This area of study leaves a large amount of room for additional research. The first area of concern is sample size. Although 71 respondents may adequately represent a small population, once that sample was separated into those who had served (or were currently serving) as a department chair and those who had not, those sample sizes were reduced to 46 and 25, respectively. Future research should attempt to include a larger number of respondents to increase generalizability. This may be obtained by including more than one university with a rotating system and some with permanent full-time chairs to allow for comparisons.

It is also recommended to use focus groups rather than electronic surveys. Focus groups would allow participants to provide more in-depth information about the issues they faced rather than the abbreviated information obtained from an electronic survey. The author plans to invite many of the current participants to participate in a focus group to expound on the responses already provided.

Summary

In no other employment setting do you see a system where employee A becomes supervisor of employee B, then several years later

the roles are reversed, and employee B becomes the supervisor of employee A. If this is such a great system, why don't we use it for the positions of Associate Dean, Dean, Provost, or President of the university? The department chair position is the only one rotating in this manner. Both rotating and permanent full-time department chair positions have their advantages and disadvantages. However, based on the results of this study, the author concludes the negative consequences may be more severe in a rotating chair system. Therefore, the author makes the following recommendation: The negative effects presented in this study must be considered when (1) a university/college/department is considering changing to or from a rotating department chair system and/or (2) faculty are deciding whether to accept a nomination for a department chair position.

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Scroll, Click, Mitigate: Unmasking and Taming the Social Media Mental Health Concerns Haunting Utah's Kids

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Abstract

Suicide and depression remain pressing public health challenges, claiming over 49,000 lives annually in the United States and generating an estimated \$484 billion in economic losses. In Utah, suicide is the second leading cause of death among individuals aged 10–24 years, with rates consistently surpassing national averages. Despite 95% of Utah adolescents actively engaging with social media, empirical research on the psychological risks and protective factors embedded within these digital environments remains underdeveloped. This study employed a cross-sectional survey of 2,793 active social media users in Utah aged 18–29 years to investigate demographic, psychological, and platform-specific predictors of online engagement, social comparison, and mental health outcomes. Ordinal regression analyses identified significant associations between engagement patterns and gender, age, residence, anxiety, depression, cyberbullying, and sleep deprivation. Visual-intensive platforms, including Instagram, and Snapchat, were strongly

linked to heightened appearance-based comparison, diminished self-esteem, increased emotional distress, and elevated suicide risk. Online gaming provided partial emotional relief yet reintroduced comparative pressures through competitive design features. Perceptions of social media regulation, risk communication message effectiveness, and prosecutorial success were shaped by institutional trust, content relevance, and the visibility of legal or policy outcomes. Supportive online interactions, particularly peer encouragement and advocacy, were positively correlated with mental well-being, with rural respondents demonstrating comparatively more substantial protective effects. These findings highlight the dual role of digital media in adolescent life: fostering connection and resilience while posing substantial psychological hazards. The study advances a multilevel framework linking adolescent mental health, platform architecture, and governance, offering evidence-based recommendations for integrating digital literacy and resilience education, embedding online behavior assessment in early mental health interventions, implementing algorithmic safeguards, codeveloping policy with youth stakeholders, and strengthening family engagement.

Introduction

Adolescence constitutes a developmental juncture in which neurobiological maturation, cognitive expansion, and social reorientation converge to shape identity formation, emotional regulation, and interpersonal negotiation. In the early 21st century, these processes occur within a digital ecology of unprecedented reach and persistence. Social media platforms now function as primary arenas for self-presentation, peer affiliation, and civic engagement, extending opportunities for creative expression and cross-cultural exchange. Yet the same affordances that facilitate connection and visibility also heighten exposure to risks that carry profound mental health implications. Suicide remains among the most pressing public health crises worldwide, claiming more than 700,000¹ lives annually. In the United States alone, 49,449² individuals died by suicide in 2023, with

¹World Health Organization, "Suicide Worldwide in 2021: Global Health Estimates," May 23, 2025, <https://iris.who.int/server/api/core/bitstreams/769d0a45-b50a-4b17-ba40-259bef44d9dd/content>, 7.

²Sally C. Curtin, Matthew F. Garnett, and Farida B. Ahmad, "Provisional estimates of suicide by demographic characteristics: United States, 2022." *Vital Statistics Rapid Release*, no. 34. November 1, 2023, <https://doi.org/10.15620/cdc:133702>, 2.

associated medical expenditures and productivity losses estimated at \$484 billion.³ Suicide has emerged as the second leading cause of death among individuals aged 10 to 24 years in Utah,⁴ where 95% of adolescents report active use of social media.⁵

A substantial and expanding body of scholarship has identified consistent associations between the frequency, intensity, and qualitative nature of social media engagement and adverse psychological outcomes, including depression, anxiety, and suicidal ideation.⁶ Algorithmically curated visual environments, epitomized by platforms such as Instagram, TikTok, and Snapchat, intensify processes of social comparison, often privileging narrow ideals of beauty, success, and social capital. For adolescents, these curated portrayals not only reinforce dominant cultural norms but also marginalize diverse identities, contributing to dissatisfaction with body image, diminished self-worth, and identity instability.⁷ Such effects are frequently magnified for young people navigating systemic inequities related to race, gender identity, or sexual orientation, for whom online spaces may reproduce offline patterns of exclusion.⁸

Although the prevailing narrative in both scholarly and policy discourse emphasizes the dangers of adolescent digital immersion, a countervailing literature underscores the potential of online environments to foster resilience. Research has documented the role of digital communities in providing social validation, emotional support, and a sense of belonging, particularly for adolescents who are geographically isolated or socially marginalized.⁹ The capacity of such

³ Cora Peterson, Tadesse Haileyesus, and Deborah M. Stone, "Economic cost of U.S. suicide and nonfatal self-harm," *American Journal of Preventive Medicine* 67, no. 1 (July 2024): 129–133, <https://doi.org/10.1016/j.amepre.2024.03.002>, 130.

⁴ Utah Department of Health & Human Services, "Complete Health Indicator Report of Suicide," Public Health Indicator Based Information System, 2024, https://ibis.utah.gov/ibisph-view/indicator/complete_profile/SuicDth.html, 1.

⁵ Office of the Surgeon General, "Social media and youth mental health: The U.S. Surgeon General's Advisory 2023," U.S. Department of Health & Human Services, 2023, <https://www.hhs.gov/sites/default/files/sg-youth-mental-health-social-media-advisory.pdf>, 4.

⁶ Sarah M. Coyne et al., "Does time spent using social media impact mental health?: An eight year longitudinal study," *Computers in Human Behavior* 104 (March 2020): 106160, <https://doi.org/10.1016/j.chb.2019.106160>, 4–5.

⁷ Jasmine Fardouly et al., "Social comparisons on social media: the impact of Facebook on young women's body image concerns and mood," *Body Image* 13 (March 2015): 38–45, <https://doi.org/10.1016/j.bodyim.2014.12.002>, 42–44.

⁸ Brendesha M. Tynes et al., "Online racial discrimination and the protective function of ethnic identity and self-esteem for African American adolescents," *Developmental Psychology* 48, no. 2 (March 2012): 343–355, <https://doi.org/10.1037/a0027032>.

⁹ *Ibid.*

environments to strengthen protective factors remains insufficiently understood, as does the question of how these benefits might be cultivated without amplifying risk. Evidence suggests that family-based strategies, including active parental monitoring, collaborative media engagement, and targeted digital literacy education, can mitigate harmful effects and promote adaptive patterns of use.¹⁰ Yet the empirical foundation for these approaches is uneven, and their efficacy within high-risk populations, such as Utah's youth, remains underexamined.

Parallel to these developments, state-level policy interventions have sought to regulate adolescent engagement with social media. Utah has enacted some of the most comprehensive and restrictive measures in the nation, mandating age verification, parental consent, and heightened transparency from platform providers.¹¹ Although designed to limit exposure to harmful content and attenuate addictive design features, these measures face contested debates over privacy, feasibility, and alignment with the lived realities of adolescents. Public perception, shaped by demographic, cultural, and political variables, has emerged as a potentially decisive factor in the long-term viability of such regulations.

This study positions itself within an interdisciplinary nexus of communication research, public health scholarship, and youth studies. It addresses five interconnected domains: the relationship between social media use and internalizing symptoms such as depression and anxiety; the influence of online social comparison on self-concept; the role of familial mediation in shaping digital well-being; the capacity of online networks to foster resilience; and the social perception of policy measures governing adolescent media use. By synthesizing these strands, the research aims to produce a theoretically grounded and empirically informed account of social media as a communicative environment capable of both exacerbating psychological distress and sustaining pathways toward recovery. The ultimate objective is to inform the design of interventions, policy frameworks, and educational initiatives that recognize and reconcile this dual capacity.

¹⁰ Ali Soyooft et al., "The impact of parent mediation on young children's home digital literacy practices and learning: a narrative review," *Journal of Computer Assisted Learning* 40, no. 1 (August 31, 2023): 65–88, <https://doi.org/10.1111/jcal.12866>.

¹¹ Utah State Legislature. "Social Media Regulation Act." S.B. 152 (2023) <https://le.utah.gov/~2023/bills/static/SB0152.html>; and "Social Media Regulation Amendments." S.B. 194 (2024); <https://le.utah.gov/~2024/bills/static/SB0194.html>.

Literature Review

The influence of social media on adolescent mental health is neither linear nor monolithic. Empirical evidence demonstrates that frequent and problematic engagement correlates with heightened symptoms of depression, anxiety, and suicidal ideation, with adolescent girls exhibiting greater vulnerability to adverse outcomes than boys.¹² Although demographic factors such as age and gender shape patterns of engagement, recent research suggests that the quality of online interaction, whether supportive, neutral, or hostile, serves as a more reliable predictor of psychological outcomes than usage frequency alone.¹³ The dominance of platforms such as YouTube, TikTok, and Instagram in adolescent media repertoires further compounds these risks, as their algorithmically optimized, visually saturated content amplifies exposure to idealized lifestyles, physical appearances, and consumer practices that may foster both emotional strain and identity insecurity.¹⁴ Engagement often begins before age 10, typically without sustained parental mediation, increasing susceptibility to harmful encounters such as cyberbullying, exposure to age-inappropriate material, and sleep disruption.¹⁵ These experiences not only erode well-being but also contribute to patterns of disengagement from school, peer withdrawal, and diminished self-efficacy.¹⁶ Survey data indicate that nearly half of U.S. adolescents believe they spend excessive time on social media, with girls significantly more likely than boys to report deleterious effects on mental health and sleep quality.¹⁷ These dynamics inform the first

¹² Candice L. Odgers and Michaeline R. Jensen, "Annual research review: adolescent mental health in the digital age: facts, fears, and future directions," *Journal of Child Psychology and Psychiatry* 61, no. 3 (January 17, 2020): 336–348, <https://doi.org/10.1111/jcpp.13190>.

¹³ Ine Beyens et al., "Social media use and adolescents' well-being: developing a typology of person-specific effect patterns." *Communication Research* 51, no. 6 (December 13, 2021): 691–716. <https://doi.org/10.1177/009365022110381>.

¹⁴ Jasmine Fardouly et al., "Social comparisons on social media: the impact of Facebook on young women's body image concerns and mood," *Body Image* 13 (March 2015): 38–45, <https://doi.org/10.1016/j.bodyim.2014.12.002>, 42–44.

¹⁵ Faverio, Michelle, and Olivia Sidoti. "Teens, social media and technology 2024." Pew Research Center, December 12, 2024. <https://www.pewresearch.org/internet/2024/12/12/teens-social-media-and-technology-2024>, 6–9.

¹⁶ Candice L. Odgers and Michaeline R. Jensen, "Annual research review: adolescent mental health in the digital age: facts, fears, and future directions," *Journal of Child Psychology and Psychiatry* 61, no. 3 (January 17, 2020): 336–348, <https://doi.org/10.1111/jcpp.13190>.

¹⁷ Faverio, Michelle, and Olivia Sidoti. "Teens, social media and technology 2024." Pew Research Center, December 12, 2024. <https://www.pewresearch.org/internet/2024/12/12/teens-social-media-and-technology-2024>, 6–9.

research question (RQ1) and hypothesis (H1), which investigate the relationship between type and frequency of use, severity of psychiatric symptoms, and the possibility that depression may, paradoxically, increase social media engagement as a maladaptive coping strategy.

Digital gaming introduces a parallel but distinct dimension to adolescent digital immersion. Modern gaming consoles integrate social networking features such as chat functions, multiplayer lobbies, and live-streaming, which facilitate both peer connection and, at times, sustained exposure to harassment. Although 32% of adolescent gamers report mental health benefits derived from gaming, 41% cite sleep disruption, and 80% identify harassment as a persistent concern.¹⁸ Gender disparities in usage are pronounced: boys report daily gaming at far higher rates than girls, reflecting entrenched cultural patterns of digital participation and leisure. As with social media, gaming's effects are bidirectional, offering both opportunities for psychosocial support and pathways to heightened risk. Cross-platform analyses that account for the interplay of gaming and social media use remain limited, yet such inquiry is essential to understanding the cumulative effects of adolescents' media ecologies.

The mechanisms underlying harm and resilience in these digital environments are often mediated through social comparison processes. Leon Festinger's foundational articulation of social comparison theory posits that individuals evaluate themselves relative to others to form judgments about abilities, attractiveness, and worth.¹⁹ In the algorithmically curated environments of contemporary social media, opportunities for upward social comparison are more frequent, visually intense, and personally salient than in offline contexts. Adolescents with depression appear especially prone to such comparisons, which can exacerbate distress and diminish self-esteem.²⁰ Although comparative processes can, in some contexts, motivate self-improvement and goal-setting,²¹ appearance-based comparisons, particularly those involving manipulated or filtered images, are strongly associated with body

¹⁸ American Psychological Association, "Teens say video gaming has social and mental health benefits, but some downsides as well," *APA Monitor* 56, no. 2 (March 2025), 72, <https://www.apa.org/monitor/2025/03/teen-video-gaming-benefits-downsides>.

¹⁹ Leon Festinger, "A theory of social comparison processes," *Human Relations* 7, no. 2 (1954): 117–140. <https://doi.org/10.1177/001872675400700202>.

²⁰ Brian A. Feinstein et al., "Negative social comparison on Facebook and depressive symptoms: rumination as a mechanism," *Psychology of Popular Media Culture* 2, no. 3 (July 2013): 161–170, <https://doi.org/10.1037/a0033111>.

²¹ Armin Falk and Markus Knell, "Choosing the Joneses: on the endogeneity of reference groups," (July 2000). Institute for Empirical Research, University of Zurich, Working Paper No. 53. <https://doi.org/10.2139/ssrn.244405>, 1-39.

dissatisfaction and negative affect, especially among adolescent girls.²² Features such as visible “like” counts, augmented reality filters, and algorithmically personalized content streams reinforce cycles of validation-seeking, internalization of unrealistic standards, and habitual checking behaviors. However, existing studies rarely distinguish between comparisons with known peers and those with influencers or celebrities, nor do they systematically investigate the effects of specific content formats like short-form videos, ephemeral “stories,” or livestreams, on comparative intensity. Addressing this gap, the present study’s second research question (RQ2) and hypothesis (H2) link platform design and content style to the strength and consequences of social comparison processes.

Patterns of engagement and comparison are embedded within broader social structures, most notably the family and the school. Family systems theory situates adolescent development within a network of interdependent relationships, emphasizing parental warmth, monitoring, and responsiveness function as protective factors against adverse digital experiences.²³ Parental mediation strategies range from restrictive controls to active coengagement, with evidence suggesting that collaborative approaches that include discussing content, sharing online experiences, and negotiating boundaries are more effective than unilateral restrictions in promoting digital well-being.²⁴ Educational institutions exert comparable influence: supportive teacher relationships, accessible counseling services, and adaptive intervention strategies are associated with increased help-seeking and more positive mental health trajectories.²⁵ Conversely, school-based interventions that lack transparency, consent, or cultural sensitivity may undermine trust, exacerbate resistance, and limit efficacy.²⁶ These insights inform the third

²² Jasmine Fardouly et al., “Social comparisons on social media: the impact of facebook on young women’s body image concerns and mood,” *Body Image* 13 (March 2015): 38–45, <https://doi.org/10.1016/j.bodyim.2014.12.002>.

²³ Diana Baumrind, “Effects of authoritative parental control on child behavior,” *Child Development* 37, no. 4 (December 1966): 887–907, <https://doi.org/10.2307/1126611>, 887–907.

²⁴ Sonia Livingstone and Ellen Helsper, “Parental mediation of children’s internet use,” *Journal of Broadcasting & Electronic Media* 52, no. 4 (2008): 581–599, <https://doi.org/10.1080/08838150802437396>.

²⁵ Robert W. Roeser, Jacquelynne S. Eccles, and Arnold J. Sameroff, “School as a context of early adolescents’ academic and social-emotional development: a summary of research findings,” *The Elementary School Journal* 100, no. 5 (May 2000): 443–471, <https://www.jstor.org/stable/1002279>.

²⁶ Barnes, Sophie P., and Stephanie M. Jones, *Social and Emotional Learning (SEL) in Schools*, Milton Park, Abingdon: Routledge, 2022. <https://doi.org/10.4324/9781138609877-ree113-1>, 203–218.

research question (RQ3) and hypothesis (H3), which examine how technology-enabled monitoring and communication, when integrated into family and school contexts, can either enhance or strain adolescent well-being. The critical design tension lies in balancing the adolescent's need for autonomy with the protective oversight of trusted adults.

Despite the dominance of risk-oriented narratives, a growing body of scholarship identifies the capacity of social media to reinforce protective factors and foster resilience. Positive online interactions, characterized by warmth, humor, shared reminiscence, and expressions of support, can enhance feelings of belonging, affirm identity, and strengthen coping resources.²⁷ This aligns with the premises of Uses and Gratifications Theory, which frames media consumption as an active process through which individuals seek to satisfy social, informational, and emotional needs.²⁸ Adolescents who engage in digital spaces for community-building report higher perceived social support and greater self-efficacy in managing stressors, though these benefits often coexist with heightened exposure to harmful content.²⁹ The presence of strong offline relationships, particularly with parents, moderates these effects, reducing the likelihood of suicidal ideation even among heavy users.³⁰ The fourth research question (RQ4) and hypothesis (H4) address the processes by which supportive exchanges and shared identities in online spaces translate into tangible mental health benefits, returning to the earlier emphasis on the quality of interaction as a decisive factor in adolescent outcomes.

The policy environment constitutes the final structural context in which adolescent digital life unfolds. Utah's 2023–2024 legislative package, including SB 152, HB 311, SB 194, and HB 464, imposed age verification requirements, mandated parental consent, and compelled transparency from platform operators regarding content moderation and

²⁷ Douglas Smith, Trinity Leonis, and S. Anandavalli, "Belonging and loneliness in cyberspace: impacts of social media on adolescents' well-being," *Australian Journal of Psychology* 73, no. 1 (January 2, 2021): 12–23, <https://doi.org/10.1080/00049530.2021.1898914>, 18.

²⁸ Elihu Katz, Jay G. Blumler, and Michael Gurevitch, "Uses and gratifications research," *Public Opinion Quarterly* 37, no. 4 (1973): 509–523. <https://doi.org/10.1086/268109>.

²⁹ Nicole B. Ellison, Charles Steinfield, and Cliff Lampe, "The benefits of Facebook 'friends': social capital and college students' use of online social network sites," *Journal of Computer-Mediated Communication* 12, no. 4 (July 2007): 1143–1168, <https://doi.org/10.1111/j.1083-6101.2007.00367.x>.

³⁰ Eline Frison and Steven Eggermont, "Toward an integrated and differential approach to the relationships between loneliness, different types of Facebook use, and adolescents' depressed mood," *Communication Research* 47, no. 5 (December 3, 2015): 701–728, <https://doi.org/10.1177/0093650215617506>.

algorithmic design.³¹ Intended to reduce exposure to harmful content and curtail addictive design practices, these measures place Utah at the forefront of state-level regulatory experimentation. However, they have generated contentious debate over privacy, potential government overreach, and the feasibility of enforcement, particularly given the resistance of technology firms and civil liberties concerns.³² National advisories have urged further empirical research into the effects of such policies, highlighting the importance of public trust and stakeholder engagement in shaping outcomes.³³ Despite these calls, little is known about how adolescents and parents perceive these regulations, or how such perceptions vary across gender, socioeconomic status, and prior digital experiences. The fifth research question (RQ5) and hypothesis (H5) thus link policy evaluation to the demographic and psychological factors delineated earlier, framing regulation not only as a matter of institutional design but also as a communicative and cultural process.

Research Method

This study employed a cross-sectional survey design to investigate the relationship between adolescent social media engagement and mental health outcomes. The design was selected for its capacity to capture self-reported behaviors, perceptions, and retrospective experiences from a large and geographically dispersed population within a single period of data collection. Cross-sectional approaches are widely used in communication and social science research for their efficiency and ability to identify patterns of association between variables without imposing the temporal and logistical demands of longitudinal designs.³⁴

Sampling and Participants

The target population comprised U.S. residents aged 18 to 29 currently residing in Utah who actively use social media. Participants were asked to retrospectively report on their social media use during

³¹ Tech Policy Press, “Utah Social Media Regulation Act—S.B.152/H.B.311,” Tech Policy Press, March 7, 2024, <https://www.techpolicy.press/tracker/utah-social-media-regulation-act/>.

³² Agency for Healthcare Research and Quality, “Surgeon General’s advisory on social media and youth mental health,” U.S. Department of Health and Human Services, May 21, 2023, <https://integrationacademy.ahrq.gov/news-and-events/news/surgeon-generals-advisory-social-media-and-youth-mental-health,1>.

³³ Kyle Dunphey, “Judge blocks Utah’s social media laws, writing they likely violate the First Amendment,” *Utah News Dispatch*, September 11, 2024, <https://utahnewsdispatch.com/2024/09/11/judge-blocks-utah-social-media-law/>.

³⁴ Janet Salmons, *Doing Qualitative Research Online* (Thousand Oaks, CA: Sage, 2022).

adolescence. A non-probability sampling strategy combining stratified convenience and snowball sampling was employed to maximize reach and diversity while accommodating resource constraints. Stratification by age, gender, and socioeconomic status sought to improve representativeness across key demographic categories.³⁵ Initial recruitment occurred through digital distribution of the survey via Qualtrics on multiple social media platforms. To extend participation beyond initial networks, respondents were invited to share the survey with peers, a method effective in accessing underrepresented or hard-to-reach subpopulations such as niche online communities.³⁶ The final dataset comprised 2,793 valid responses, following the removal of incomplete or ineligible entries from the initial 2,890 collected.

Instrumentation, Procedures, Reliability, Validity, and Data Analysis

The survey instrument combined established, validated scales with items tailored to the study's research questions. Constructs were operationally defined, and item selection drew from peer-reviewed measures to strengthen construct validity.³⁷ The instrument was pilot tested with 40 participants to assess clarity, relevance, and technical functionality. Revisions were made to address ambiguous wording and ensure conceptual alignment with the study's objectives. Expert reviewers with experience in adolescent media research evaluated the revised instrument for content validity.

Internal consistency reliability was assessed through Cronbach's alpha, with a threshold of 0.70 indicating acceptable reliability.³⁸ Pilot testing further informed the refinement of item wording and scale integration. Validity was reinforced by adherence to established measures, expert review, and iterative instrument development grounded in relevant literature. Data were analyzed using SPSS (version 29.0). Descriptive statistics summarized participant demographics and reported patterns of social media use. A Kolmogorov-Smirnov test indicated non-normal distribution ($p < .05$) for key variables, prompting the use of non-

³⁵ John W. Creswell and J. David Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 6th ed. (Thousand Oaks, CA: Sage, 2023).

³⁶ Patrick Biernacki and Dan Waldorf, "Snowball sampling: problems and techniques of chain referral sampling," *Sociological Methods & Research* 10, no. 2 (1981): 141–163. <https://doi.org/10.1177/004912418101000205>.

³⁷ Mark Wilson, *Constructing Measures: An Item Response Modeling Approach* (New York: Routledge, 2023): 25–40.

³⁸ Mohsen Tavakol and Reg Dennick, "Making sense of Cronbach's Alpha," *International Journal of Medical Education* 2 (2011): 53–55. <https://doi.org/10.5116/ijme.4dfb.8dfd>.

parametric inferential techniques to examine associations between social media use patterns and self-reported mental health indicators. These analyses were guided by the study's research questions and hypotheses, enabling systematic exploration of both risk and protective factors in adolescent digital engagement.

Results

Demographic Profile of Respondents

The final analytic sample included 2,793 respondents, derived from 2,890 initial participants after data cleaning. Age distribution was heavily weighted toward younger adults, with 71.64% between 18 and 23 years and 28.36% aged 24 to 29. The gender composition revealed a marked imbalance: women accounted for 62.62% whereas men comprised 34.37% and 3.01% identified as non-binary or preferred not to disclose. Regional representation was concentrated in Northern Utah (68.53%), with 21.14% from Central Utah and 10.33% from Southern Utah, suggesting geographic skew likely influenced by recruitment channels and digital penetration patterns in the state.

RQ1: Frequency and Type of Digital Engagement and Relationship to Psychiatric Symptoms

Hypothesis 1 predicted that higher frequency and specific types of social media and gaming use would be associated with greater psychiatric symptom severity and that depression could also act as a driver of increased use.

Platform preference data showed Instagram as the most frequently used platform (21.69%), followed by YouTube (17.18%) and Snapchat (16.27%). Mobile gaming led among gaming modalities (29.8%), ahead of console gaming (22.04%) and online multiplayer formats (16.32%). Daily engagement patterns indicated that 35.77% of respondents spent 3 to 4 hours per day on social media or gaming, 31.47% spent 1 to 2 hours, and 3.87% exceeded 8 hours daily. Ordinal regression supported the hypothesis, with significant predictors aligning with expected patterns. Age demonstrated a negative association ($B = -0.558$, $p < .001$), confirming that younger individuals were more likely to be heavy users. Gender also significantly influenced usage ($B = -0.248$, $p < .001$), indicating that female users had lower odds of excessive use compared with male users.

Exposure to negative experiences was strongly linked to higher use: never experiencing cyberbullying reduced odds of high usage by 78.6%

($p < .001$), and never encountering inappropriate content reduced odds by 49.0% ($p < .001$). Sleep deprivation emerged as a robust correlate: those who never experienced it were 82.4% less likely to be high users ($p < .001$), with significant but diminishing protective effects for “rarely,” “sometimes,” and “often” categories.

An unexpected outcome partially supported the hypothesis. Participants reporting no depression (OR = 2.37, $p = .002$) or minimal symptoms (OR = 2.54, $p < .001$) were *more* likely to be in high-use categories than those with frequent depressive symptoms. This finding suggests that heavy use may function as a socializing or coping mechanism, rather than solely as a correlate of distress. Conversely, the absence of suicidal ideation significantly reduced the odds of high use by 70.6% ($p < .001$), supporting the link between severe psychological risk and heavy digital engagement. Overall, H1 was partially supported; frequency and type of use were strongly associated with several psychiatric symptoms and experiences, but the directionality for depression was counter to the original expectation.

RQ2: Psychological and Platform-Specific Predictors of Social Comparison

Hypothesis 2 proposed that higher engagement in social comparison would be linked to specific demographic traits, platform types, and content features that amplify comparison frequency.

The analysis revealed a powerful dose-response relationship. Compared with those who never engaged in social comparison, odds increased substantially for “rarely” (OR = 16.76, $p < .001$), “sometimes” (OR = 102.54, $p < .001$), and “often” (OR = 1,031.77, $p < .001$) engagement levels, confirming the hypothesized gradient effect. Age was a negative predictor (B = -0.127, $p = .037$), indicating younger participants were more susceptible. Women’s odds of frequent comparison were 2.34 times higher than men’s ($p < .001$), supporting the gender-related expectation. Urban residence showed a small but significant protective effect (B = -0.145, $p < .001$).

Platform-specific patterns further confirmed H2. Users of X, YouTube, LinkedIn, Pinterest, Discord, Telegram, Tumblr, and Twitch had significantly higher odds of frequent comparison in comparison to Facebook (B range: 0.76 to 2.19, all $p < .05$). Content format effects were pronounced: photos (B = 10.51), videos (B = 9.43), reels (B = 8.62), and livestreams (B = 7.95) all sharply increased odds of frequent comparison, whereas engagement metrics such as likes, comments, and follower counts were negatively associated (all $p < .001$), suggesting these metrics may fuel evaluative stress rather than fostering adaptive comparison.

Gaming variables partially aligned with the hypothesis. Online multiplayer participation increased odds of frequent comparison by 5.31 times ($p = .007$), whereas mobile and console gaming were weakly negative predictors. In-game social collaboration ($B = 0.41, p = .002$) and expressive gestures ($B = 0.90, p = .037$) promoted comparison-related outcomes, while messaging features ($B = -5.18, p < .001$) and reward systems ($B = -1.10, p < .001$) reduced them. As a result, H2 was fully supported, with clear demographic, platform, and content-driven predictors of social comparison behavior.

RQ3 & H3: Risk Communication Effectiveness and Wellness Promotion

Hypothesis 3 posited that message type, delivery channel, and thematic focus would significantly predict perceived effectiveness of risk communication and that credibility of sources would influence outcomes.

Effectiveness ratings showed strong predictive validity: “moderately effective” messages describing the risks of social media had 23.37 times higher odds of favorable reception ($p < .001$) and “very effective” messages had 115.52 times higher odds ($p < .001$) than “not effective at all.” These estimates were derived by exponentiating the ordered logistic regression coefficients, which yielded substantial and statistically robust effect sizes, confirming that higher perceived effectiveness translated into markedly greater likelihood of audience acceptance. Age ($B = 0.136, p = .019$) and urban residence ($B = 0.173, p < .001$) were also positive predictors. Message type analysis confirmed the hypothesis: informational (+78.6%, $p < .001$), emotional (+76.0%, $p < .001$), and directive (+32.0%, $p = .022$) appeals were all more effective than preventive framing. Channel effects were similarly robust: government websites ($OR = 1.72, p = .023$), community organizations ($OR = 1.52, p = .017$), and mobile apps ($OR = 1.78, p < .001$) outperformed traditional media.

As predicted, source credibility effects were negative for certain actors. Messages attributed to parents, schools, government agencies, or social media companies reduced perceived effectiveness by 79–83% (all $p < .05$). Topic focus mattered; cyberbullying (+82.0%, $p < .001$) and privacy/data security (+50.7%, $p = .027$) improved impact. At the same time, online predators and mental health effects were not significant. Parental control tools added nuance: NetNanny was associated with 41.4 times higher odds of perceived message effectiveness ($p < .001$), Kaspersky Safe Kids with 2.11 times higher odds ($p = .015$).

Consequently, H3 was fully supported, with all 3 dimensions—message type, channel, and source—demonstrating significant predictive effects.

RQ4: Public Perceptions of Legal and Policy Measures

Hypothesis 4 anticipated that higher perceived policy effectiveness and successful enforcement outcomes would predict favorable public perceptions, moderated by demographic and awareness factors.

Those rating Utah's regulations as "moderately effective" had 5.04 times higher odds of having positive perceptions ($p = .005$), whereas "very effective" ratings corresponded with a 34.54-fold increase ($p < .001$). Gender effects favored women (+32.0%, $p < .001$). Awareness effects peaked for "slightly knowledgeable" (+106.1%, $p = .003$) and "moderately knowledgeable" (+103.1%, $p = .003$) respondents; the highest awareness level was non-significant. Perceptions of prosecution success showed even steeper gradients: "moderately successful" cases were associated with 17.08 times higher odds of positive perceptions ($p < .001$) and "very successful" with 93.89 times higher odds ($p < .001$). These specific prosecutorial outcomes—public apologies (+129.7%, $p < .001$), financial penalties (+63.1%, $p = .005$), policy changes (+63.9%, $p = .002$), safety feature enhancements (+35.3%, $p = .049$), and jail terms (+75.8%, $p < .001$)—all significantly improved perceptions. H4 was therefore fully supported, confirming that both perceptions of policy effectiveness and visible, substantive enforcement outcomes strongly shape public attitudes.

RQ5 & H5: Positive Social Media Interactions and Mental Health Outcomes

Hypothesis 5 predicted that greater frequency of positive social media interactions would be associated with better mental health outcomes and that confidence in collaborative mental health participation would strengthen perceived effectiveness.

Findings showed a steep, graded effect: compared with those who "always" experienced positive interactions, the odds of reporting high mental health were 98.9% lower for "never" ($p < .001$), 92.5% lower for "rarely" ($p < .001$), 85.9% lower for "sometimes" ($p < .001$), and 68.9% lower for "often" ($p < .001$) experiencing positive interactions. Gender (+22.1%, $p = .002$) and urban residence (+11.7%, $p < .001$) were also significant predictors, whereas age was not.

Confidence in participation showed robust associations: "moderately confident" respondents had 5.47 times higher odds ($p = .019$) of perceiving effectiveness, and "very confident" respondents had

39.11 times higher odds ($p < .001$). Lack of confidence sharply reduced odds by 90.6% ($p = .001$). Stakeholder analysis, on the other hand, showed that parental involvement reduced perceived effectiveness by 52.5% ($p = .041$), whereas students' involvement trends toward significance ($B = -0.643$, $p = .068$), suggesting that while youth voices are crucial, they may not always feel empowered or heard in decision-making spaces. Among corporate strategies, only transparent compliance was associated with significantly improved perceptions (+75.4%, $p = .041$). H5 was thus fully supported, with consistent evidence that both the quality of social interactions and confidence in participation are decisive in shaping mental health and collaboration outcomes.

Discussion

Digital environments have become central to the developmental ecology of contemporary adolescents, structuring identity formation, emotional regulation, and social participation. In Utah, where nearly all minors report active use of at least one social media platform, the findings of this study reveal a mobile-first ecosystem in which visual intensive platforms such as Instagram, and online gaming dominate daily routines. Regression analyses demonstrate that cyberbullying, anxiety, and sleep deprivation significantly predict patterns of engagement. At the same time, depression shows a paradoxical association with increased usage, suggesting that digital interaction may function as both a coping mechanism and a stressor. These results align with existing scholarship emphasizing the dual nature of digital spaces, which can simultaneously afford psychosocial support and introduce acute vulnerabilities.³⁹

Psychological and demographic patterns suggest differentiated risk and resilience profiles. Younger participants exhibited higher daily engagement, consistent with research linking early and middle adolescence to heightened reliance on mediated peer networks.⁴⁰ Gender disparities, most notably lower reported engagement among female users, may reflect the compounding effects of social comparison

³⁹ Andrew K. Przybylski and Netta Weinstein, "Digital screen time limits and young children's psychological well-being: evidence from a population-based study," *Child Development* 90, no. 1 (2019): e56–e65. <https://doi.org/10.1111/cdev.13007>.

⁴⁰ Candice L. Odgers and Michaelaeline R. Jensen, "Annual research review: adolescent mental health in the digital age: facts, fears, and future directions," *Journal of Child Psychology and Psychiatry* 61, no. 3 (2020): 336–348. <https://doi.org/10.1111/jcpp.13190>.

pressures, targeted harassment, and digital fatigue.⁴¹ The positive association between depressive symptoms and use supports earlier findings that adolescents may turn to digital environments for distraction or emotional validation; however, the observed lower level of participation among those with suicidal ideation suggests withdrawal in moments of acute crisis, a pattern that warrants closer clinical attention. Notably, body shaming did not emerge as a significant predictor in multivariate models, underscoring the likelihood that other forms of online victimization or self-concept processes mediate its effects.

Patterns of social comparison were strongly mediated by age, gender, geographic location, and platform affordances. Younger participants reported higher susceptibility to peer influence and identity-relevant comparisons, consistent with developmental socialization processes.⁴² Female users reported greater engagement in appearance-based comparisons, a finding supported by literature linking visual social media platforms to internalized beauty ideals and body dissatisfaction.⁴³ Rural adolescents reported lower rates of comparison, potentially reflecting differences in offline reference groups or cultural attitudes toward mediated identity display. Platform architecture, especially algorithmically curated visual content on Instagram, TikTok, and Snapchat, appears to amplify comparison behaviors. Although interactive features such as comments and direct messaging may provide some buffering effects, these are offset by design elements, such as “likes,” filters, and trending audio, that reinforce normative validation loops.

Gaming also revealed a bifurcated impact on mental health. Cooperative and narrative-driven play offered avenues for connection and escapism, echoing studies that identify gaming as a potential tool for stress reduction.⁴⁴ However, competitive environments frequently reintroduced comparison dynamics and increased exposure to

⁴¹ Amy Orben, “Teenagers, screens and social media: a narrative review of reviews and key studies,” *Social Psychiatry and Psychiatric Epidemiology* 57 (2022): 407–414. <https://doi.org/10.1007/s00127-019-01825-4>.

⁴² Elisabeth Frison and Steven Eggermont, “Exploring the relationships between different types of Facebook use, perceived online social support, and adolescents’ depressed mood,” *Social Science Computer Review* 34, no. 2 (2016): 153–171. <https://doi.org/10.1177/0894439314567449>.

⁴³ Jasmine Fardouly et al., “Social comparisons on social media: the impact of Facebook on young women’s body image concerns and mood,” *Body Image* 13 (2015): 38–45. <https://doi.org/10.1016/j.bodyim.2014.12.002>.

⁴⁴ Catherine Beavis, “Games as text, games as action: video games in the English classroom,” *Journal of Adolescent & Adult Literacy* 57, no. 6 (2014): 433–439. <https://doi.org/10.1002/jaal.275>.

harassment, particularly among younger male participants. This ambivalence underscores the necessity of addressing both content and context when evaluating digital leisure activities.

Perceptions of risk communication messages (RCMs) further illuminate the role of demographic and trust factors in shaping receptivity. Older participants rated RCMs as more effective, possibly reflecting greater institutional trust or experience with public health messaging.⁴⁵ Gender differences approached statistical significance, with women more responsive to emotionally framed appeals, consistent with evidence on affective persuasion in health contexts.⁴⁶ Message content addressing cyberbullying and privacy elicited higher perceived effectiveness. Moreover, delivery through school guest speakers was rated lower, potentially because of perceived lack of authenticity or alignment with students' lived experiences.

Attitudes toward regulatory measures also revealed gendered variation. Women were more likely than men to view Utah's recent social media regulations as effective. This pattern may be linked to broader social responsibility orientations and support for protective policy interventions.⁴⁷ Interestingly, participants with lower awareness of specific laws expressed higher confidence in their efficacy, a dynamic that may reflect optimism bias or heuristic-driven trust. The absence of significant age or residence effects suggests that support for regulation cuts across some demographic boundaries. Finally, perceptions of judicial and prosecutorial success were closely tied to the visibility and salience of case outcomes. Financial penalties, public apologies, and policy changes were rated as the most effective consequences, lending empirical support to salience theory and research on symbolic justice.⁴⁸

Implications

The present findings have several implications for communication scholarship, public health practice, and policy design. First, they

⁴⁵ Gerd Gigerenzer and Rocio Garcia-Retamero, "Cassandra's regret: the psychology of not wanting to know," *Psychological Review* 124, no. 2 (2017): 179–196. <https://doi.org/10.1037/rev0000055>.

⁴⁶ Federico R. León et al., "Gender Moderates Persuasion Effects of Negative Health Messages," *Multidisciplinary Journal of Gender Studies* 14, no. 2 (June 25, 2025): 79–97. <https://doi.org/10.17583/generos.13151>, 79–97.

⁴⁷ Stephanie Paterson and Francesca Scala, "Gender-mainstreaming in public policy." *Encyclopedia of Public Policy*, December 24, 2024. https://doi.org/10.1007/978-3-030-90434-0_121-1.

⁴⁸ Paul Slovic and Elke U. Weber, "Perception of risk posed by extreme events." In: *Regulation of Toxic Substances and Hazardous Waste* (2nd edition) (Applegate, Gabba, Laitos, and Sachs, Editors), Foundation Press. <https://ssrn.com/abstract=2293086>.

demonstrate the need for integrated approaches that combine digital literacy with emotional resilience training. Adolescents' ability to critically assess and respond to online content is inseparable from their broader psychosocial competencies. Second, gendered experiences of digital life, particularly the disproportionate emotional labor borne by girls in managing social comparison and harassment, require targeted intervention strategies. Third, rural adolescents' comparatively lower exposure to certain online risks, coupled with their often-stronger offline support networks, suggests that community-based models may be especially effective in such contexts. The results also point to opportunities for improving risk communication strategies. Trust in message sources, alignment of content with audience priorities, and congruence between delivery mode and cultural context are central to message efficacy. Furthermore, policy measures must be codeveloped with youth stakeholders to ensure both relevance and legitimacy.

Limitations

This study's cross-sectional design constrains causal inference, because temporal ordering between online experiences and mental health outcomes cannot be definitively established. The reliance on self-reported measures introduces potential recall and social desirability bias. Although the sample size was large ($n = 2,793$), the demographic composition lacked racial, ethnic, and religious diversity, limiting generalizability beyond the Utah context. The absence of qualitative data precludes deeper exploration of individual meaning-making processes, and the noninclusion of behavioral analytics prevents triangulation with objective usage patterns.

Recommendations

Based on these findings, the following recommendations are advanced:

1. Education

Educational systems should institutionalize comprehensive digital literacy and resilience programs as part of core curricula. These programs must extend beyond basic technical skills to address the psychosocial dimensions of online life, including the mechanics of social comparison, strategies for safeguarding personal data, and recognition and response to harassment. Such training should be scaffolded across developmental stages to ensure students build adaptive competencies over time.

2. Clinical Practice

Mental health assessments in clinical settings should routinely integrate measures of adolescents' digital behaviors, particularly for patients presenting with depressive or anxiety symptoms. Standardized tools capable of capturing patterns in social media use, online interactions, and exposure to harmful content would allow practitioners to identify risk factors that may otherwise remain invisible in traditional intake processes.

3. Policy

Legislative bodies should craft regulatory frameworks for digital environments that are transparent, adaptable, and informed by the perspectives of young people. Policy design must strike a deliberate balance between safeguarding adolescents from harm and preserving their agency and capacity for exploration, ensuring that protective measures do not inadvertently curtail developmental opportunities.

4. Platform Design

Social media companies should recalibrate recommendation algorithms to reduce the amplification of harmful or distressing content. Safety tools must be developed in direct collaboration with adolescents, ensuring that interventions are both technologically effective and aligned with the lived realities of young users. This codesign approach can foster trust, improve adoption, and enhance overall platform safety.

5. Parental Engagement

Parents should cultivate sustained, open-ended dialogue about their children's online experiences, resisting purely supervisory or punitive approaches. By modeling critical engagement, emotional regulation, and healthy media consumption, caregivers can position themselves as trusted interlocutors rather than gatekeepers, thereby increasing the likelihood that adolescents will seek guidance when confronted with online challenges.

6. Research

Future research agendas should prioritize longitudinal and mixed-method designs capable of capturing the evolving interplay between digital environments and adolescent well-being. Broadening demographic representation is essential to illuminate differential impacts across cultural, socioeconomic, and geographic contexts. Integrating qualitative insights with behavioral analytics will provide a richer and

more actionable understanding of how vulnerabilities and strengths manifest online.

7. Theory Development

There is an urgent need to advance theoretical models capable of systematically detecting and interpreting both vulnerabilities and resilience factors in adolescents' online behaviors. Such frameworks should bridge developmental psychology, communication theory, and computational analytics, offering a coherent structure for intervention design and policy formulation.

Conclusion

Social media and gaming environments present adolescents with a paradox: they are spaces of both vulnerability and resilience. This study advances understanding of how demographic variables, mental health status, and platform architectures interact to produce divergent outcomes. Recognizing adolescents not merely as passive recipients of online influence but as active agents in shaping their digital experiences opens new pathways for designing healthier, more equitable online ecosystems. The findings underscore that protective interventions must be multidimensional: addressing structural, interpersonal, and individual factors, if they are to meet the evolving challenges of youth digital life.

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“Then I Remembered”: Joan Didion on Grief and its Replication— Minimalism and Phenomenology

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Abstract

*The modernist project, in its pursuit of capturing internal reality, frequently grappled with the failure of language to articulate the un-articulable, particularly in the face of profound loss. Joan Didion's *The Year of Magical Thinking* (2005) emerges as a pivotal text in this tradition, pushing against the limits of prose to articulate a state of being that resists conventional narrative. This paper focuses on the rhetorical and stylistic strategies within the memoir's second chapter, demonstrating how Didion's use of sentence variation, literary minimalism, and rhetorical questioning functions not to describe grief but to actively enact its destabilizing, fragmented effects. Drawing on Merleau-Ponty's phenomenology of the phantom limb and Matthew Ratcliffe's theories on bereavement, this analysis argues that Didion's prose creates an aesthetic mimesis of mourning, mirroring the unsettling experience of absence that paradoxically asserts a continuous presence. Her textual choices trap the reader within the author's hyper-focused, disoriented consciousness, ultimately interrogating the central paradox*

of the grief memoir: can this profound act of "textual grieving" genuinely bridge the epistemological divide between writer and reader, or does the essential, untranslatable nature of grief ensure that this most intimate of human experiences remains exclusive to its author?

Joan Didion's *The Year of Magical Thinking* (2005) is a grief memoir exploring her disorienting experience following the sudden death of her husband, John Gregory Dunne. In an attempt for connection to herself and these experiences, Didion tries to translate her chaos of loss into language, capturing the psychological and emotional unraveling within tragedy. This paper focuses specifically on the memoir's second chapter—the chapter of her husband's death—to examine how Didion's sentence variation, literary minimalism, and rhetorical questioning do not merely describe grief but enact its fragmented, destabilizing effects. These stylistic choices mirror Merleau-Ponty's concept of the "phantom limb" in grief, in which absence paradoxically asserts presence, as well as Matthew Ratcliffe's theories on bereavement as a disruption of lived experience. Drawing on these literary and philosophical ideas, this analysis will demonstrate how Didion creates a textual experience that mirrors the disorienting and isolating nature of mourning. I hope to enact a rhetorical analysis of her question types, a literary analysis through her minimalist style, a comparative analysis with other American authors, and a theoretical analysis with phenomenology. In pulling in all these methods of analysis, the goal of this paper is to attempt to tackle the timeless, ever-elusive question of grief—specifically, whether Didion's portrayal can authentically translate the experience to those who have yet to endure it, or if this upending loss remains fundamentally exclusive to its author.

In the current literary landscape regarding Didion and *The Year of Magical Thinking*, critics report on Didion's grief, why her recording of her experiences is meaningful, and the way the memoir is related to other grief literature, but none have really explained how Didion is able to evoke these experiences. In F. Brennan and M. Dash's article, "*The year of magical thinking: Joan Didion and the dialectic of grief*," they align Didion's recorded thoughts and experiences alongside other grief literatures, like *A Grief Observed* (1961) by C.S. Lewis, and make sense of her actions through a Freudian perspective, but the article fails in recording Didion's ability to situate her pain and the effect of doing such. Similarly, in Katarzyna Małecka's article on Didion's memoir, she connects parallels between Didion's grief and that of Joyce Carol Oates in *A Widow's Story: A Memoir* (2011), writing that "Oates employs stylistic techniques similar to Didion's," yet she doesn't explain what

this means (191). But Marta Bladec gets close to Didion's literary approach by writing that she uses spatial imagery to create a sense of loss and grief through Didion's mental and physical displacement in order to structure the memoir as a "grief map that charts mourning across space and time" (940). Bladec suggests that throughout the memoir, where Didion interrupts the present with past memories, readers enter a space akin to Didion's grief vortex, but the analysis ends there with Didion's recurring flashbacks (192). It seems that most scholars spend their time explaining the chronological process of Didion's grief and healing, yet ignore Didion's ability to create—or rather, dismantle—a moment for the reader that needs such fixing. In her memoir, Didion replicates her mental upheaval for a reader untouched by her specific nature, but how true is this union of reader and speaker? It is Didion's moment of loss, later recounted through her grief-laden perspective that molds the reader to her own experience that I will interrogate.

To continue this idea of grief observed by another, rather than experienced by the user, Raymond Carver's poem "Grief" similarly navigates the realization of loss, highlighting the divide between intellectual understanding and personal involvement. Carver places readers in the perspective of a person who learns the seemingly absurd actions performed by another after he loses his wife. But then, with the speaker's loss of their own inferred partner, the speaker understands why the other man behaves so. Carver writes, after his realization: "Such display / I found embarrassing. So did his other / friends. I couldn't see it. / Not until this morning." For his character, the concept of loss remained abstract until it was felt, and this idea of distance to knowledge through experience is also mirrored in Didion's second chapter: "Grief, when it comes, is nothing we expect it to be" (26). She explains that she didn't feel grief when her parents died, maybe because she was expecting it—or possibly the distance between her and them minimized the feelings; but when her husband died, as Carver also wrote, she understood it. She felt it.

This raises a central question: can a writer effectively convey grief to an audience that has never personally experienced it, or is such an emotion inherently untranslatable? For both Didion's and Carver's personas, they had to actually experience loss first-hand in order to understand; do they expect the same from their audience? This might be unanswerable because each reader brings with them individual experiences, and for some, the simple mention of "loss" might rehash old memories, moments, and encounters upon reading. But for others—the personally death-untouched—how are they supposed to *know* a loss they haven't had? Because the grief that comes from intimate loss—in both Didion's and the Carver poem's cases, a partner—is for many so

intense it can even border time-halting paralysis—as André Breton writes in his “The Spectral Attitudes”: “Death is the least offence / The future never comes.” Is translating and projecting this experience onto another impossible? For Didion, at least, I will first be arguing that in her use of certain rhetorical strategies, she is able to simulate a concept of the disorienting, negotiating, and realizing aspects in which loss-fused grief *feels* through sentence variation, a minimalist literary style, and usage of specific, differing question types.

In her second chapter, Didion alternates between sentence lengths to draw her readers into something greater on-page: an imitation of her anxious, disorienting experience. Moments before Dunne’s final collapse, Didion writes a paragraph describing their dinner scene and a few of their talking points (10). In the First Vintage International Edition copy (published in 2005), the first sentence is three lines, twenty-six words. The next three are two lines, and sixteen, four, and twelve words. The last is four lines, thirty-two words. There is enough variety in this paragraph for the reader to move onto the next scene without, I assume, much pause. As Irvin Hashimoto questions the importance of sentence variety, he states that variation may be for “sentences [to] ripple on like a various mountain stream” (66). It is the same here with Didion.

Readers flow across her sentences like running water. Yet this comfortable sentence variety loses shape alongside the safety of Didion’s space. When Dunne falls from his seat, then onto his face, and Didion attempts the Heimlich maneuver before calling an ambulance, her once secure sentence variety disrupts: “I called one of the numbers. A dispatcher asked if he was breathing. I said *Just come*” (11). *Boom boom boom*. Six words, seven words, four words. Didion’s intense moment with quick, brief sentences replicate a feeling of short breathing, as if the readers are also panicking: like the beats of hyperventilation. In an analysis of literary minimalism, Robert C. Clark writes in reference to Carver’s “Cathedral” and Cormac McCarthy’s *No Country for Old Men* (2005) that “The less that is said, the more pointed the statement, the more menacing the tone” (109). And for Didion’s case, in these three brief, consecutive sentences, we can swap Clark’s use of the word “menacing”—something which tension dwells in—for “urgency.” Both words capture the importance of the moment: intensity.

Didion’s minimalist prose further reinforces the rawness of her experience, stripping away excess detail to focus only on what she is conscious of in the moment, denying the reader any distractions from her reality. She tunnels her readers into her perspective and doesn’t release them. After Dunne’s collapse, Didion and her readers are forced into her fixation of ambulance numbers taped by the telephone in the kitchen, which takes the better half of a paragraph (11). We cannot separate from

Didion's hyperfocusing to explore her other rooms, Dunne's separate movements, or her subconscious emotions. The readers become what Didion is. And, reflexively, Didion becomes the reader.

The use of short sentences and focusing the reader on only what the author is experiencing is nothing new. Didion's strategy aligns with that of another champion of the minimalist style, Ernest Hemingway, who strips away excess detail to confine readers within the characters' narrowed perceptions. This way of writing offers a stark contrast to other popular writers like Annie Proulx, whose expansive descriptions distance readers from the immediacy of lived experience. With Hemingway, we see this reader-author intimacy in such stories like "Big Two-Hearted River," the final short from his *In Our Time* (1924) cycle. Here, he describes all of Nick Adams's miniscule actions, emphasizing that for his character—in the burned-out town, burned-out forest, catching hidden grasshoppers and the strongest trout—he is only in control of the most minute aspects of his life, like setting up a tent: "There had been this to do. Now it was done. It had been a hard trip. He was very tired. That was done. He had made his camp" (115). The short sentences pant with exhaustion like a child catching breath while recounting a story. This tiredness is reflexive on both the reader and literary character, creating a bond of weariness. Readers are only allowed what the author has experienced; in their fatigue, they learn their world. Now let's contrast the tiring, containing method of Hemingway and Didion with that of the aforementioned author, Annie Proulx, in how she describes a moment of intensity. In B. R. Myers's *The Atlantic* article "A Reader's Manifesto," he critiques a scene from Proulx's *Accordion Crimes* (1996) in which a character has her arm quickly cut off by a piece of sheet metal (4). Proulx's moment is described in a long sentence, of six lines and eighty-eight words—enough for its own paragraph, as the character observes "the grain of the wood of the barn clapboards, paint jawed away by sleet and driven sand, the unconcerned swallows darting and reappearing with insects clasped in their beaks looking like mustaches, the wind-rippled sky [...]," etc. But the problem with a sentence that details every shadow, insect, the sky, a home's windows, etc., according to Myers, is that "the last thing Proulx wants is for you to start wondering whether someone with blood spurting from severed arms is going to stand *rooted* long enough to see more than one bird disappear, catch an insect, and reappear, or whether the whole scene is not in bad taste of the juvenile variety. Instead you are meant to read the sentence in one mental breath and succumb, under the sheer accumulation of words, to a spurious impression of what Walter Kendrick, in an otherwise mixed review in *The New York Times*, called "brilliant prose" (and in reference to this very excerpt, besides)" (4).

Now, to clarify, I don't mean to say that what Proulx does here is a "bad" literary technique—but unlike Didion, she doesn't replicate a phenomenological experience. For Didion, she only focuses on one thing at a time and everything else leaves the stage, whereas Proulx creates something outside of natural experience, leaving the reader unable to truly relate to the scenario. Yet for Didion, it is her and only her; no other unknown details are absorbed. And with that, the readers are bound to her same restrictions. They are denied the ability to look around her apartment to smell the food on the table, to feel the heat of the fire. No, they remain with Didion. Then, when her sentences following Dunne's collapse stretch out again and details reenter the clauses, we, as with Didion, can begin to breathe.

Paramedics come. Dunne is rushed to the hospital. He dies. And Didion questions.

In doing so, she writes a series of erotema-styled questions—those which remain unanswered—to portray her disorientation and the confusion that grief often brings: "I wondered what an uncool customer would be allowed to do. Break down? Require sedation? Scream?" (16). "*If they were here that long does it mean he was alive?*" (21). "What did he mean? Did he know he would not write the book? Did he have some apprehension, a shadow? [...] Was something telling him that night that the time for being able to write was running out?" (23). "Should I rekindle what was left of the fire, would we have a drink, would she have eaten? Had I eaten?" (30). There are others, but I believe these capture her feelings best. The questions seek to disorient. They place the reader in new settings and pull them out of established ones; Didion wrings out her past while in the present and debates with the future. Her questions place Didion elsewhere. She no longer remains in the present, and in this, she forgets her immediate self.

In reference to Freud's concepts of desires, James Strachey explains that desires function outside of reality in order to achieve satisfaction, even to the extent of pushing out concerns "with adaptation to reality and the avoidance of external dangers" (21). So he explains that this desire contains an override of tendencies for self-preservation. For Didion, readers follow her questions, see her disorder and lack of concern for herself, such as in her revelation of not having eaten (30). She desires her husband so much she avoids usual, natural instincts, and it is through her questions that readers can feel this disorienting process. Through engaging with a text, a reader becomes more than an isolated viewer: they see, smell, and feel what the author wants them to; so as Didion disorients, so does the reader. When author Ann Boushy writes in her article, "The Grief Cycle—One Parent's Trip Around," about the feeling of receiving a traumatic shock or change, such as a divorce or death, she

says that “things become blurry after this devastating news. You continue to function, but you don’t know how you do it or later remember the details.”

Didion, too, doesn’t want her readers to know how she gets through the night, or other details unknown to her at the time; unlike the example of Proulx, Didion restrains her readers, just as how she was personally restrained from understanding (Myers 4). This further projects onto the reader the actual feelings of grief confusion, simulating the experience for the other.

By strategically employing the phrase “I remember” to counteract memory loss, Didion reveals the gaps in her own recollection, which in turn creates an immersive, fog-like experience for the reader. In the moment when the paramedics come and work on Dunne, Didion calls attention to the overwhelming wave of the night’s incomprehension with multiple uses of the term “I remember” as she later tries to recollect this night: “I remember trying,” “I remember one glancing” (12). She uses the term to push against the event’s memory loss, inferring that everything else that isn’t explicitly mentioned is forgotten. Didion later attests to this with a few other details in the same paragraph when she recounts following Dunne’s ambulance to the hospital: “I have no memory of sirens. I have no memory of traffic” (13). So, within this framework, it wouldn’t make sense for Didion to mention any other details outside of what she was conscious of—again, unlike Proulx’s paralyzing moment (Myers 4). Didion keeps her readers intimately alongside her so that they, too, might experience the same suffocating haze that she shuffled through.

In the chapter’s final moments, Didion transitions from rhetorical questioning to a self-answered question, signaling her slow acceptance of reality and marking a narrative shift in her processing of loss. Didion, the morning after Dunne’s passing, now truly alone, wonders: “When, only half awake, I tried to think why I was alone in the bed” (31). Didion mentions it was the same feeling she’d had after fights between the two. She questions: “Had we had a fight? What about, how had it started, how could we fix it if I couldn’t remember how it started?” (31). There’s a pause as the paragraph ends and drops into the next; consisting of one line, three words. Didion answers: “Then I remembered” (32).

This answering of her own question, the “I remembered,” is the use of a rogatio question: the asking then answering by the original proposer.

In the chapter’s final moments, Didion shifts from a series of unanswered, grieving questions to one she can finally answer—a quiet but significant turn in her processing of loss. Earlier, her thoughts spiral through uncertainties she cannot resolve: why did Dunne hand her that clipping, or would things have changed if she had made something else

for dinner (23)? These unanswerable questions mark the psychological disorientation of grief. In “Disruption, Hesitation, Silence,” Louise Glück suggests that “all earthly experience is partial [...] because that which we do not know, of the universe, of mortality, is so much more vast than that which we do know” (30). For Didion, this partiality becomes all-consuming; the unknowable pushes out what once felt stable. Her use of erotema questions reflects that psychic condition. But with her day-after question, the deviation from erotema questions to a rogatio question is that here, now, Didion knows why her bed is empty. She knows why she can’t remember an argument between them. It is not unanswerable. Because Dunne is gone. She remembered.

As the chapter concludes, Didion’s sentence structure stabilizes, mirroring her own reluctant but inevitable grounding in the present, as she prepares to navigate her grief in the year ahead. The third to last sentence of her chapter is seven lines long—seventy-three words (33).

She talks about people and places and appointments. It is her final bout of disorientation. Her last stumbling of thoughts. And the following two sentences are each one line—eleven words, ten words—which carry the reader back to a solid, stable state and setting them in an albeit tired, but steady and familiar sentence-structured pace (33). She talks about herself now alone, about her future year, and also the weight of her new reality. As Didion finds her conclusion, so do the readers.

The chapter ends. And everything is still.

With the chapter’s end, the reader may pause and breathe and process its contents, feeling its sadness like earlier-mentioned critics, then move onto the next page as Didion continues her struggle with, and navigation of, grief; but all is not finished. Didion’s questioning, her minimalist prose, and her variation pleads for further analysis. As Danish philosopher Søren Kierkegaard and Alastair Hannay write in *Concept of Anxiety*: “Anxiety can just as well express itself by muteness as by a scream” (119), which attests to Didion’s minimalist qualities in her chapter. As she withholds excess details and focuses on her brief sentences, Didion creates an almost muteness of sound. Everything else is shoved out into the peripheral except for what she chooses to focus on, as she slows the pace of her writing with abrupt stops and short thoughts. This also attests to Clark’s statement in how the less is said, “the more menacing the tone” (109). As Glück writes:

The unsaid, for me, exerts great power: often I wish an entire poem could be made in this vocabulary. It is analogous to the unseen, for example, to the power of ruins, to works of art either damaged or incomplete. Such works inevitably allude to larger

contexts; they haunt because they are not whole, though wholeness is implied: another time, a world in which they were whole, or were to have been whole, is implied. (30)

It is in this duality of these moments that there is something paradoxically both present and absent—powerful while being empty, “whole” where it “is implied” (Glück 30). According to Kierkegaard and Hannay, anxiety exists in something that both *is* and *is not* there: the loudness of a scream versus the silence of muteness; but, in conflict, are both not present? In the phenomenology of grief, and specifically Merleau-Ponty’s theory of the “phantom limb” within his *Phenomenology of Perception* (1945), is the idea that the deceased individual is still present in another living person’s life, despite their physical displacement. And this paradoxical simultaneity is what Ratcliffe argues in his article “Towards a phenomenology of grief: Insights from Merleau-Ponty.”

Merleau-Ponty’s concept of the “phantom limb” speaks to a profound experience of absence that paradoxically continues to embody presence, suggesting that even when something or someone is no longer physically there, their absence continues to shape our lived experience. In grief, this manifests as the lost individual remaining alive in one’s senses, even though their body is gone. Didion reflects this very sentiment throughout her grief process. Through her rhetorical questioning and fragmented sentences, she mirrors Merleau-Ponty’s idea of presence through absence. Her memory, like the “phantom limb,” insists that her husband remains present in her life, but his absence—the silence of his death—forces her to reckon with the void.

As Ratcliffe explains, Merleau-Ponty conceives of “phantom limbs as involving the preservation of a purposively organized life structure that is reflected in one’s experienced surroundings and at odds with one’s current abilities” (Ratcliffe 658). This insight deepens our understanding of Didion’s struggle: the world around her still holds the same practical possibilities as before her loss, yet her ability to engage with it is fundamentally altered. As Merleau-Ponty writes: “to have a phantom limb is to remain open to all the actions of which the arm alone is capable and to stay within the practical field that one had prior to the mutilation” (Ratcliffe 658). Didion’s grief similarly involves an ongoing openness to the actions and expectations that included her husband, despite his absence. The world, though changed, still structures itself around his presence, making his absence a continuous disruption rather than a singular loss. For Didion, and the self-reflexive nature of her grief-memoir, she loses Dunne again, and again.

The diffused sense of presence captured by Merleau-Ponty overlaps and alternates with an equally diffused sense of absence. Ratcliffe describes how negation of specific patterns of anticipation leads to localized experiences of absence, e.g., expecting to find someone in a particular place and consequently encountering it as lacking (Ratcliffe 659). Didion experiences this when she instinctively expects her husband's return or presence in her now-vacant bed. Her grief does not function as a passive remembrance but as a perpetual encounter with absence.

In his study, Ratcliffe shows how Kym Maclaren, in her article "Emotional clichés and authentic passion" argues an authentic passion harbors the potential to reshape the world, yet Ratcliffe extends this by demonstrating that grief does so precisely because it dismantles the very context in which it arises. "The person who has died was not only an object within one's world but also a condition of intelligibility for that world" (660-661), writes Ratcliffe. Didion's world is not just altered by her husband's death; it is made unintelligible. The emotional experience of grief is emancipated from the habits and norms that had previously shaped it because the concrete object of grief—her husband—implies their inapplicability. This, Ratcliffe explains, leads to "a profound sense of being lost" (660-661)—not in the sense of lacking direction, but in the sense that no recognizable path remains to be followed or to return to.

So, grief, then, disrupts the fundamental anticipatory structures that shape perception and action. As Ratcliffe explains, even as one continues to perform simple tasks such as walking to the supermarket or squeezing toothpaste from a tube, the larger structures of meaning that once connected these actions to long-term projects collapse; "they no longer relate to one another in stable, unambiguous ways" (Ratcliffe 661). These philosophical insights do not stand apart from Didion's text; rather, they find their echo in the very grammar of her mourning. Her language does not describe grief—it grieves. The memoir unfolds less as narrative than as a field of broken perceptions and anxious returns. Didion's prose reflects this disintegration through fragmented sentences and rhetorical questions, enacting the very rupture she experiences. Her world has not been abandoned and rebuilt; rather, it undergoes a slow and painful reconfiguration, as the tension between past and present remains an integral part of the grieving process (Ratcliffe 662). Didion writes at the end of her second chapter: "After that first night I would not be alone for weeks [...], but I needed that first night to be alone. I needed to be alone so that he could come back. This was the beginning of my year of magical thinking" (33).

Ratcliffe then refutes the idea that bereavement consists of a conflict between bodily, habitual expectations and cognitive acceptance

of death. The rupture, he argues, encompasses language and thought as much as experience and activity (Ratcliffe 662). Didion's narrative style mirrors this phenomenon: her writing is not a clear, structured reflection on grief but a raw embodiment of its disorienting effects. As Merleau-Ponty puts it, "we only understand the absence or the death of a friend in the moment in which we expect a response from him and feel that there will no longer be one" (Ratcliffe 663). Didion's prose is haunted by these unfulfilled expectations. By the questions that will never receive answers.

Didion's grief is not simply about remembering her husband as he was, but about how his way of being—his *style*—continues to shape her world. "Of course I knew John was dead," she writes. "Yet I was myself in no way prepared to accept this news as final: there was a level on which I believed that what had happened remained reversible" (32). This tension between cognitive awareness and emotional disbelief runs through her waking moments—she describes rising in the morning, wondering where he is, before remembering all over again (32). His absence is not a clean break but a lingering presence that continues to orient her thoughts, movements, and perceptions. In this way, Didion does not simply remember; she relives. Her world remains shaped by Dunne's presence, even as she must confront its impossibility. As Ratcliffe notes in his reading of Merleau-Ponty, the experience of grief involves a continued sensing of the deceased's style, not as a static memory but as an active force that shapes one's lived experience (665). This theoretical insight affirms what Didion so precisely enacts: grief is not retrospective but relational, ongoing, and rooted in the sensory and structural rhythms of a shared life that no longer exists.

Didion's writing also makes clear how grief disorients the self—not only through what is lost, but through how that loss reshapes the self's relationship to the world. "I needed to be alone so that he could come back," she writes of her first night without Dunne, capturing the paradox of needing solitude to preserve an impossible hope (33). Here, Didion exposes how loss affects not just emotional states but the very conditions of meaning and understanding. As Merleau-Ponty suggests, we are always constituted in relation to others, and their absence can rupture the coherence of our world. "The situation of the patient whom I question appears to me within my own situation," he writes, describing a doubled center of experience that reveals the porousness between self and other (Ratcliffe 666). Didion's account of grief brings this into visceral focus: the reader is not merely observing her sorrow but inhabiting its phenomenological texture. Through her stark prose, looping thoughts, and sensory distortions, *The Year of Magical Thinking* does not describe grief from a distance—it draws its readers into its destabilizing orbit,

showing how love lost continues to haunt, structure, and shape the living. In doing so, she offers not only a narrative but a shared terrain, allowing readers to recognize grief as both singular and universal, intimate and enduring.

Through Didion's textual strategies, her account of grief transcends simple intellectual analysis or sympathy. Although it is impossible for an author to completely replicate all of the shared memories and emotions experienced in connection with another, and without such a framework of life for the reader to pull from when that other dies—minimizing readers' emotional reaction to the character's loss—Didion forces her readers to reckon with the unsettling nature of grief as an embodied experience, one that cannot be easily understood without living through it. So although the reader is not fully submerged in the same paralyzing pain as Didion, readers are able to edge the border of the fictitious and the real, peering close into the eye of anguish. In this way, Didion accomplishes what so many before her have not—she presents grief to her readers not as an abstraction or a story to be told, but as a presence that clings to the body, a memory that cannot be fully known, and a future that is forever shaped by absence.

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Race off the Agenda: The Visibility and then Invisibility of Black Americans in the *Chicago Tribune* in 1859 and 1952

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Abstract

The presence of Blacks in U.S. history is the overarching theme in an analysis of the Chicago Tribune during two, one-week periods, approximately a century apart, in 1859 and 1952. Each issue during the February 11–18, 1859, period contained numerous articles discussing the most burning issue of the time, inarguably the most important issue in American history after the Revolution: Slavery. Just under 100 years later, in 1952, the issue could have been Civil Rights, certainly should have been, had the Tribune set the agenda on civil rights. The study period, November 23–30, 1952, preceded Brown v. Board of Education and subsequent Supreme Court desegregation decisions. Except in the sports pages, and scarcely even there, the Black was Ralph Ellison's "invisible man." In terms of coverage in the Chicago Tribune, the plight of Blacks, so obvious in every column of the paper in 1859, was just as obviously absent in 1952. It was as if the White America that owned the newspaper and dominated the political system, had decided the only

problem that ever faced Blacks had been slavery. Once emancipated, the problem simply ceased to exist. The purpose of this study is to determine whether Chicago Tribune readers could have foretold in the pages of that newspaper the coming of Civil War in the late 1850s and the Civil Rights movement in the early 1950s during two, one-week periods, February 11–19, 1859, and November 23–30, 1952. And the answer is unequivocally “no.”

“Our Constitution is color-blind, and neither knows nor tolerates classes among citizens. In respect of civil rights, all citizens are equal before the law. The humblest is the peer of the most powerful. The law regards man as man, and takes no account of his surroundings or of his color when his civil rights as guaranteed by the supreme law of the land are involved.”

– Associate Justice John Marshall Harlan¹

Introduction

Race, in Gunnar Myrdal’s evaluation, is not just at the center of America, but “is a problem in the heart of the American.”² In Myrdal’s estimation, that is “where the interracial tension has its focus.”³ In 1903, W.E.B. DuBois predicted that “the problem of the Twentieth Century” would be “the problem of the color-line.”⁴ Henry Louis Gates, Jr. defined the color-line as “a geological fault” along which both “tensions build and find at times violent release” and where “the larger contradictions

¹ Plessy v. Ferguson, 163 U.S. 537 (1896). From Harlan’s dissent. The case, decided 7-1, established the constitutional principle of separate but equal. Harlan was a former slaveowner. Plessy was unanimously overturned 9-0 in *Brown v. Board of Education of Topeka, Kansas*, 347 U.S. 483(1954).

² Gunnar Myrdal, with the assistance of Richard Sterner and Arnold Rose, *An American Dilemma: The Negro Problem and Modern Democracy* (New York, Evanston, Illinois, and London: Harper & Row, Publishers, 1962), lxxi. The Swedish author is part of a tradition that stretches back to de Tocqueville, that of a foreign scholar producing a book that illuminates America in a profound way. Myrdal shared the 1974 Nobel Prize in Economics.

³ *Ibid.*

⁴ W.E.B. DuBois, *The Souls of Black Folk* (Chicago: A. C. McClurg & Co., 1903; reprint, New York: Johnson Reprint Corp., 1968); quoted in Whittemore, ed., *Voices in Black & White: Writings on Race in America from Harper’s Magazine* (New York: Franklin Square Press, 1993), vii.

and conflicts of” American society are “played out.”⁵ Race—specifically, the presence of Blacks in U.S. history—is the overarching theme in this analysis of the *Chicago Tribune* during two one-week periods, approximately a century apart, in 1859 and 1952.⁶

Each issue during the February 11–18, 1859, period contained numerous articles discussing the most burning issue of the time, perhaps the most important issue in American history: slavery. Just under 100 years later, in 1952, the issue *could* have been Civil Rights, certainly *should* have been, had the *Tribune* desired to help set the agenda on the race issue. The second study period, November 23–30, 1952, was before *Brown v. Board of Education of Topeka, Kansas* and subsequent U.S. Supreme Court desegregation decisions. Except in the sports pages, and scarcely even there, the Black was Ralph Ellison’s “invisible man,” not to be seen, as if he (and she) did not exist.⁷ In terms of coverage in the *Chicago Tribune*, the plight of Blacks, so obvious in every column of the paper in 1859, was also so obviously absent in 1952. It was as if White America, the America that owned the newspaper and dominated the politics of the country, had decided the *only* problem that ever faced Blacks in their midst had been enslavement. Once emancipated, the problem simply ceased to exist. Charles Silberman, discussing Reconstruction, asserted that “the North washed its hands of the whole question and proceed[ed] to look away from a principal fact of life in the United States.”⁸

According to the 1950 census, Chicago had approximately 3.1 million White residents and about 500,000 Black citizens.⁹ Judging from the pages of the Windy City’s leading newspaper, about one in seven of its inhabitants simply did not appear to exist. Blacks had disappeared, if not from the national agenda, at least from the *Tribune* in Chicago and the 1950s *Tribune* had not yet returned its editorial gaze to the Black individual in America. The purpose of this study is to determine whether *Chicago Tribune* readers could have foretold in the pages of that newspaper the coming of Civil War in the late 1850s and the Civil Rights

⁵ Henry Louis Gates, Jr., “Introduction,” *The Problem of the Color Line at the Turn of the Twentieth Century: The Essential Early Essays*, ed. Henry Louis Gates, Jr. (New York: Fordham University Press, 2015), vii.

⁶ In 1859, the *Chicago Tribune* was actually called the *Chicago Daily Press and Tribune*, while in 1952 it was the *Chicago Daily Tribune* or the *Chicago Sunday Tribune*. For the sake of consistency, the newspaper is referred to by its modern name.

⁷ Ralph Ellison, *Invisible Man* (New York: Random House, 1952).

⁸ Charles E. Silberman, *Crisis in Black and White*. (New York: Random House, 1964), 7.

⁹ Source: U.S. Census Bureau at http://www.iuperj.br/rc28/papers/RC28_Sandoval.pdf.

movement in the early 1950s during two, one-week periods, February 11–19, 1859, and November 23–30, 1952.

Background and Method

When Blacks were “first enslaved, their subjugation was not justified in terms of ... biological inferiority,” but as a “much more unquestioned element in the existing order of economic classes and social estates,” in Myrdal’s view.¹⁰ “The [Black] was brought to America for the sake of the White man’s profit” and “kept in slavery for generations in the same interest.”¹¹ Once liberated, “he was no longer so necessary and profitable” and so his position “in American society has been precarious, uncertain and changing.”¹² The *Chicago Tribune*, owned, edited, and read mainly by White people, grappled with that dilemma. Before the Civil War, the moral ground was unequivocal: abolition. By the 1950s, the landscape was not so clear: what to do with them? The *Tribune* chose to look the other way. Blacks, captured Native Americans, and White indentured servants were “originally ... kept in much the same status,” until chattel slavery was instituted.¹³ It must be borne in mind that, at the time of the Revolutionary War, slavery was legal throughout the entire country, North and South, and persisted in some form, despite proscription, in a number of northern states until well into the 1830s.

Silberman took issue with Myrdal. “The tragedy of race relations in the United States is that there is no American Dilemma. White Americans are not torn and tortured,” he concluded, but not because “justice is being denied.”¹⁴ Americans were troubled because “their peace is being shattered and their business interrupted,” Silberman claimed.¹⁵ In his view, an appeal to the American conscience would not rectify the situation. That would require another reconstruction, this time a “radical” one and one that did not just start in the South, but in the North as well.¹⁶

¹⁰ Myrdal, *An American Dilemma: The Negro Problem and Modern Democracy*, 84.

¹¹ *Ibid.*, xlvii.

¹² *Ibid.*, lii.

¹³ *Ibid.*

¹⁴ Silberman, *Crisis in Black and White*, 10.

¹⁵ *Ibid.*

¹⁶ *Ibid.*

Joel Williamson, in his Pulitzer Prize-nominated *The Crucible of Race*, contended that America “did not yet know the potential” of Blacks but was “deeply impressed with the progress that Black people had made under Northern leadership during Reconstruction,” framing the question in terms of Whites, rather than those who had and were suffering centuries of oppression.¹⁷ “Liberals rued the desertion” of Blacks by northerners after Reconstruction and lamented the “failure of Southern Whites (liberal ones) to pick up again the cross of missionary labor to blacks that they had, in their own eyes, carried before the war.”¹⁸ Conservatives “always began, proceeded, and ended upon the assumption of Negro inferiority,” and the “Black problem” was a question of “accommodating society” to whatever that level was.¹⁹ “The great sin of the North against the South,” in Williamson’s view, came when Reconstruction ended.²⁰ That great sin “was to destroy slavery and yet not destroy the culture that slavery had generated.”²¹ The North abandoned the South militarily but also morally.²² Silberman agreed, quoting abolitionist Wendell Phillips’ comment that “the Emancipation Proclamation freed the slave but ignored” Blacks.²³ Whites did not conflate the two, and the systemic racism—and the violence that enforced it—persisted and festered without being either addressed or excised.

Williamson declared that the “profound tension in Southern society ... that ramifies into areas ... that seem to have nothing to do with race” is shared by all America.²⁴ Williamson observed: “White America, in its stubborn and residual racial egotism, resists the realization of how very deeply and irreversibly Black it is, and has been. The struggle against that awareness, the rage against the realization of the blackness and its legitimacy is the struggle of White people in race relations.”²⁵ And the biggest blind spot and impediment to societal reckoning.

To recognize that blackness within itself, Williamson reasoned, would require that whites “respect” it within the whole nation and

¹⁷ Joel Williamson, *The Crucible of Race: Black-White Relations in the American South Since Emancipation* (New York and Oxford: Oxford University Press, 1984), 5.

¹⁸ *Ibid.*

¹⁹ *Ibid.*, 6.

²⁰ Williamson, *The Crucible of Race*, 43.

²¹ *Ibid.*

²² *Ibid.*

²³ Silberman, *Crisis in Black and White*, 6.

²⁴ Williamson, *Crucible of Race*, 522.

²⁵ *Ibid.*

“surrender the uses, physical and psychological, that they have learned to make of Blacks as a separate people.”²⁶ “It is an unhappy world that White America has made, and it is unnecessary,” Williamson contended, adding that “ultimately, there is no race problem in the South, or in America, that we, both black and white, do not make in our own minds.”²⁷ Calling it “the simple fact,” Williamson concluded “that white America is married to Black America by the space of national geography and by centuries of time” and needed to come to grips with that immutable fact that would otherwise always divide the nation.²⁸

Method

The selected week-long study periods were each approximately two years before defining moments in U.S. history: the attack on Ft. Sumter in April 1861 and the Supreme Court decision in *Brown v. Board of Education* in May 1954. If rumblings of the Civil War and the Civil Rights movement—both dramatic and massive upheavals in the fabric of America—could be discerned, there could or should have been evidence in these representative weeks. The dates in question were chosen randomly, in one sense, but with an arbitrary logic: The author was born November 23, 1952, while the author’s grandfather was born February 11, 1859.

The *Chicago Tribune* was selected as the test vessel because it represented a leading newspaper in a state, Illinois, in what was termed “the West” in the decades preceding the Civil War and was not the focal areas of the coming struggle between North and South. Given its length that extended into the South, the state was also divided geographically, north and south, between the Union and the Confederacy. In addition, in the wake of World War I, the great migration north of southern Blacks occurred with Chicago as one of the principal destinations.²⁹

II. The Antebellum *Tribune*

In the seven issues from February 1859 that were analyzed, there was no intimation of civil war, no suggestion that, within two years the nation would be shattered by war. On February 12, the House Committee

²⁶ Ibid.

²⁷ Ibid.

²⁸ Ibid.

²⁹ The author and his grandfather both spent long portions of their lives in Illinois as well.

on Military Affairs “recommended a reduction in certain items of the army appropriation bill, to the amount of several hundred thousand dollars,” something it would not have done had the immediacy of war been a concern.³⁰ Six days later, though, President James Buchanan bewailed Congress’ refusal to “vote him (the) means to carry on the Government and execute their own laws,” and threatened to call Congress into special session in August if necessary.³¹ On the floor of the Senate on February 14, Sen. Robert Hunter (D) of Virginia assailed Congress and the administration, “saying that the present issue is between high taxation on the one side, and moderation expenditure on the other.”³² He felt that \$48 million, excluding servicing the national debt, was sufficient to run the U.S. government. He suggested a reduction of \$4 million for the Navy would be helpful to balance the budget, again something inconceivable if a war was looming.³³ Within two years, Hunter would be secretary of state of the Confederacy and a year after that the president pro tempore of the Confederate Senate.

Republicans and Democrats met in the capital on the evening of February 8, the *Tribune* related in its February 13 issue, in “two furiously excited” caucuses to argue over taxes.³⁴ Democrats loyal to President Buchanan – “Old Buck,” he was called – declared that:

...the present tariff will yield fifty-six millions. As the (spending) estimates are \$73,000,000, this will reduce them to (\$72,000,000). The remaining million will be made up by miscellaneous. The meeting discussed the report with great gravity, for a space. They then began cussin’ in great anger, and end by laughing at themselves and their schemes. Somebody created intense alarm by suggesting that if the Democrats could not carry on the Government for less than eighty millions a year, it had better be turned bodily over to the Republicans.³⁵

The possibility of war in Europe seemed far more likely than civil war, judging from the pages of the *Tribune*. In a February 18 editorial, the *Tribune* referred to the “prospect of a new European tumult,” perhaps

³⁰ *Chicago Tribune*, 12 February 1859, p. 1.

³¹ *Ibid.*

³² *Chicago Tribune*, 15 February 1859, p. 1.

³³ *Ibid.*

³⁴ *Chicago Tribune*, 13 February 1859, p. 2.

³⁵ *Ibid.*

perhaps to the U.S., although this was not specified.³⁷ “Belligerent movements” by Louis Napoleon and his Hapsburg counterparts in Austria were suggesting the “near prospect of war.”³⁸ The *Tribune* felt war, though, was not “probable,” a conclusion somewhat at odds with the evidence suggested in the editorial.³⁹

The foreign slave trade had been outlawed in the U.S. decades before, and yet, in the late 1850s, it was still thriving. Three articles and an editorial addressed the controversy. American slavers plied the Atlantic carrying their human cargo with, at the very least, tacit cooperation from Southern officials. On February 16, the following story appeared:

The President, in reply to a resolution from the House, communicated a message to-day enclosing a report from the Attorney General, who says that the local officers of the Government at Savannah have been specially and strictly enjoined to perform the duties imposed on them by the several acts of Congress for the suppression of the slave trade ... (and that) diligence and activity of all persons engaged in the public service to find the [slaves] ...⁴⁰

In the same column, but in an unrelated incident, “true bills” were brought against Selvas & Mares, a partnership, and the captains of the bark *Angelica*, which had been “seized here on suspicion of being *fitted out for the slave trade*.”⁴¹ Earlier in the month “privy advices from Jacksonville, Fla.” indicated that a vessel had left “that port a few weeks ago ... to take in a cargo of slaves” and that a “brig sailed” the previous day to meet the other ship and “transfer the cargo.”⁴² In an angry February 14 editorial, the *Tribune* railed against the foreign slave trade, calling it “repulsive ... shameless and wicked” and “a barbarism ... openly at war with our own history and ... principles.”⁴³ The *Tribune* also noted bitterly

³⁷ *Ibid.*

³⁸ *Ibid.*

³⁹ *Ibid.*

⁴⁰ *Chicago Tribune*, 16 February 1859, p. 4.

⁴¹ *Ibid.* Emphasis added.

⁴² *Chicago Tribune*, 11 February 1859, p. 1. The same column reported from Honolulu that “the whaling season had closed” on Christmas Day with 218 whalers having put into port carrying 130,000 barrels of whale oil and 15 million pounds of bone. “The season was regarded as an unprofitable one,” according to the *Tribune*.

⁴³ *Chicago Tribune*, 14 February 1859, p. 2.

that 84 Democrats had refused to vote against “condemning the traffic in native Africans on the high seas;” and that these were not all southerners.⁴⁴

International relationships, however, complicated matters. Britain had a quarter century earlier prohibited slavery throughout its empire and empowered its warships to shut down the slave trade wherever they found it. This brought them into conflict with the U.S. early in 1859. An “outrage” was “perpetrated on a slave brigantine, the *Rufus Soule*, on the coast of Africa, by the British war steamship *Viper*,” resulting in the sinking of the slave ship.⁴⁵ The *Rufus Soule* had been flying the “American colors” when “she was overhauled” and, even though “her papers were found correct,” the captain of the *Viper* had searched the vessel.⁴⁶ Presumably, he found evidence of the ship’s function, although the editorial did not mention whether slaves were found.⁴⁷ The *Tribune* thought the resulting chauvinistic contretemps would “diminish the horror” of the slave trade, by emphasizing British interference with American shipping, rather than the purposes of that shipping.⁴⁸

The *Tribune* devoted nearly half a column to a heated exchange between Sen. Owen Lovejoy (R) of Illinois and Sen. Otho Singleton (D) of Mississippi on the floor of the Senate, involving a judiciary appropriation bill that exposed the tensions of the times.⁴⁹ Lovejoy “moved to strike out the words ‘and for the safe keeping of prisoners,’” the *Tribune* reported, because he understood “that means for the safe keeping of fugitive slaves.”⁵⁰ Lovejoy continued:

I will not dwell on the moral considerations pertinent to this matter. I do not believe that the Constitution confers on this House the power of taxing me and taxing my constituents, to feed and clothe and keep these fugitive slaves till their trial comes on. If there is anything in the Constitution about it, it is that they are simply allowed to be taken and carried back. And, sir, it is a thing so utterly odious to the people of the free States,

⁴⁴ Ibid.

⁴⁵ Ibid.

⁴⁶ Ibid.

⁴⁷ Ibid.

⁴⁸ Ibid.

⁴⁹ *Chicago Tribune*, 15 February 1859, p. 2.

⁵⁰ Ibid.

so utterly degrading, and so abhorrent to the feelings of humanity, North and South, that I go for adhering to the letter of the bond, giving nothing more than the pound of flesh. That is all we can give; and we give that reluctantly.⁵¹

Singleton rounded on his colleague, throwing “pound of flesh” back in his face, and demanding that “the gentleman would return the negro whom he helped to steal away from one of my late constituents.”⁵² Sen. Lovejoy responded:

MR. LOVEJOY. I never stole away any of the gentleman’s negroes—he never rightfully owned a negro. Every human being that God made belongs to himself against the universe. And, sir, if this committee wish to know—as my attention has been several times called to this, and as scurrilous letters have been read here —whether I help fugitive slaves, I march right up to the confessional and tell them that I do ... (I)f the invisible spirit of slavery expects to cross my humble threshold and forbid me to feed the hunger or shelter the houseless, I bid that demon defiance in the name of my God.

MR. SINGLETON. I would like the gentleman to define what he calls “stealing,” if that be not stealing.

MR. LOVEJOY. Stealing is to take a man and keep him a slave.⁵³

The exchange got uglier, and in previous decades, might have involved blows being landed. During the ensuing exchange, there were interruptions and cries of “order.”⁵⁴ Lovejoy was a prominent abolitionist and a “conductor” on the Underground Railroad. Singleton went on to serve in the Confederate House of Representatives and postwar in the U.S. House.

The *Tribune* was filled with other national and state news. Indiana’s senators were denied seating by Congress, for reasons the newspaper did not elaborate upon, but which drew an unfavorable comparison with the

⁵¹ Ibid.

⁵² Ibid.

⁵³ Ibid.

⁵⁴ Ibid.

British Parliament.⁵⁵ Frederick Douglass met an “old protector,” the newspaper reported, someone who had helped him during his escape from slavery in Maryland years earlier.⁵⁶ Foreign immigration “to the West” was controversial, the West being Illinois, Wisconsin, and Iowa at the time.⁵⁷ One front page item noted there was “excellent sleighing” a few miles outside of Galena, Illinois, quoting the town’s newspaper.⁵⁸

There were hints at the upcoming presidential election of 1860. “Judge” Douglas (Sen. Stephen Douglas, a Democrat) was mentioned several times as was Abraham Lincoln, a Republican; both men were from Illinois.⁵⁹ The *Tribune* quoted a *New York Tribune* article alleging that William Herndon, law partner and intimate of Lincoln in Springfield, had actually expressed admiration for Douglas when talking to that New York newspaper about the Lincoln–Douglas debates of 1858.⁶⁰ The paper then charged that Herndon wrote a letter contradicting his in-person statements.⁶¹ The *Chicago Tribune* refuted this. In an editorial, the Chicago daily remarked on Douglas’s “position and power” and accused him of “an extreme pro-slavery and Dred Scott platform” at a state convention his party held earlier.⁶² The *Tribune* was pro-Republican—just three years after the G.O.P. ran its first candidate for the presidency, John C. Frémont—and favored Lincoln for the party nomination at the convention to be held in Chicago the next year.⁶³

Other than specific references to slavery—and yet inextricably tied up in the controversy over slavery—Oregon and Kansas figured prominently in the news during the middle of February 1859. On February 12, Oregon was admitted to the Union with only the president’s signature necessary to complete the arrangement.⁶⁴ The *Tribune* referred to Oregon as a state sympathetic to slavery and likely to vote with South Carolina and Louisiana.⁶⁵ Abolitionists in Congress voted for its statehood in the expectation it would modify its constitution of two years

⁵⁵ *Ibid.*

⁵⁶ *Ibid.*, p. 3.

⁵⁷ *Chicago Tribune*, 11 February 1859, p. 2.

⁵⁸ *Ibid.*, p. 1.

⁵⁹ *Ibid.*

⁶⁰ *Ibid.*

⁶¹ *Ibid.*

⁶² *Ibid.*

⁶³ *Chicago Tribune*, 16 February 1859, p. 2.

⁶⁴ *Ibid.*

⁶⁵ *Ibid.*

earlier, one that recognized “the most odious principle in the Dred Scott decision,” one that “placed [Blacks] totally beyond the protection of law” and specifically deprived them of what rights they did have.⁶⁶ However, Republicans split over statehood; had they been united, Oregon would not have been admitted. Congressional Republicans felt a double (or perhaps triple) standard was at work. Oregon had a population of approximately 40,000 and was admitted, while Missouri was “ruled out till she can show 90,000 or 100,000” residents.⁶⁷ Kansas, the *Tribune* editorialized, also had to show a population greater than Oregon, in its case at least 93,000.⁶⁸

III. The Post-war *Tribune*

Blacks have virtually no presence in the *Chicago Tribune* of November 23-30, 1952. In the seven issues examined, amounting to several hundred pages, there were only three photographs of Black people, and two of them were on the sports pages. In one, a high school athlete was singled out with an arrow in the middle of the photograph. Other than the coach, in a crowd of 40 young men, he was the only Black person. The cutline called him a “star.”⁶⁹ Three days later, a Black boxer was shown in one photo, and in another a Black boy was photographed praying over a turkey dinner at an organization for underprivileged youngsters.⁷⁰ What was notable was what was not there—news of residents from the Chicago Black community and any news about civil rights, whether local or national. Except for one small crime story that identified a man as a Black (no person was identified as “White” in the *Tribune*), there were no news stories in which Blacks figured. An ad, also on the sports page, publicized the game between the Harlem Globetrotters and the Washington Generals before the regular NBA game between the Milwaukee Hawks and Philadelphia Warriors.⁷¹

⁶⁶ *Chicago Tribune*, 15 February 1859, p. 2.

⁶⁷ *Ibid.*

⁶⁸ *Ibid.*, pp. 1-2.

⁶⁹ *Chicago Tribune*, 23 November 1952, sec. 2, p. 4.

⁷⁰ *Chicago Tribune*, 26 November 1952, sec. 2, p. 4 .pp 11-12.

⁷¹ *Chicago Tribune*, 23 November 1952, sec. 2, p. 2. The Globetrotters had very strong support from White audiences and, in this case, seemed to be used to lure fans to the predominantly White NBA. The NBA was integrated only two years before this ad appeared.



WINNIE RUTH JUDD CAPTURED

Ike Names Lodge U. S. Envoy to U. N.

STEER OF IOWA GIRL 1ST GRAND CHAMPAT SHOW

Big Crowd Cheers Fry Muggie, 15

Show Facts... IRISH CONQUER TROJANS, 9 TO 6; ARMY LOSSES, 7-0



\$25,000 A YEAR POST GIVEN TO SENATE LOSER

Speech Writer to Be Speechwriter Aid

BY WILLIAM FLETCHER... Speech Writer to Be Speechwriter Aid

Seize Slayer of 2 in Home of Guardian

PHOENIX, Ariz., Nov. 29 (AP)—The slayer of two young girls was seized today in his home in Phoenix, Ariz., by police officers from the Arizona State Police.

REP. HOFFMAN PRODS U. S. ON MOB PAROLE

Promises Action if McNamara Lags... REP. HOFFMAN PRODS U. S. ON MOB PAROLE

NEWS SUMMARY

NEWS SUMMARY... STEER OF IOWA GIRL 1ST GRAND CHAMPAT SHOW

Sister Kenny Dies; Fought Polio 43 Years

Sister Kenny Dies; Fought Polio 43 Years... Sister Kenny died today at the age of 79 after a long and painful battle with polio.

U. S. Immigration and Presses Jacks Fate

U. S. Immigration and Presses Jacks Fate... U. S. Immigration officials today pressed for the deportation of a man named Jacks.

Beer Guzzling Steer Beats 79 - While Sobor

Beer Guzzling Steer Beats 79 - While Sobor... A steer named Sobor, who has been drinking beer, has beaten the record of 79 years.

THE WEATHER

Table with weather forecasts for various cities including Chicago, New York, and Los Angeles.

Speech Writer to Be Speechwriter Aid

Speech Writer to Be Speechwriter Aid... A speechwriter is to be named as an aid to the speaker.

Seize Slayer of 2 in Home of Guardian

Seize Slayer of 2 in Home of Guardian... The slayer of two young girls was seized today in his home.

REP. HOFFMAN PRODS U. S. ON MOB PAROLE

REP. HOFFMAN PRODS U. S. ON MOB PAROLE... Rep. Hoffman urged the U.S. to take action on mob parole.

Chicago Tribune, front page. November 30, 1952.

Three weeks after Dwight Eisenhower was elected to his first term as president, there was considerable news about the incoming chief executive, his cabinet choices, and his inauguration plans. An eight-column banner headline told readers that "Ike Gives Women 2 Key Jobs" in his administration: one as head of the Federal Security Agency and the other as treasurer of the U.S. A plum position was given to G.O.P.

national chair Arthur Summerfield, that of postmaster general.⁷² Summerfield had been “largely instrumental in swinging” the party’s nomination to Eisenhower.⁷³ At a press conference, Summerfield indicated he was “interested in seeing whether twice-a-day mail service to homes can be restored” and the “postal deficit ... cut or wiped out.”⁷⁴

One of Ike’s campaign promises had been to go to Korea and his plans to visit that war zone were splashed all over the *Tribune*’s pages. However, there was very little battlefield news or photographs, little of the coverage expected of a country still at war. The superiority of U.S. fighter planes over Soviet-built MiGs was discussed, however.⁷⁵ While combat reports were conspicuously absent, an article bragged about the destruction of 785 communist trucks by U.S. warplanes.⁷⁶ That article contained about the only reference to fighting: “ground fighting today fell off to minor Red probing attacks. All were repulsed without loss of ground.”⁷⁷ There was no mention whether loss of life accompanied the attacks.⁷⁸ Bureaucratic snafus prevented recovery of vehicles stolen from the U.S. military by Koreans, the *Tribune* reported.⁷⁹

A *Tribune* editorial defended American doctors and dentists from charges by the surgeon general of the Navy of lacking patriotism “because they are not signing up for military duty as fast as he would like.”⁸⁰ Rear Admiral Lamont Pugh accused doctors of being “pantywaist(s)” for not accepting “with good grace” their “bald responsibility” to enlist as “others” did.⁸¹ The *Tribune* took issue with Adm. Pugh.

The “good grace” with which the “others” accept their military service arises from the fact that they are conscripts. If they don’t accept with good grace, they find themselves in Leavenworth or Portsmouth prison. The only people in this country who accept military service with good grace are the professionals ...⁸²

⁷² *Chicago Tribune*, 26 November 1952, sec. 1, p. 41

⁷³ *Ibid.*

⁷⁴ *Ibid.*

⁷⁵ *Chicago Tribune*, 23 November 1952, sec. 1, p. 7.

⁷⁶ *Ibid.*

⁷⁷ *Ibid.*

⁷⁸ *Ibid.*

⁷⁹ *Chicago Tribune*, 23 November 1952, sec. 21, p. 20.

⁸⁰ *Ibid.*

⁸¹ *Ibid.*

⁸² *Ibid.*

President-elect Eisenhower's plans to visit Korea created problems for the press; only three seats on the presidential plane—not yet referred to as Air Force One—were available.⁸³ An arrangement was proposed by Eisenhower's press representative James Hagerty reserving seats for a pool representative of the wire services, still photographers, and "motion picture cameraman" to represent the "newsreel and television industry."⁸⁴ The three principal wire services and the three television networks protested strongly.⁸⁵ Frank Stanton of CBS called it a "dangerous precedent" because Americans relied "more heavily on radio and television for news of major events than on any other (media)."⁸⁶ Hagerty said Eisenhower's security and available space were the deciding factors.⁸⁷

South Korean president Syngman Rhee said he expected Eisenhower would "bring peace and unity," because he was a "professional soldier (who) understands all about war."⁸⁸ He made his remarks while activating two new divisions.⁸⁹ Coincidental with Rhee's remarks, banners for Eisenhower's visit were hung in Seoul, including one "strung across the front of the burned out capitol," welcoming the president-elect and opposing any withdrawal of United Nations forces.⁹⁰ Several days later, "police ransacked Seoul's ruins ... for subversives and 400 Koreans were jailed in 'operation safeguard,'" in anticipation of Eisenhower's visit.⁹¹ "This city of rubble and 800,000 residents swarmed with national and metropolitan police, afoot and on horseback," according to an Associated Press story in the *Tribune*.⁹²

America's army was then, as now, composed of citizen-soldiers, few of whom were reluctant to voice their opinions about the war and what the incoming president should do. In a story datelined "somewhere in Korea," a dozen soldiers, none officers, had "an earful for

⁸³ *Chicago Tribune*, 24 November 1952, sec. 1, p. 43

⁸⁴ *Ibid.*

⁸⁵ *Ibid.* Those complaining included the Associated Press, United Press, International News Service, the National Broadcasting Company, the Columbia Broadcasting System, and Mutual Broadcasting System.

⁸⁶ *Ibid.*

⁸⁷ *Ibid.*

⁸⁸ *Chicago Tribune*, 23 November 1952, sec. 1, p. 4.

⁸⁹ *Ibid.*

⁹⁰ *Ibid.*

⁹¹ *Chicago Tribune*, 28 November 1952, sec. 1, p. 3.

⁹² *Ibid.*

Eisenhower,” according to the headline.⁹³ Some of the comments were: “Let’s get this damn war over with ... Let’s drive at the enemy, I’ll tell (Eisenhower). Let’s push ‘em back ... Why, at this rate, my kids might be coming over here some day for this thing ... Let’s throw everything we’ve got at the Commies ... What’s causing the delay in rotation—why they’re not getting replacements over here like they should. I’d also like to know the possibility of getting out of the army on schedule.”⁹⁴ One soldier did not quite grasp the country’s constitutional system. “What I want to know is when he gets in office will he put the United States under military rule? I don’t want military rule for the United States. I’ve been in the army long enough.”⁹⁵

Britain and the U.S. were at odds over the formula for peace in Korea, the British under Prime Minister Winston Churchill preferring an India-proposed plan.⁹⁶ The *Tribune* hung the word “appeasement” around the neck of Foreign Minister Anthony Eden, the man who had resigned from government in the late 1930’s to protest appeasement of Hitler.⁹⁷ Under an all-caps, eight-column headline about a U.S.-Britain split, the *Tribune*’s reporter wrote:

A British commonwealth program to end the Korean war by appeasing the Communists resulted tonight in a split between the United States and Britain in the United Nations. There was general agreement among U.N. delegates that the appeasement project, masterminded by Anthony Eden ... had collapsed. The scheme was rebuffed first by the soviet press and radio services. Later it was rejected in effect by [Secretary of State Dean] Acheson.⁹⁸

Three sticking points that caused the U.S. rejection, the *Tribune* contended, involved forced repatriation of prisoners of war. Any repatriation plan must be “workable,” and “that prisoners who resist repatriation must be released, and not confronted by the prospect of rotting in detention camps,” the newspaper explained.⁹⁹ The U.S.

⁹³ *Chicago Tribune*, 23 November 1952, sec. 1, p. 1.

⁹⁴ *Ibid.*

⁹⁵ *Ibid.*

⁹⁶ *Ibid.*

⁹⁷ *Ibid.*

⁹⁸ *Ibid.*

⁹⁹ *Ibid.*

presumption was that North Korean, Chinese, and Russian POW's might prefer to remain in South Korea.¹⁰⁰

Richard Nixon was long a divisive figure in American politics, and this attribute was on display in late November 1959. At the time, Nixon was vice president-elect and was sent by President-elect Eisenhower as his personal representative to the inauguration of Mexican President Adolfo Ruiz. The *Tribune* reported on the brewing controversy.

American political fireworks may mar the Mexican presidential inauguration Dec. 1 when and if Vice President Elect Nixon and Ambassador William O'Dwyer come face to face. Nixon called for the ouster of O'Dwyer on the floor of the [S]enate after the former New York City mayor's activities engaged the attention of the [S]enate crime investigating committee more than a year ago.¹⁰¹

Three days later, the *Tribune* reported that Nixon would be staying in a hotel "rather than in the United States embassy residence which is customary with high ranking visitors...."¹⁰² Nixon was going to receive "a first rate snubbing" by Ambassador O'Dwyer and would not even be invited to the embassy, the *Tribune* predicted.¹⁰³ A reception at consular official's home was on the agenda.¹⁰⁴

There were hints of other trouble spots that would plague America in coming years. Viet Minh forces in French Indochina (Vietnam) were closing in on French troops, forcing them to retreat.¹⁰⁵ "A general withdrawal of its forces from the hilltop town of Sonia" was announced by the French high command, the *Tribune* commented on November 24 on an inside page.¹⁰⁶ The French, though, were preparing for an assault by 18,000 Viet Minh on the air force base at Na San where the troops were repositioned and "dug in."¹⁰⁷ Viet Minh troops were at least within six miles of the French perimeter at Na San.¹⁰⁸

¹⁰⁰ Ibid.

¹⁰¹ Ibid., p. 6.

¹⁰² *Chicago Tribune*, 26 November 1952, sec. 1, p. 41

¹⁰³ Ibid.

¹⁰⁴ Ibid.

¹⁰⁵ *Chicago Tribune*, 24 November 1952, sec. 1, p. 13.

¹⁰⁶ Ibid.

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

Iraqi mobs “set fire to a United States information service building and attacked the British embassy and two police stations” in Baghdad.¹⁰⁹ “At least 11 persons were believed killed in two days of rioting which began (on November 22) with demands for election reforms,” a *Tribune* wire story stated.¹¹⁰ At the same time, Gen. Nur Aldin Mahmoud, army chief of staff, “was named premier and formed a new civilian cabinet ... and took over rule of Iraq.”¹¹¹

Several demonstrators were killed in attacks on the two police stations, and one of the stations was burned down. Martial law was proclaimed throughout Baghdad province. Schools were closed for an indefinite period. The outbreak of violence yesterday, in which one man was killed and 38 wounded, forced the resignation of Premier Mustapha Al Umari’s cabinet. Early today the mobs, shouting “Down with foreign imperialism” and “Down with forged elections,” careened on the United States information office and stoned it.¹¹²

The Eisenhower era, and the late Truman era, were defined by anti-communist paranoia. And while Nixon may have been a divisive figure, Alger Hiss was a defining figure. On the front page of the November 25 edition, the *Tribune* reported a parole board’s refusal to set him free.¹¹³ Hiss was a former state department official and had been “serving a five-year term in the federal prison in Lewisburg, Pa., for perjury to conceal Russian espionage.”¹¹⁴ He had served one-third of his sentence when his parole was turned down.¹¹⁵

The hearing came after Hiss had been an issue in the Presidential campaign. Gov. Stevenson of Illinois, Democratic Presidential candidate, had been a voluntary character witness for Hiss at the latter’s first trial. President Elect Eisenhower had served with Hiss briefly on the (Carnegie Endowment for International Peace) board ... John Foster Dulles, state

¹⁰⁹ *Ibid.*, sec. 2, p. 14.

¹¹⁰ *Ibid.*

¹¹¹ *Ibid.*

¹¹² *Ibid.* The building was then ransacked by the mob.

¹¹³ *Chicago Tribune*, 25 November 1952, sec. 1, p. 1.

¹¹⁴ *Ibid.*

¹¹⁵ *Ibid.*

secretary designate, had been instrumental in getting Hiss the foundation post.¹¹⁶

Hiss, the *Tribune* mentioned, had been a “political protégé of Supreme Court Justice Frankfurter ... and rose to sit beside Franklin D. Roosevelt at the Yalta conference in 1945.”¹¹⁷ A day earlier in a multi-part story, the mysterious death (suicide and murder were suggested) of U.N. general counsel (and former New Deal official) Abraham Feller was explored.¹¹⁸ Links with Hiss and communist spies were alleged.¹¹⁹

Demonstrating that the power of the press could be deployed at will by those who own one, in a news story on page three of the November 26 issue of the *Tribune*, the newspaper’s owner/editor/publisher, Col. Robert R. McCormick, “denounced the selection of John Foster Dulles” by Eisenhower as the new Secretary of State. He spoke before the Yale Political union.¹²⁰ McCormick, the article revealed, a lifelong Republican, had endorsed Eisenhower “reluctantly.”¹²¹ McCormick stated that:

A few days ago President Elect Eisenhower announced he would appoint John Foster Dulles secretary of state. Dulles belongs to the millionaire socialist crowd who would put European interest before American interests, a policy to which Eisenhower seems to have been attracted by his command of armies ...¹²²

Other articles, showing the breadth of the *Tribune*’s coverage, dealt with a “glum” and mum Pentagon on protecting the U.S. against a Russian H-bomb attack,¹²³ a dockyard wildcat strike by union “goons” in New York City that delayed four transatlantic steamships,¹²⁴ and an

¹¹⁶ Ibid.

¹¹⁷ Ibid. In an adjacent column, the *Tribune* revealed that a staff sergeant had been arrested for “conspiring to sell secret flight test data on the top American jet plane in the Korean theater” to a Korean civilian.

¹¹⁸ *Chicago Tribune*, 24 November 1952, sec. 21 p. 2.

¹¹⁹ Ibid.

¹²⁰ *Chicago Tribune*, 26 November 1952, sec. 1, p. 3.

¹²¹ Ibid.

¹²² Ibid.

¹²³ *Chicago Tribune*, 23 November 1952, sec. 1, p. 25.

¹²⁴ *Chicago Tribune*, 27 November 1952, sec. 1, p. 1.

amendment to the Constitution mandating a four-year term for members of the House of Representatives.¹²⁵ A C-124 Globemaster crash in Alaska, the sixth U.S. military aircraft crash in 16 days, was given front-page banner headline treatment.¹²⁶ A woman convicted of murder, and once sentenced to be hung, escaped from custody for the sixth time, allegedly with inside help, the *Tribune* noted.¹²⁷ And former Vice President John Nance Garner went hunting for the 34th straight year—missing only one year—to celebrate his 84th birthday.¹²⁸

IV. Conclusions

Historians have the good fortune to exploit the advantages of 20/20 hindsight. History is also filled with rivers, tributaries and streams, lakes, and bogs, and often the way safely through those waters is hidden from those navigating them. World War I looks inevitable only in retrospect. At the time, numerous other crises—Agadir in 1911 stands out most dramatically—could have sparked the Great War. And, if it had touched off World War I, more than a century later as we looked back it would have appeared tragically inevitable. Besides the disparity between the visibility and invisibility of Blacks, the most obvious differences between the 1859 and 1952 versions of the *Tribune* were page count, size and type of advertisements, a business section with stock quotations, and a sports section.

An examination of the *Tribune* that week in 1859 did not create a feeling that civil war was near or even possible. And a reading of the *Tribune* in the 1950s did not leave the impression that something momentous—the Civil Rights Movement—was imminent. The purpose of a newspaper is not necessarily to foretell but to inform and, at its best, to explain. In this sense, the *Tribune* in both eras fulfilled that expectation, even though it was prescient neither time.

¹²⁵ *Chicago Tribune*, 24 November 1952, sec. 1, p. 11.

¹²⁶ *Ibid.*, sec. 1, p. 1

¹²⁷ *Chicago Tribune*, 28 November 1952, sec. 1, p. 1.

¹²⁸ *Chicago Tribune*, 23 November 1952, sec. 1, p. 5.

Effects of Heavy Metal Uptake in the Growth and Development of *Lactuca sativa* L.

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Abstract

*This research aims to support the hypothesis that heavy metal exposure negatively impacts plant growth and development. To test this hypothesis, two experiments using *Lactuca sativa* L. (lettuce) were performed. The first experiment tracked germination rate, overall well-being of the plants, and analysis of the leaves, roots, and soil by inductively coupled plasma mass spectrometry. A contaminated solution was made up of 7 heavy metals: bismuth subnitrate, cadmium nitrate tetrahydrate, chromium(III) potassium sulfate dodecahydrate, cobalt(II) nitrate, cupric sulfate, nickel (II) sulfate hexahydrate, and zinc sulfate heptahydrate at 10 and 50 ppm concentrations, which were used to inoculate the substrate. Ten seeds were sown into each pot and observed over a period of 39 days. Although germination rates were not significantly affected, heavy metal presence was detected in plant tissues, and qualitative growth and root morphology differences were observed. The second part of this experiment tracked germination rates of each metal individually by sowing seeds in a sterile Petri dish at the same 2*

specified concentrations above with water as a control. There were no significant differences in germination rates across the different heavy metals, but morphological differences were observed.

Introduction

Heavy metal contamination in plants is becoming more prevalent worldwide because of human activities such as mining, smelting, and chemical manufacturing. This has caused increased concern for heavy metal uptake in plants and how this might affect plant growth and development (Boamponsem et al., 2012; Moreira et al., 2020; Mot et al., 2019; Naser et al., 2018; Paradelo et al., 2020). Prior research has shown that some heavy metals, depending on their concentration, damage structures and affect biochemical functions (Cheng, 2003). Absorption of heavy metals has been observed, with zinc (Zn) and manganese (Mn) being the most frequently found heavy metals in *Lactuca sativa* L. (lettuce). Although Zn and Mn are both essential for specific physiological functions, in excess both of these metals can lead to toxic effects on the plant body (Boamponsem et al., 2012). Most studies have shown that even under high levels of contamination, *L. sativa* L. has been consistently under the level of contamination deemed safe by many environmental agencies including the World Health Organization (Naser et al., 2018; Boamponsem et al., 2012).

Given what early experimentation has shown and the increased concern of contaminated sites, this research aims to determine how heavy metal contamination in *L. sativa* L. affects its growth and development. We hypothesized that exposure to the selected heavy metals would alter growth metrics and result in measurable uptake in the tissues of *L. sativa* L.

Materials and Methods

Evaluation of different concentrations of heavy metals

To make the contaminated solutions, 0.15 g of each heavy metal compound—bismuth subnitrate, cadmium nitrate tetrahydrate, chromium(III) potassium sulfate dodecahydrate, cobalt(II) nitrate, cupric sulfate, nickel (II) sulfate hexahydrate, and zinc sulfate heptahydrate—was weighed (Fisher Science Education, ALF203) and added to 1.8 L of distilled water on a magnetic plate (Fisher Scientific Isotemp, 1892071118875). After dissolving, more water was added to bring the volume to 3 L to make the stock solution of 50 ppm. To make the 10-

ppm solution, 1.8 L of the stock solution was combined with water until the final volume reached 3 L.

To inoculate the substrate, 200 mL of each respective solution was added to 6-inch pots filled with a standard germination mix of 80/20 peat and perlite. After the substrate was saturated, 10 seeds of *L. sativa* L. (Super Red Romaine lettuce, Seeds for Life) were sown on September 26, 2024. The pots were placed into the growth chamber (Conviron Gen1000) with a 16-hour day and 8-hour night cycle kept at 23°C. The pots were watered when they appeared dry. After 2 weeks, each pot was thinned to the 2 largest plants.

Evaluation of overall wellbeing

The fresh mass of each leaf used to calculate the specific leaf area (SLA). The ratio of the leaf area was measured by using a leaf area meter and putting a single leaf from each plant onto the conveyor (LI-3000C). The previously measured fresh mass was used to calculate the leaf dry matter content (LDMC) to predict the availability of resources, capture, and usage of those resources by the plant (Wilson et al., 1999). The overall well-being of the plants was determined by comparative analyses of the control versus the contaminated plants; traits such as general size, coloration, and root system health were observed.

Evaluation of the effect of individual heavy metals on seed germination

The 500-ppm stock solution was made by adding 0.15 g of each metal to 100 mL of distilled water. To make the 50-ppm solutions, 10 mL of the stock was added to 90 mL of water. The last concentrations were made using 2 mL of the 50-ppm solution and diluted with 98 mL water. This process was repeated for all 7 metals, and 3.5 mL of every solution was used to saturate dry filter papers inside Petri dishes. Once saturated, 20 *L. sativa* L. seeds were placed inside, sealed with Parafilm, and placed into the growth chamber (Conviron ATC26) with the same specifications as above. The seeds were tracked daily for germination rates over 6 days.

Analysis with ICP-MS

Each plant was harvested by cutting at the soil level. The roots were cleaned with water to rinse off as much of the soil as possible. An approximate 5 g sample of each soil replicate was taken as well. The samples were labeled “leaves,” “roots,” and “soil,” respectively. The fresh and dry weights were taken for each sample, with the dry weight

being measured after placing them in a standard drying oven for 72 hours. Two replicates of each sample type were prepared for inductively coupled plasma mass spectrometry (ICP-MS) analysis (PerkinElmer NexION 1000), with the following soil processing procedure. Each sample was sieved using a No. 35 sieve, ground with a mortar and pestle, and sieved again. The sieve was cleaned and dried between each sample. After grinding, the samples were placed onto a folded weigh paper and weighed (Ohaus AdventurerPro AV213) to $0.5000 \text{ g} \pm 0.0003 \text{ g}$. Acid digestion was performed by adding the weighed samples to a Teflon tube with 10 mL of 70% nitric acid and 3 mL of 30% hydrogen peroxide for the soil samples only. The tubes were placed into the microwave (Model MARS 6 230/60) for 15 minutes. A blank Teflon tube was prepared with 10 mL of 70% nitric acid. After the digestion was complete, the samples were moved to a DigiTUBE and filtered by attaching 2 DigiTUBEs with a filter between them, then placed on the vacuum manifold. Once filtered, the samples were added to a 50-mL volumetric flask. Nanopure water was added to bring the total volume to 15 mL. Finally, the ICP-MS analysis was performed.

Results

Germination rate—Petri dishes

All three treatments had similar germination rates with no statistically significant difference between the control and the 10-ppm dilution or the control and the 50-ppm dilution ($P=0.556$ and $P=0.178$, respectively, Figure 1). Between the seedlings placed in heavy metal solutions and the seedlings placed in the control solution of water, the seedlings in heavy metal solutions varied in health despite similar germination rates (Figure 2).

Vegetative growth—6" pots

Plants grown in the presence of heavy metals displayed a larger SLA and LDMC (Table 1) before and after drying, along with subjective observations of larger size and more redness than the control (Figure 3).

Roots - 6" pots

When each pot was thinned, the root systems of the seedlings grown in the contaminated solutions were observed to be smaller compared with the control (data not shown). However, when the roots

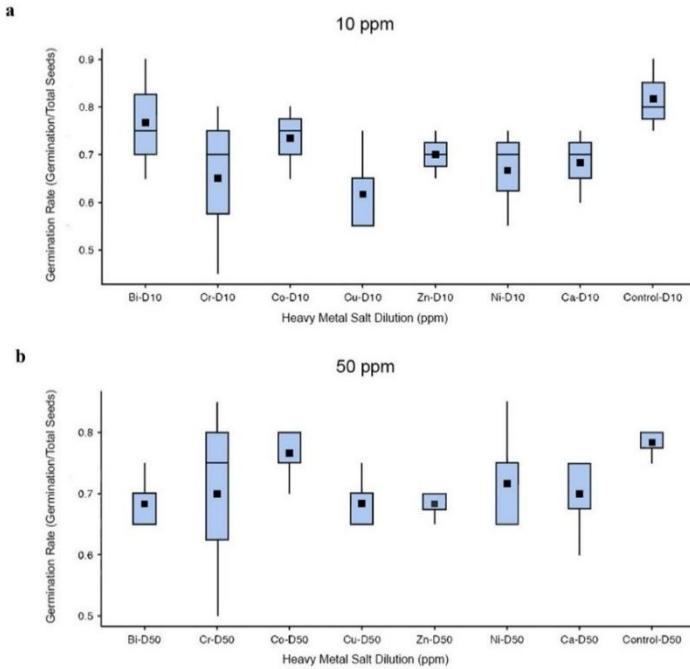


Figure 1: (a) Box plot depicting the mean, median, and interquartile range (IQR) of seeds that germinated ($n=20$) in 3.5 mL of 10-ppm solution over the 6-day period from 3 replicates per treatment. One-way ANOVA testing indicated no statistically significant difference ($P=0.556$). (b) Box plot depicting the mean, median, and IQR of seeds that germinated ($n=20$) in 3.5 mL of 50-ppm solution over the 6-day period from 3 replicates per treatment. One-way ANOVA testing indicated no statistically significant difference ($P=0.178$).

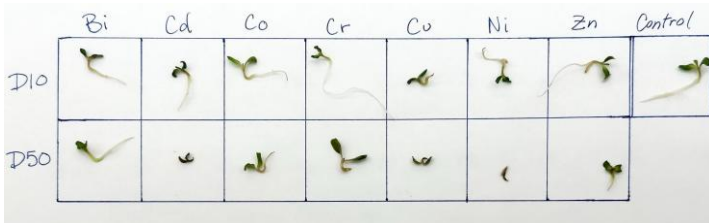


Figure 2: A representative average seedling from its respective Petri dish after the 6-day trial. D10 represents the 10-ppm solution ($n=20$) and D50 represents the 50-ppm solution ($n=20$) of each individual heavy metal, the seeds were grown in. A representative average seedling for the control ($n=20$) is shown also.

Treatment	Mean leaf area (cm ²)	Fresh mass (g)	Mean dry mass (g)	SLA (cm ² /g)	LDMC (g/g)
C-R1	5.48	0.16	0.04	133	0.27
C-R2	7.37	0.22	0.05	165	0.24
D10-R1	4.85	0.13	0.03	138	0.27
D10-R2	14.4	0.46	0.12	123	0.26
D50-R1	24.6	0.75	0.16	161	0.21
D50-R2	21.9	0.69	0.18	125	0.26

Note. The SLA is mean leaf area divided by mean dry mass.

	χ^2	df	p
SLA	0.317	2	0.854
LDMC	7.096	2	0.029



Figure 3. (A) Photographs of plants on October 8, 2024, 19 days after sowing. From left to right, with each treatment in its own tray: D50-R2 (50 ppm dilution, replicate 2 (n=6)); D10-R1 (10-ppm dilution, replicate 1 (n=6)); D10-R2 (10-ppm dilution, replicate 2 (n=6)); C-R2 (control dilution, replicate 2 (n=6)); C-R1 (control dilution, replicate 1 (n=6)). (B) Photographs of plants on October 29, 2024, 40 days after sowing. From left to right, D10-R2, D10-R1, D50-R2, D50-R1, C-R1, C-R2 (10-ppm dilution, replicate 2 (n=6); 10-ppm dilution, replicate 1 (n=6); 50-ppm dilution, replicate 2 (n=6); 50-ppm dilution, replicate 1 (n=6); control dilution, replicate 1 (n=6); control dilution, replicate 2 (n=6)). Note order of trays has changed from A to B.

were harvested at the end of the experiment, it was observed that the root systems of the contaminated solutions were more robust than the control

(Table 2). Because the control roots were more fragile, a larger amount of them were lost during washing, which would account for errors in our calculations.

Table 2: Average fresh mass followed by its respective standard deviation of each replicate, then dry mass, % water content, and dilution averages of the roots from each replicate (n=6)					
Treatment	Fresh mass (g) (n=6)	Standard deviation	Dry mass (g) (n=6)	% water	Dilution averages (g) (n=12)
C-R1	11.6	0.015	1.22	90	12.6
C-R2	13.4	0.008	1.52	89	
D10-R1	9.43	0.035	0.90	90	26.0
D10-R2	42.6	0.020	4.38	90	
D50-R1	35.5	0.027	3.83	89	38.3
D50-R2	41.1	0.030	4.31	90	

The treatments include the experimental dilutions: control (C), 10 ppm dilution (D10), and 50 ppm dilution (D50) with two replicates each (R1 & R2).

Metal uptake - 6" pots

Plants grown in the presence of heavy metals showed a greater uptake of the heavy metals they were exposed to during their vegetative growth; however, because of the small margins in the results, this greater uptake lacked statistical significance (Table 3 and Figure 4).

Table 3: Mean concentrations (ng/mL) of heavy metals identified by ICP-MS in the soil (S), leaves (L), and roots (R) of plants across treatments					
Treatment	Heavy metal concentration (ng/mL)				
	Ca	Co	Cu	Ni	Zn
S-C	0	1	25	3	24
L-C	2	0	11	2	34
R-C	3	0	1220	2	56
S-D10	2	3	32	4	31
L-D10	3	0	11	1	31
R-D10	1	1	689	2	38
S-D50	6	8	58	5	45
L-D50	9	2	12	2	33
R-D50	15	12	6	13	52

The treatments include the experimental dilutions: control (C), 10-ppm dilution (D10), and 50-ppm dilution (D50). Samples were taken from plants grown in the growth chamber at T = 39 days.

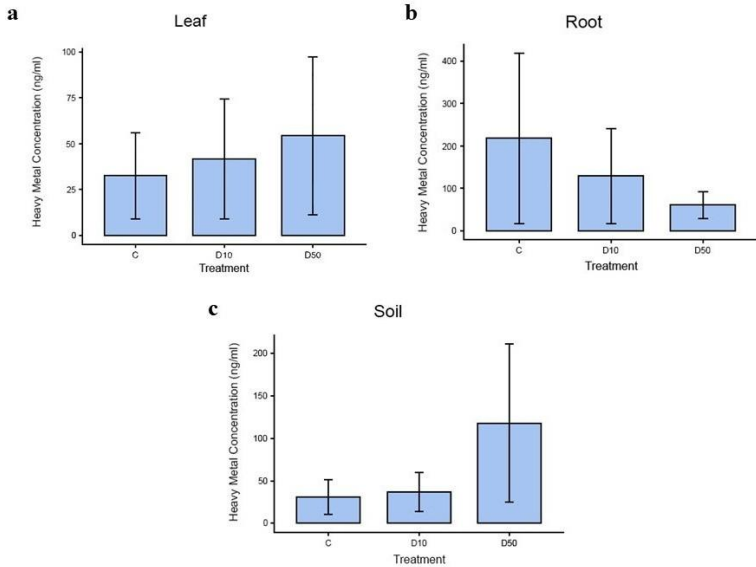


Figure 4: (A) Bar plot showing the total concentration of heavy metals found in the leaves of each plant per treatment ($n=12$) using ICP-MS. Kruskal-Wallis nonparametric one-way ANOVA analysis showed no statistically significant difference in mean heavy metal concentration across treatments ($P=0.852$). (B) Bar plot showing total concentration of heavy metals found in the roots of each plant per treatment ($n=12$) using ICP-MS. Kruskal-Wallis nonparametric one-way ANOVA analysis showed no statistically significant difference in mean heavy metal concentration across treatments ($P=0.574$). (C) Bar plot showing the total concentration of heavy metals found in the soil of each pot per treatment ($n=12$) using ICP-MS. Kruskal-Wallis nonparametric one-way ANOVA analysis showed no statistically significant difference in mean heavy metal concentration across treatments ($P=0.354$).

Discussion

There were no statistically significant differences in germination rates between the Petri dish and potted plant trials between the control and the level of contamination in either treatment. However, there were significant qualitative differences between the control and the higher concentrations of Cd, Ni, Zn, Co, Cu, Cr, and Bi, seen in Figure 2. Emamverdian et al. (2018) had previously seen a reduction in multiple physiological processes in *Indocalamus latifolius*, including a reduced emergence of new plants and overall health. Another possibility for this discrepancy could be that the concentrations were not high enough when

compared with other studies. Evaluation of the germination rates in other studies showed strong support for exposure to the same metals used in this study, causing a significant decrease in germination success (Mot et al., 2019). Although this study does not fully support decreased germination when exposed to metals, the range of contamination in the study by Emamverdian et al. was much larger than this experiment.

In the evaluation of health based on the color, apparent size, and overall look of the plants, it was found that those grown in contaminated substrates displayed more signs of distress. Signs of this distress included the lack of redness in mid-veins among other parts of the leaves along with the wellbeing of the root systems. Other studies have shown that heavy metals such as Cd, Pb, Hg, and Zn, have growth-inhibiting effects (Cheng, 2003; Khan et al., 2019). Despite appearing distressed, the leaves of plants that were exposed to the mixture of these heavy metals showed signs of vigorous growth when compared with those in the control group (Figure 2). An explanation for this is that the reagents used to produce the contaminated solutions were attached to nitrates, sulfates, and potassium that acted as an unintentional fertilizer. A possible solution for the fertilizing constituents would be to remove the fertilizing molecules or isolate the heavy metals. This could be done by chemical precipitation, ion exchange, and solvent extraction. Following this process, the products would be used to make a solution where only the heavy metals are active in affecting plant development.

Other studies have found conclusions that oppose those found in this work, in systems including *Ammophila breviligulata* and *Filipendula ulmaria* when analyzed growing in known contaminated areas containing Cu, Cd, Ni, Cr, and As (Cheng, 2003; Enel, 2003; Shi et al., 2023). The referenced research supports the hypothesis of this paper. This suggests that in this experiment the null statistical significance with regard to the uptake of heavy metals in *L. sativa* L. could be attributed to the relatively low concentrations of the contaminating solutions. It is hypothesized that making the solutions with much higher concentrations would yield similar results to the above mentioned work.

Conclusions

In summary, the plant growth of *L. sativa* L. grown in the contaminated substrate had higher SLA when compared with the control, along with larger vegetative and root systems. Analysis showed no change in the germination rates of seedlings exposed to heavy metals at the tested concentrations. However, the vitality of the seedlings was extremely poor, with the overall health declining rapidly once sprouted.

Future experimentation could include quantitative measurements of these seedlings, such as root and shoot lengths. Testing more replicates, doing only one heavy metal per pot, and isolating the individual heavy metal from its fertilizing constituents could yield more refined results.

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Wellbeing, Experiential Learning, and Food Justice: A Mixed Methods Case Study of a University Campus Garden

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University of Utah

Abstract

University campus gardens (UCGs) contribute to their campuses in significant ways. Research suggests that the benefits of UCGs include improvement of student wellbeing, experiential learning, and food justice on campus. This paper reports on the results of a mixed methods pilot study that was developed in collaboration with the Edible Campus Gardens (ECG) program at the University of Utah. All research materials were developed with the ECG program leadership to ensure that all data gathered could be used to effectively assess the program. Both phases of the study, the focus groups and the survey, highlighted the connection of the ECG program to student wellbeing. The strongest theme from the focus groups was wellbeing, with students discussing social, mental, and physical wellbeing. From the survey results, this study found that spending 10 hours total or more in the garden space had a significant impact on student personal wellbeing ($p=0.045$). This pilot study has made significant strides in accurately measuring program

impact. However, the potential for continuing this research is great as additional investigation can contribute to a more generalizable understanding of UCG impact on student experience.

Introduction

University campus gardens (UCGs), sometimes referred to as campus food gardens, can present in various forms, such as a community-based model with students leading the garden (Laycock Pederson & Robinson, 2018) or as university staff-led sites of formal and informal learning (Duram & Klein, 2015). Although leadership and purposes of the campus gardens can differ, UCGs are often located within the university's central campus or close to the campus, contributing to positive student impact (Duram & Klein, 2015; Bice et al., 2018). UCGs play important roles on their campuses, yet are vulnerable to institutional change due to funding and possible administrative neglect (Duram & Klein, 2015). A comprehensive understanding of a UCG's benefits can strengthen data-driven external and internal reporting by centering the positive local impacts. Continued engagement with UCGs in the form of student involvement, stakeholder investment, and use for research and education is critical for the success, and thus justification, of UCGs (Duram & Klein, 2015). Literature surrounding UCGs often addresses aspects of the gardens benefiting students and the larger university community. Benefits associated with UCGs within the literature describe themes such as experiential learning, student wellbeing, and food justice on campus.

This paper reports the results of a pilot study of the UCG program at the University of Utah, the Edible Campus Gardens (ECG). This study emerged from discussions of how to use research to support the ECG's programmatic goals and describe the benefits of the ECG. The mission of the ECG is "to engage the campus through garden-based education and urban food production to foster environmental stewardship, community resilience, and belonging on campus."¹ The ECG program has multiple garden sites. The largest garden site is Nuh Eevaat, and there are two smaller gardens at other locations on campus. The three gardens together produced 560 pounds of produce during the growing season for 2024. The food is distributed directly on campus through the Feed U Pantry on campus and Sustainability Office farmers markets in the Fall. The gardens are used as living, learning laboratories in addition to

¹ To view the ECG program mission, visit: <https://sustainability.utah.edu/edible-campus-gardens/>.

producing food. Students, faculty, staff, classes, researchers, and community members spend time in the garden space to contribute to course outcomes and provide hands-on learning. This study was designed to collect data about student perspectives and experiences in engaging with the ECG program.

Background

UCGs contribute uniquely to the campuses of which they are a part. Three major types of contributions have been identified through the literature: wellbeing, experiential learning, and food justice. Concerning student wellbeing, UCGs provide access to green space on campus that impacts student social wellbeing (Bice et al., 2018). Campus gardens also provide a pathway for experiential learning through building food literacy, deepening understanding of food systems, and building critical thinking skills (Ruhl & Lordly, 2021; Sherry, 2022). In addition to furthering educational impacts, UCGs address food justice on their campuses and positively impact their larger university communities (Sherry, 2022). This background section aims to identify and contextualize the reasons why UCGs benefit and serve students and their larger university communities.

Student Wellbeing

Universities are increasingly looking for ways to bolster student wellbeing (Upsher et al., 2022). Two pathways connect UCGs to student wellbeing: access to green space and community building. Green spaces on campus have been connected to restoration from stress and offer opportunities for physical activity (Bice et al., 2018). Places on campuses that encourage connectedness with nature can potentially positively affect the general wellbeing of students (Baur, 2022). Additionally, students that actively engage with green spaces report a positive impact on their quality of life, mood, and stress levels (Holt et al., 2019). Although the research concerning the extent of green-space impact on mental health reports varying results because of a high level of heterogeneity (Beute et al., 2023), access to green space like a UCG is generally associated with positive outcomes (Bice et al., 2018).

UCGs also support student wellbeing by providing space for community building. One pathway identified is the facilitation of connectivity among students, staff, and the wider community. The collaboration and participation in the garden can improve social connection, which is correlated to improved psychosocial wellbeing (Marsh et al., 2020). Students are able to make connections to one another, to food, and to the larger community through participation (Ruhl

& Lordly, 2021). Community garden spaces additionally provide “third places” where community members can connect and build relationships (Baur, 2022). Campus gardens provide a space that facilitates student connection and community building.

Experiential Learning

Multiple sources engaging with the topic of campus gardens detailed the role of these gardens as spaces for experiential learning. Experiential learning is distinct from formal education models because of the focus on development of long-lasting skills (Laycock Pederson & Robinson, 2018), critical thinking, and contexts personally relevant to the students (Duram & Klein, 2015). Research supports that when experiential learning pedagogies are implemented, students experience superior educational outcomes (Burch et al., 2019). UCGs can provide an environment for students to engage with experiential learning (Classens et al., 2021). Students are able to deepen their education through interacting with UCGs.

UCGs also support sustainability education for both students focused on that discipline and the larger campus community. Students are able to gain an understanding and first-hand experience growing food. This can allow students to think critically about topics connected to the food system, such as seed patents, genetically modified food, and industrial agriculture (Sherry, 2022). Gardens also provide community education through sustainability awareness initiatives (Duram & Klein, 2015). These spaces demonstrate sustainable practices that encourage participation and reflection (Williamson et al., 2023). UCGs are recognized for their connections to sustainable practices (Williamson et al., 2023) and can deepen student understanding of the implications of the food system (Classens et al., 2021).

Food Justice

UCGs can play a role in health education and access to food in the university community. Community gardens can allow for the development of a healthy lifestyle through health education and access to fresh produce (Bice et al., 2018). Additionally, UCGs are connected to food literacy, which corresponds to the empowerment of individuals and the community (Ruhl & Lordly, 2021). Specifically, UCGs are increasingly aiming to address food insecurity within the student population they serve. Through access to produce, food literacy, and addressing food insecurity, UCGs are tied to food justice.

In addition to direct service to the community, UCGs have also been identified as spaces that support food systems transformation on

campus. Alternatives to conventional campus food services are important pedagogical spaces to promote food systems transformation. (Classens et al., 2021). UCGs can also foster cultural transformation by reframing student perspectives of food and place (Laycock Pederson & Robinson, 2018). Community gardening provides opportunities for civic engagement and political action (Marsh et al., 2020), as well as justice-oriented thinking (Williamson et al., 2023). The literature demonstrates a connection of UCGs to promotion of food system transformation and justice.

Study Purpose

This paper describes the impact of the ECG program on students at the University of Utah. We used a mixed-method approach to investigate how the program impacted student experiences and attitudes. Additionally, a critical component of the study was the partnership with the ECG, which guided the direction of the research to meet their data needs. The partnership was grounded in three community-based participatory research (CBPR) principles: 1) “CBPR disseminates findings and knowledge gained to all partners and involves all partners in the dissemination process”; 2) “CBPR requires a long-term process and commitment to sustainability”; and 3) “CBPR integrates and achieves a balance between research and action for the mutual benefit of all partners” (Israel et al., 2008, 50-52). This orientation for research allows the research to be more responsive to community needs (DeJonckheere et al., 2019). Based on the literature, the collaboration focused on student wellbeing, educational outcomes, and overall impact on their experience at the University of Utah. The following research question guided this study: How and to what extent does the ECG program impact student experience at the University of Utah?

The study was designed as a mixed methods study to provide multiple forms of data for the ECG to support decision making for the program. The focus group component of the study was intended to gain student perspectives on their experiences in the ECG. The survey component of the study was intended to provide the ECG with descriptive statistics that provide valuable insight into the student population. Additionally, the study was intended for future use by the Edible Campus Program and larger Sustainability Office. The study was also designed to collect relevant data for external and internal reporting, guide educational conversations, inform program management, and provide a template for future data collection about student attitudes.

Methods

Study Design

The study used three focus groups and a survey to gather data on student perspectives of the ECG. Focus group data were used to inform survey questions. All research materials were developed in collaboration with the ECG coordinator to ensure data informed ECG objectives (e.g., student success, program demographics, belonging on campus). Grounding the study design and implementation in partnership with the ECG reflects the principles of CBPR (Israel et. al, 2008). Additionally, mixed methodology was utilized to provide various forms of data for ECG usage. Mixed methodology research can improve measurement validity when qualitative measures such as focus groups are used to refine questions for a quantitative survey (Schutt, 2015). Both the qualitative and quantitative phases of the study were approved by the University of Utah Institutional Review Board.

Focus Groups

Focus groups were conducted using a semi structured interview guide with questions (see Appendix A) from the three categories identified in the literature review. Participants were selected on the basis that they had engaged with the ECG in some way, including but not limited to volunteering, receiving produce, or attending a class that engages with the ECG. Three focus groups were facilitated with 9 participants across the focus groups. There were four participants in the first focus group, three in the second, and two in the third. The focus groups took place at the beginning of Fall semester 2024, lasted 60 minutes each, and were transcribed verbatim. The focus groups were facilitated before the survey to provide insight into the strength of various themes. Those themes were then converted into survey questions.

Student Experience Survey

Survey questions (see Appendix B) were informed by the three categories identified through the literature search, important demographic information for the ECG, and focus group themes (see Table 1). Demographic information collected includes year in school, first interaction with the program, how students learned about the program, etc. These demographic questions inform the ECG of when students are learning about the ECG program and how. Questions intended for descriptive statistics were developed by considering the

mission statement of the program and the focus group results. ECG program leadership was consulted to confirm the utility of the questions and to identify any other questions that would support the program. Students that volunteered or worked in the garden space were asked to complete the survey. Students that met the beforementioned criteria and fully completed the survey were included in the analysis. Administered digitally through Qualtrics, the survey had 25 questions and lasted under 10 minutes. Forty-nine students fully completed the survey.

Data Analysis

Qualitative Analysis

All focus groups were recorded and transcribed. Deductive qualitative analysis was utilized for the focus groups. The three categories from the literature search provided guidance for possible themes and subthemes during the focus groups. First, Author 1 familiarized themselves with the transcripts and discussed with Author 2 the possible prominence of themes. Next, Author 1 conducted open axial coding (Strauss & Corbin 1990), linking significant information from the literature to the focus groups. Authors 1 and 2 held meetings often to discuss the progression of the analysis and the patterns between the focus groups. The strengths of the various themes were considered through the appearances and length of engagement with a theme throughout the three focus groups. Repetition and length indicated deep consideration of the topic. The themes that appear in the results sections are each supported by a minimum of five student quotes.

Quantitative Analysis

Excel was utilized to carry out the quantitative analysis of the survey. Additionally, Fisher's exact test was run to compare independent and dependent variables. Fisher's exact test is a 2×2 contingency table that is appropriate for small sample sizes (Bower, 2003). Groupings for Fisher's exact test were decided based on theoretical relevance and were consistent across the tests. For example, concerning the Fisher's exact test comparing time spent in the gardens and students' feeling that their education had been deepened through the experience, student responses were dichotomized into fewer than 10 hours spent in the gardens or 10 hours or more spent in the garden space. Student responses were sorted into agree, neutral, and disagree.

Results

Qualitative Results

Qualitative results regarding themes were collected through the focus groups (Table 1). Wellbeing—social, mental, and physical health—was the strongest theme. Students discussed the social aspects of the garden environment, mental health benefits, and exercising in the garden space. Food justice—regarded as adequate access to healthy, nutritious, culturally appropriate food—was the second theme. Students focused on feeling a deeper understanding of farmworker justice and the value of proximity to food production. Experiential learning—active participation rather than passive absorption—was the third theme. Students mentioned application to their education as well as their lives and transferable skills gained. Some less prominent themes included civic responsibility and access to the garden.

Table 1. Main themes and subthemes identified through the focus groups	
Themes	Subthemes
Wellbeing	Social Mental Physical
Experiential learning	Application Skills
Food justice	Food production Farmworker justice
Civic responsibility	Contribution Increased engagement
Access to the garden	Convenience Safety

The Impact of the Edible Campus Program on Student Wellbeing

Impact on student wellbeing was seen to be developed through time spent in the garden space. Three subthemes for the wellbeing theme were present: social, mental, and physical wellbeing. Concerning social wellbeing, students touched on the ECG program providing an environment conducive for building community and establishing friendships. One student shared their perspective of the social aspects of the program:

“The campus gardens was one of the first places that I made friends on campus. I think that as a community space it’s very

welcoming...it gives you ample opportunity to talk and build trust with other people and work together.”

—Focus Group 2

Through this quote, it is apparent that the ECG program played an important role in this student’s social life on campus at the beginning of their university experience. Additionally, the attributes of the garden mentioned, such as being welcoming, providing opportunity to talk, and opportunity to build trust, demonstrate the various ways the program benefits student social wellbeing.

Students in the focus groups also touched on the mental health benefits of the garden space. Students mentioned access to the garden space as a natural, green space:

“Being outside in the garden definitely directly improves my mood...I feel like college is just a lot sometimes, and the culture of it is just like you’re constantly on the go, and studying and doing the classes and commuting. And I feel like the gardens [help] you slow all that down, and just kind of, I guess, get back to yourself in a way. So, I just find it really relaxing and grounding.”

—Focus Group 1

For this student, the gardens not only provided a place to decompress but also to improve daily mental wellbeing. The contrast of the culture at the campus gardens in comparison with the rest of campus demonstrates how the gardens are conducive for improved mental wellbeing.

In addition to social and mental wellbeing, students also discussed the physical benefits of working in the campus gardens. Students were asked about their perspective of exercise within the garden space. One student focused on the unexpected exercise experienced through the garden:

“But then with gardening, maybe your intent is not the workout, but it’s a nice side effect. You get a nice workout in because it can be laborious. So, I think I like it personally...[it’s] satisfying to wake up the next day, and your body hurts like, oh, I did something, that’s good.”

—Focus Group 3

While not a focus of the ECG program, exercise and physical activity are associated with the garden experience for students. As the

student mentioned, exercise through the garden can be satisfying and a way to move the body. This example highlights how the garden space also addresses physical wellbeing.

ECG Program Connection to Experiential Learning

Supporting hands-on and experiential learning is an important focus of the ECG program. Students touched on the application of learning within the garden both for their education and their lives. The other facet of experiential learning that students discussed was skills gained, including transferable skills. One student mentioned the importance of learning within the campus garden for their education:

“And I feel like it’s like a space that I learn a lot of things that tie into my major and my emphasis, like food systems. And it’s not just theoretically, I like learning about food sovereignty on paper. And discussing a lot of politics. But actually being able to contribute to community gardens, and learn how to grow and harvest. And how to contribute to food systems in the community that I’m glad to be part of.”

—Focus Group 3

This student’s experience in the ECG program allowed them to apply what they have learned to their program. In this case, hands-on experience was necessary for understanding the reality of the local food system within the context of their studies.

Students also discussed skills they gained through their time at the campus gardens. One student shared a specific skill that they thought they had gained through interacting with the edible plants in the garden space:

“I feel like one big skill that I’ve learned was knowing when to harvest something as opposed to letting it continue growing for next week or the next harvest, and just kind of getting a better sense of...when to harvest things.”

—Focus Group 2

This example demonstrates how skills and confidence in the garden can be gained through time spent engaging with the ECG program.

Aspects of Food Justice Supported by the ECG Program

Through the focus groups, two subthemes were prominent. Students discussed their experiences being involved in urban food

production, the transformation they perceived on the food system on campus, and valuing proximity to food production. Students also talked about understanding farmworker justice issues more intimately after their time in the garden space. One student engaged with the experience of understanding food production on a deeper level:

“I think for me, ultimately knowing where we get our food from is super valuable, and a lot of people based on the food system here in America don’t know where that food comes from...I just feel like there’s a concept [that] it just appears in the grocery store. So I think actually seeing a variety of food grown different ways, was really valuable.”

—Focus Group 2

Another student described how the ECG transformed the campus food system through the donation of fresh produce to the on-campus food pantry:

“So, learning like where it’s coming from, and having or seeing kind of the entire process...it was really cool just to see the entire process. They’re growing this food, and then they’re giving it to the Feed U Pantry, and then it’s going to the students, and the students are getting better from it.”

—Focus Group 2

These examples illustrate how the ECG program provides students with a clear picture of the food system within local contexts. The first quote ties to urban food production and the value of deeply understanding the logistics of producing food. Similarly, with the second quote, the student connects to the idea of food system transformation on campus.

Concerning farmworker justice issues, students discussed how labor in the garden space provided insight into the challenges farmworkers face every day in terms of labor requirements. A student touched on the impact of growing food in the garden space on understanding the labor required to produce food:

“When you’re growing food, you appreciate the labor that goes into everything you buy from the store. Someone else had to

grow it. And you just develop, the deeper appreciation for all the farm workers that make our lives possible that are being often mistreated and underpaid, especially in the US...Growing

your own food just reminds you of how hard other people are working to make your life possible.”

—Focus Group 1

This student’s experience of growing food within the garden space informed a deeper understanding and appreciation of the labor provided by farm workers.

Bolstering a Sense of Civic Responsibility through the ECG Program.

Students mentioned two ways that the ECG program has influenced their view of civic responsibility. One subtheme was students feeling a desire to contribute to the ECG program and the community. Another subtheme was the ECG program inspiring further student engagement within the campus community. One student explained the ways that the ECG program supported their desire to contribute:

“This sounds so corny, but it was very joyful. Everyone was laughing and having fun. Everyone was working together... The atmosphere was really good, and I think...that you can kind of just feel that walking into it, that it’s already a good atmosphere. So you don’t wanna make it worse, you want to add to it.”

—Focus Group 2

This student explained how the culture of the garden space elicited a desire to add to the garden community.

In addition to contributing to the campus gardens, students also discussed how the ECG program itself inspired continued engagement from students. One student talked about the community aspect of the campus gardens positively impacting their subsequent engagement with the ECG program:

“I feel like after I start volunteering at the gardens...it’s made me see that I’m coming to school to go to class and eat and go home. I feel more engaged like: oh! This is actually community. And also, make friends through it...But I felt like I take up some responsibility within part of the community I’m a part of. So, it made me feel like I’m engaging more, and I felt more included in the campus community.”

—Focus Group 3

This example demonstrates how the campus gardens supported this student’s journey to becoming engaged in the campus community and feeling a sense of civic responsibility.

Accessing the ECG Space

Two subthemes were present pertaining to access: convenience and safety. Concerning convenience, students mentioned ease of getting to the garden because it is located on campus. In addition to being in a convenient location, students also discussed it being a safe space. One student discussed being able to access the campus garden:

“I think [it] has impacted my—yeah, my experience at the U...It’s nice living on campus to have somewhere to garden. That’s something I grew up doing, and still really enjoy doing.”
—Focus Group 1

For this student, an easily accessible garden on campus had a positive impact on their overall experience at the University of Utah. Additionally, this access to a garden space holds personal significance to the student as they enjoyed gardening growing up and would not otherwise have access to garden space while living on campus.

While convenience supports accessibility, a sense of safety also bolsters accessibility for folks looking to engage with the garden space. One student talked about the different ways that they feel that the garden space is welcoming and accessible:

“But also as a physical space, because it’s quiet and you can like reflect there and do your own internal growing...For me, it’s just like, yeah, I really like being here. I feel content here. I feel safe here. I feel like I enjoy the people I work with.”
—Focus Group 2

This student’s experience in the garden space demonstrates how the garden itself provides a safe environment to grow and reflect.

Quantitative Results

Forty-nine survey responses were completed between November 2024 and December 2024. The demographics of the survey sample included a mostly female identifying sample (75%), with most students being in their first year at the university (51%). A large majority of the student sample identified as White (63%). In considering time spent in the garden space, most student respondents reported spending less than 3 hours in the garden space (59%). The open response question allowed students to fill in their major or program. From that question, 23 unique majors and programs were represented in the student sample.

Descriptive Statistics

The descriptive statistics for this study are particularly important for the ECG program, because they provide a snapshot of student experiences and attitudes. Of the students that completed the survey, 98% (n=48) agreed (“strongly agree” and “somewhat agree”) that they felt welcomed into the ECG program. In comparison, 78% of students (n=38) agreed they felt that they belonged in the ECG program. Concerning experiential learning, 76% (n=37) agreed that they could identify tangible skills through their experience in the ECG program. Additionally, 90% of students that responded to the survey conveyed awareness of food insecurity on campus through acknowledging the ECG working to address the issue. Most student respondents, 86% (n=43), agreed that the ECG has made a positive impact on food insecurity on campus. Additionally, 86% (n=43) agreed that garden space was important to them. Finally, demonstrating the impact of the program, 86% (n=43) agreed that involvement with the ECG has had a positive impact on their overall experience at the University of Utah.

Fisher’s Exact Test

In assessing years in school and time spent in the garden as independent variables, more years in school did not necessarily predict more positive outcomes such as deepened education, belonging, or feeling involved on campus. Rather, these outcomes from the survey were reported by all students to some degree. Most students reported positive outcomes related to the ECG, even when spending relatively few hours in the garden space during their first year. However, spending more than 10 hours engaging with the ECG was a significant predictor of a positive impact on student personal wellbeing.

Beneficial to personal wellbeing	Time spent (hours)		Total
	<10	≥10	
Agree	26	9	35
Neutral	14	0	14
Disagree	0	0	0
Total	40	9	49

Note. The Fisher’s exact test comparing time spent with the ECG and positive impact to wellbeing ($p = .045$). For the purposes of the test, the agree and neutral categories were used for the calculation. The result is significant at $p < .05$

Discussion and Impact

UCGs like the ECG program require continual support and investment to continue growing as programs (Duram & Klein, 2015). Data about student perspectives and experiences with the program are important to inform future program management and prepare program leadership with metrics detailing the importance of the program. The findings of this study bolster the broad literature on UCGs by supporting direct ties to wellbeing. Wellbeing was the strongest theme, with students discussing the social aspect of the garden environment, mental health benefits, and physical health benefits. Experiential learning was the second theme, with students mentioning application to their education and transferable skills gained. Food justice was the third theme, with students focusing on feeling a deeper understanding of farmworker justice and the value of proximity to food production. Additionally, local food systems transformation was touched on by students in the focus groups, demonstrating the transformative nature of a program like the ECG. For the survey, Fisher's exact test revealed that spending 10 hours or more in the garden space had a significant impact on student personal wellbeing ($p=0.045$). Both the focus groups and the survey demonstrate the impact of the program on various forms of student wellbeing.

Additionally, the findings are important within local contexts and provide additional support for the ECG program. With the University of Utah channeling energy and resources to addressing student wellbeing, the connection of the ECG to wellbeing is significant.² Additionally, this study was designed for future use by the Sustainability Office and especially the ECG program at the University of Utah. The ECG program can leverage the results of this study to communicate the positive impact of the program on student experiences through data-driven external reporting and ultimately amplify wider recognition of program excellence. This study served as a pilot for the ECG, providing insight into the varied experiences of engaged students. The pilot study has made significant strides in accurately measuring impact, and continuing this research can contribute to a comprehensive understanding of ECG impact to student experience. Additional research based on CBPR principles in partnership with UCGs is encouraged to address local community needs and support UCG program success.

² For an example of a University of Utah wellbeing initiative, visit: <https://academic-affairs.utah.edu/wellbeing-and-resilience/>

Limitations and Future Research

While holding utility for the ECG and potentially other UCGs, the study is limited mostly by the sample. The sample size for this study was neither representative nor large. The study could have benefitted from additional varieties of student experiences. The small, limited sample still provided usable and impactful data for the ECG. An increase in the quality of the sample could amplify the impact of a study of similar focus. There is great potential for future research in collaboration with UCGs. One topic that is increasingly important for understanding university retention is belonging (Pedler et al., 2022); conducting research on belonging within a UCG environment can provide insight into what attributes support belonging within university environments.

Conclusion

UCGs contribute to their campuses in important ways. A deeper understanding of UCGs' benefits can support the programs and provide a way to communicate about program successes. Benefits associated with UCGs within the literature indicate improved experiential learning, student wellbeing, and food justice on campus. The objective of this project was to conduct a mixed methods engagement and impact study in collaboration with the ECG at the University of Utah. The study used three focus groups and a survey to gather data on student perspectives of the ECG. All research materials were developed in collaboration with the ECG program leadership to ensure data contributed to ECG objectives. The findings of this study bolster the broad literature on UCGs by outlining the direct ties to wellbeing. Both phases of the study, the focus groups and survey, highlighted the connection of the ECG program to student wellbeing. The data from this study are important to the ECG program and will be utilized in the future by the Sustainability Office at the University of Utah and especially by the ECG program. This pilot study has made significant strides in accurately measuring impact; however, the potential for continuing this research is great as additional investigation can contribute to a more generalizable understanding of UCG impact on student experience.

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Appendix A

Semi-structured Focus Group Guide

Introduction:

- How did you first get involved with the gardens?
- Why did you get involved?
- How frequently did you work at the garden?
- What was that experience like for you in the garden?

Garden specific

Are there things that you think about or understand differently given your time in the garden? What do you know that you didn't before?

In what you have learned through the ECG, what have you seen as valuable personally to you?

Students from Community Engaged Learning classes with the ECG, was there connection to class content that was valuable to you? If so, what was it?

Have you learned any skills through your involvement with gardens? Can you describe them?

How could those skills tie in to your classes or profession?

In thinking about spending time in the garden versus other spaces on campus, how did that experience impact you in terms of your mood or overall wellbeing?

How do you now think about the physicality of garden labor?

Do the gardens feel like a welcoming space to you? Please explain.

Have there been opportunities to meet new people in the gardens?

Did you feel more involved in campus afterward?

Are there things that could support your further involvement in the gardens?

Appendix B

Student Experience Survey

What year are you at the University of Utah.

- a. First year
- b. Second year
- c. Third year

- d. Fourth year
 - e. Fifth year or beyond
- What year did you first interact with the Edible Campus Gardens?
 - a. First year
 - b. Second year
 - c. Third year
 - d. Fourth year
 - e. Fifth year or beyond
- What is your major or program? (Dialogue box)
- Please choose the description that best fits how you think of yourself.
 - a. Agender
 - b. Female
 - c. Male
 - d. Non-binary
 - e. Transgender
 - f. A gender identity not listed here
 - g. I don't know
 - h. I prefer not to respond
- Please choose the description that best fits your racial/ethnic identity.
 - a. Asian
 - b. Black or African American
 - c. Hispanic
 - d. Latinx
 - e. Multiracial
 - f. Native North American or American Indian
 - g. Pacific Islander
 - h. White
 - i. A racial/ ethnic identity not listed here
 - j. I don't know
 - k. I prefer not to answer
- How did you first learn about the Edible Campus Gardens?
 - a. Class session in the gardens
 - b. Feed U Pantry
 - c. In-class presentation
 - d. Internet/ social media
 - e. The Sustainability Office

- f. The UofU Farmers Markets
 - g. Volunteer shift or event
 - h. Walking through campus
 - i. Word of mouth
 - j. Other forms of outreach
 - k. Another option not listed
- How often have you volunteered or engaged with the Edible Campus Gardens? (Four-point Likert scale from “Never” to “Often”)
 - How often have you accessed Edible Campus Gardens’ produce from the Feed U Pantry, UofU Farmers Market, or volunteer shifts? (Four-point Likert scale from “Never” to “Often”)
 - Please estimate the total number of hours you have spent volunteering with the gardens.
 - a. 3 or fewer hours
 - b. 3-10 hours
 - c. 10-20 hours
 - d. 20 + hours

Remaining questions are five-point Likert scales strongly disagree to strongly agree.

- Involvement with the Edible Campus Gardens has deepened my education.
- I have felt welcomed into the Edible Campus Gardens program.
- I feel that I belong in the Edible Campus Gardens.
- Accessing the gardens has been beneficial to my personal well-being.
- Involvement with the Edible Campus Gardens has helped me feel more involved with the campus community.
- I feel that I can identify tangible skills that I have learned through my experience with the Edible Campus Gardens.
- I see the Edible Campus Gardens working to address food insecurity on campus.
- I feel that the Edible Campus Gardens has a positive impact on food insecurity on campus.
- Garden space on campus is important to me.
- The social aspect of the Edible Campus Gardens is valuable to me.
- Closer connection with the growing process is important to me.
- Engaging in my campus community is important to me.

- The Edible Campus Gardens being environmentally conscious is important to me.
- Knowing where my food is from is important to me.
- The Edible Campus Gardens offers a space to decompress on campus.
- I enjoy the Edible Campus Gardens as a space on campus.
- Involvement with the Edible Campus Gardens has had a positive impact on my overall experience at the University of Utah.

Utah Lake: The Complex Origins and Consequences of Shifting Baseline Syndrome

Teri Harman

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Abstract

The cultural reputation of Utah Lake is an odd tangle of outdated information, missing facts, and misunderstandings. Situated at the center of Utah Valley, immediately south of Salt Lake Valley in Northern Utah, the lake acts as a critical freshwater oasis in the arid Great Basin. Utah Lake provides the necessary resources for many forms of life, as much today as thousands of years ago. Despite its importance and central location, local collective memory retains certain things, even when they are no longer true, and forgets others, even when they are essential. Anglo-American settlement in the mid-1800s instigated several rounds of “ecological disabling,” or damage from pollution, toxins, and development. Large-scale changes over the past two centuries created the current negative public perception of the lake. Instead of more accurate recognition as a life-sustaining haven, restoration marvel, and recreation mecca, commonly repeated refrains describe it as “unsafe for swimming,” “smells bad,” “too many bugs and algae blooms,” “a dumping ground for trash,” and “toxic runoff.” As human interactions

reshaped and, in some cases, ruined the Utah Valley landscape, community connection deteriorated. This disconnect from ecological reality is a sociological, psychological, and cultural phenomenon known as “shifting baseline syndrome.” This paper explores the complex origins and consequences of Utah Valley’s unique shifting baseline syndrome by following the “track and traces” of human interactions over time.

As humans reshape the landscape, we forget what was there before. Ecologists call this forgetting the “shifting baseline syndrome.” Our newly shaped and ruined landscapes become the new reality. Admiring one landscape and its biological entanglements often entails forgetting many others. Forgetting, in itself, remakes landscapes, as we privilege some assemblages over others. Yet ghosts remind us. Ghosts point to our forgetting, showing us how living landscapes are imbued with earlier tracks and traces.”

Arts of Living on A Damaged Planet: Ghosts
Anna Tsing, Heather Swanson, Elaine Gan, Nils Bubandt

Introduction

The cultural reputation of Utah Lake is an odd tangle of outdated information, missing facts, and misunderstandings. Situated at the center of Utah Valley, immediately south of Salt Lake Valley in Northern Utah, the lake acts as a critical freshwater oasis in the arid Great Basin. Utah Lake provides the necessary resources for many forms of life, as much today as thousands of years ago. Despite its importance and central location, local collective memory retains certain things, even when they are no longer true, and forgets others, even when they are essential.

Anglo-American settlement in the mid-1800s instigated several rounds of “ecological disabling,” or damage from pollution, toxins, and development.¹ Large-scale changes over the past two centuries have created the current negative public perception of the lake. Instead of more accurate recognition as a life-sustaining haven, restoration marvel, and recreation mecca, commonly repeated refrains include that it is “unsafe for swimming,” “smells bad,” has “too many bugs and algae

¹ A term and concept from the work of Sunaura Taylor, *Disabled Ecologies: Lessons from a Wounded Desert*. Oakland: University of California Press.

blooms,” is “a dumping ground for trash,” and contains “toxic runoff.”² As human interactions reshaped and, in some cases, ruined the Utah Valley landscape, community connection deteriorated.³ This disconnect from ecological reality is a sociological, psychological, and cultural phenomenon known as “shifting baseline syndrome.”⁴

Shifting baseline syndrome (SBS) arises from the “absence of past information or experience with historical conditions” and lowers “accepted thresholds for environmental conditions.”⁵ In other words, as ecological conditions change, so do cultural ones. Unfortunately, in the case of Utah Lake, the community’s ecocultural identity, or multifaceted connection to the landscape, stalled at the height of environmental abuse and has not recovered along with the water.⁶ Hundreds of restoration projects have repaired the lake’s ecology and habitat, but reputation and knowledge lag far behind. This paper explores the complex origins and consequences of Utah Valley’s unique SBS by following the “track and traces” of human interactions over time.⁷

Origin Stories

SBS contains an inherent timeline of actions and results, but the experience of SBS is not linear. Cultural narratives and rhetoric tend to loop, cycle, and drift among past, present, and future, as well as merging fantasy and reality. Confluences of people, processes, environment, and time create beliefs about and relationships to nature. Historian Paul Sutter writes that it is important to see “all environments as interweaving the natural and cultural in complex ways.”⁸ Of course, the complexities arise from a sequence of events, so it aids understanding to know the who, what, where, when, why, and how.

Human populations have gathered in Utah Valley since ancient Lake Bonneville drained about 14,000 years ago and left behind the mountains, valleys, rivers, and lakes of the watershed system.⁹ Because the majority of significant ecological changes occurred after Anglo-American settlement, the pre-existing landscape marks the original conditions. Under those circumstances, Utah Lake created and sustained

² Zoe Foster and Utah Lake Authority. 2024. ULA Market Research Project Final Report. N.p.: Utah Lake Authority.

³ Anna Tsing et al., *Arts of Living on a Damaged Planet*, G6.

⁴ Soga & Gaston, “Shifting baseline syndrome,” 222.

⁵ *Ibid.*

⁶ See ecocultural identity work by Melissa M. Parks.

⁷ Anna Tsing et al., *Arts of Living on a Damaged Planet*, G6.

⁸ Rogers and Godfrey, *The Earth Will Appear as the Garden of Eden*, 2.

⁹ Grayson, *The Great Basin*.

a biodiversity haven, subsistence stronghold, and fishery wonderland. The watershed was so productive that by the mid-1800s, the valley supported the largest concentration of Native Peoples in the Great Basin.¹⁰ The Timpanogos and Ute built prosperous lives on the shores of Utah Lake, all of which were permanently interrupted after the arrival of the Mormon pioneers. Experts and residents alike refer to the arrival of the pioneers in 1847 as a significant turning point in many ways. But what about the why: *why* did the Mormons choose Utah? My research indicates that a critical moment for Utah Lake occurred three years earlier on a pleasant spring morning in 1844. Without this event, it is likely the Mormons would have settled elsewhere, such as California, Oregon, or Vancouver Island, all of which were top contenders for the new religious homeland.¹¹

On May 25, 1844, American explorer John C. Frémont and his company traveled down Spanish Fork Canyon and arrived in Utah Valley. Tasked by the U.S. Government with surveying the vast American West for possible travel routes and settlement areas, he was thrilled to see a lush, idyllic landscape. The Wasatch Mountains, running north–south on the east side of the valley, were capped with snow. Canyon rivers flowed high and fast with spring runoff, draining into the large freshwater lake. The original Provo River Delta spread a wide network of tributaries across the shore. In the streams, native June Sucker fish hatched by the hundreds. Across the lake, several hot springs sat steaming near the Jordan River inlet. The only outflow of the lake, the river ran north to feed Great Salt Lake. Lake Mountain, the short range on the west side of the valley, held hundreds of examples of ancient rock imagery and other artifacts.¹² Although he wasn't the first white person to admire the watershed, Frémont arrived in the valley during a junction of historical and social changes that then shifted the course of Utah history in profound ways.¹³

In his detailed reports, Frémont recorded Utah Lake as “a lake of note in this country.”¹⁴ He wrote, “The lake is bordered by a plain, where the soil is generally good, and in greater part fertile; watered by a delta of prettily timbered streams. This would be an excellent locality for stock farms; it is generally covered with good bunch grass, and would

¹⁰ Northcutt, *The Wasatch Oasis*, 34.

¹¹ Carter, *Founding Fort Utah*, 2.

¹² See Hora and Merritt, “Utah Lake Rock Imagery” and The Smith Family Archaeological Preserve.

¹³ The first Europeans arrived in Utah Valley with the Dominguez–Escalante Expedition of 1776.

¹⁴ Frémont, *Memoirs of My Life*, 387.

abundantly produce the ordinary grains.”¹⁵ This suggestion of fertile farmland and abundant fresh water caught the attention of the Mormon leaders in Illinois as they carefully studied the expedition reports. Historian Alexander L. Baugh notes that Frémont’s enthusiasm for the Great Basin had a “profound influence on Brigham Young and the church’s leadership and their decision to select the Wasatch region of northern Utah as the main place of Mormon settlement.”¹⁶

After the murder of founder Joseph Smith, Brigham Young assumed leadership of The Church of Jesus Christ of Latter-day Saints.¹⁷ Similar to most Anglo-American settlers, the Mormons were primarily farmers and ranchers, seeking out land that met their needs. Also, like all settlers, the Saints did not recognize Native sovereignty and decided to settle on land owned by others. In early 1845, the church leadership decided Utah Valley offered everything they desired for their new home and set to work preparing for an overland journey.¹⁸ Shortly before leaving Winter Quarters, Nebraska, in March 1847, Brigham Young shifted plans. Concerned about the large population of Timpanogos and Ute near Utah Lake, he decided his company should arrive in Salt Lake Valley.¹⁹ On July 24, 1847, the wagons descended Emigration Canyon, with Great Salt Lake about 20 miles to the west and Utah Lake about 50 miles to the south in the neighboring valley. Almost immediately, the settlers started changing the landscape.

Water Out and Damage In

Significant ecological changes to Utah Lake began with irrigation projects, with taking water out of the natural system. The Mormon environmental mindset included a spiritual respect for nature but also the practices of “taming” and “engineering” the land more than adapting to it. The LDS members moved to Utah with plans to create a prosperous society of irrigated farms and domesticated animals. The techniques and practices they employed were based on landscapes with very different water systems, such as those found in eastern America and Great Britain. Farming was also much more than a practical pursuit, and the Saints arrived with set religious and cultural ideals, too. Historian Brian Q. Cannon explains that Mormon pioneers subscribed to the practice of “farm life as the ideal laboratory for nurturing religious faith, morality,

¹⁵ *Ibid*, 388.

¹⁶ Baugh, “John C. Frémont’s 1843-44,” 256.

¹⁷ The LDS Church no longer prefers the term Mormon, but because it was used historically and for most of the church’s lifespan, I use it here.

¹⁸ Baugh, “John C. Frémont’s 1843-44,” 266.

¹⁹ *Ibid*, 267.

and industriousness.”²⁰ Each dam, canal, and diversion project carried the weight of necessity *and* religious commandment.

Sadly, this work and belief system did not include robust knowledge of the region’s ecology, and an odd hubris formed that insisted water was in endless supply. Mormon scholar George B. Handley, in his memoir and environmental history of the Provo River, writes, “In our heady embrace of the recompenses of an engineered world, we rejected the recompenses of its wilderness, failing to see that the desert blossoms with its own brilliant colors. It was always already a blossoming garden.”²¹ Instead of recognizing and carefully harnessing the powerful Great Basin water cycle, settlers constructed an incredibly thirsty irrigation system.

In 1853, only four years after the founding of the first Utah Valley Mormon settlement, the Provo Canal and Irrigation Company redirected *half* of all the water in the Provo River, the main tributary of Utah Lake, to irrigate farmland.²² More diversions began in 1865 when counties formed irrigation districts with claims to water in other rivers and tributaries.²³ The removal of such a high volume of water had immediate negative consequences for the water quality, aquatic plant systems, and wildlife. Utah Lake is a naturally shallow lake, its basin wide and long, but with a maximum depth of about 15 feet, historically and currently. Without deep reserves, the lake is much more sensitive to change. Additionally, the natural Provo River Delta, which was truly an oasis of biodiversity, was cut off and drained for agriculture, as were other wetland and marsh areas. This eliminated vast sections of indigenous breeding and feeding grounds for fish, birds, and other wildlife.

A few years later, in 1859, settlers constructed a dam across the Jordan River at the inlet in present-day Saratoga Springs. A second dam followed in 1872, farther north at The Narrows in Salt Lake County, near Bluffdale. These dams converted Utah Lake into a reservoir to redirect Jordan River water to Salt Lake Valley agriculture and industry.²⁴ Not only did this remove a large amount of water from the lake, but it also caused a significant reduction in the natural outflow of Utah Lake to Great Salt Lake. Although northern watershed rivers such as the Bear River and Weber River contribute higher amounts of water to Great Salt Lake, the rare north-flowing Jordan River is also a crucial source to help balance the saline ecosystem. When pioneers diverted and dammed the

²⁰ Rogers and Godfrey, *The Earth Will Appear as the Garden of Eden*, 195.

²¹ Handley, *Home Waters*, xiii.

²² Bishop et al., “Historical Overview,” 2.

²³ *Ibid.*

²⁴ *Ibid.*

river, they began not only to strain Utah Lake but also Great Salt Lake, which currently teeters on the edge of ecological collapse as a direct result.²⁵

After a cyclical drought season at the turn of the twentieth century left Salt Lake Valley farm canals and mill races empty, an electric pump station was installed at the Utah Lake-Jordan River Inlet.²⁶ Completed in the fall of 1902, the initial four 48-inch Byron Jackson centrifugal pumps pulled 3000 gallons of water every second from Utah Lake to feed the Jordan River and Salt Lake canals.²⁷ City officials, farmers, and mill owners were so pleased with the consistent flow that several upgrades were funded over the next two decades. In 1905, a fifth pump was added, then two more in 1907. In 1913, a monstrous 60-inch pump was added, increasing capacity to 700 million gallons per day. This made it the most powerful and productive pump station in the world at that time.²⁸

The mismanagement of water levels exacerbated the realities of drought in a 1934-35 environmental disaster, resulting in Utah Lake drying up to puddles. A *Lehi Sun* reporter lamented the loss of a “vanishing friend,” and wrote, “From the north shore of what used to be a beautiful lake we were unable to see any water.”²⁹ The dust-bowl conditions had a devastating impact on the fish, plant, and bird populations, as well as irrigation needs in both valleys.³⁰ Crops failed, mills stopped producing, some plants and mollusks disappeared, and a native fish, the Utah Lake sculpin, went extinct.³¹ This event also marked a change in cultural connection to the lake. As the water slowly returned, local attention shifted away from time at the lake to canyon and mountain recreation. And although some protections were put in place to prevent another dust bowl, abuse of the ecosystem continued.

The second major settler-induced ecological change to Utah Lake occurred when waste was dumped *into* the water. Humans have a habit of discarding unwanted things into waterways, especially when a place is not culturally valued. But ecological rules of interconnection don’t allow for disappearance, and everything remains, a ghost in some way, often to return with haunting consequences. The habit of dumping waste into Utah Lake started as soon as Mormon settlers arrived. They quickly clear-cut the areas of “prettily timbers streams” to build houses, fences,

²⁵ See <https://growtheflowutah.org> and <https://fogsl.org>.

²⁶ *The Salt Lake Tribune*, “Pumping Plant Approved,” 1902.

²⁷ *The Salt Lake Tribune*, “The Fourth Pump,” 1902.

²⁸ Lehi City, “Jordan River Pumping Station.”

²⁹ *Lehi Free Press*, “Utah Lake Disappeared,” 2017.

³⁰ Carter, Utah Lake: Legacy, 18 and Farmer, *On Zion’s Mount*, 123.

³¹ Abbott, “Getting to Know the Utah Lake Ecosystem.”

and other structures to prepare land for monoculture planting.³² Mills powered by hydrological flow to process this wood and other types of industry followed. By 1894, “the Provo River provided power for 28 mills and foundries.”³³ All these mills regularly dumped sawdust, dye, lanolin, and other byproducts directly into the mill race, which ran into the lake.³⁴ As the industrial inputs flowed downstream, so did local municipal wastewater, raw sewage, and agricultural runoff. Water quality suffered greatly, compounding over the next several decades.

Dumping practices took a glaring turn in 1944 when the massive Geneva Steel plant opened on the shores of the lake in Vineyard (Orem). The company, initially tasked with supporting the mechanical efforts of World War II, “failed to initiate significant environmental control practices until the early 1990s” and so contaminated the valley with hazardous materials for nearly 50 years.³⁵ Geneva Steel worsened air quality as the smokestacks belched emissions, including microscopic particulates known as PM_{2.5}, which human and animal lungs cannot filter out.³⁶ Residents breathed in the toxins, and the pollution settled on the surface of the lake from wind, rain, and snow.

A polio outbreak hit Provo in the late 1940s, and because raw sewage carried the disease, officials warned residents to avoid Utah Lake. This, no doubt, created a visceral panic in residents and exacerbated the growing fear of the water as unsafe.³⁷ An increase in harmful algal blooms also worsened the danger. Nutrient loading from industrial and municipal sources increased phosphorus and decreased oxygen in the water and created favorable conditions for cyanobacteria growth, some of which is toxic to human and animal life if ingested.³⁸

The wildlife of Utah Valley also encountered serious distress. The mills restricted natural movements along the rivers and tributaries, and thousands of fish died in waterwheels, dams, and irrigation ditches. Others suffocated when sawdust clogged their gills.³⁹ The June Suckers were separated from their native spawning grounds, and invasive species of fish, such as common carp, were introduced to the lake.⁴⁰ The bottom-feeding habits of the carp further damaged the submerged vegetation

³² Frémont, *Memoirs of My Life*, 388.

³³ Farmer, *On Zion's Mount*, 120.

³⁴ Carter, *Utah Lake: Legacy*, 75.

³⁵ *Ibid*, 78.

³⁶ Farmer, *On Zion's Mount*, 224.

³⁷ Carter, *Utah Lake: Legacy*, 78.

³⁸ For current info on HABs: <https://deq.utah.gov/water-quality/recreational-water-quality-home>.

³⁹ Carter, *Utah Lake: Legacy*, 75.

⁴⁰ Abbott et al., “Getting to Know Utah Lake,” 20.

systems that protected Suckers from predators, filtered water, and reduced turbidity or sediment dispersal. Birds exposed to toxins in water became sterile or died. Wild mammals and livestock who drank the water also suffered sickness and death. Native plants at Utah Lake were crowded out by invasive, water-guzzling species planted by settlers along the shoreline, such as tamarisk, Russian Olive trees, and—the bane of all Western waterways—phragmites reeds.⁴¹

By the 1960s, Utah Valley residents had few favorable opinions of the lake as demonstrated by dumping unwanted trash onto the shoreline and advising everyone to stay away. SBS took full effect: a damaged and severely altered landscape now mostly abandoned by public opinion and attention. Few residents retained any stories of the lake as vital to survival or as a biodiversity haven. But, while the general community turned away, restoration work quietly began. Officially declared “impaired” based on federal water standards in 2002, state agencies bulked up Utah Lake restoration efforts that had started in the 1980s when the June Sucker, a native fish species, landed on the Endangered Species List.⁴²

Since then, hundreds of projects have reduced nutrient loading and pollution sources, properly treated wastewater, removed carp biomass, cleaned up trash, and controlled phragmites encroachment. Impressive conservation work also restored hundreds of acres of wetlands and uplands. The multi-agency effort the June Sucker Recovery Implementation Project played an unmistakably important role in the positive changes of the lake. The project restored Hobble Creek, near Spanish Fork, increased water flow through the rivers and, most recently, rewilded the Provo River Delta.⁴³ In 2021, the June Sucker was downlisted from endangered to threatened, a rare achievement.

Repairing the Narrative

Today, Utah Lake is healthier than it has been in 100 years. Yet, most residents still recite the conditions of 40 or 50 years ago, as proved by the comment section of a recent KSL article on Utah Lake. The article announced a new advertising campaign by the Utah Lake Authority, a state agency involved in lake management. The goal of the campaign is to address the SBS and pull popular opinion out of the past and into the present. The comments, however, demonstrate the severity of the

⁴¹ Utah Division of Forestry, Fire and State Lands: “Utah Lake Phragmites Control.”

⁴² Utah Department of Environmental Quality, “Water Quality Assessment and Analysis.”

⁴³ See <https://provoriverdelta.us> and <https://junesuckerrecovery.org>.

waterbody's social uncoupling: "the lake is dead...we've killed it;" "nothing about Utah Lake is desirable;" "a disgusting sludge pit;" "a sewer."⁴⁴ These stories and rhetoric have deep, stubborn roots, and adjusting the stalled SBS presents a major communicative challenge.

As a direct result of these types of local misunderstandings and disconnect, a massive dredging and island-building development project was nearly approved a few years ago. Between 2018 and 2022, a company named Lake Restoration Solutions (LRS) manipulated public opinion in efforts to secure state approval and funding for Utah Lake development. LRS framed their proposal as a silver-bullet restoration project, which included a plan to dredge over a billion cubic feet of lakebed to build about 30 islands for housing development—all of which LRS would have owned and profited from.⁴⁵ The rhetoric presented to residents, lawmakers, and investors amplified the outdated facts and ignored the ecological reality of the carefully repaired lake. The LRS proposal also disregarded the hydrology of a shallow lake, the presence of multiple lakebed springs, the needs of wildlife, and the benefits of the water to local climate regulation, snowpack, and human storage functions. This narrative manipulation gained many powerful supporters, including Utah legislators, influential residents, and even the governor, all of whom subscribed to the problematic shifted baseline.

Fortunately, in October 2022, Forestry, Fire, & State Lands, a division in the Department of Natural Resources, officially rejected the project on grounds of protecting the sovereign lands of the lakebed.⁴⁶ Even so, this event demonstrates the risk of future damage to Utah Lake if the SBS is not rehabilitated and new narratives are not shared broadly.

The disassociation of Utah Valley's current SBS is not permanent. SBS can fade as the grime of forgetting is wiped clean and residents see the lake with fresh eyes. A positive narrative can replace a negative one, but it requires a dedicated and far-reaching effort. Currently, state agencies such as the Utah Lake Authority, the June Sucker Recovery Implementation Project, and the Provo River Delta Restoration, are providing education, hosting local events, and creating improved lake access alongside restoration projects. Local volunteer-led nonprofit Conserve Utah Valley works to spread awareness and engage the public in shoreline cleanups. Scholars and scientists at Brigham Young University and Utah Valley University explore solutions, provide information, and create resources. A 2025 art exhibit, "*Healing Waters: Restoring Our Relationship to Utah Lake*," included several public

⁴⁴ Fletcher, "That's bull carp," 2025.

⁴⁵ Abbott, "Seven more problems."

⁴⁶ Miller and Maffly, "Utah Lake dredging project rejected."

events to encourage conversations and a project to collect community memories and stories. Additional research at the University of Utah continues to explore communicative solutions and provide public resources.

I encourage other communication and social scholars to pay attention to Utah Lake and join in these efforts. A wealth of quantitative data exists for the lake, thanks to the efforts of a robust scientific community. But far less qualitative research on cultural and social issues has been conducted to aid in community restoration. Utah Lake, like many waterways in the American West, is “an ecological conundrum and a study in paradoxes” that demands thoughtful, careful interdisciplinary scholarly attention.⁴⁷ The stewardship of the cultural relationship with Utah Lake is as important as protecting the environment. In fact, holistic restoration encompasses both the social and ecological aspects.

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⁴⁷ Voyles, *The Settler Sea*, 2.

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“It’s Not So Easy to Be Free”: The Sounds of Protest in Folk Rock

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Abstract

The 1960s and 1970s were a time of profound societal and political upheaval in the U.S., truly a maelstrom of sociohistorical transformation. Folk rock artists in this milieu would articulate sounds of protest in America as they expressed the struggles and concerns of their day. Artists spoke to issues that impacted poor and working people. They reflected on the extraordinary movements of disenfranchised groups, particularly the Civil Rights movement. They spoke to a brutal war in Vietnam that was costing thousands of lives. This paper focuses on a lyrical and thematic analysis of the work of selected folk rock artists as they reflected on and responded to the sociohistorical context of their times. The paper specifically unpacks the lyrics of our selected artists through a theoretical lens that examines oppositional cultures or cultures of resistance within marked social locations or cultural formations—an authentic and strident response to the chaos of their times.

INTRODUCTION

I would like to see every single soldier on every single side, just take off your helmet, unbuckle your kit, lay down your rifle, and set down at the side of some shady lane, and say, nope, I ain't a gonna kill nobody. Plenty of rich folks wants to fight. Give them the guns.

—Woody Guthrie quoted in Uitti 2022

Woody Guthrie was one of the most significant folk artists of the 20th century. In this quote, he strips away all pretense and speaks plainly to a few of the most pressing concerns of the 20th century. The quote speaks of an on-going war—people are killing and being killed. In addition, Woody Guthrie describes a distinct social class separation in the song. He notes that there are many wealthy people who are anxious to keep this war going, but he is clear in implying that they are not actually fighting the war. The song suggests that the task of fighting has been relegated to soldiers of much less means. This class distinction is further implied by the language of the songwriter on behalf of the soldier—the vernacular of “I ain’t a gonna kill nobody.” But perhaps the most remarkable thing about the quote is the direct entreaty Woody Guthrie makes to all the soldiers caught up in the conflict, regardless of side, as he appeals for them to lay down their arms—to stop the needless killing of other human beings. Instead, he suggests that if the wealthy want this killing done, then let them take up the guns and fight. There is a thinly veiled intimation here that if the wealthy really had to fight, the war would have never taken place.

Woody Guthrie’s plainspoken words speak to momentous struggles that the artist could clearly observe and describe. His voice would echo down through many folk rock artists that would follow. This paper is an exploration of the lyrics of several folk rock artists who describe their sociohistorical context and times in markedly oppositional voices. The paper contributes to our understanding of the work of folk rock artists through a conceptual lens drawn from what Bonnie Mitchell and Joe Feagin (1995) describe as “oppositional cultures” and what Raymond Williams (1989) introduced as “cultural formations.” In this way, we will discover voices of resistance among folk rock artists as they describe their own sociohistorical location and moment.

PROTEST MUSIC IN CONTEXT: OPPOSITIONAL FORMATIONS

The theory of oppositional cultures or cultures of resistance was presented by Mitchell and Feagin (1995) as a framework to illustrate how disenfranchised peoples engage cultural traditions and unique knowledge bases to resist domination. According to Mitchell and Feagin, oppositional cultures can take the shape of kinship networks or even social movements, but for the purposes of the present study, the authors emphasize that art and music can also serve as significant sites of oppositional culture. In this respect, Mitchell and Feagin (1995: 69) suggest that oppositional cultures such as art and music can serve to “give members of the dominant group an insightful critique of their own culture.” Although Mitchell and Feagin introduced the development of oppositional cultures or cultures of resistance among people of color, the theory has potentially broader implications for understanding groups experiencing various forms of oppression and repression.

The work of Raymond Williams (1989) resonates with that of Mitchell and Feagin, but particularly focuses on the social location in which music and art work emerge. Williams (1989: 175) proposes that any historical analyses will reveal an uncanny consistency—the “remarkably extended and interpenetrating activity of artistic forms and actual or desired social relations.” It is an interrelationship that Williams (1989: 175) describes as “cultural formations,” which are significant in being “simultaneously artistic forms and social locations.” In essence, Williams is arguing that art itself is always in active and constant relationship to the location in which it originated and where it exists. Williams (1989: 176) also makes a point of emphasizing a characteristic of cultural formations whereby “the cultural and artistic intention is shaped, from the outset, by the acceptance and the possibility of broader common relationships, in a shared search for emancipation.”

It is the central argument of this paper that our selected folk rock artists gave deliberate weight to oppositional and resistance messages within their music. These artists challenged domination within their sociohistorical location—times of profound racial, gendered, and class inequity as well as a brutal war in Vietnam. The work of these artists represents strident oppositional cultures within specific social locations—cultural formations in their times.

PROTEST ROOTS

The sociohistorical context that deeply influenced folk rock music in the 1960s and 1970s included two interwoven threads—the battle for

labor rights and the battle for civil rights—whose roots went deep. With regard to labor rights, Ahmed White (2022: 13) notes that by at least the turn of the 20th century, industrial capitalism had transformed “the relationship between workers and employers, which had been governed to some extent by principles of mutuality and community, into a nakedly economic association between alien and profoundly unequal parties.” In this regard, White (2022: 13) asserts that workers were consigned to lives of “deprivation and insecurity” with no real regard for their well-being. In fact, as White suggests, workers were considered patently expendable to the extent that people were made to work “among unprecedentedly powerful machinery and an extraordinary array of toxic substances, often with little training and every expectation that complaints would result in discharge” (2022: 14). Resistance to these conditions came in the form of unions like the Industrial Workers of the World (I.W.W.), whose members went by the name “Wobblies”—part of a growing labor movement at the time. However, as White (2022: 12) notes, while the Wobblies “opened the union’s membership to everyone, without regard for sex, age, race, or nativity,” this was an exception because “most unions and the great majority of civic organizations in the country” excluded people of color.

The Civil Rights movement itself was reaching an apotheosis by the 1960s. Among some of the most significant civil rights actions taking place at the time folk rock artists were coming up were a series of marches and demonstrations in Selma, Alabama, in 1965, that were focused on voting rights (Garrow 2015). The voting rights of Black people in the South had been suppressed for nearly a century after emancipation by local communities and law enforcement but also tellingly by members of the Ku Klux Klan and their seemingly more respectable counterparts in the “daytime Klan” or White Citizens’ Councils (Pratt 2017: 38). The tipping point of this voting rights campaign took place on Sunday, March 7, when state troopers and local possemen—some riding on horseback—savagely attacked unarmed, peaceful Civil Rights marchers. The troopers and possemen used billy clubs and tear gas as well as grotesque instruments of torture, including “bullwhips, ropes, and lengths of rubber tubing wrapped with barbed wire” (Fager 2015: 100). Marchers were “knocked to the pavement, screaming in pain and terror, the wooden clubs thudding into their flesh” while “from the sidelines a shrill cheer went up from the watching whites” (Fager 2015: 100).

A key figure who binds the histories of labor rights and civil rights together is A. Philip Randolph, who was a Black trade unionist as well as the founder and first president of the Brotherhood of Sleeping Car Porters (BSCP). Randolph fought for decades in the early 20th century to

end racial discrimination against Black workers in all its forms (Kersten 2007). It was Randolph who initiated the March on Washington Movement and was an organizer of the legendary March on Washington in 1963 (Kersten 2007). But what is not generally known is that the 1963 march was originally named the “March on Washington for Jobs and Freedom” (Kersten 2007: 96). In this regard, A. Philip Randolph and his trade unionist allies were signaling that labor and civil rights were inextricably connected. As Eric Arnesen (2021) writes,

This demonstration was not simply about civil rights broadly construed, particularly the abolition of segregation across the land. It also had an economic dimension, and the “jobs” demand rested on an understanding that all American workers, black and white, needed access to employment, something, organizers argued, that the government was responsible for ensuring.

In fact, Arnesen suggests that by “the early 1960s, many union internationals offered crucial support—moral, financial, and organizational—to the push for civil rights legislation” and “tens of thousands of those present at the 1963 March on Washington were trade unionists” (Arnesen 2021).

Beyond the hardships of working people as well as the Civil Rights movement, folk rock artists were also shaken by a direct spawn of the Cold War—the war in Vietnam (Farber 1994; Szatmary 2007). The war had escalated appallingly in the mid-1960s with hundreds of thousands of young men shipped overseas, many never to return. David Farber (1994: 145) describes the war’s escalation in starkly human terms.

In 1961 there had been 3,200 American advisers; in 1963 there were 16,300; in 1964, 23,300. By the end of 1965 there were 184,300 American troops in Vietnam. In three years, 550,000 U.S. military personnel would be serving there. And by the end of 1968, 30,610 American servicemen had been killed in action.

Moreover, this was a war fought mainly by young men of color and other disenfranchised young men—“disproportionately they came from America’s small towns, farms, and inner cities” (Farber 1994: 146). The war in Vietnam would eventually become a quagmire with tens of thousands of casualties, but it took time for opposition to the war to take hold. Early opponents of the war included “a number of civil rights activists...and members of several small student groups” (Farber 1994: 155).

In all, the sociohistorical backdrop of folk rock encompasses several overlapping realities. Folk rock artists would be profoundly influenced by the battles for the rights of working people. In addition, “[a]nother prominent concern of these young and idealistic musicians was civil rights that had also started to dominate headlines across the country” in the 1960s (Phull 2008: 6). More than this, opposition to the war in Vietnam—an insidious result of Cold War politics—was likewise a prominent theme in the work of folk rock artists. These threads bear witness to a particular sociohistorical context and location in which the music served as a reflection and harbinger of an era.

THE METHOD

Folk rock emerged within a particular sociohistorical context, as we have seen. The present study will center on a thematic and lyrical analysis of the work of four folk rock artists—Judy Collins, Arlo Guthrie, Richie Havens, and Bob Dylan (Unterberger 2002; Friedlander 2006; Szatmary 2007). Each of these artists frame oppositional messages within their specific sociohistorical location, offering unique cultural formations that unambiguously express resistance to the status quo. These artists were chosen because of their particular relevance to their times (Unterberger 2002; Friedlander 2006; Szatmary 2007; Cain 2019).

The present study is a lyrical and thematic analysis that examines the work of these artists within an analytical rubric whereby “analysis is conceived as an emergent product of a process of gradual induction...very much a creative act” (Lofland and Lofland 1995:181-182). The analysis will specifically describe common themes and tropes that emerge from unpacking the lyrics of selected songs by each artist. As Shulamit Reinharz (1992: 159) suggests, “qualitative sociologists apply an inductive, interpretive framework to cultural artifacts. What differentiates sociologists from historians is simply the use of sociological theory as an aid in the explanation.” In sum, the analysis of our selected folk rock artists will be guided by our theoretical lens, as each artist shaped oppositional messages within their unique sociohistorical context (Mitchell and Feagin 1995). In so doing, we will reveal cultural formations—the remarkable combination of art and social location (Williams 1989).

THE SOUNDS OF PROTEST

The folk rock artists selected for the present study—Judy Collins, Arlo Guthrie, Richie Havens, and Bob Dylan—unfold the brutality and tragedies of their times with often pointed and stinging lyricism. We will, in fact, reveal strident oppositional messages in their music with lyrics

that consistently “give members of the dominant group an insightful critique of their own culture” (Mitchell and Feagin 1995:69). More than that, the lyrics of our folk rock artists will reflect on a distinct social location born out of battles for the rights of workers, the struggle for the civil rights of Black people, and opposition to the war in Vietnam—a cultural formation that explicitly faces injustice with voices of resistance (Williams 1989).

WON'T GET FOOLED AGAIN

The history of protest songs in the U.S. is a lengthy one going back to the turn of the 20th century with songs written by the Wobblies as part of a growing labor movement that fought for the rights of American workers (Phull 2008). Creating rallying songs on behalf of working people was a legacy that would carry on with Woody Guthrie—a young man from Oklahoma who grew up in poverty and traveled the country “to sing songs to and about the American worker” (Szatmary 2007: 83). Woody Guthrie was “convinced that only if the common people banded together, via unions and other associations, could they successfully fight for their rights” (Friedlander 2006: 133). The music and legacy of Woody Guthrie would eventually revive with a generation of folk rock artists in the 1960s as college students across the country searched for musical alternatives to the romantic hit singles of the time—a revival framed in coffeehouses from New York to San Francisco (Szatmary 2007).

The two artists selected for this analysis of labor movement songs were actually singing covers of much older work. The first song, “Bread and Roses,” was performed by Judy Collins (1976) but written by James Oppenheim in 1911 and inspired by a labor movement slogan attributed to suffragist and workers’ rights activist, Helen Todd (Weldon 2022). The song is largely associated with a textile strike led by women in Lawrence, Massachusetts, in 1912 that united dozens of immigrant communities under the leadership of the Wobblies (Hubler 2012; Popik 2014).

The first verse of the song “Bread and Roses” performed by Judy Collins, centers on a protest march of some kind—“As we go marching, marching.” More than that, it’s clear the mood of the marchers is hopeful and expectant because the march is described as happening “in the beauty of the day.” Not only that, but the next line suggests that the marchers are women because no one is working in the kitchen—“A million darkened kitchens.” This is followed by the employment of the women who are marching—“A thousand mill lofts gray.” These women are clearly going on strike. But even these kitchens and mill lofts, usually

surrounded by grueling work, “are touched with all the radiance/that a sudden sun discloses,” because the women are on the march and the “people hear us singing/‘Bread and roses! Bread and roses!’” We’ll return to that collective shout in a moment.

The marching continues in the second verse—“As we go marching, marching”—but the listener now understands that the march is not just about women, as the women marchers are said to “battle too for men/For they are women’s children/and we mother them again.” The next lines are all about the wretchedness and atrocious hardships surrounding the existence of these women and men, for their entire lives are overshadowed and overburdened by the ominous and daily toil of harsh labor—“Our lives shall not be sweated/from birth until life closes.” But hope builds at the end of the verse with the plea that “Hearts starve as well as bodies/Give us bread, but give us roses!”

The third verse continues the march—“As we go marching, marching”—but takes the plight of the women marchers to a level of utter devastation, describing “unnumbered women dead.” Yet the marchers carry on, and their voices speak for those whose lives were lost to these appalling working conditions over generations—a venerable legacy of “crying through our singing/their ancient call for bread.” The misery of the lives of the unnumbered women who have died is described in loving and compassionate yet painfully candid terms—“Small art and love and beauty/their drudging spirits knew.” At the end of the verse, the marchers are unequivocal in their demand—“Yes, it is bread we fight for/but we fight for roses, too!”

In the final verse, the march continues as it has in all the previous verses—“As we go marching, marching”—but the message becomes far more encompassing because the marchers are said to “bring the greater days.” This is followed by a powerful declaration of the magnitude and meaning of women’s lives—“The rising of the women/means the rising of the race.” Then for the first time we are introduced to those who are not required to live their lives in miserable drudgery, and the message suggests that such appalling class differences are unacceptable—“No more the drudge and idler/ten that toil where one reposes.” Instead, the marchers make their brilliant, final plea for a more equitable world—“But a sharing of life’s glories/Bread and roses! Bread and roses!” The plea is repeated and then the song closes with a refrain from the second verse, once again highlighting the profound lifelong burden of wretched working conditions and the demand for change—“Our lives shall not be sweated/from birth until life closes/Hearts starve as well as bodies/Bread and roses! Bread and roses!”

The plea and shout of the marchers—“Bread and roses!”—is a constant chorus that uplifts the entire song and speaks to what the women

who are marching will no longer do without. The mention of “bread” seems clear enough—human beings cannot survive without sustenance. Yet the word “roses” bears a bit more scrutiny. This repeated term is perhaps best understood in the third verse of the song as the marchers sing that “art and love and beauty” have been glaringly lacking in the lives of these women. And “bread” notwithstanding, perhaps this is the most heartbreaking plea of all—the women described in the song had no real lives, no access to the “glories” that others took for granted. It is the tragedy and the brilliance of the song.

The Lawrence, Massachusetts, textile mill strike of 1912 was sparked by a devastating pay cut for the mill workers who were already blatantly disregarded in terms of human life. Bruce Watson (2005: 18) notes that “not many lasted that long in the mills” for a gruesome surplus of horrifying reasons, including inhaling fibers, malnutrition, pneumonia, and tuberculosis, as well as being “crushed by machinery” and “mangled by looms and spinners.” It’s also noteworthy that the marchers were made up mostly of immigrants from “fifty-one different nations”—as far away as Syria, Russia, and Armenia, but also Ireland, Italy, Belgium, Scotland, and more (Watson 2005: 18). While the mill owners and powers that be hoped to crush the strike with threats and violence as well as immigrant group factionalism, they found what Watson (2005: 12) describes as a “surprising scenario,” that is, “[w]orkers were not in despair, they were singing. On the sidewalks, women locked arms and marched together.”

Our second song was originally a poem written by Woody Guthrie, which a friend set to music (Daley 2018), that was later performed by Woody’s son, Arlo Guthrie (Guthrie 1974). The poem originated from a tragic story—a horrific plane explosion over Los Gatos Canyon near Fresno, California, in 1948. Guthrie read about the tragedy but noticed that only four of those killed in the explosion were identified by name, while 28 Mexican migrant workers who were also killed were not identified— “[t]heir names were not listed, their families were not notified, and they were buried in a mass grave” (Daley 2018). Woody Guthrie wrote the poem in outrage because he believed the migrant workers “were not treated with the same respect as the flight crew” (Daley 2018).

The song “Deportees” performed by Arlo Guthrie begins with a description of fruit crops—“The crops are all in and the peaches are rotting/The oranges are piled in their creosote dumps.” Then the protagonist in the song alludes to the fact that it is a Mexican migrant worker who is part of a workforce responsible for bringing these fruit crops in and that they are being flown back to their own country, “They’re flying ‘em back to the Mexican border,” though it is evident

that the wages they pay are hand to mouth because the migrant worker will pay “all their money to wade back again.” The reference to wading back seems to allude to Mexican migrants, “wading or swimming across the Rio Grande” river into the U.S. (Goodman 2020: 47). It seems clear in the context of this song that Guthrie is describing this practice openly, unequivocally, and even respectfully, in a repudiation of the hateful and derogatory term for those who wade across the river—“wetback” (Goodman 2020: 47).

In the second verse, it’s made clear that the lyrical protagonist in the song is a Mexican migrant worker who represents generational migrant work—“My father’s own father, he waded that river.” This work is not only paid marginally but saps the lifeblood out of the workers as we see from the line—“They took all the money he made in his life.” Whole families are clearly involved in this migrant work—“My brothers and sisters come working the fruit trees.” But the highly arduous nature of this work is only emphasized by the following line, which underscores how it breaks down a person’s body inexorably—“And they rode the truck till they took down and died.”

In the third verse, the lyrical protagonist discusses their own plight as well as that of all the Mexican migrants who come to work in the U.S.—“Some of us are illegal, and some are not wanted.” Here Guthrie uses the term “illegal” for Mexican migrants, a term likely common in his generation but considered an ethnic slur currently. It’s likely that some of the workers are part of the Bracero Program (Daley 2018), which allowed Mexican guest workers to come contractually and work across the border—“Our work contract’s out and we have to move on.” Yet many of these workers are not afforded any transportation back to their homeland—“Six hundred miles to that Mexican border.” Moreover, if they are undocumented their fates are even more perilous—“They chase us like outlaws, like rustlers, like thieves.” This is strikingly hypocritical because the migrant workers are allowed to toil to bring in crops for American tables but are not considered “wanted” or treated humanely.

The fourth verse reads like a sort of litany of how grotesquely easy it is for Mexican workers to perish. The verse reads as follows.

We died in your hills, we died in your desserts
 We died in your valleys and died on your plains
 We died ‘neath your trees, and we died in your bushes
 Both sides of the river, we died just the same.

The implication is that Mexican migrant workers are not afforded the most basic of human rights for simply trying to work and feed their

families. It particularly highlights the precarious nature of existence for undocumented workers.

The fifth verse gets to the heart of the story where learn about the tragedy that spurred the writing of the poem—"The sky plane caught fire over Los Gatos Canyon/A fireball of lightning, and shook all our hills." The lyrical protagonist asserts that the Mexican migrant workers on the plane were known and loved—"all these friends"—but, in a memorably aching line, their lives were "all scattered like dry leaves." This is followed by the goad that spurred the poem written by Guthrie—"The radio says they are just 'deportees.'" There is an awful implication that the Mexican migrant workers were not quite seen as human.

This terrible implication is only stressed in the final verse where the lyrical protagonist asks the listener telling questions about the nature of American agribusiness and the lives of migrant workers—"Is this the best way we can grow our big orchards?/Is this the best way we can grow our good fruit?" The lines that follow this are gutting in their effect—"To fall like dry leaves to rot on my topsoil/And be called by no name except 'deportees.'" The Mexican migrant workers who died in the explosion, the lines suggest, are considered as little more than dust—faceless and expendable.

The chorus that runs through the song is almost like a eulogy and certainly a farewell between loved ones—"Goodbye to my Juan, goodbye Rosalita/*Adios mi amigos* Jesús y Maria." These lines are boldly naming those who died and are clearly personal and affirming. They are also partly written in Spanish—a respectful nod from Woody Guthrie to the language of the Mexican workers. But the following lines emphasize the on-going struggle—"You won't have your names when you ride the big airplane/All they will call you will be 'deportees.'"

Woody Guthrie was quite an activist songwriter and poet, "riding the rails and walking the hot roads, scourging hypocrisy and oppression from sea to shining sea" (Lynskey 2011: 14). This poem made into a song, brought down to us by his son and folk rock artist, Arlo Guthrie, is of particular note as Guthrie focused on a population rarely discussed—Mexican migrant workers. In point of fact, a lack of discussion of diverse working people is the norm as Kim Kelly (2022: xxiii) writes,

There are precious few ... history books that focus on labor at all. ... And stories of poor and working-class women, Black people, Latino people, Indigenous people, Asian and Pacific Islander people, immigrants of all backgrounds, religious minorities, queer and trans people, disabled people, the sex workers and undocumented people whose work is criminalized, and the people who are incarcerated seldom get top billing when it's

time to publish. ... It's a damn shame, too, because those are the people who had the most to lose, yet have found it within themselves to give more and fight harder than anyone else.

A CHANGE IS GONNA COME

Music was essentially woven into the very heart of the Civil Rights movement. As Ellen C. Leichtman (2010: 179) asserts, the “civil rights movement often elicits remembrances of its freedom songs because music was integral to its struggle for equality.” T.V. Reed (2005: 2) similarly suggests that “[s]ongs were everywhere in the movement—in meetings, on the picket line, on marches, at the sit-ins, in jail, everywhere.” Moreover, Reed notes that songs “formed the communication network of the movement, and they also expressed the ‘soul’ of the movement, linking its spirit to centuries of resistance to slavery and oppression” (2005: 2). This was clearly a sociohistorical moment viewed through the prism of resistance in the work of our selected folk rock artists.

Richie Havens takes on one of the most racist terrorist organizations on American soil with his song, “The Klan” (1968). In the first verse, the lyrical protagonist describes a bleak and forbidding scene reminiscent of Christian imagery with the crosses on Calvary (The Holy Bible: King James Version 1976)—“The countryside was cold and still/There were three crosses on the hill.” But instead of a Christian scene these crosses are burning and it is here that we have our first allusion to the Klan and its practice of cross burning (Madison 2020)—“Each one wore a burning hood to hide its rotten core of wood.” Then the lyrical protagonist calls on his father in an echo of Christ on the cross (The Holy Bible: King James Version 1976)—“And I cried ‘Father!’”—but any resemblance to the Bible story immediately fades, because in this instance the son is hearing the approach of the Klan—“I hear an iron sound, ’hoof beats on the frozen ground.”

The second verse describes the approach of the Klansmen as witnessed by the lyrical protagonist—“Downhill the riders came.” But in the next lines, the lyrical protagonist implies that the Klansmen have already spilled blood in their arrogant disdain for human life. More than this, the tone of the lyrical protagonist is mournful and plaintive about a great loss in correspondence to this bloodshed. These lyrics read,

Lord, it was a cryin’ shame
 To see the blood upon their whips
 To see the snarlin’ from their lips

Then the lyrical protagonist cries out for his mother, and it is here that we realize that the protagonist is in some way being brutally tortured by the riders, “And I cried, ‘Mother! I feel a stabbing pain’/Hey, blood flows down like summer’s rain, summer’s rain.”

In the third verse, the lyrical protagonist describes the infamous markers of Klan costume as they conceal pitiless identities—“Each one wore a mask of white/To hide his cruel face from sight.” The lyrical protagonist describes the Klan’s lust for wanton slaughter—“Each one sucked a hungry breath/Out of the empty lungs of death.” This ominous phrasing is followed by the lyrical protagonist calling for his sister, and in an agonizing following line we learn that this tortured young man has already died. The lyrics read as follows:

And I cried, ‘Sister! Hey Sister!
Raise my bloody head’
It’s so lonesome to be dead, mmm, to be dead.

The fourth and last verse is a blazing pronouncement by the lyrical protagonist on the Klan’s depravity and degeneracy, again using Christian imagery as he likens the Klan to a demon—“He who rides with the Klan is a devil and not a man/For underneath his white disguise/I have looked into his eyes.” The lyrical protagonist calls on his brother, pleading with him to strive together in the struggle for deliverance from a life that resembles nothing less than bondage, “And I cried, ‘Brother! Stand by me/It’s not so easy to be free.’” The final lines are a calling together of the lyrical protagonist’s family in this extremity and a final plea to stand in concert in the struggle—“Brother, sister, hey mother, hey father!/Stand by me/Hey it’s not so easy to be free, to be free.” For all its Christian iconography, there is no redemption or resurrection in this song, but only the evocation of a terrible tragedy and an entreaty to continue the struggle for freedom.

Folk rock artists in the tradition of Woody Guthrie carried on a tradition of rallying songs during the Civil Rights movement, “performing on makeshift stages, standing on truck beds and in churches and homes across the South, getting the message out in song” (Cain 2019: 57). These artists were reminding their audiences that “no matter how divided the nation was, joining together was the only thing that was going to make it work” (Cain 2019: 56-57).

GIMME SHELTER

Jeneve R. Brooks (2009: 11) suggests that during the height of the Vietnam war, “music from that period helped to expand the national

conversation on issues of social import and shape the nascent ideologies of the sixties generation.” Folk rock artists were part of the vanguard against the war in Vietnam with legendary antiwar songs. Our selected artists reflected on the appalling brutality of the war in message and song.

The song “Masters of War” by Bob Dylan (1963) is a ferocious diatribe against the crafters and manipulators of war. It is made clear from the first verse that throughout the song the lyrical protagonist is addressing the warmongers directly, beginning with “Come, you masters of war.” In that opening verse, the lyrical protagonist describes the “masters of war” as those who build “big guns,” “death planes,” and “big bombs,” but likewise asserts that these folks “hide behind walls” and their “desks.” The final lines assert that the lyrical protagonist can “see through their masks” to their inherent cowardice. The second verse notes that the masters of war “never done nothing but build to destroy,” playing with the world of the protagonist and everyone else “like it’s your little toy.” The lyrical protagonist makes clear that they themselves are a soldier being toyed with by the masters of war—“You put a gun in my hand”—but that the masters are unable to face the soldier—“And you hide from my eyes.” The verse ends with another jab at the spinelessness of the masters—“you turn and run farther when the fast bullets fly.”

In the third verse, the lyrical protagonist likens the masters to an ultimate betrayal—“Like Judas of old”—and claims that the masters are lying about the real repercussions of war—“A world war can be won you want me to believe.” But the protagonist can see through this deception—“I see through your eyes and I see through your brain” and likens the masters’ brains to waste like “the water that runs down my drain.” The fourth verse again focuses on how cowardly the masters are as they “fasten all the triggers for the others to fire” while sitting back to watch as “the death count gets higher.” In a particularly biting line evocative of the sheer cost of human life in war, the masters “hide in your mansion,” while “the young people’s blood/Flows out of their bodies and is buried in the mud.”

In the fifth verse, the lyrical protagonist decries an egregious and shocking level of wickedness of the masters—the creation of a world so appalling that it has manifested in “fear to bring children into this world.” The lyrical protagonist almost spits the next lines, “For threatening my baby, unborn and unnamed/You ain’t worth the blood that runs in your veins.” In the sixth verse, the lyrical protagonist notes that the masters may consider him young and “unlearned,” but he knows that what the masters are doing is immoral—“even Jesus would never forgive what you do.”

The final verse is a reckoning and a questioning as the lyrical protagonist asks the masters if the money they made from the war will

buy them mercy for the deaths they caused—“Will it buy you forgiveness?/Do you think that it could?” But the protagonist states that when the masters finally expire—“When your death takes its toll”—there will be no room for forgiveness—“All the money you made will never buy back your soul.” The lyrical protagonist then excoriates the masters with his final words.

And I hope that you die and your death will come soon
 I'll follow your casket by the pale afternoon
 And I'll watch while you're lowered down to your deathbed
 And I'll stand over your grave 'til I'm sure that you're dead

Brooks (2009: 10) suggests that just as one cannot imagine the Civil Rights movement without thinking of the influence that protest music had in spreading the movement's message of inclusion and unity, likewise “interviews with famous anti-war musicians from the Vietnam period [confirm] that they believed in the ability of their songs to work on a deep subconscious level and often intended to transform or validate the belief and value systems of their audiences.” As Unterberger (2002: 359) notes, “fear of death in Vietnam, and death by nuclear obliteration, cannot be overestimated as factors that made both listeners and musicians grow up faster.”

CONCLUSION

In his book, *Bound for Glory*, Woody Guthrie (2004: 295) writes that, “my songs has [sic] been messages that I tried to scatter across the back sides and along the steps of the fire escapes and on the window sills and through the dark halls.” The present study focused on four folk rock artists whose music spoke to issues facing real people, bringing to light profoundly significant issues, as they scattered messages along the way. Lyrical analysis of our selected folk rock artists songs reflected on the fight for the rights and indeed the lives of working people, the fundamental need for human and civil rights for Black people in America, and a biting commentary on the futility and depravity of war. Our selected artists certainly provided “members of the dominant group with an insightful critique of their own culture” (Mitchell and Feagin 1995: 69). Moreover, the music of our selected folk rock artists was clearly created in constant and dynamic relationship to the sociohistorical moment in which it arose as these artists shaped distinctive “cultural formations” (Williams 1989: 175).

Indeed, our folk rock artists crafted protest music within a time of fierce upheaval during which “free speech debates on campus heightened

awareness of politics and civil rights,” while the “war in Vietnam was escalating rapidly, with Lyndon Johnson announcing...that call-ups would double to 35,000 a month”—35,000 more young men sent off to war (Unterberger 2002: 358). Our selected folk rock artists spoke to their times, sometimes in strident and often biting verses very much demonstrating what Williams describes—“where the cultural and artistic intention is shaped, from the outset, by the acceptance and the possibility of broader common relationships, in a shared search for emancipation” (Williams 1989: 176). Judy Collins, Arlo Guthrie, Richie Havens, and Bob Dylan captured the legacy of Woody Guthrie and their folk predecessors—their songs like scattered messages that command attention in the struggle for social change.

ACKNOWLEDGMENTS

Many thanks to Raymond Williams, Joe Feagin, and Bonnie Mitchell for the wealth of their ideas. Thanks to Brett Clark who was a tireless advocate and advisor on the paper. Profound thanks goes to the many folk rock artists who spoke authentically to their sociohistorical context, challenging the powers that be in a chaotic time.

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Abstracts

ARTS

Female Creators in Mexican Surrealism: The Psychological Effects of Exile on the Art of Remedios Varo and Leonora Carrington

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Utah Valley University

Themes of transformation and mysticism are commonplace in the work of Remedios Varo and Leonora Carrington. This paper will examine the effect that exile had on these Mexican female surrealists in their exploration of the creative powers within feminine identity. Their paintings mix alchemy and witchcraft with distorted or hybrid female forms. Carefully planned compositions are rich with symbolism and metaphors. Explorations into this shared pictorial language reveals their personal journeys with femininity. Female artists of this period struggled with identity and artistic freedom when confronted with Surrealist ideals. The framework of the movement pushed the concept of femme-enfante and femme-fatale onto women, trapping these artists into the state of object and muse. Their freedom and sense of self were further restricted by the effects of World War II. Many were exiled from their home countries and transplanted into a new environment. In *Art and the Conditions of Exile*, Linda Nochlin discusses how the state of exile affects artists' creativity. She specifically, but briefly, addresses the bond created between Varo and Carrington by exile. These two artists were able to explore identity together and developed overlapping artistic worlds to explore the idea of androgyny and creation. The state of exile created an opportunity for collaboration and metaphysical exploration that would not have been possible otherwise. This concept will be further explored in relation to Gloria F. Orenstein's analysis of the female surrealist's identity crisis. Varo and Carrington's psychological and spiritual developments are visible in the subject matter and symbolism of their art. These ideas will be explored in Varo's works *Born Again* and *Creation of the Birds*, as well as Carrington's *Amor che move il Sole e l'altre Stelle* and *The Kitchen Garden on the Eyot*.

ARTS

Bomba from Utah: Studying a Puerto Rican Folk music in a Modern Diasporic Context

Drew Fallon

University of Utah

Bomba is an Afro-Puerto Rican folk music and dance tradition that, although heavily stigmatized within Puerto Rico and its diaspora, has become a symbol of Puerto Rican national identity and autonomy in working-class communities. Although previous work examines Bomba's important role in establishing a cultural identity for Afro-Puerto Ricans, little research examines its role in diasporic communities. This paper addresses the gap in the literature by examining the experiences of Bomba Marilé in Salt Lake City, Utah, one of the only prominent representatives of Puerto Rican culture in Utah. The members' experiences offer insights into the way bomba can create a space for both intercultural exchange and pan-Latinx community-building in Salt Lake City. I propose that bomba's development among an African diasporic slave population allows it to fulfill similar exigencies in the modern Latinx community, including the need for self-expression and community-building. These are especially important in the current context of xenophobia and mass deportations in the U.S., and in light of Puerto Rico's status as a colonized state.

ARTS

Harmonious Inclusion: Exploring Accessibility in Musical Theatre for the Deaf and Blind Communities

Francesca Mintowt-Czyz and Audree Clark

Weber State University

Musical theater is an art form that thrives on spectacle. It is an art form that combines music, movement, and text, weaving all elements together to tell powerful stories. Yet, for Deaf and Blind audiences, these elements often remain out of reach because of longstanding accessibility gaps. In this presentation, we will explore the barriers that prevent sensory-disabled individuals from fully experiencing musical theater and discuss how the industry can evolve to be more inclusive. Currently, accessibility efforts in theatre remain limited. Although American Sign

Language (ASL) interpretation and captioning have become more common, they are not always integrated in a way that allows Deaf audiences to experience the full nuance of performance. Similarly, audio description is available in some productions but is rarely designed to capture the dynamism of musical theater's choreography, set changes, and character interactions. Sensory-disabled individuals deserve more than minimal accommodations; they deserve a theatre that actively invites them into the storytelling process. We will present both immediate and long-term solutions that theater educators, producers, and artists can implement to bridge this gap. Short-term strategies include hiring Deaf and Blind consultants, offering designated ASL-interpreted and audio-described performances, and incorporating haptic feedback and tactile elements into productions. By reimagining accessibility in musical theater, we move toward an industry where every audience member, regardless of ability, can fully experience the magic of live performance. This presentation aims to inspire change and provide actionable steps toward a more inclusive future.

ARTS

The Choreography of Fear: Exploring the Societal Anxieties of “The Other”

Abbie Simpson

Utah Valley University

As we transition into the 21st century, societal anxieties around identity and “the other” have resurfaced, stemming from the sociopolitical turbulence of the 1980s and 1990s. This era, marked by events like the AIDS crisis, the fall of the Soviet Union, and racial tensions, highlighted issues of marginalization faced by LGBTQ+ communities and racial minorities. This research examines Michael Jackson's short film *Ghosts*, an artistic commentary on these fears, using the horror genre to amplify societal anxieties. Using a New Historicism framework, this analysis considers how *Ghosts* reflects the cultural context of the late 20th century. By incorporating Joann Kealiinohomoku's idea of dance as cultural research, the study explores how movement narrates complex societal issues. Combining written source analysis, historical context, and a critical analysis of Jackson's choreography, this research investigates how the film addresses the concept of “othering.” The study also explores how dance can express identity and societal fears. The findings show that *Ghosts* uses horror to symbolize marginalized identities,

confronting the audience with fears that challenge notions of normality. The Maestro, played by Jackson, embodies the complexities of “the other,” highlighting the relationship between power and marginalization. Scenes of the Mayor’s authority clashing with the Maestro’s defiance emphasize anxieties surrounding societal rejection. A detailed analysis of Jackson’s choreography reveals movement that resonates with the experience of being “the other,” critiquing prejudice while expressing empowerment and resilience against discrimination. Ghosts exemplifies how art engages with cultural dialogues on inclusion and representation. By analyzing horror, dance, and societal fears, this research contributes to understanding how performance articulates identity in the face of marginalization and advocates for a nuanced perspective on inclusion across artistic domains.

ARTS

Deciphering the “Jesus Is Here” Cave: Early Christian Worship, Sacred Space, and Hierophany at Horvat Beit Loya

Brandon Ro

Utah Valley University

This study reexamines the so-called “Jesus is Here” cave, a rock-hewn cistern at Horvat Beit Loya in Israel, that was later transformed into a sacred Christian site. The cave contains a Greek inscription reading “Jesus is here” or “Jesus is present,” a stylized cross-like Christogram, and an artistic depiction of a man standing in a boat with a raised right hand. These elements suggest that the site functioned as a place of religious significance, possibly serving as a hermitage, a location for early Christian liturgical practices, or even a secret place for baptism. The study contextualizes the inscription and iconography within the broader landscape of early Christian sacred spaces by drawing from archaeological, epigraphic, and ritual studies. Through comparative analysis with similar inscriptions and religious symbols in the region, the research explores the potential meanings of Christian hierophany, “the manifestation of the sacred,” at Beit Loya. The study concludes that the cave’s transformation from a utilitarian structure to a site of religious devotion aligns with broader patterns of sacred space formation in early Christianity. The inscription’s ambiguous yet powerful declaration of Jesus’ presence reflects theological concepts of divine immanence, ritual practice, and the sanctification of space.

ARTS

The Body as Border in Laura Aguilar's Three Eagles Flying

Amanda Platt-Allen

University of Utah

Laura Aguilar's *Three Eagles Flying*, taken in 1990, acts as a photographic performance of the U.S.-Mexico border. In this image, Aguilar cleverly and purposefully positions her body between the Mexican and American flags, literally making herself the border between the two cultures, identities, and lands. My paper will interpret this photograph through an overarching borderlands framework centered on how the body exists in-between places and identities (specifically Mexico and the United States), informed most prominently by writer and poet Gloria Anzaldúa. I will also contextualize this image by examining how and why *Three Eagles Flying* is unique among Aguilar's oeuvre; how it intersects and relates to the broader story of Chicana art; how we can situate this work within the visual language of the U.S.-Mexico border, and finally what it means to position the body as a border, especially that of a fat, queer, Chicana woman. As Aguilar's body becomes the border, she draws attention to the strain and unnatural boundary of the actual borderland between the U.S. and Mexico and those who call it home.

ARTS

The Consequential Career of Francis Davis Millet

Charlotte Poulton

Utah Valley University

One of the most influential 19th-century artists is one few have heard of: Francis Davis Millet. He has been overshadowed by friends and colleagues like Mark Twain, Henry James, John Singer-Sargent, Lawrence Alma-Tadema, and Edwin Austin Abbey, despite his similarly successful career. He is remembered more for his tragic death in the sinking of the Titanic than for his titanic life as a painter, illustrator, muralist, writer, adventurer, war correspondent, costume designer, and arts administrator. Some scholars argue that because he did not focus on excelling in one area, like painting, Millet doomed himself to fade into relative obscurity. However, it is Millet's astounding competence and

success in each of these areas that make him one of the last truly Renaissance men in America. His life and career must be explored from a holistic perspective rather than isolating a few individual accomplishments for examination. A cursory examination of Millet's career reveals that he participated in wide-ranging, often interconnected, global events and artistic developments at the end of the nineteenth century from the Russo-Turkish war to the 1893 Columbian Exposition to the Broadway Colony. A closer examination reveals that without fanfare or ego, Millet exceeded all expectations, and he always left a remarkable, indelible impression with every endeavor. This paper examines Millet's key contributions to three different areas of American art—training, subject matter, and arts administration—to argue for his recognition as one of the most consequential artists and cultural figures of the late nineteenth century. It derives from my work with the FD Millet Research Project, which is dedicated to creating a catalogue of Millet's visual and literary works.

ARTS

The “Last Woman”: Reimagining Female Apocalyptic Experiences in *Threads* (1984)

Sophia Osburn

Brigham Young University

Female representation in science fiction film has historically been limited and restricted, often placing female characters in idealized, sexualized, and passive roles subordinate to male heroes. The late 70s and early 80s show a shift towards more active roles for women as empowered heroines with films such as *Alien* (1979). In this context, Barry Hines's anti-nuclear apocalypse film *Threads* (1984) aligns with these trends toward increasingly active roles for women in science fiction films. Although much of the scholarship around *Threads* has focused on its political and polemical statements about nuclear war, the film's emphasis on depicting the extent of nuclear destruction across demographics necessitates an examination of its unique depiction of women. Unlike the heroines of films such as *Alien* (1979), Ruth, the protagonist of *Threads*, is not a salvific figure nor is she a passive damsel as seen in earlier eras. Instead, the film gives Ruth many of the markers and narrative functions of the postapocalyptic “last man” archetype, serving as a lonely, determined everyman guiding the audience through the apocalypse. However, simply reading Ruth as a female “last man” is

insufficient, as the film takes care to highlight the female experience. Rather than simply being a woman placed in a placeholder role of a “last man,” the portrayal of Ruth in the film leans more towards a reading of the character as a “last woman.” Her uniquely female experiences are emphasized and treated with dignity while still allowing Ruth to perform the functions associated with the “last man” role. This depiction raises questions about the narrative potential for female characters in nuanced roles in science fiction rather than following the tired tropes of classic sci-fi or simply plugging female characters into male archetypes.

ARTS

Gendered Sacrifice: The Impact of Site and Story at the 1785 Salon

Elli Coupe

University of Utah

A large blank space on the wall greeted the audience for the opening of the 1785 Salon. This space and subsequent painting, *Oath of the Horatii* by Jacques-Louis David, became the talk of the Salon. Its distinct subject matter, and the imposing quiet grandeur of the composition, drew the audience’s attention like none of the other paintings displayed could. Of course, there were hundreds of paintings exhibited at the same time. One of these paintings, sitting directly left of *Oath of the Horatii* and nearly half the width of his massive composition was an understated depiction of *Piety and Generosity of Roman Women* by Nicolas-Guy Brenet. Here too was an image of women’s sacrifice, one that, like David’s, was soon to become closely tied to the Revolutionary events of 1789. *Piety and Generosity* imagined an episode first told by Plutarch, in which the Roman women donated their gold to the state for an offering to Apollo after his help with their conquest of Veii. In 1789, the gesture was emulated by the wives of prominent artists, who publicly donated their jewels to the cause of the Revolution. Brenet’s painting of the antique model for the gesture was recalled by many and, as a consequence, re-exhibited in the Salon of 1791. Despite this later success, in 1785 the painting received a lukewarm response, while David’s *Oath* was universally praised. This paper situates the contrasting critical responses received by David’s *Oath* and Brenet’s *Piety and Generosity*, looking to the conditions of display in the Salon Carré as well as the differing visions of women’s sacrifice offered by the two paintings. Through a comparison of the paintings’ formal strategies and subject matter, I

explore the complicated questions and contradictions of the gender they evoked.

ARTS

Marcel Duchamp and Rose Selavy: Gender as Readymade

Cameron Christensen

Utah Valley University

Dada artist Marcel Duchamp's use of a female alter ego in his publishing, artmaking, and personal life is compared with his use of mass-produced objects in his ready-made series. The invention of Rose Selavy is explored, emphasizing her identity as a modern Jewish woman experiencing new independence as well as eroticization. The new female consumer culture and independence afforded to women arising after WWI is offered as explanation for the conflation between women and commodities in society as well as Duchamp's work. Judith Butler's phenomenological gender theory is used to establish the repetition of gender as its own mass-produced object. The established visual traditions for male artists are examined to explain how Duchamp subverts the artist identity with Rose Selavy. Both in his Fountain and in Rose Selavy, Duchamp disrupts the aestheticized repetition found in manufactured objects and gender norms, eliminating their pre-existing directives and turning them into art. Revealing the performative nature of gender radically eliminates its restrictive functions and furthers his goal to critique bourgeois modernism.

ARTS

Touching Loss: The Language of Hands in Käthe Kollwitz's Maternal Mourning

Lily Greenwood

Utah Valley University

German Expressionist artist Käthe Kollwitz is known for her depiction of hardship, loss, and grief. Having lived through two World Wars, Kollwitz was a first-hand witness to the sights that dealt with the pain and devastation of these heavy subjects; she was able to embed these

deep and uncomfortable emotions into every line, shape, and shadow of her artwork, thus transferring the grief from the subjects in the prints to the hearts of the viewer. Although Kollwitz was talented in expressing hardship, she was especially skilled in depicting a specific type of sadness: maternal mourning. During the First World War, she lost her son, and in the Second, she lost her grandson. These experiences helped her understand the true nature of a mother's grief, grief that she then transferred to her artwork. In Kollwitz's representation of maternal mourning, her depiction of hands and their language serves as a major channel to communicate grief. This presentation will look specifically at how Käthe Kollwitz uses her depiction of hands as an outlet to express motherly loss and mourning. When looking at Kollwitz's work, I will specifically explore how her use of gestures, hand positioning, and hand emphasis work to articulate maternal emotions. As I'm exploring these hands, I will look specifically at works like *Woman with Dead Child* (1903), *The Widow II* (1922), *Lament* (1938-41), *The People* (1922), and *The Mothers* (1922-23), all which use hands in their telling of motherly grief and anxiety. Through exploring this topic, I hope to add to the conversation of the deep emotion communicated through Kollwitz's work, exploring how much of this delivery comes specifically through her depiction of hands.

ARTS

Art Beyond Western Tradition: The Never-ending Influence of Taíno Art in the Dominican Republic

Amanda Lowry Wiberg

Southern Utah University

My thesis examines the lasting influence of Taíno art on the artistic identity of the Dominican Republic, challenging the prevailing Eurocentric narrative in art history. Although Western artistic traditions were introduced to the Caribbean through Spanish colonization in the 15th century, the indigenous Taíno artistic expressions have played a more significant role in shaping the Dominican Republic's visual identity. Taíno art, characterized by symbolic imagery, zemí sculptures, pottery, and woven designs, was deeply tied to religious and social practices. However, Spanish colonization sought to suppress and replace these traditions with European artistic conventions, particularly through the introduction of Christian iconography. Despite the eradication of the Taíno people due to colonization, their artistic influence persisted. My

study proves this by focusing on the 20th-century Post-Taíno movement, which saw a resurgence of indigenous aesthetics in Dominican visual art. My thesis explores the works of artists like Paul Giudicelli and Ramón Oviedo, who incorporated Taíno themes into their work. Similarly, my writing includes an examination of Taíno influences that are evident in Dominican performance arts, particularly in Bachata music, which blends indigenous rhythms with modern styles. Additionally, I focus on contemporary artists who continue to draw inspiration from Taíno motifs as well as museums and cultural institutions that celebrate this artistic heritage, further solidifying its role in the nation's identity. My thesis ultimately argues that Taíno art has had a greater impact on Dominican artistic developments than the Western traditions introduced during colonization. The continued presence of Taíno aesthetics in contemporary Dominican art, music, and cultural tourism highlights the resilience of indigenous heritage and its role in shaping national identity. By recognizing the significance of Taíno artistic contributions, my research challenges the notion that artistic innovation stems primarily from Western influence, underscoring the importance of non-Western artistic traditions in global art history.

BIOLOGICAL SCIENCES

Temperature-Dependent Strategies for Dengue Control: Integrating *Wolbachia* and Natural Predators in a Mathematical Model

Vinodh Kumar Chellamuthu

Utah Tech University

Dengue is a mosquito-borne viral infection that is widespread in tropical and subtropical regions, leading to millions of infections annually. The disease is primarily transmitted by *Aedes aegypti* mosquitoes (AEM) and is caused by one of four dengue virus serotypes, with secondary infections often resulting in more severe health complications. A well-established strategy for reducing transmission involves infecting AEM with *Wolbachia pipiensis* bacteria, which can limit the mosquitoes' ability to transmit the virus. However, dengue remains a persistent global health challenge because of environmental factors that influence mosquito populations and viral transmission rates. Recent research suggests that leveraging natural predators, such as *Toxorhynchites splendens* (TxS) larvae, could provide an additional means of controlling AEM populations. Given that both *Wolbachia* effectiveness and

mosquito-predator interactions are influenced by temperature variations, understanding these dependencies is crucial for optimizing dengue control strategies. To address this, we developed a mathematical model that incorporates both *Wolbachia*-infected mosquitoes and TxS larvae, explicitly accounting for temperature-dependent factors that impact mosquito survival, reproduction, and predation rates. By integrating these ecological and biological dynamics, our model aims to identify effective intervention strategies under varying climate conditions.

BIOLOGICAL SCIENCES

Brain-eating Amoeba *Naegleria fowleri*: Drug Inhibition in a Human Cell Infection Model

Aspen Acuña, Braden Freestone, Kody Korth, Victoria Green, Hannah Payne, Ethan Jensen, and Daniel N. Clark

Weber State University

Naegleria fowleri, a thermophilic, pathogenic amoeba, is the causative agent of primary amoebic meningoencephalitis (PAM), a rare and almost universally fatal infection with a 97.5% mortality rate. The amoeba, often found in the sediments of warm freshwater environments, infects hosts via the nasal passages, leading to fatal brain inflammation and swelling. Currently, there is no standardized treatment protocol for PAM, although rare attempts at treatment have been successful. This study investigates the potential efficacy of multi-drug combinations, using amphotericin B, azithromycin, fluconazole, and rifampin, to improve treatment outcomes against *N. fowleri*. Infection assays were conducted using human cells (HeLa cervical carcinoma cells and IMR32 neuroblastoma cells) to assess the amoeba's response to these treatment combinations. In testing various drug combinations against *N. fowleri*, we found that the combination of amphotericin B, fluconazole, and rifampin achieved the highest levels of *N. fowleri* cell death while allowing the cultured human cells to survive. Preliminary results show which drug combinations provide better chances at survival. These findings underscore the critical importance of therapeutic treatments to improve survival rates for PAM patients, providing hope for individuals who currently have few effective treatment options.

BIOLOGICAL SCIENCES

An Examination of the Chloroplast *petD* Intron among Eusporangiate Ferns

William Speer

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The chloroplast *petD* gene consists of 2 exons separated by a group II intron with six stem-loop domains (DI-DVI). This study examines the *petD* intron of taxa representing the major eusporangiate lineages from downloaded GenBank sequences. For the eusporangiate ferns examined here, the intron length varied from 591 to 712 bp. As expected for group II introns, DI was the largest of the 6 group II intron domains and accounted, on average, for approximately 52% of the overall intron length, although intron length variation among taxa was observed. Additionally, there did not appear to be a directly proportional relationship between DI and intron lengths. For example, the *Equisetum* species had the smallest introns (591-597 bp), with a DI (343-345 bp) representing approximately 58% of the overall length. In contrast, the taxa in the genus *Ophioglossum* all had introns of 712 bp, with their DI (347 bp) making up about 49% of the total length. Length variation between eusporangiate taxa was observed not only for the *petD* intron itself but also among the domains. Among the eusporangiate ferns, DI did not exhibit the greatest degree of variation (324 to 347 bp). Instead, this was observed for DIV (63 to 172 bp). The lowest level of observed length variation was for DV (34 to 35 bp). Also included for comparison were members of the Osmundaceae, a group of ferns considered intermediate between eusporangiate and leptosporangiate ferns and/or as basal leptosporangiate ferns. Intron and domain values for osmundaceous ferns were, in general, comparable with the eusporangiate ferns. Secondary structures were generated, and a phylogenetic analysis was also conducted.

BUSINESS

Utah's Rising Property Tax and Income Tax Cuts

Xiaoli Ortega

Utah Valley University

This article examines the complex relationship between Utah's income tax cuts, school funding, economic growth, and the rapidly rising

property taxes. It explores how the growing problem of property tax shifting affects homeowners' tax bills and how the Truth-In-Taxation law has not been able to balance between economic growth and rising property taxes.

BUSINESS

Undergraduate Business Student Attitudes towards General Education Classes

James C. Brau and Cash Schmutz

Brigham Young University

In this study, we surveyed over 1,000 undergraduate students at a large, western, US private university. The sample was drawn from an undergraduate Principles of Finance course, required for all Business Majors and Business Minors. Student sentiment towards general education courses was recorded and analyzed based on a rich data panel of demographic data.

BUSINESS

Desired Leadership Traits in First Bosses: A Study of Extant Leadership Theories

Nathan Boekweg, James C. Brau, and Jameson L. Brau

Brigham Young University

In this paper, we document the extant theories of business leadership and partition them into main threads (i.e., Democratic, Transformational, Authentic, Authoritarian, Trait, Great Man, Transactional, Laissez-faire, and Path-Goal). Next, we examine the sociocognitive literature on Generation Z and formulate hypotheses of desired leadership traits in first bosses. We then conduct a comprehensive survey gathering data from 799 undergraduate college students, asking them what preferred traits they would like to have in their first boss upon graduating from college. Empirical analyses are then conducted to test the various hypotheses pertaining to the extant leadership theoretical camps.

BUSINESS

Undergraduate Student Attitudes Towards the Impact of AI on Future Business Careers

James C. Brau and Cash Schmutz

Brigham Young University

In this study, we surveyed over 1,000 undergraduate students at a large, western, US private university. The sample was drawn from an undergraduate Principles of Finance course, required for all Business Majors and Business Minors. Student sentiment towards the impact of artificial intelligence on their future careers was recorded and analyzed based on a rich data panel of demographic data.

BUSINESS

The Oyster is Your World: A Revised Look at International Diversification

Robert Dubil

University of Utah

How should a U.S. investor saving for retirement construct the right stock portfolio across international markets? Using new WRDS country index data, this study constructs mean–variance efficient frontiers for dollar returns on up to 37 country stock indices over 1995–2023 and sub-periods to determine the empirical optimal global allocation. Contrary to recent studies showing rational over allocations to the U.S. market, the global tangent market portfolios are definitely U.S.-underallocated, resembling nominal-GDP or PPP-adjusted GDP weights and not market cap weights or 100% U.S. Home-biased U.S. investors expose themselves to 0.4-0.7% higher monthly standard deviation of returns and suffer 0.1-0.2% lower means than the optimal allocators. The optimal strategies contain high Sharpe-ratio less correlated allocations to non-Eurozone European economies (Denmark, Norway, Switzerland), as well as Indonesia, Taiwan, Australia. Allocations to India are smaller than, and to China greater than, the GDP share of the world. Overall, nominal and PPP-adjusted GDP tend to be the best guide to portfolio construction. Market cap weighting that favors developed economies seems to harm long term mean-variance tradeoffs.

BUSINESS

Protecting the Mushroom Kingdom: A Case Study on Nintendo's Intellectual Property Regulation

Hassan El-Cheikh

Brigham Young University

Since 1985, Nintendo Inc. has been a dominating force in the video game industry. Exclusive franchises such as Mario, Zelda, and Pokémon have provided millions of fans with hours of gameplay and generated significant revenue for the Japanese company. However, with their successes has also come scrutiny over Nintendo's stringent regulation over its intellectual property. Although common assumptions suggest Nintendo's actions stem from greed or market dominance, this research argues that the primary factors of fear of piracy, loss of its intellectual property, and business pragmatism are the primary factors to the company's decision to follow their protectionist approach. Through an analysis of Nintendo's corporate behaviors, decisions, and public responses, this study reveals that the company not only desires to preserve its brand but through calculated strategies tries to maintain control in a competitive and ever-evolving market.

BUSINESS

Autonomous Annotations for Second-hand E-commerce Platforms using Generative Artificial Intelligence

Taehyun Noh, Jimin Go, and Seokwoo Song

Weber State University

Second-hand e-commerce platforms help customers reduce the cost of purchasing products and provide sellers with economic benefits. For successful product trading on second-hand e-commerce platforms, sellers should provide well-crafted product descriptions, build a strong reputation, and enhance communications. However, the platforms face challenges in achieving growth due to several concerns. First, customers may doubt the reliability of products on these platforms, as their descriptions are often subjective and simplistic. Second, sellers are most likely to post multiple product images on these platforms. The authenticity of product conditions significantly impacts customers' trading decisions, yet there is often a lack of evidence to verify product

conditions. Finally, these platforms are often inadequately managed, failing to meet customer expectations and enhance user experiences. Recently, generative artificial intelligence (AI) has been widely utilized to enhance the quality of e-commerce platforms. In addition, deep learning techniques have been adopted to detect defects from pictures across various domains, such as diagnosing faults in e-commerce, disease detection, and pixel defects on the screens. This study examines the impact of generative AI and deep learning techniques on second-hand e-commerce platforms. We propose an integrated method combining generative AI and deep learning techniques with TF-IDF and LDA approaches. Our findings highlight that the proposed method can enhance seller reliability, customer confidence, and the overall quality of second-hand e-commerce platforms.

BUSINESS

Cultivating Career Growth and Enhancing Workforce Resilience: The Role of Mentorship in Job Satisfaction and Engagement

Wu-Ting Chen

Utah Valley University

This study examines the impact of mentorship on employees' career satisfaction, development opportunities, job engagement, and personal growth, addressing two primary research questions: (1) How does access to mentorship impact employees' career satisfaction and development opportunities? (2) To what extent do mentoring relationships enhance job engagement and personal growth? Using a mixed-methods approach, survey responses from employees across various industries were analyzed to assess their experiences with mentorship, job satisfaction, and engagement levels. The survey included constructs such as meaningful work, job satisfaction, access to mentoring, work values, and engagement. Perceptions of mentorship were assessed through Likert-scale questions that explored mentor-mentee relationships, career development support, and mentorship's impact on workplace engagement. Results revealed a significant correlation between mentorship access and higher job satisfaction, with mentored employees reporting greater fulfillment in their roles and more opportunities for career advancement. Mentorship also significantly enhanced job engagement, with employees demonstrating increased workplace involvement, motivation, and professional growth. Notably, female

employees with mentors reported lower job satisfaction than their male counterparts, suggesting potential gender-related differences in mentorship experiences. This study contributes to the growing body of literature emphasizing mentorship as a pivotal factor in employee well-being and career progression. It underscores the need for organizations to implement structured mentorship programs to support workforce development, foster leadership skills, reduce job-related stress, and promote long-term career resilience. By providing empirical evidence on the benefits of mentorship, this research advocates for the strategic integration of mentorship initiatives within the workforce to enhance employee retention, satisfaction, and engagement.

BUSINESS

Is TikTok Affecting the Mental Health of Your Employees? Examining the Link Between Compulsive TikTok Use and Mental Health.

Jeffrey A. Clements

Weber State University

This study investigates the potential relationship between compulsive TikTok use and mental health issues among employees. A survey of 603 men and women was conducted to examine their TikTok usage patterns, and the Mood Disorder Questionnaire was utilized to assess the presence of mood disorders. Results revealed that 26% of participants exhibited signs of mood disorders, a rate significantly higher than the general population's 10%. Notable limitations include the reliance on self-reported data and the exclusion of non-TikTok users. The findings suggest that compulsive use of TikTok may have a more pronounced negative effect on mental health than previously recognized. This is particularly concerning for employers, because the mental health consequences of social media use may extend into the workplace, affecting employee well-being and productivity. Understanding this link could help businesses implement policies and support systems that promote healthier technology use, fostering a more positive and productive work environment for both employees and organizations. Additionally, businesses may consider incorporating digital wellness strategies and educational programs to raise awareness about the potential mental health risks associated with excessive social media use. This could include promoting work-life balance, reducing stigma around mental health, and offering resources for managing compulsive

technology use. These efforts could reduce burnout, improve employee engagement, and ultimately enhance organizational success. Companies that address these issues proactively may also experience reduced healthcare costs and better retention rates, positioning themselves as leaders in mental health advocacy and corporate responsibility.

BUSINESS

Long-Haul Trucking Firm Targets: An Empirical Analysis of the M & A Logistics Market

Gregory L. Adams, James C. Brau, and Rebekah Inez Brau
Brigham Young University

This paper investigates the characteristics of acquiring firms in mergers and acquisitions (M&A) involving trucking companies, utilizing data from the Thomson/Refinitiv M&A database. The study focuses on identifying key traits of the acquiring firms, including financial health, market positioning, and strategic motivations, and evaluating how these factors influence their decision to acquire trucking firms. By analyzing a sample of M&A transactions, the research explores trends in the size, industry focus, and financial performance of acquiring firms, while also examining the role of market conditions and acquisition strategies. The findings shed light on the profiles of successful acquirers, offering insights into their motivations for consolidating within the highly competitive trucking industry. This paper contributes to the understanding of strategic behavior in logistics-focused M&A, providing a detailed analysis of the factors driving acquisition decisions in the transportation sector.

BUSINESS

Leverage Pays: An Analysis into Investing in Leveraged Exchange-Traded Funds Long-Term

Ashton Call, Todd Griffith, and Asher Mitchell
Utah State University

Leveraged exchange-traded funds (LETFs), which amplify the daily returns of an underlying index using derivatives, have been criticized for their inherent risks, causing concern for long-term investors. We

investigate the viability of a long-term investment strategy in two LETFs, the ProShares Ultra S&P500 (SSO) and the Direxion Daily S&P 500 Bull 3X Shares (SPXL), both of which track the S&P 500 Index. We address three key concerns: tracking error, volatility decay, and default risk. First, through various empirical methods, we show that the lost returns due to tracking error are not significant enough to entirely offset the leverage factor. Second, using Monte-Carlo analysis to simulate random entry and exit points, we find that volatility decay does not substantially erode performance in sample market conditions. Finally, we present a stress test that shows that fund liquidation is highly unlikely even in extreme bear markets. We conclude that LETFs have been unfairly characterized and, with appropriate risk management, can be a keystone investment for long-term investors.

BUSINESS

Does Ethics or Diversity Training Impact Perceptions of Emerging Adults towards Corporate Social Responsibility Diversity Metrics: A Mixed Methods Analysis

James C. Brau, Jameson L. Brau, and Sabrina D. Volpone

Brigham Young University, Gonzaga University, University of Colorado Boulder

The focus of this study is to examine emerging adult perceptions of diversity, equity, and inclusion (DEI) topics. We used a sample of 679 undergraduate students from a large private and a large public university, both located in the Western US to ask questions pertaining to how important diversity is in the ideal first job. The dependent variables are derived from a corporate social responsibility database and focus on DEI issues. We employed a set of econometric tests to find correlations between demographic independent variables and 6 dependent variables as well as an aggregate Diversity Index dependent variable. The tests show that gender and political affiliation are robustly correlated with the DEI variables. Additionally, we tested whether high school or college courses or on-the-job training covering DEI affect emerging adult perception. We found that college-level DEI classes have a statistically significant positive impact in individuals' perceptions of the importance of DEI issues, although this impact seems confined to only certain components of the many issues that comprise the broad topic of DEI. Two such affected components are the support of LGBTQ+ individuals

and the employment of underrepresented groups. Our thematic analyses reveal 9 themes for company social responsibility and 5 themes for women in leadership positions.

EDUCATION

Transitions into Leadership: Peer Leadership Experiences of First Year Administrators

Douglas Stump

Southern Utah University

In K12 schools, entry-level leadership positions can include team leader, curriculum director, assistant principal or dean of students and often come through the appointment of teachers currently working within the school. Teachers who accept these initial leadership positions experience a transition in scope of work and a shift in relationships among fellow teachers, including a unique set of challenges setting and enforcing policy and protocol with their peers. This presentation shares the findings of a qualitative field study of 9 first-year administrators across three states—Utah, Ohio, and New York—to better understand the experiences of first-year peer leaders and to inform ethical leadership induction and mentorship practices.

EDUCATION

A “Formula” for a Perfect Youth Soccer Story

Faoiltiarna (Lilly) Schlenker, Cassidy Lamm, Halle Taylor, and Whitney Blanchard

University of Utah

A rise of interest in sports-related youth literature in the United States is pushing educators to seek out increasingly more sports stories for their libraries. One sport in particular gaining recent national popularity is soccer, and thus soccer-related literature is also increasingly popular. However, many of these soccer stories are memoirs or biographies by and about well-known athletes and retell their journeys as players. This style of book can often be more difficult, and potentially too didactic, for young readers who may be newer to both reading and soccer. In this study, we examined fictional stories that potentially combine the

authenticity of true soccer with the excitement and reading level of the middle-grades. We examined the in-print young adult literature where soccer plays an integral role to the plot. Using our pre-designed and pilot-tested codebook and codes, we began by recording trends in elements such as plot, settings, and themes. We considered character traits related to gender, ethnic, and socio-economic diversity, and went beyond to examine positions played, skill level in soccer, attitudes towards soccer, and relationships between characters. We further recorded the amount and types of “soccer” present in each title, from informal play to practices and games to simply talking about soccer. Thus, this content analysis provides a unique and accurate lens into the current state of youth soccer literature, considering the intersectionality of identities and elements of the sport itself leading to a stronger understanding of current middle-grades sports literature in general.

EDUCATION

Living the Kodály Concept Beyond Elementary: An Historical Case Study of Rosalind Hall’s Legacy in Secondary Choral Education

Heather Christiansen

University of Utah

The Kodály Concept emphasizes teaching music literacy through the music of the student’s own culture. Although its application at the secondary level has been explored by some teachers and researchers, in the U.S., it is primarily associated with elementary music education. However, many students in the U.S. begin formal music education in middle school or later, leaving a gap in Kodály applications for older learners. This historical case study examines how Rosalind Hall, a Welsh-born music educator, successfully applied the Kodály Concept in secondary choral settings. Hall taught secondary choirs at the Waterford School in Sandy, Utah, before becoming a professor at BYU. I analyzed artifacts, including lesson plans, a scope and sequence outline, and assessment materials, to understand how she implemented the Kodály Concept and structured her curriculum. Personal interviews with Hall provided insight into her experiences, while interviews with Jean Applonie, a colleague, and Jason Hewlett, a former student, triangulated the findings. This study offers valuable implications for secondary educators in regions like Utah, where elementary music education is not mandatory, or where students often have limited access to formal music

instruction. By providing a late entry point into music, this research fosters greater accessibility to music classes, ensuring more students have opportunities to develop musical literacy and experience the benefits of music education.

EDUCATION

Clicking to Connect: A Qualitative Study on How Personal Engagement with Professors Enhances Online Learning Outcomes

Sana Shahid

Utah State University

The importance of emotional and personal engagement in online teaching has been recognized as a key factor in improving learning outcomes. However, there is a gap in the literature regarding the specific strategies instructors use to create such engagement and their impact on student achievement. The objective of this study is to examine how instructors who incorporate emotional and personal engagement into their online teaching practices achieve better learning outcomes. The study uses a qualitative approach, beginning with a non-participant observation of 10 “exemplar” courses at Utah State University and a review of existing literature. Interviews with exemplary instructors and students will follow further to explore the strategies employed by instructors. Initial findings suggest that these instructors utilize personal engagement techniques, such as sharing personal experiences, actively supporting students within the Learning Management System (LMS), offering post-course availability, and providing guidance on non-curricular matters. These strategies foster a supportive learning environment where students feel valued beyond their role as learners. Further data from interviews will offer deeper insights into the effectiveness of these strategies.

ENGINEERING

Experimental Indirect Evaporative Cooling Fridge

Lucas Hatch and Ali Siahpush

Southern Utah University

Evaporative cooling is a concept everyone has experienced but not many people fully understand or consider it. At Southern Utah University, undergraduate research was performed to re-create and validate a fridge designed by students at the University of Calgary that used indirect evaporative cooling to cool the air temperature in an insulated container. Based on the very limited information available from University of Calgary and the internet, attempting to recreate and test their system showed little to no change in temperature. Therefore, different measures were added to improve their design. This modified system was able to better cool air by incorporating a fine mist that sprayed directly over the coils. The results from each test were included for comparison.

ENGINEERING

Launch and Analysis of High Altitude PICO Weather Balloon

Raine Pratt, Sadie Schenk, Taylor Davis, and Ali Syed Siahpush

Southern Utah University

As part of a Mechanical Engineering Capstone project at Southern Utah University (SUU), we successfully launched a PICO helium balloon from Cedar City, Utah. The mission goal was to analyze and predict the static and dynamic behavior of the balloon throughout its ascent. Using one-dimensional (1D) theoretical models, we predicted parameters such as temperature, pressure, altitude, ascending velocity, floating altitude, and buoyancy force. Weak Signal Propagation Reporter tracking methods were used to monitor the balloon's location and showed that the balloon reached a maximum altitude of 39,000 feet, closely matching our predicted values. The strong correlation between our theoretical analysis and launch data validated our predictive models, demonstrating the effectiveness of our approach. The procedure for balloon preparation and launch was developed and documented. This project serves as a foundation for future high-altitude balloon research and engineering applications at SUU.

ENGINEERING

Slab of Ice Melting Rate Due To Natural Convection and Thermal Radiation

Tim Amodt and Ali Syyed Siahpush

Southern Utah University

This paper discusses the effects of natural convection and thermal radiation on the melting rate of ice. It aims to validate the results of a previously conducted experiment performed at Southern Utah University, improve the experiment by considering radiation effects, and create a model that can accurately predict melting rates for vertical and horizontal orientations. The vertical setup had an experimental melting rate of 280 g/hr. The theoretical results from natural convection plus two different cases of thermal radiation heat transfer were 285 g/hr for a large enclosure and 281 g/hr for a two-surface enclosure. The horizontal setup had the melting experimental result of 287 g/hr, with theoretical melting results of 282 g/hr for a large enclosure and 277 g/hr for a two-surface enclosure. A sensitivity analysis was performed for the heat transfer coefficient and temperature deviations from experimental values. The heat transfer coefficient linearly changes with the mass flow rate. Increasing temperature deviations increased the mass flow rate error by roughly 4% per one-degree deviation. Sources of error were considered, and the greatest melting rate error source was from using a heat gun to extract the ice and human error while recording data.

ENGINEERING

Low-Cost Dual-Band Radar System for Drone Detection and Tracking with AI-Driven Target Prioritization

Ahmed Amin

Southern Utah University

The rapid proliferation of unmanned aerial vehicles (UAVs) in both civilian and military domains has elevated the need for robust detection and tracking solutions to mitigate potential threats. This research introduces a cost-effective, dual-band radar-based drone detection and tracking system that integrates a software-defined radio platform with a 24-GHz radar module for enhanced performance. The proposed system

employs a hybrid radar architecture, utilizing both frequency modulated continuous wave and Doppler radar techniques to achieve accurate detection and real-time tracking of UAVs. An artificial intelligence (AI)-driven signal processing approach is implemented to analyze and classify detected objects using a deep learning-based fusion model. This model leverages both Doppler signatures and micro-Doppler effects to distinguish UAVs from clutter and other airborne objects, reducing false alarm rates and improving overall detection accuracy. The system architecture also incorporates low-cost solutions, demonstrating the feasibility of achieving high-performance detection with limited resources. The system is validated through a series of real-world field tests conducted under diverse environmental conditions and with different drone types. Key performance metrics, including detection range, accuracy, false alarm rate, and response time, are evaluated to assess the effectiveness of the system. This research contributes to the field of radar signal processing and AI-driven threat detection by providing a scalable and adaptable solution for UAV surveillance, highlighting the potential for low-cost, high-accuracy radar systems in real-world applications.

ENGINEERING

Heat Transfer Experiment: Top-Down Spray Type Direct Evaporative Cooler

Erik Berthoty and Ali Syeed Siahpush

Southern Utah University

This project was a continuation of the downdraft evaporative cooler that was designed at Southern Utah University. The purpose of this research was to improve upon the existing design of the direct evaporative cooler by simplifying the heating system within the cooler, as well as exploring different water droplet sizes and their cooling performance. The relative humidity and dry bulb temperatures at the inlet and outlet of the cooler were measured when evaluating the performance of the evaporative cooler. Psychrometric charts and equations were used to predict the necessary flow rate of the water to yield a reasonable cooling performance while keeping the relative humidity close to the comfortable range of 30%-60%. It was determined that a nozzle configuration comprised of 2 parallel nozzles performed well. It cooled the air from 35.6°C to a temperature of 22.9°C with a relative humidity of 63.3%.

ENGINEERING

Critical Radius of Insulation For a Cylindrical Copper Tube

Taylor Davis, Raine Pratt, Brock May, and Ali Syyed Siahpush
Southern Utah University

This study evaluates the critical radius of insulation for a cylindrical copper tube. The critical radius of insulation represents the point of maximum heat transfer rate. The location of the critical radius can be evaluated using the thermal conductivity of the insulation and convection heat transfer coefficient as k/h . A constant temperature bath, copper tube, and insulation were used in this experiment to determine the critical radius of insulation. The theoretical value for the critical radius was calculated to be 96.41mm. The raw data collected did not provide an accurate reading of the critical radius at first. After considering how much the insulation was compressed during the test, the experimental critical radius was recorded to be 97.94 mm, which falls within 1.58% margin of error of the theoretical value.

ENGINEERING

Heat Transfer Analysis of Melting Rate of Ice In Clay and Paper Mixture Containers

Kailee Richman and Ali Syyed Siahpush
Southern Utah University

Locally available and biodegradable insulating material decreases cost and environmental footprint compared with synthetic materials. This experiment aims to determine the effectiveness of a shredded paper and clay mixture for use as biodegradable insulation. Two similar containers were constructed from locally available Kaolinite and Illite clay, with one container including shredded paper. The mixture's insulating capability was determined by measuring the rate at which a suspended cylinder of ice melted inside the container. The equations for convection and radiation heat transfer and latent heat of fusion provided a theoretical melting rate of the ice cylinder for comparison. Also, comparing the results of the clay container experiment to the results when using a Styrofoam cooler showed that the clay was a less effective insulator than the Styrofoam but still maintained a cold temperature and reduced the

ice melting rate as compared with an ambient environment. The container with the shredded paper mixture had a lower thermal conductivity than pure clay. It was concluded that a clay and paper composite presents a cheaper option than Styrofoam while still being an effective insulating material.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

John Wesley Powell, the Grand Canyon, and the Myth of Native Self-Imprisonment

Evan Mahler

University of Utah

In 1869, one-armed Civil War Veteran John Wesley Powell set out from Green River, Wyoming, with a rag-tag crew to map the Great Unknown—the last large unmapped space within American jurisdiction—also known as the Grand Canyon. Powell’s “true” account of this journey, *Exploration of the Colorado River and its Canyons* (1875), operates as a hero’s tale of a dangerous (somewhat successful) expedition. This paper focuses on Powell’s consequential myth-making in relationship to his ascending political power and the passage of the Indian Appropriation Act of 1871, marking the end of treaty-making between Native Americans and the U.S. Government. To elucidate this relationship, this paper works to position Powell’s language within a “rhetoric of empire,” going on to focus on Powell’s “carceral imagination” as he details his elaborate myth of Native self-imprisonment, in tandem with his own “imprisonment,” within the Grand Canyon. Contemporary scholarship tends to name Powell’s depictions of Native peoples (and the devastating effects of the policies he endorsed) as they are: cartoonish, belittling, and racist. With this in mind, recent scholarship seems to shy away from critically analyzing racist texts depicting Indigenous groups. This paper, instead, analyzes a specific passage about Native people, not as a study of Natives, but as a study of the literary world Powell has written into being. This world is a reflection, not primarily of the people or places he encountered, but of himself: his opportunities, ambitions, power, and his relationship to the empire he helped establish.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Beckett, McCarthy, and the Boundaries of Dystopia

David A. Hatch

Southern Utah University

Utopia was not originally an island, as the founders altered 15 miles of isthmus to create the island and control the border. By extension, this allowed them to control the population, where an ideal number could be maintained by removing or importing people from the mainland. These types of boundaries have been essential to our understanding of the qualities of a utopia or dystopia, the differences between the two, and the cultural criticism resulting from these narratives. This presentation will explore the concept of dystopian boundaries in Samuel Beckett's "Endgame" and Cormac McCarthy's *The Road*. These works share stylistic and thematic similarities, but in each case the author also displays a dystopian world in the process of a slow spin down to a dark, ash-filled end. This paper explores the qualities and messages of these works with an eye on how the two help us define dystopia.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Faith and Feeds: The Impact of Social Media on Voter Attitudes and Presidential Support in the USA

Aggrey Willis Otieno

Utah State University

Despite the significant impact of religious affiliation on voting patterns in the U.S., the pervasive influence of social media—engaging 246 million users, or 72.5% of the population—on shaping public opinion and political engagement, particularly through religious-themed messaging, remains largely unexplored. This research investigates how different social media platforms influence voters' political attitudes and support for presidential candidates. It examines the effect of frequent engagement with religious messages on social media on voter backing for these candidates. Additionally, the study analyzes the role of religious leaders in shaping their social media followers' support for presidential candidates. It also assesses the impact of religiously themed

disinformation on social media on voter support for specific candidates. Finally, the research explores the relationship between trust in social media platforms and user engagement in efforts to mitigate religious-themed political disinformation. To achieve these objectives, the study used snowball and convenience sampling to collect a sample size of 890 respondents. The gathered data was analyzed using descriptive statistics and regression analysis with SPSS version 29.0 to investigate the relationships between the variables of interest. The findings provide valuable insights into how religious messages on social media influence voter behavior during presidential elections, contributing to the development of strategies to mitigate the spread of disinformation and enhance the democratic process. The study also discusses its limitations and offers recommendations for future research.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Unmasking and Taming the Social Media Mental Health Concerns Haunting Utah's Kids

Aggrey Willis Otieno

Utah State University

Depression and suicide represent critical public health challenges, with over 40,000 Americans succumbing to suicide annually, incurring approximately \$44.6 billion in combined medical and work loss costs. In Utah, suicide is the second leading cause of death among individuals aged 10 to 24 years, prompting extensive research into the potential link between social media use and rising adolescent distress. Despite 95% of Utah teens being active on social media, there is a notable lack of studies addressing adverse outcomes such as cyberbullying, social comparison, body image issues, depression, anxiety, and their connection to suicidal ideation. This study employs a multivariate regression analysis on data from 1,206 active social media users in Utah, exploring the frequency and nature of social media use, the impact of social comparison with influencers and peers, the correlation between digital markers in social media posts and mental health conditions, and the role of family-based interventions for at-risk adolescents. Public perceptions of social media regulations were also evaluated. The findings reveal the dual impact of social media on adolescent mental health, highlighting both its positive and negative effects. Adolescents are particularly vulnerable to social comparison processes, which exacerbate issues related to body image,

self-esteem, anxiety, depression, suicidality, and overall mental health. The study underscores the complex relationship between social media use and adolescent mental health, emphasizing the need for targeted interventions and policy measures to mitigate the adverse effects of social media on young individuals. The implications and limitations of the study are discussed, advocating for comprehensive strategies to address these critical issues.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

‘Then I Remembered:’ Joan Didion on Grief: Minimalism and Phenomenology

George Dibble

Brigham Young University

My presentation will be examining Joan Didion’s autobiographical *The Year of Magical Thinking*, focusing on the second chapter to analyze how Didion explores the phenomenology of grief through sentence variety, minimalist literary style, and rhetorical questioning. By investigating these stylistic elements, I will interrogate Didion’s capacity to translate the emotional complexity of loss into a textual experience that resonates with readers. Drawing parallels with Raymond Carver’s poem “Grief,” the analysis emphasizes the challenge of articulating grief to an audience who may or may not have experienced such loss firsthand. This raises critical questions: can grief, a deeply personal and disorienting experience, be authentically communicated to readers, or does it remain ultimately inaccessible to those untouched by personal loss? I argue that Didion’s stylistic choices simulate the chaos and intensity of grief, pulling readers into her emotional landscape, and then, the silence of realization. For example, her strategic use of sentence variation mirrors the abrupt shifts in her psychological state during pivotal moments, such as her husband’s sudden collapse. Brief, fragmented sentences replicate panic, while longer, reflective ones convey moments of disorientation. These patterns, rooted in literary minimalism, resonate with critic Robert C. Clark’s observation that restraint in language heightens scenes of intensity, as seen in specific works of Cormac McCarthy. Furthermore, Didion employs a series of certain rhetorical questions to illustrate her psychological fragmentation and, later, to signify moments of clarity. These devices, coupled with her sparse prose, evoke Søren Kierkegaard’s concept of anxiety, which can

manifest as both muteness and a scream. This duality underscores the paradox of grief as both present and absent; tangible yet elusive. I will be using French Philosopher Maurice Merleau-Ponty's idea of the "phantom limb" within grief phenomenology to discover the strategies and effectiveness of Didion's evocation of her intense loss and its consequences.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Race off the Agenda: The Visibility and then Invisibility of Black Americans in the Chicago Tribune in 1859 and 1952

Thomas C. Terry

Utah State University

The presence of Blacks in U.S. history is the overarching theme in an analysis of the *Chicago Tribune* during two, one-week periods, approximately a century apart, in 1859 and 1952. Each issue during the February 11-18, 1859, period contained numerous articles discussing the most burning issue of the time, inarguably the most important issue in American history after the Revolution: slavery. Just under 100 years later, in 1952, the issue could have been civil rights, certainly should have been, had the *Tribune* set the agenda on civil rights. The study period, November 23-40, 1952, preceded *Brown v. Board of Education* and subsequent Supreme Court desegregation decisions. Except in the sports pages, and scarcely even there, the Black was Ralph Ellison's "invisible man." In terms of coverage in the *Chicago Tribune*, the plight of Blacks, so obvious in every column of the paper in 1859, was just as obviously absent in 1952. It was as if the white America that owned the newspaper and dominated the political system, had decided the only problem that ever faced Blacks had been slavery. Once emancipated, the problem simply ceased to exist. The purpose of this study is to determine whether *Chicago Tribune* readers could have foretold in the pages of that newspaper the coming of Civil War in the late 1850s and the civil rights movement in the early 1950s during two, one-week periods, February 11-19, 1859, and November 23-30, 1952. And the answer is "no."

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Quality of Life on an ‘Indian’ Reservation: A Comparative Analysis of the Navajo Nation and General U.S. Population

Adam Nez

Snow College

As of today, there are 574 federally recognized Native American tribes in the United States. Out of this 574, there are about 326 federally recognized Native American reservations. Life differs from reservation to reservation, but all continue to struggle to keep up in modern America. It is my intention to bring to light the disparities in the quality of life on Native American reservations, particularly in terms of healthcare, education, and economic opportunities. I will more specifically be researching the reservation I come from, the Navajo Nation. Diné Bikéyah, or the Navajo Nation, is a sovereign nation within the U.S., located just by the four corners area in between the states of Utah, Colorado, Arizona, and New Mexico. This is the homeland of the Diné, or referred to as the Navajo. I come from the reservation and have seen and experienced the disparities that plague this nation. I have also lived off the reservation and have noticed major differences in the quality of life that many overlook. Major differences can be found in the nation's education system, healthcare system, and economical situation. These will be the main pillars of comparison with the nation that surrounds the reservation, the United States. By comparing these disparities, I hope to bring to light the difference in quality of life between one of the largest Native American tribes, and the general population of the United States.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Forced Displacement and Assimilation: A Long-lasting Legacy for Native Communities

Emerson Hackford

Snow College

This presentation will be regarding the forced displacement and assimilation of Native Americans, outlining elements in correspondence

to cultural identities to emphasize the resulting disconnection from ancestral lands causing lasting impacts within Indigenous communities. As a mixed Uintah Band Northern Ute from the Uintah and Ouray Reservation, I intend to maintain focus on prior historical happenings in correlation to severing ties Native Americans hold to their ancestral homelands and identities within a cultural context. Historical happenings regarding the displacement of Indigenous people from their ancestral homelands will be entailed. Cultural and spiritual belonging is relative to the ancestral lands in which Indigenous communities inhabited but now serves to be misconstrued. One may seek a correlation of such to restricting access to spiritual lands and more that have maintained means for essential survival for prolonged generations of Indigenous peoples. Relative to the context of assimilation, reference to Native American boarding schools, the Dawes Act, etc. will be included. It will serve to provide structure for emphasis on the topic. All information to be entailed will give a better understanding of disrupted cultural identity, with factors that correlate severing Indigenous spirituality, and social-psychological factors at play today. My resulting presentation will be a culmination of periodicals from psychologists and historians, as well as articles from journalists, seeking to emphasize the aspects of my topic. Important for evident truth to my presentation, highlighting Indigenous viewpoints from Native Organizations, as well as firsthand accounted sources of experience will be elevated throughout. This all culminated in a means to create visibility of history long ago, linked with factors of present times that Native communities face. As the cause and effect entailed within this topic are often misrepresented or shrouded with invisibility.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

From ‘Abominable Snowman’ to ‘Yeti Anila:’ Exploring Yeti Mythology Across Himalayan Cultures

Dawa Dechen Lama

Snow College

The Yeti, the Abominable Snowman, is a mythical yeti with deep and lasting ties in Himalayan mythology and folklore. The beast, a mythical ape-man living in Asia’s most inhospitable and most remote hills, managed to mesmerize everyone in the world into thinking about it. Yetis, however, are not supposed to be typical mythical creatures; they

are much more a signifier of wonder, an object of veneration, and a metaphor for nature in Himalayan cultures. What I propose to explore in the following pages is the cultural identity of Yeti, particularly with relation to the phrase “Yeti Anila,” which evokes a concept that reflects a deeper and more respectful signifier for such a mythical creature. Using “Anila,” a revered name for a figure in Tibet, the Yeti becomes signifier not of terror, but reverence and admiration; not a monster to be feared but rather full of reverence and awe. The core question that I will ask is this: what might be Yeti’s cultural and spiritual significance for these Himalayan cultures, particularly the label “Yeti Anila”? By using this “label,” Anila—a term of respect for a learned Buddhist through my inquiry—I will challenge stereotypical representations of Yeti as a monster in Western interpretation. In conclusion, I shall present in my work how “Yeti Anila” recontextualizes and reinvents Yeti in a venerable way and also transforms him into a protective god of the hills, not as just a cryptid but as an obvious presence with which to revere and perhaps pray for or even speak with in human terms. Ultimately, I will show how in such a study Yeti mythology is a living and continuing ongoing phenomenon and cultural artifact in contemporary times.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Across the Gulf: Land, Memory, and Identity in northern Guatemala and the US South

Fernando Nieto Montaña, Jr.

Snow College

Relationships with land have long defined human memory and group identity and continue to do so now, as evidenced, for example, in recent controversies over US efforts to (re)name the Gulf of Mexico. In this presentation, I will explore relationships between land, identity, and memory in two specific communities in Louisiana and Guatemala, especially in terms of aspects of both natural and built environments. I will be focusing on the Whitney Plantation, along the bank of the Mississippi River in southern Louisiana, as well as the classical and contemporary Mayan community of Uaxactún, Guatemala. In each place, the natural environment has been altered over time, leaving, among other impacts, distinct human feelings and other relations with the land. For example, the Whitney Plantation we have today is not the one that was operated into the mid 1800s. It is now an educational venue,

exceptional among other plantation tours, teaching visitors about how enslaved people were treated on the plantation. At the southern end of the Gulf, Uaxactún, Guatemala, is area abundant with jungle as well as a small human community today. The Uaxactún that is presented to visitors today has changed drastically from the classical Mayan period. These areas that have been built, while they may be experienced as “natural” by many of us, were once lands with dramatically different kinds of human interactions and interventions. I believe the built environment and the natural environment work in correlation with each other in shaping the identities and memories that reside there.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

Nights at the Museum: Agroforestry and Cultural and Ecological Patrimony in the Maya Biosphere Reserve of Northern Guatemala (a field report, in haibun style)

English Brooks

Snow College

This presentation will discuss the community of Uaxactún, in the Petén region of northern Guatemala, in relation to larger conversations on and increasing attention to decolonizing museum collections and curation, and to traditional ecological knowledge/Indigenous science. In particular, I will focus on some of the ways in which these forms of knowledge and management of cultural and ecological heritage mediate the terms upon which local Indigenous and Mestizo communities in the Americas engage with larger colonial/global systems of knowledge and trade. For instance, among the distinguishing features of Uaxactún is the unique community-managed forest concession arrangement it maintains within the Maya Biosphere Reserve (the largest tract of contiguous, undisturbed rainforest in the Americas, north of Amazonia). The agroforestry crops this community manages in the region include *Manilkara zapota*, *Pimenta dioica*, *Brosimum alicastrum*, *Chamaedorea oblongata*, and a number of tropical hardwoods for lumber and other wood products. My orientation to this community’s relationship with these forest products and their places in local and global cultures and economies, and within history, is informed by the theoretical premise that coloniality and modernity are mutually defining concepts, as demonstrated by thinkers like Aníbal Quijano and Walter Dignolo. This is further defined in the work of Silvia Rivera Cusicanqui and María

Josefina Saldaña-Portillo, who articulate some of the fundamental roles played by Indigenous relations with biotic communities of the Americas, and Indigenous modes of production, in shaping the material basis for modernity. Finally, I wish to relate these issues of forest management and conservation, to analogous questions of management and conservation of cultural patrimony (artifacts, architecture, infrastructure, etc.) in the region, and how these are informed by concepts of heritage and memory. My presentation approach will also occasionally integrate haiku/haibun style verses to better illustrate various central concepts along the way.

HUMANITIES, PHILOSOPHY AND FOREIGN LANGUAGE

A PEG Tube: Who Decides?

Kade Miller and Debbie Olsen

Snow College

Our case surrounds a man named Greg Strong that lives in a care facility. Mr. Strong has Down syndrome, which has resulted in his being somewhat intellectually disabled. Recently, Mr Strong has stopped eating and drinking altogether. The staff of the facility has inserted a nasal feeding tube to combat this issue, but he continues to pull the tube out. Family members and the healthcare team have discussed placing a percutaneous endoscopic gastrostomy (PEG) tube into Mr Strong's stomach. Some of the caregivers are concerned that PEG tube surgery may be too burdensome for an older man to go through that type of procedure. Others think it is the best option to prolong time to research a better solution for his dangerous levels of malnourishment. The main questions we have to answer are "How can you morally solve the issue of a person that is incapable of reasoning refusing to provide themselves with the nourishment their body needs?" and, "When someone incapable of reasoning needs a surgical operation, who decides what is to be done?" To answer the first question, we have to first look at what a PEG tube is and how it works. Are there any other alternative solutions? If so, what are they and how do they work? We then need to assess the risks involved and whether they are greater than the ones imposed by the situation. We have to decide who ethically gets to make decisions for a person who doesn't have the ability to reason. We see these questions as particularly important because if we don't know and understand our possible solutions, we can't measure the morality of those solutions. We

recommend the most moral course of action is to go through with the procedure and place the PEG tube.

KINESIOLOGY AND HEALTH SCIENCES

Smart Tools, Smarter Teaching: AI Challenges and Opportunities for Nursing Faculty and Academic Librarians

Tavish Bell

Utah Tech University

Artificial intelligence (AI) is rapidly transforming education, especially within health-related fields like nursing. AI-driven tools such as virtual clinical simulations, automated feedback systems, and predictive decision-making support offer unique opportunities to enhance critical thinking and clinical preparedness in nursing education. However, the integration of AI introduces challenges, including ethical concerns about bias, privacy, and the preparedness of both faculty and students to utilize these technologies effectively. This study, set at Utah Tech University, investigates the integration of AI within nursing curricula, examining the experiences and challenges nursing faculty face in adopting these tools. With its polytechnic mission and emphasis on applied technology, Utah Tech provides a unique environment to assess AI's impact in an educational setting deeply connected to real-world applications.

KINESIOLOGY AND HEALTH SCIENCES

Gaps in Research on Women with Autoimmune Diseases

Emma Smith

Utah Valley University

This research aims to understand gaps and inadequate research for women aged 18-65 years with autoimmune disorders. The average woman in the U.S. waits over a year for a diagnosis of an autoimmune disease and even longer for treatment. Women have a 50% greater chance of experiencing adverse effects from their medication as their male counterparts. Key events that have occurred in research of women's autoimmune diseases are the genetic studies of autoimmune disease and

links to hearing disorders. Political advancements in Congress led to the creation of an office of autoimmune disease research in 2023. One key finding is a study conducted by Stanford University. This study examined genetics and autoimmune diseases in 2022. What they found is that the female XX chromosome is associated with proteins that trigger autoimmune diseases. As a result, 80% of autoimmune patients are women. Women also experience adverse effects from medication twice as often as men. This is a result of many medications being tested on the male body but not the female body. Data show that 5.6% of women with premature ovarian insufficiency had at least one severe autoimmune disease in the U.S. Changes need to engender knowledge of differences in women's symptoms in order to build empathy in healthcare. This aims to build awareness and knowledge to be open to studying and talking about women's bodies.

KINESIOLOGY AND HEALTH SCIENCES

Musical (Department) Chairs: The Health Impacts of Serving as a Rotating Department Chair

James Bemel

Utah Valley University

Serving as a department chair in higher education has been called probably the most important, least appreciated, and toughest administrative position in higher education. Department chairs are tasked with a myriad of duties and responsibilities, including those related to department governance, student affairs, external communication, budget and resources, professional development, and faculty affairs. Within academia, there are primarily two methods by which a department chair is selected. The first is through the election of a department chair from the current department faculty. That individual serves for a specific period of time and is then either re-elected or replaced by another department faculty member. The second method is through the hiring of a full-time department chair, from inside or outside the department, and that individual serves in the position until released from employment or moving to another position. Most universities choose the rotating chair system, promoting from within the department and rotating the role among faculty, each filling an approximate three- or four-year appointment, then returning to the rank of faculty after term expiration. Because many universities select department chairs from current department faculty, the potential exists for negative impacts on the

chair's physical, psychological, and social health as they transition into the department chair role, fulfilling those duties, then transitioning back to faculty status as another colleague assumes the role of department chair. This study examined those health effects on current and former department chairs and the results were staggering with significant impacts to all three dimensions of health.

KINESIOLOGY AND HEALTH SCIENCES

Elucidating the Roles of TOX and LRRC1 on Melanoma Cell Migration and Invasion

Allison Stevens, Janellie Valmaceda, Mya Gleed, Kingdom Wanjoku, and Gennie Parkman

Weber State University

Melanoma is the most common and deadliest form of skin cancer, with Utah reporting the highest incidence rates per capita in the United States. Although advances in treatment have improved patient outcomes, therapy resistance remains a significant challenge, particularly in addressing melanoma metastasis. The progression of melanoma from benign nevi to invasive cancer is well understood at the genetic level; however, the molecular mechanisms driving migration and invasion require further investigation. Two genes of interest, thymocyte selection-associated high mobility group box (TOX) and leucine-rich repeat containing 1 (LRRC1), have been identified as a potential driver of melanoma metastasis. A study by our collaborator, Dr. Benjamin Izar, found that TOX and LRRC1 expression are elevated in melanoma brain metastases compared with non-metastatic tumors, suggesting its role in tumor progression.

KINESIOLOGY AND HEALTH SCIENCES

Exploring the Impact of COVID-19 on Smoking Cessation: A Comprehensive Literature Review

Linnette Wong

Weber State University

The COVID-19 pandemic has significantly influenced smoking cessation behaviors in the United States, with health concerns, stress, and

awareness of smoking-related risks playing key roles in smokers' attempts to quit. This literature review synthesizes findings from multiple quantitative and qualitative studies conducted during the pandemic, examining how COVID-19 affected smoking behaviors, motivations for cessation, and the use of cessation resources. Key themes identified include the heightened awareness of the respiratory risks associated with smoking, the psychological impact of stress, and the limited yet increasing use of cessation resources. Smokers, particularly those with pre-existing health conditions, were motivated by fears of severe COVID-19 outcomes, yet many struggled with relapse due to stressors such as isolation, financial instability, and lifestyle disruptions. Despite some success in motivating quit attempts, barriers such as lack of access to resources and demographic differences (e.g., age, socioeconomic status) limited the long-term effectiveness of cessation efforts. The review also highlights gaps in the literature, including the need for longitudinal studies to track long-term cessation success and relapse, and calls for targeted health promotion campaigns that address both behavioral and emotional challenges. Overall, this review provides important insights into the complex factors influencing smoking cessation during the pandemic and suggests avenues for future research and public health interventions aimed at improving smoking cessation outcomes, particularly in high-risk populations.

LANGUAGE AND LITERATURE

Ethical Editing: Care Ethics in Technical Editing Pedagogy

Rachel Bryson, Thabata Fay, Zabrina Le, Emmerson Martin, and Cora Romero

University of Utah

Technical Editing (TE) is a core course in Technical Communication programs, preparing student editors-in-training for academic and workplace editing contexts. Although many TE instructors incorporate discussion of general ethics into their curriculum, little scholarship exists advocating specifically for instruction in care ethics. Care ethics, as a framework that emphasizes human interdependence and relationality, should be part of how we teach and learn about TE. Particularly in the age of generative artificial intelligence, enacting an ethic of care is one way for technical editors to demonstrate the human value of editing work, which encompasses far more than just copyediting or

proofreading. This presentation advocates for focused instruction on relational care ethics in inclusive editorial pedagogy. This panel will highlight the experiences of a TE instructor and four undergraduate student editors in researching and enacting empathy and care in editorial work. Participants in this session will learn strategies for implementing empathy and care ethics into TE pedagogy, as well as the complications of enacting these strategies. Ultimately, the panelists argue that editing work is fundamentally relational and that a care ethics framework can enhance editing relationships and processes.

LANGUAGE AND LITERATURE

To Every Fish a Fantasy: “The Little Mermaid,” Disability, and the Right to Love

Miranda Slusser

Snow College

Since its inception, “The Little Mermaid” has captured the imaginations of audiences across the world, inspiring a multitude of retellings. This essay looks closely at how three versions of the story, including the original fairy tale by Hans Christian Anderson, the Disney movie, and Miyazaki’s “Ponyo,” all play into ableist narratives as “mermaidness” acts as a metaphor for disability. In all three iterations, the titular character must escape her nonnormative body to achieve acceptance, love, and ultimate happiness. Anderson requires his protagonist to trade her “mermaidness” for pain and muteness. Throughout the story, she is treated by the human world and even her love interest as more like a child, an exhibit, and an entertainment than a fully realized woman. Her sacrifice is unseen, and she remains separated from both society and love. To make the story more acceptable to a modern audience, Disney cures Ariel of both her muteness and her fins—i.e., her difference—in order for her to find her happy ending with her prince. And “Ponyo,” which avoids some of the most excessive ableism of the other two stories as she finds love even in her alternative form still requires the mermaid to erase her nonhuman traits to achieve full acceptance and audience satisfaction. In identifying these patterns, this essay shows how stories often exclude disabled people from representation and perpetuate notions that only the abled are capable of finding full acceptance, love, and a happily ever after.

LANGUAGE AND LITERATURE

“A Lotus Flower in the Mud”: Woman as Dialectical Image in 19th-century Japan and America

Coleman Numbers

Brigham Young University

In 19th-century Japan and the United States, many prose writers wrote novels and short stories that documented modernization’s liberatory and oppressive consequences for women. Two such writers—Edith Wharton in America and Higuchi Ichiyō in Japan—both examine how women’s social and economic roles are shaped by accelerating transformation; however, despite the scholarly focus given to each individually, these writers have not yet been put into conversation. Reading these authors together clarifies the capitalist mechanisms that distorted women’s social and economic opportunities across continents. I will focus on Higuchi’s short story “Nigorie,” which follows O-Riki, a low-class Japanese prostitute, and Edith Wharton’s novel *The House of Mirth*, which tracks socialite Lily Bart’s fall from high society. Although Wharton’s novel and Higuchi’s story address different socioeconomic strata in different cultures, both narratives feature heroines who face the exhaustions of what Wai Chee Dimock has called “a system of debasing exchange”—a system that liquidates women’s bodies for monetary and social remunerations. O-Riki and Lily Bart meet the predations of this system, which are fueled by a rapid pace of change in their respective societies, in ways that reveal how the 19th century was a global phenomenon with implications for women in both hemispheres. Specifically, this essay finds that Lily Bart and O-Riki function as living versions of Walter Benjamin’s “dialectical image” subjects who are aware of the dialectic processes that objectify and fetishize them.

LANGUAGE AND LITERATURE

An Arrangement of Cogs: Speculative Form and Reality in Alan Moore and Dave Gibbons’ “Watchmen”

Ezra Stein

Southern Utah University

What can we learn from the way panel form and visual content interact in comics that are also works of speculative and political fiction? Alan

Moore's "Watchmen" utilizes a structure wherein each page is comprised of a 3×3 grid of evenly sized panels, but he does occasionally break from this structure, combining panels to make them larger. In this essay, I will argue that Moore breaks from his established grid structure to accommodate the speculative elements of the comic, specifically the existence of superheroes and villains in the comic's world. When Moore introduces a new superhero, he will often do it in one of these larger combined panels, demonstrating their breaking from the form of established reality. In this paper, I will explore how within the comic's opening chapters, Moore and Dave Gibbons visually introduce the comic's superhero team using this visual motif. We can see for example one prominent instance of this in the character Dr. Manhattan's introduction, which presents him as three panels tall and emphasizes his size when compared with the more ordinary characters. For the sections in between chapters, Moore breaks from the comic form entirely, presenting in-world texts as prose. I will argue that because these texts are understood to be a part of the reality of "Watchmen," they do not meet the definition of being speculative to the characters and are therefore not presented in the previously established style; they instead use academic language and refer to superhero ephemera familiar to audiences of the real world. My paper will ultimately show that Moore and Gibbons use the formal elements of the comic medium not only to enhance the elements of the work that fit into the medium of speculative fiction but also to demonstrate said elements application to reality.

PHYSICAL SCIENCES

High-Velocity Pulsar Kicks via Anisotropic Neutrino Emission

Tate R. Thomas and Alexander M. Panin

Utah Valley University

Observations reveal that some neutron stars (NS) exhibit high velocities, reaching over 1000 km/s in some instances. This cannot be attributed to the orbital velocity of the NS around our Milky Way galaxy, as it is around 250 km/s on average. The origin of this phenomenon, known as a pulsar kick, is not fully understood and remains a subject of debate among astrophysicists. During NS formation, the rotation and strong (potentially asymmetric) magnetic field of its progenitor star may result in an asymmetric collapse of the star's core plasma. If this is the case, we might anticipate the formation of dense neutron matter slightly offset

from the center of the forming NS, which will be the source of subsequent neutrino radiation. This offset results in an imbalance of neutrinos reaching opposite sides of the NS, creating a net momentum of neutrino radiation into space and propelling the NS in the opposite direction. Because of strong interactions of high energy ($\sim 10\text{-}100$ MeV) neutrinos with dense neutron matter, we expect the neutrinos to propagate throughout the NS in a diffusive manner. Hence, we used a diffusion model to investigate neutrino emissions from an offset source and analytically proved that it will result in significant anisotropic emissions. From this, we derived a novel linear relationship between the velocity of a pulsar kick and the offset percentage (relative to NS radius), with the proportionality constant dependent solely on the average energy of the formed neutrinos. This formula predicts kickback velocities consistent with observational data from small asymmetries (2-7% offset for 100 MeV neutrinos). Our findings suggest that an offset neutrino source can indeed account for significant recoil velocities, and thus it seems a full theory explaining pulsar kicks should most certainly include anisotropic neutrino emission as a primary cause.

PHYSICAL SCIENCES

Gravity Solutions in the Cloud: A Repository of General Relativity Computations

Morgan Maxwell, Joseph Ray, Maria J. Rodriguez, and Luis Fernando Temoche

Utah State University

The goal of this project is to create a public repository that provides access to important software related to differential calculus and the general relativistic solutions of Einstein's equations. This unique repository, in Wolfram coding language, aims to ensure reliable access and maintenance of essential software packages, including the EDCGRTC code, while providing an introduction to the physical properties of gravitational systems within this framework. Additionally, we will perform detailed computations on gravitational solutions to Einstein's equations to extract key observables, such as the location of singularities in these systems and the computation of their associated conserved charges.

PHYSICAL SCIENCES**How Much Quantum Confusion Does it Take to Catch an Eavesdropper****Boaz Oswald and Jean Francois Van Huele***Brigham Young University*

Quantum cryptography uses the inherent quantum uncertainty in polarization of photons and the inability to copy quantum states to catch an eavesdropper in communication channels carried by light. If a polarization is detected in a frame rotated from the frame it was sent in, it gives probabilistic results. In the original version of the well-known BB84 cryptography protocol, sender and receiver agree on two fixed bases, rotated by 45 degrees, to send and receive the photons. The ambiguity in bases forces an eavesdropper to intercept and forward possibly wrong polarizations, thereby revealing their presence. We explore the effect of increasing the number of bases and attempt to maximize the probability of detecting the eavesdropper. We show that, maybe surprisingly, this probability does not depend on the number of bases.

PHYSICAL SCIENCES**Taphonomic, Stratigraphic, and Morphological Analysis of Hadrosauroids from the Lower Wahweap Formation (Early Campanian): Insights into the Early Evolution and Ecology of Hadrosauridae in North America****Madison S. Watkins, Alan L. Titus, Katja Knoll, Bryce A. Cassiano, Joseph J.W. Sertich, Grant T. Shimer, and Arianna Harrington***Southern Utah University*

The early evolution of Hadrosauridae remains obscure, with identifiable materials currently restricted to the Milk River (Alberta), Menefee (New Mexico), Mooreville Chalk (Alabama), Aguja (Texas), and Wahweap (Utah) formations. Overall, the Wahweap Formation has arguably yielded the largest volume of material, but diagnostic cranial material is rare. Redating of sediments was previously used to create a Bayesian model that projects the base of the Wahweap Fm at 82.17 Ma

(uncertainty of $+1.47/-0.63$ Ma), placing these among the oldest North American hadrosaurids. We analyzed the stratigraphy, facies, taphonomy, and morphological diversity of 8 hadrosauroid localities from the Last Chance Creek Member and 2 localities from the Reynolds Point Member, with all localities restricted to the lower 50 meters of the formation. Six localities were mudstone-hosted, 2 were in a sandy mudstone, and 2 were in a channel sandstone, which was likely reworked. Individual bones show very little wear or evidence of scavenging, but the degree of disarticulation, sorting, and current orientation at 7 localities indicate that burial was not immediate postmortem. Seven localities contain elements from Voorhies groups I and II. Three localities contain material from all three Voorhies groups, although 1 locality only has minimal group II and III elements, suggesting most localities have been influenced by low- to medium-velocity currents. Bone orientations confirm current influence, with 4 localities showing moderate current alignment, 2 localities showing a strong current alignment, and 3 localities that were completely random with no current signature. The remaining locality was an articulated partial skeleton from which we could derive no current data. Our taxonomic identifications and sedimentary interpretations suggest that the early Campanian radiation of hadrosaurids in southern Laramidia consisted of members of both Brachylophosaurini and Kritosaurini that lived in or around persistent bodies of water large enough for moderate-velocity currents.

PHYSICAL SCIENCES

Revisiting Tidal Deformations in Black Holes

Maria J Rodriguez and Malcolm Perry

Utah State University

Black holes are among the most resilient compact objects in the universe. Within the theory of general relativity, black holes cannot be disrupted or disintegrate. However, recent studies have shown that black holes can deform in response to time-varying (dynamical) gravitational tidal forces. In this presentation, we will explore the tidal deformability of black holes and revisit the gravitational tidal Love numbers of extremal, zero-temperature rotating Kerr black holes.

PHYSICAL SCIENCES

Gravitational Tidal Deformations of Rotating Black Holes

Daniel Glazer, Austin Joyce, Maria J. Rodriguez, Luca Santoni, Adam R. Solomon, and Luis Fernando Temoche

Utah State University

Black holes are influenced by external gravitational fields in the universe, which are generated by other astrophysical objects in their surroundings. Because of this gravitational interaction, they experience tidal deformations of their event horizons. To quantify this effect, we compute the so-called Love numbers, which measure the deformability of the event horizon. Theoretical results from several authors have shown that Love numbers vanish for black hole solutions in four-dimensional spacetime. But does this behavior persist for black hole solutions in higher-dimensional spacetimes? In our presentation, we aim to address this question by demonstrating that, unlike their lower-dimensional counterparts, higher-dimensional rotating black holes exhibit non-vanishing Love numbers.

PHYSICAL SCIENCES

Metal Nanoparticles Synthesis with Biological Capping Ligands Facilitated by Microfluidic Devices

Seth Wetjen, Samuel Hodnett, Connor Cronin, and Christopher Monson

Southern Utah University

A microfluidic device was developed to fabricate silver and gold nanoparticles. Nanoparticle formation was verified through fluorescence characterization of the resulting nanoparticle solutions and SEM imaging of the nanoparticles. Silver nanoparticle formation was the most extensively investigated, and many sets of conditions resulted in nanoparticle solutions of sufficient concentration that the emission peak was significantly red-shifted (to ~550 or ~600 nm) compared with the peak observed in diluted solutions (~455 or ~465 nm). Biologically relevant molecules (proteins and to a lesser extent lipids) were shown to act as ligands forming reproducible silver nanoparticles. When gold nanoparticles were formed, it was shown that the size of the

nanoparticles could be increased by increasing the reaction time before capping ligands were added.

PHYSICAL SCIENCES

Estimating Environmental Exposure with Uncensored and Censored Data

Sazib Hasan

Utah Tech University

For some regulatory purposes, it is desirable to compare average on-site pollution concentrations in a narrowly defined geographic area with a large collection of background measurements. An approach to this problem is to treat this as a statistical prediction for the mean of a future sample based on a background sample. In this article, assuming lognormality, a fiducial approach is described for constructing prediction limits for the mean of a sample when the background sample is uncensored or censored. The fiducial prediction limits are evaluated with respect to coverage probabilities and are compared with those based on another approximate method. Monte Carlo simulation studies for the uncensored case indicate that the fiducial methods are accurate and practically exact even for small samples, and they are very satisfactory for the censored case. Algorithms for computation of confidence limits are provided. The methods are illustrated using two real data sets.

PHYSICAL SCIENCES

Quantifying Cadmium and Lead Concentrations in Cocoa Beans

Hannah J. Verhaal, Lydia E. Felix, Harrison R. Yates, Charles F. Davidson, and J. Andreas Lippert

Weber State University

The objective of this project was to determine the distribution and concentration of cadmium and lead in cocoa beans from Ghana and Guatemala by using inductively coupled plasma-mass spectrometry (ICP-MS). Careful hand-shelling gave 12 weight percent shell for both bean samples. Test solutions of beans, shells, and nibs were prepared by microwave digestion and subsequently diluted using a standard addition

calibration curve scheme. Analytical results showed that sample location influences heavy metal concentration. Guatemala samples exhibited higher concentrations of both cadmium and lead than Ghana samples. Furthermore, the concentration of heavy metals is consistently higher in the shells than in the nibs. Analyses of samples from additional locations are required to reach definitive conclusions about the geographic influence and the distribution of cadmium and lead concentrations in the cocoa beans.

PHYSICAL SCIENCES

Design and Performance Assessment of Butyl Norbornene Cross-Linked Anion Exchange Membranes for High-Efficiency Non-Aqueous Redox Flow Batteries

Md. Motiur R. Mazumder

Utah Tech University

Non-aqueous redox flow batteries (NARFBs) face a significant challenge because of the lack of suitable separators that can effectively prevent crossover. In this study, poly(norbornene) (PNB)-based anion-exchange membranes (AEMs) were synthesized and characterized to address this issue. The PNB membranes were designed as copolymers of butyl norbornene (BuNB) and bromobutyl norbornene (BrBuNB), incorporating varying amounts of tetramethyl hexadamine as a crosslinker. The performance of these AEMs was systematically evaluated under ideal conditions in NARFBs, considering key factors such as durability in non-aqueous solvents, charge-carrying ion permeability, electrical resistance, redox-active species crossover, and mechanical properties. Notably, BuNB-based AEMs demonstrated superior performance compared with the commercial Fumasep membrane in battery cycle tests. Long-term cycling tests revealed that the best-performing PNB membrane retained 83% of its total capacity over 1000 charge/discharge cycles, primarily due to minimal crossover. In contrast, the commercial FAPQ-375 membrane exhibited only 28% capacity retention, indicating significant capacity loss due to high crossover. These results highlight the potential of PNB-based AEMs as a promising alternative for improving the efficiency and longevity of non-aqueous redox flow batteries.

PHYSICAL SCIENCES

Microplastic Accumulation in Shoreline Sediments of the Ogden River System

Kenley Stanger and Davis Swanson

Weber State University

Microplastics in aquatic systems are a growing environmental concern because of their negative impacts on the health of aquatic organisms and the overall ecosystem. Although most microplastic research focuses on oceanic systems, abundance in freshwater systems remains largely understudied. Therefore, quantifying and identifying shoreline microplastics in Utah, a unique terminal lake system is crucial for informing ecological management and sustainability practices. This study investigates the accumulation of microplastics in shoreline sediments of three lakes at varying elevations in the Weber River watershed. We used a sediment-microplastic isolation device to separate plastic particles from sediment samples, utilizing density separation. Wet peroxide oxidation was carried out on each sample to remove excess organic material and biofilm on the recovered microplastics. Visual and fourier transform infrared microscopic analyses indicate the quantity and identity of plastics recovered. Data analysis will focus on determining microplastic abundance, common polymer types, and potential correlations with lake use and elevation within the watershed.

PHYSICAL SCIENCES

A Device to Measure Ionic Strength in a High School Setting

Abigail G. Petersen, Lisa Monson, and Christopher F. Monson

Southern Utah University

We are building a conductivity tester that can be used in a laboratory setting to measure the ionic strength of a solution. This device is designed to be student friendly, relatively simple to build, safe, and inexpensive. It is simple enough that students can build this conductivity tester. We are incorporating this device into a laboratory based on SEED standard CHEM.3.1. We have tested this lab in a classroom setting and are currently revising it.

PHYSICAL SCIENCES**A Stable Numerical Scheme for a Lengyel-Epstein Reaction Diffusion Model****Jianlong Han***Southern Utah University*

We study a reaction diffusion Lengyel-Epstein system, which describes the formation of chemical Turing patterns. An unconditionally stable semi-implicit difference scheme is proposed for the system. It is proven that the numerical scheme is uniquely solvable and inherits the properties of the original system. The long-term behavior of the numerical solution is analyzed.

PHYSICAL SCIENCES**Strain-Driven Metal-to-Insulator Transition and Ferroelectricity in WTe₂****Ross Richins and Shao Qiu***Southern Utah University*

WTe₂, a two-dimensional van der Waals (vdW) material, has gained attention for its potential to exhibit out-of-plane ferroelectricity. However, as a semimetal, WTe₂ requires an insulating phase for polarization to be meaningful. In this study, we investigate the effects of mechanical strain on WTe₂ to induce a transition from semimetallic to insulating behavior, which is crucial for sustaining spontaneous polarization. Using density functional theory, we apply biaxial strain to the WTe₂ system, focusing on altering the lattice constants in both the a and b-axes. So far, our efforts in the bulk system have not successfully opened a band gap, a necessary condition for ferroelectric behavior. Without an insulating phase, studying meaningful polarization becomes challenging. To address this, we have shifted our focus to a bilayer WTe₂ system. Our ongoing work involves applying strain to this reduced system, with the hope of inducing a band gap. Achieving an insulating state in the bilayer system could pave the way for investigating out-of-plane polarization, as well as polarization switching mechanisms through interlayer sliding, which is characteristic of vdW materials. Our next steps involve continuing strain analysis in the bilayer system and performing Berry phase calculations to quantify polarization in the

insulating phase. The ultimate goal is to identify conditions under which WTe₂ becomes ferroelectric, thereby advancing the potential for 2D ferroelectric materials in nanoscale electronic and memory devices.

SOCIAL SCIENCES

‘It’s Not So Easy to Be Free’: The Sounds of Protest in Folk Rock

Theresa Martinez

University of Utah

The 1960s and 1970s were a time of profound societal and political upheaval in the U.S., truly a maelstrom of sociohistorical transformation. Folk rock artists in this milieu would articulate sounds of protest in America as they expressed the struggles and concerns of their day. Artists spoke to issues that impacted poor and working people. They reflected on the extraordinary movements of disenfranchised groups, particularly the Civil Rights movement. They spoke to a brutal war in Vietnam that was costing thousands of lives. This paper focuses on a lyrical and thematic analysis of the work of selected folk rock artists as they reflected on and responded to the sociohistorical context of their times. The paper specifically unpacks the lyrics of our selected artists through a theoretical lens that examines oppositional cultures or cultures of resistance within marked social locations or cultural formations, an authentic and strident response to the chaos of their times.

SOCIAL SCIENCES

Why’s the Water Gone?: The Treadmill of Production Through Global Water Scarcity

Joshua Cafferty

Utah Tech University

This paper examines the primary drivers of global water scarcity. The theory tests three theoretical perspectives that are used in explaining environmental harm: the treadmill of production, ecological modernization, and population theories. The treadmill of production, rooted in eco-Marxist thought, asserts that capitalism’s demand for continuous growth leads to unsustainable exploitation of natural

resources, including water. In contrast, the ecological modernization perspective suggests that economic development can drive technological innovations that enhance sustainability. Population theories contend that population growth is the sole driving factor of environmental harm as more people populate the earth and use its resources. This study employs qualitative comparative analysis to evaluate these competing theories, utilizing data on water use, economic activity, and resource efficiency from various global sources. The findings indicate that population growth alone does not drive water scarcity; rather, scarcity is exacerbated when water is allocated primarily to industrial and agricultural sectors rather than domestic use. Additionally, the study finds limited support for ecological modernization, as technological advancements in water efficiency do not significantly mitigate scarcity. In contrast to the above theories, the results provide evidence that economic expansion, as explained by the treadmill of production theory, is the dominant driving factor in growing water scarcity. This research contributes to environmental sociology by highlighting the systemic nature of water scarcity, emphasizing the role of production over individual level consumption. It calls for policy interventions that address economic drivers of water depletion rather than focusing solely on population growth or technological solutions. Given the critical role of water in sustaining human and ecological systems, a shift toward more sustainable economic models is imperative.

SOCIAL SCIENCES

Students on the Margins: Investigating Student Belonging, Academic Success, Resilience, and Enrollment Intentions Among Marginalized Utah College Students

Sydney O'Shay, Amanda Lilly, Nicole Allen, Rachel Robison-Greene, Henry Greene, and Grace Pulsipher

Utah State University

Identity characteristics such as gender, race/ethnicity, and family income significantly shape student experiences, success, and well-being in higher education. Research indicates that marginalized students, especially Black/African American, LGBTQIA+, and low-income students, face heightened challenges related to belonging, mental health, and academic barriers. Diversity, equity, and inclusion (DEI) initiatives have sought to address these disparities, yet recent anti-DEI legislation

across the U.S. threatens their implementation. In Utah, HB261, which took effect in July 2024, raises concerns about its impact on student belonging, academic success, and institutional trust. This study examines how students at Utah's public universities perceive anti-DEI legislation and how it affects their educational experience. We will conduct a two-phase, mixed-methods study: first, quantitative surveys will measure perceptions of anti-DEI laws, belonging, academic success, psychological well-being, and enrollment intentions. In phase two, qualitative interviews will capture students' personal experiences with the bill. Data collection will span Utah's 6 public universities to assess the true effects of this legislation. Our findings will not only provide insight into the genuine lived experiences of Utah college students under the anti-DEI policies but will contribute to further discussions on higher education as a whole. How will students, educators, and those affiliated with higher education be affected by these policies? Our results will be able to go further into this question, especially with the variety of concerns on student well-being and institutional inclusion efforts living in an anti-DEI country. We intend to share our findings with legislators, higher education administrators, and scholars through conferences, academic publications, and research briefs. By critically analyzing the effects of anti-DEI legislation, this research aims to inform future policy decisions and advocate for equitable access to higher education for all students.

SOCIAL SCIENCES

Can the Socratic Method Revive Academic Integrity? A Comparative Analysis of Assessment Strategies among Professors and Students in Pakistan and the U.S.

Sana Shahid

Utah State University

With the rise of artificial intelligence and online learning, educators face growing challenges in maintaining academic integrity. Previous studies highlight that students increasingly submit artificial intelligence (AI)-generated assignments, but limited research explores how professors perceive and address this challenge in their assessment practices. Hence, this study adopts an exploratory approach to investigate the strategies university professors use to detect and mitigate AI-assisted academic dishonesty. The study also explores oral examinations as a Socratic alternative to written assessments in the digital age. Using a comparative

framework, the study collects perspectives from 15 professors and 15 students at Utah State University (USU) in the United States and 15 professors and 15 students from Sindh Madressatul Islam University (SMIU) in Pakistan. By gathering data from both professors and students, this research will provide insights into what professors believe will be effective strategies and how students perceive these approaches. This dual perspective will allow for a more comprehensive understanding of the dynamics between teaching practices and student reception. The inclusion of both U.S. and Pakistani academic contexts enables a comparative analysis of cultural and institutional differences in addressing AI-related challenges. Employing purposive sampling, in-depth interviews will be conducted, and thematic analysis using MAXQDA software will identify key insights. By comparing faculty and student perspectives across these distinct academic settings, the research aims to provide a thorough view of evolving assessment practices in response to AI-driven challenges and the potential reintegration of the Socratic method as a pedagogical tool in higher education.

SOCIAL SCIENCES

Navigating Food Choices: A Qualitative Diabetes Camp Study

Morgan Heelis, Echo Oliver, Carla Cox, Eddie Hill, and Christina Aguilar

Weber State University

According to the US Centers for Disease Control and Prevention, 304,000 youth under the age of 20 years have Type 1 diabetes (T1D), with numbers continuing to rise. T1D is an autoimmune disease in which the immune system attacks the pancreas's beta cells, causing insufficient insulin production. Nutrition and exercise are vital for managing T1D, yet little qualitative research exists on how youth with T1D experience nutrition decisions. This study aims to explore the experiences of youth with T1D, using an interpretive phenomenological analysis (IPA) approach, which focuses on understanding individuals' perspectives. We interviewed 8 campers from the REACH Weber diabetes camp in August 2024. IPA involves exploring the lived experiences of 3 to 10 participants. Interviews included 10 questions, aiming to learn more about three overarching research questions: 1) How does T1D influence food choices in youth? 2) What are their experiences with nutrition education? 3) What barriers do they face in social settings? Data were

analyzed using a phenomenological approach. Three themes emerged: food and insulin dosing, challenging food environments, and nutrition education and support. Our results were consistent with other studies, finding that youth with T1D struggle to follow management plans despite awareness of healthy eating because of social distractions and limited nutrition education. This study highlights the need for comprehensive nutrition education for families. Camps, like Reach Weber, serve as effective venues for nutrition education.

SOCIAL SCIENCES

The Sacred Structures of Ogden's 25th Street

Brittney Mast and Chelsea Raza

Weber State University

Based on Randolph Hester's idea that areas of cities have a "sacred structure" that deeply connects residents with these places, this study explores the ongoing cultural and historical significance of downtown Ogden's 25th Street. Based on a survey of 132 visitors, we discovered that visitors greatly enjoyed 25th Street. They saw the scenery and daytime activities as important, with Union Station especially essential. They also did not think that adding major chain store would increase their likelihood of visiting. This suggests that urban areas like Ogden connect with individual identities, and the loss of such places to neglect or development will greatly loosen community ties.

SOCIAL SCIENCES

Media Influence and Policy Response: The Impact of Media Coverage in International Human Rights Violations

Macy McCormack

Weber State University

This paper critically examines the relationship between Western media coverage and international policymaking, focusing on how media representation shapes global responses to human rights violations. Through an analysis of the media coverage and implications of the Rwandan genocide, and three current case studies, the Russia-Ukraine

conflict, the Nagorno-Karabakh conflict, and the Democratic Republic of Congo conflict, this research highlights significant disparities in media attention and their corresponding impacts on humanitarian intervention, military aid, and diplomatic action. The paper begins with the Russia-Ukraine conflict, where extensive media coverage amplified international responses, including United Nations resolutions and military support from Western allies. It then turns to the Nagorno-Karabakh crisis, which demonstrates how constrained media representation limits international policy actions and humanitarian engagement. Finally, the Democratic Republic of Congo underscores the consequences of sustained media neglect in addressing one of the most enduring and devastating humanitarian crises of modern times. This research contributes to a deeper understanding of how Western media narratives influence global governance and policy formation, particularly in addressing human rights crises. It also examines the ethical implications of media coverage, emphasizing the need for balanced and nuanced reporting to ensure equitable and informed policy decisions. By integrating these perspectives, the paper offers insights into how media can better support ethical and effective policymaking in a globalized world.

SOCIAL SCIENCES

Navigating Motherhood and Fieldwork in Post-Conflict and Post-Genocide Contexts

Miriam Greene and Stephanie Wolfe

Weber State University

Although a few books have explored motherhood and fieldwork, none has specifically addressed the complexities of conducting research in post-conflict and post-genocide settings. Fieldwork in these contexts presents unique challenges, particularly for researchers traveling with children. The emotional and psychological impacts on mothers conducting this type of research remain largely understudied. Balancing the dual roles of mother and genocide researcher inevitably shapes one's engagement with the research, particularly during interviews and ethnographic work. Although this does not inherently compromise objectivity, it is important to assess how these experiences influence the research process, if at all. Moreover, women, especially mothers, have historically been underrepresented in academia and fieldwork. Understanding the challenges they face can provide valuable insight into

necessary structural changes to increase their participation. This project seeks to address this gap in the literature.

SOCIAL SCIENCES

Investigating the Source and Veracity of Utah Stereotypes

Ryan T. Cragun,¹ Bethany Gull,² Michael Nielsen,³ Rick Phillips,⁴ and Jesse Smith⁵

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Utah has a distinctive religious subculture fostered by the consolidation of church, community, and kinship ties in the state. This leads to several stereotypes about members of The Church of Jesus Christ of Latter-day Saints in Utah. This paper examines the origin and veracity of these stereotypes by analyzing a stratified random sample of current and former members of the church. We find mixed support for these stereotypes. Current members of the church are more likely than former members to be involved in multilevel marketing ventures, in accordance with a common stereotype. However, they are less likely to use antidepressant drugs, contrary to a pervasive folk belief. Current and former church members do not differ in their use of cosmetic surgery. We find that Utah's religious subculture is evolving, and the primary cultural divide in the state is the demographic and behavioral variance between current and former members of The Church of Jesus Christ of Latter-day Saints.

SOCIAL SCIENCES

Wellbeing, Justice, and Experiential Learning: A Mixed Methods Study of a University Campus Garden

Elisa Diaz and CoCo James

University of Utah

University campus gardens (UCGs) play an important role on their campuses yet are vulnerable to institutional change. Identifying the role of a UCG can potentially ease challenges the garden faces from an

administrative perspective. Through the literature, UCGs have been connected to academics, student wellbeing, and food justice on campus. The objective of this project was to conduct a mixed methods engagement and impact study in collaboration with the Edible Campus Gardens (ECG) at the University of Utah. The study used three focus groups and a survey to gather data on student perspectives of the gardens in addition to feedback on what can be improved within the ECG. Deductive qualitative analysis indicated three major themes: experiential learning, wellbeing, and food justice. Wellbeing was the strongest theme, with students discussing both the social aspect of the garden environment and mental health benefits. Focus group data was used to inform the development of the subsequent survey. Quantitative analysis demonstrated that most students experienced positive outcomes related to the ECG, even when spending relatively few hours in the garden space during their first year. In assessing years in school and time spent in the garden as independent variables, an increase did not necessarily predict more positive outcomes such as deepened education, belonging, or feeling involved on campus; these outcomes were reported by all students to some degree. However, Fisher's exact test revealed that spending more than 10 hours engaging with the ECG was a significant predictor of a positive impact to student personal wellbeing. Although limited in scope, this study served as a pilot for the ECG, providing insight into the varied opinions of engaged students. Additional research on UCGs can improve our understanding of impacts to student experiences and garden connection to health, sustainability, and belonging.

SOCIAL SCIENCES

Utah Lake: The Complex Origins of Shifting Baseline Syndrome

Teri Harman

University of Utah

This paper employs an interdisciplinary lens of historical synthesis, environmental theory, and social aspects of place to explore human relationship with Utah Lake. This large freshwater lake is the center of Utah Valley, ecologically, historically, and physically. Yet, culturally, it is adjacent, even absent. This complicated community connection is a prime example of "shifting baseline syndrome" (SBS), defined as a change in perception of a landscape as it responds to environmental

abuse. Curated memory, accidental forgetting, and the privilege of some stories over others has drastically altered how residents interact with and understand the lake. Once a subsistence haven and vibrant fishery that sustained Indigenous peoples for thousands of years, much changed after Mormon settlement in 1849. Within the first few decades of pioneer stewardship, racial injustices toward the Timpanogos and Ute people, ecological consequences of irrigation and industry, and practical aspects of religious identity created a new version of the valley. The evolution of lake as vital sustenance to lake as a “disabled ecology” is a fascinating journey that cannot be separated from the beliefs and actions of the people living on the shores. In this paper, I explore Utah Valley’s SBS and its effect on human and nonhuman life. Key historical inflection points created new ways of using and perceiving the water. Failures in philosophy, pursuits of capitalism, and broader American patterns contributed along the way. As Utah Valley continues to expand around this central lake, with massive urban and suburban development projects and a steadily increasing population, the severe case of SBS threatens conservation and restoration efforts. This brief but fresh environmental history argues that a robust understanding of these complex confluences opens a path to better ways forward that atone for but don’t repeat the abuses of the past.

SOCIAL SCIENCES

Demographic Survey of a Utah Street Tai Chi Program

Sabrina Espinoza, Cassidy Drage, and Daniel Poole

Salt Lake Community College

Researchers from Salt Lake Community College (SLCC) are working with a local nonprofit organization to collect demographic data on program participants. The organization provides several programs focusing on individuals experiencing homelessness. One of the opportunities is a street Tai Chi program run several days a week at outdoor public locations. The organization has asked SLCC researchers to collect and analyze data about program participants. We have gathered preliminary demographic survey data to help the organization better understand the population they are serving and meet the needs of participants. In this paper, we present updated data and recently collected responses. We evaluate strengths and weaknesses of the program and discuss future research efforts.

SOCIAL SCIENCES

Infrastructure Discrimination in the Westside of Salt Lake City: A Systems Mapping Approach

Sebastian Trias, Morgan Aamodt, and Hyrum Forstrom

Utah Valley University

A salient issue facing Salt Lake City is the food and healthcare apartheid demarcating the east and west sides of the city. This resource inequity disproportionately affects minorities and low-income residents of the city. Similar to many urban areas in the United States, the infrastructure of Salt Lake City, Utah, reflects a history of systemic racism and exploitation of minorities through redlining, environmental racism, wage theft, employment discrimination, a sectarianist monopoly, and other related legislature and cultural attitudes. Today, in addition to disparate healthcare access and food inaccessibility, residents of Salt Lake City's west side are burdened with significantly higher levels of air pollution, hazardous waste, and heavy metals when compared with the predominantly white, affluent east side of the city. Centuries of discrimination have led to the distrust of medical establishments and a gap in general health literacy, causing these marginalized populations to be the most in need of the very resources that are inaccessible and further marginalization for those who rely on welfare. Our research aims to utilize a systems mapping approach, which includes studying underlying patterns, structures, mental models, historical contexts, stakeholders, existing interventions, and feedback loops. In developing a systematic, interrelated understanding of resource accessibility as a complex issue, future interventions and directions will be identified to guide potential avenues for social change in Salt Lake City.

POSTER: ARTS

Empowering Collegiate Dancers: Navigating the Transition to Professional Dance Careers

Samantha Marx and Laurie Wilson

Utah Valley University

Our research explores the challenges that collegiate dancers face when transitioning into professional dance careers upon graduation. Since the outbreak of the coronavirus pandemic, much of the audition process

required to enter a professional dance company has shifted to online formats. Many online requirements include classical and contemporary variations, partnering work, and ballet class technique footage. Additional requirements include professional headshots and dance photos, an updated CV or resume, and a letter of intent to company directors. Although these changes have made it possible for dancers to audition for professional companies without having to travel to each company's location, they have also made it difficult because dancers must navigate each of the online requirements to even be considered for an in-person call back. Our research is relevant to the field of ballet but also to current and future university students because this is new audition territory for dancers all over the country. By meticulously documenting our audition experiences at multiple companies (through in-person and online auditions), we aim to provide insights for current and future university students seeking a company position. Our goal in conducting this research is to help aid students in making the transition from earning their Bachelor of Fine Arts in dance to using that degree as a launching pad as they leave the collegiate world and enter the professional world of dance.

POSTER: ARTS

Illuminating Motion: The Art of Dance and Light Synergy

Anya Adib

Utah Tech University

Background: This presentation explores my creative research designed around the question: how can precise timing in lighting design transform dance performances, enhancing both visual effects and audience engagement? In this session, participants will gain insights into my choreographic research process, with a focus on how lighting became a central element in my creative work. I will show how lighting can influence movement dynamics and contribute to the overall impact of a dance. *Purpose:* My curiosity was first sparked while dancing with my sister, observing how blinds let light come through and create captivating shadow effects. This inspired me to research light across two semesters, starting in my composition class and culminating into my senior capstone project. Thus, the purpose of this research was to experiment with dynamic dance movements and lighting interactions. *Methods:* In my initial research, I discovered a lack of online resources and examples

exploring the specific visual effects I was interested in. This revealed a gap and highlighted an underexplored area in dance and lighting. With the available resources, I drew inspiration from online sources such as David Parsons' "Caught" and other texts on lighting design. To pursue this, I conducted weekly rehearsals and collaborated closely with a lighting designer. Using my research, I sketched lighting concepts and refined them through practical experimentation, setting lights and cues to achieve the desired effects. *Findings/Conclusions:* My research revealed that lighting can be transformative in dance performance; it can alter the perception of movement and guide the audience's eyes. In sharing my findings, I want to showcase for participants how we can understand the relationship between lighting and dancers, as well as how we can push the boundaries of traditional stage dynamics. This approach opens new possibilities for storytelling and audience connection through the synergy of movement and light.

POSTER: ARTS

Mind and Body, East and West Integration: Bartenieff Fundamentals and Laban Movement Analysis Meets Manipura (Solar Plexus) Chakra

Samantha Bickerstaff

Utah Valley University

Human brains need frameworks and systems to make meaning from their experience. We need systems as tools (like language) to conceptualize and categorize ourselves, each other, our environments, and the relationships among them. If two separate systems from different cultural lineages identify a similar pattern, their usefulness for meaning making is increased at their intersection. Yogic spiritual tradition posits a system of energy centers called chakras along the spinal column, each responsible for unique elements of the body and mind, so that each part is essential to the whole and a change in one part reflects a change to the whole. Similarly, Bartenieff Fundamentals, a somatic practice created by Irmgard Bartenieff, posits 6 patterns of total body connectivity (PTBCs) which develop sequentially, each contributing to the development of an integrated being. Irmgard's work was greatly influenced by Rudolph Van Laban's system of movement analysis, which distills movement into the categories of space, effort, shape and body. Each of these systems reflect physical and psychological elements and highlight their interconnectivity. My research synthesizes knowledge of body/mind

integration from Eastern and Western frameworks, highlighting the similarities between the Yogic Chakra System, born in the East, and Bartenieff Fundamentals/Laban Movement Analysis, developed in the West. With focus on upper–lower body patterning from Bartenieff Fundamentals, effort qualities from Laban Movement analysis, and the third chakra (Manipura) from the Yogic spiritual tradition, I emphasize their complementary nature in hopes of providing dance educators and those interested in movement as a healing modality with another possible tool for creating efficient and expressive movement and promoting wholistic well-being.

POSTER: ARTS

Exploring Dance Reels as a Tool for Artistic and Professional Growth

Melissa Long

Utah Tech University

Background: This presentation shares my creative research exploring digital reels. As digital submissions become a key hiring tool, reels must effectively convey movement quality, teaching style, and artistic identity. A dance reel is a short, edited video showcasing a dancer's skills, technique, and artistic vision. Typically 2-5 minutes long, it serves as a visual resume for auditions, job applications, and networking. **Purpose:** My research explores how to share my artistry through both visuals and narrative, using my reel to translate my choreographic process and teaching philosophy into a digital format. Through movement, interviews, and editing, I aimed to communicate not just technique but the deeper intention behind my work, making my artistic voice accessible beyond live performance. **Methods:** My initial research with digital reels began with my dance piece in my university's student dance concert. This project allowed me to explore film as a platform for articulating my creative process. Now, I am expanding my research by creating both a teaching reel and a choreography reel. I followed five key phases: (1) Preparation: Exploring how to present creativity in a digital format; (2) Building: Filming rehearsals, interviews, and moments of me directing dancers; (3) Editing: Structuring footage for clarity and impact; (4) Feedback: Evaluating how my reel is perceived by peers and professionals; and (5) Sharing: Presenting the reel professionally. **Findings/Conclusions:** Authenticity is key—reels should reflect an artist's true style. Short, structured clips are more effective than long,

unedited footage. Teaching reels benefit from voiceovers or subtitles explaining methods. Professional lighting and framing enhance movement quality. When I began creating my reels, I realized the importance of balancing clarity with creativity to authentically represent my movement and teaching style. Future Implications: I will continue refining how my artistry is conveyed through film and use these reels for job applications and networking.

POSTER: ARTS

Escaping to Margaritaville: Exploring Escapism and Identity through Theater

Madisen Rayburn

Weber State University

For centuries, theater has provided a sense of escapism and self-exploration, allowing audiences and performers alike to step outside the constraints of everyday life and immerse themselves in stories that reflect, challenge, and reshape personal and collective identities. Musical theater, in particular, offers a unique avenue for emotional connection, and self-reflection, allowing song and narrative to transport individuals into alternate realities. This research explores how escapism in *Escape to Margaritaville; A Jimmy Buffet Musical* intersects with personal and collective identities, offering insights into the broader function of theater not only as a means of entertainment, but also as a temporary retreat from reality and a means of internal reflection. Through a hands-on assistant directing experience at the Pagosa Springs Center for the Arts, I was able to engage in creative collaboration while analyzing the show's themes, character development, and audience reception. *Escape to Margaritaville*, with its vibrant music and tropical setting, provides an ideal case study for examining how theatrical escapism operates on multiple levels—both within the story itself and in its impact on audiences. The musical's central themes of self-discovery, nostalgia, and the search for happiness highlight the ways in which individuals use theater to explore their own identities, aspirations, and emotional needs. This presentation showcases key research findings, directorial contributions, and personal reflections on how *Escape to Margaritaville* portrays the human desire to escape, not just from daily routines but also from internal conflicts and societal expectations. By examining how audiences respond to the show's themes and immersive qualities, this research sheds light on the enduring power of musical theater as both a

source of joy and a vehicle for deeper self-exploration. Ultimately, *Escape to Margaritaville* serves as a compelling example of how theater creates space for both temporary reprieve and lasting personal insight.

POSTER: ARTS

Reconstructing the Past: Experiencing the Beit Loya Basilica through Virtual Visualization

Tyler Hansel and Brandon Ro

Utah Valley University

This research project explores the intersection of historical reconstruction and modern visualization technologies by developing an immersive virtual reality (VR) experience of the Beit Loya Basilica. The project aims to refine an existing 3-dimensional reconstruction of the Basilica through incorporation of accurate materials and refined environmental elements based on the structural and mosaic remains. The project consists of three phases, beginning with an examination of contemporaneous architecture from the region to ensure accurate materials and details. Second, the model will be refined using the Twinmotion software. This includes adding materials and combining the point cloud data from the existing drone scans of the site's topography with the basilica model to create an immersive digital environment. Lastly, 360-degree panoramic renders will be produced to allow users to experience the digital reconstruction as if they were there. By combining architectural research, digital modeling, and VR technology, this project seeks to advance the role of digital tools in historical preservation and education. VR experiences are a growing development in these fields, and this digital reconstruction is the first of its kind for this site. In conclusion, this VR experience enhances engagement and understanding of ancient architecture, specifically the Beit Loya Basilica. This work contributes to the fields of architecture and preservation, demonstrating how VR can serve as a transformative medium for historical interpretation and public engagement with historical spaces that no longer fully exist.

POSTER: ARTS**Evaluating Educational Environments: Insights from Post-Occupancy Evaluations of School Buildings****Alexandra Elizabeth Mackenna, Brandon Ro***Utah Valley University*

This research explores the impact of architectural design on educational environments through post-occupation evaluations (POE) of school buildings. It focuses on how elements such as natural and electrical lighting, classroom flexibility, temperature, air quality, and acoustic design influence student engagement and performance in elementary schools. It investigates which architectural elements enhance student engagement and teacher satisfaction. Recent studies indicate that well-designed educational spaces can substantially influence academic performance, engagement levels, and overall well-being of students and staff. For instance, Barrett et al. (2015) found that classroom design elements such as light, temperature, and spatial configurations can affect academic progress by up to 16%. Additionally, Herman Herzberger's theories on educational space further explore the practical implications of architectural flexibility in learning environments. Furthermore, the study "Understanding the Impact of School Design on Academic Performance" from Butler Elementary provides essential insights into how flexible, student-centered learning environments significantly enhance educational outcomes. Using a comparative case study approach, this study analyzes POEs from Butler and Odyssey elementary schools, collecting qualitative and quantitative data to assess the impact of architectural elements on educational outcomes. Metrics analyzed will include student learning experience, acoustic comfort, and spatial adaptability, with statistical analysis providing a robust comparison across the case studies. Initial findings suggest that flexible learning spaces, natural lighting, and integration of technology play crucial roles in enhancing educational experiences. These insights are expected to contribute to the design of future educational facilities by emphasizing features that align with modern pedagogical needs. Although the findings advocate for integrating flexible learning spaces and natural lighting, challenges such as budget constraints and regional architectural norms may affect the implementation of these recommendations. This study contributes to the architectural field by offering evidence-based design recommendations and helps stakeholders understand the long-term impacts of school design on educational outcomes.

POSTER: ARTS

Textures of Faith: The Significance of Textures in Hindu Temples and How They Can Shape Spiritual Experiences

Beverly Cademis and Brandon Ro

Utah Valley University

This study will analyze the occupants' experiences with sacredness in Le Corbusier's La Tourette Monastery. The architectural style of the monastery is Brutalism, which is a style of building that emerged in the 1950s during the post-war era. The Oxford Dictionary defines it as "a style of architecture or art characterized by a deliberate plainness, crudity, or violence of imagery." In this research, we will examine whether the architectural qualities of the building encourage or deter spiritual reflection, contemplation, and emotional comfort. This research will make use of Julio Bermudez's database of extraordinary architectural experiences, together with users' qualitative data in the form of survey results of their experience with La Tourette Monastery. The results will be analyzed and characterized using the statistical software Jamovi. This research will reveal how the building's austere architecture affects the emotional and physical comfort of the occupants. We expect the results to show that the building provides a meaningful emotional and spiritual experience for visitors. The findings will add to discussions on architectural forms and religious/spiritual experiences. To further this research, the next step would be to conduct a survey of the people who reside there permanently to see if the experience remains the same.

POSTER: ARTS

Monochrome versus Color: How Architectural Color Choices Affect Visual Attention in Cayalá, Guatemala

Juliana Martinez and Brandon Ro

Utah Valley University

This research explores how cultural values influence the use of color in architecture by comparing the mostly white design of the City of Cayalá in Guatemala to a more colorful design. Using the eye-tracking simulation, 3M Visual Attention Software (VAS), this study will analyze

which version captures more attention. Color plays a significant role in how people experience architectural spaces. Whereas most research focuses on how color affects interiors, few studies explore its influence on larger built environments. Cayalá's monochromatic aesthetic is inspired by classical architecture. However, Latin American cities often use vibrant colors that reflect their culture. By comparing these two approaches, this study looks at how different color choices affect how people visually engage with architecture. This study compares Cayalá's white design to a digitally modified version with added color. Architectural drawings of residential homes in Cayalá will be studied, and a colorful version will be created for comparison. The study will use the artificial intelligence–driven 3M VAS simulation to determine which version of the architectural drawing captures more attention. It is predicted that the colorful version will attract more visual attention. This research will determine whether adding color increases visual engagement with architecture. This will provide insight into how color influences design and help make architecture more visually engaging for its audience.

POSTER: ARTS

Form Follows Function? How Civic Architecture Speaks to the Public

Sadie Stutz, Davis McDermott, and Brandon Ro

Utah Valley University

American architect William Strickland stated, “Buildings of a public nature ought to express in their design the uses and purposes for which they are erected; so that when we behold a Church, Bank, Courthouse, Prison etc. we may understand them to be such from some external characters in the design without the aid of a painted sign or inscribed tablet.” Observing a shift in style of civic architecture in the United States—from traditional to more contemporary forms—we seek to test Strickland's theory by examining how this change affects public perception of a building's purpose and function. A 2024 study by Brandon Ro and Hunter Huffman found that 72% of Americans prefer federal buildings with traditional architecture over modern designs. Our study seeks to determine whether the shift from traditional to contemporary civic architecture has affected the public's recognition of building function. To test this relationship between form and function, we will conduct a public survey. Analyzing basic demographics such as

age, gender, and occupation, participants will be shown 12 images of libraries, city halls, and high schools from various architectural styles across the United States. They will be asked to identify each building's function based solely on its form. This will test our hypothesis: whether the public can discern a building's function from its form. We will compare our results to a prior study that used artificial intelligence eye-tracking software to analyze public perception of civic architecture using the same twelve images. We aim to identify relationships between architectural style—traditional or contemporary—and public recognition of civic buildings. If traditional architecture is more recognizable, does this mean architects should favor classical styles, or conversely, is it a sign that public preferences are changing? We hope these insights will inform and inspire the design of future civic buildings in the United States.

POSTER: ARTS

Evaluating Biomimetic Architecture Through Eye-Tracking Analysis

Dallin R. Hansen and Brandon Ro

Utah Valley University

Biomimicry has long served as an essential framework in architecture, influencing design at both explicit and subtle levels. This research examines how biomimetic principles affect visual engagement through eye-tracking analysis, utilizing 3M Visual Attention Software (VAS) to assess human interaction with architectural forms. The study focuses on Beijing's Water Cube and Bird's Nest—two highly publicized examples of explicit biomimicry—contrasting them with Frank Lloyd Wright's Allen-Lambe House, a more restrained example of biomimicry that integrates organic principles into form and function without direct imitation. Prior research in architectural perception suggests that organic design elements can influence wayfinding, attention retention, and emotional response, yet little work has directly compared explicit and abstract biomimicry using quantitative eye-tracking data. This study measures visual engagement with these contrasting approaches to evaluate whether literal biomimetic structures hold attention more effectively or if subtler applications foster a deeper, more sustained interaction. The methodology involves eye-tracking simulations using 3M VAS to simulate and capture fixation duration, gaze distribution, and attention heatmaps. These results will provide empirical evidence on

whether overt biomimetic structures successfully engage users or if a more integrated, organic approach—such as that seen in Wright’s Allen-Lambe House—proves more effective in maintaining visual interest. Findings from this study will contribute to the broader discourse on biomimicry’s role in architectural design, offering insights that may inform future biomimetic research, urban planning, and the practical application of organic design principles.

POSTER: ARTS

Il Duomo Unveiled: The Role of Architecture in Shaping Extraordinary Experiences at the Cathedral of Santa Maria del Fiore

Levi Parry and Brandon Ro

Utah Valley University

The Cathedral of Santa Maria del Fiore, also known as Il Duomo, is famous for its captivating architecture and spiritual significance. Using survey data collected by Dr. Julio Bermudez, president of the Architecture, Culture, and Spirituality Forum, this study aims at exploring the phenomenon of extraordinary architectural experiences (EAEs) through analysis of patterns in demographic variables, descriptive accounts, and emotional responses in the statistical analysis software Jamovi. This is done to answer a central research question: which architectural elements of Il Duomo play a role in EAEs, and how do they affect visitor perception across multiple demographics? Findings indicate that the women who participated in the survey tended to have stronger emotional and physical reactions, such as weeping, to the grandeur of the cathedral, whereas men engaged with the space in a more analytical, yet still deeply emotional manner. Additionally, those aged 25-40 years reported the most intense experiences. Participants highlighted specific elements in their accounts, such as the intricacy design, the vastness of the space, the musical ambience, and the interactive journey through the dome’s inner structure played significant roles in the EAEs. Studies conducted by Julio Bermudes and Brandon Ro suggest that similar elements in other iconic structures, such as the Pantheon, Chartres Cathedral, and Ronchamp Chapel evoked similar EAEs. Future research should expand to a large and more diverse participant pool. This study was based on data from 7 participants, all of whom had architectural backgrounds, which may have influenced their perceptions. Including a broader range of individuals—especially those

without prior exposure to architectural studies—would enhance understanding of how different backgrounds shape this type of emotional experience. Additionally, such research could inform architects in designing spaces that lead to similar spiritual and transformative experiences.

POSTER: ARTS

A Comparative Analysis of Two Gothic Cathedrals Separated by Space and Time

Sinikka Lee

Utah Valley University

Through the process of drawing an analytique layout after the Beaux-Arts style, this analysis compares the composition of two distinct Gothic churches, searching for architectural similarities, exploring the idea that styles can remain relevant through time and space. These buildings were chosen for their similar Gothic styles and differing constructive expressions, times, and locations. I expect to find comparative similarities, which would suggest that traditional designs can remain relevant despite changing cultures, times, and spaces. The Orvieto Chapel in Italy, built in the Gothic period, is renowned for its frescoes and highly decorative detailing, featuring mosaics and ornament made of marble, gold and bronze. Alternately, Grundtvig's Church in Denmark, constructed in the early 20th century, embodies a simplified, modern expression of Gothic architecture, relying solely on yellow bricks for its more simplified, yet calculated construction. Both structures leverage monumental scale, bold geometry, and the power of light, to evoke a sense of awe and divine presence. The exterior facades reveal similar massing when compared side by side, sharing similar hierarchies, rhythms, angles, positioning of details, with major angled elements converging at the same point. The roots of the designs are very similar, although their expressions are comparatively distinct. A geometric analysis revealed a common relationship of $1:\sqrt[3]{}$ is used extensively throughout both building's designs. The repetitive use of the cube root unifies the designs and can symbolize wholeness, perfection, and divinity, properly fitting the context. Limitations exist in the analysis because drawings were based on photographs rather than measurements, although great efforts were made to represent the building's massing accurately. Through a visual analysis of these distinct buildings, connections were found at the roots of their designs, which reinforces

the notion that architectural thought finds continuity and relevance across centuries, cultures, and styles through the bridge of human experience.

POSTER: ARTS

Finding Beauty in Balance and Cost: Analyzing the Evolution of Mobile Homes

Hayden Fleming and Brandon Ro

Utah Valley University

Affordable housing is a problem we have been combatting for years. A hundred years ago, the shotgun home was the solution: a simple room-to-room rectangular structure. This form eventually evolved into the mobile home. Although mobile homes are affordable, they create unwelcome environments because of their lack of visual appeal. By studying the aesthetic evolution from the shotgun to mobile, I aim to use the findings towards designing a solution where affordability and beauty are met, creating a happier, more architecturally cohesive piece of society. The research involved using eye-tracking technology (3M Visual Attention Software) to analyze where the visual attention is focused on two traditional shotgun homes and two mobile homes. To eliminate distractions and bring focus to the homes' architecture, the images were rendered into pen drawings. This comparative analysis revealed which architectural elements captured visual interest and which were overlooked. The results informed the design of a new mobile home to see whether a different design could hold more attention. The software showed that although the mobile homes were successful in grabbing the eyes' attention at the point of entry, they failed to retain attention outside of that area. Although the shotgun homes were not the first to grab attention, shotgun 1 proved to have on average more visual attention than the mobile homes. Once the design was added, it dominated attention across all fields with an average visual attention score of 84.5% compared with the next largest score of 54%. By studying past and present forms, a more visually appealing mobile home can be achieved. Although the proposed design would increase the cost, it would remain much more affordable than any regular home, proving that beauty and affordability can be balanced.

POSTER: BIOLOGICAL SCIENCES

In the Cold Blood: Prevalence of Parasites in Utah's Reptile and Amphibian Species

Kyle Sparks and Jonathan Marshall

Weber State University

Interactions between hosts and parasites are complex and involve an interplay of environmental conditions, genetic diversity, and length of time of association. For reptiles, ticks and mites are some of the most common ectoparasites. Ticks and mites are final hosts and vectors for haemogregarines, a common unicellular parasite found in red blood cells. In this study, we surveyed several reptile and amphibian species in Utah to understand differences in parasite loads between native and invasive species and between species that use sexual and those that use asexual reproduction. We captured specimens over a span of four months (May to September 2024). Reptiles and amphibians were captured by hand. We recorded the species, the location and elevation, and its snout to vent length. We then took a small piece of its tail or toe and did a blood smear from the cut for microscope analysis. Results are still ongoing as several possible positive results await molecular confirmation, bringing to question what species in Utah could carry the parasite.

POSTER: BIOLOGICAL SCIENCES

Mapping Zoological Baselines through Time in the Bear River Range: When Archaeology Meets Wildlife Science

Auriana Dunn, Kasey Cole, Austin Green, Tyler Faith, and Randal Irmis

University of Utah

Zoological baselines are key data sets when evaluating climate issues and wildlife conservation projects. This project looks at three types of ecological surveys in the Bear River Basin: 1) a zooarchaeological survey of two cave assemblages; 2) modern camera trap data, and 3) modern museum live trapping surveys. The first survey, using cave assemblages of animal skeleton remains, included remains from Boomerang Cave and Thundershower Cave, in the Bear River Range of Cache County in northern Utah. There were 1,938 specimens analyzed

between the two caves. These deposits showed a distribution of species class size expected from known species diversities, and most of the mammalian diversity expected in the area. The other two surveys, camera trapping and live trapping, both bias certain size classes over others. When analyzing the data sets together using machine learning techniques, a zoological baseline can be created for the paleontological and modern Bear River Range. This information then can be analyzed in relation to climate issues and wildlife conservation, to see if and how the baseline has changed over time.

POSTER: BIOLOGICAL SCIENCES

Identifying Cranial Specimens of Utah Species of *Lepus*

Arianna Harrington and Ethan Rowland

Southern Utah University

Three species of *Lepus* (*Mammalia*, *Lagomorpha*, *Leporidae*) are native to Utah: *L. americanus* (snowshoe hare), *L. californicus* (black-tailed jackrabbit), and *L. townsendii* (white-tailed jackrabbit). Although live specimens are easily identified based on external characteristics and habitat preferences, skulls of leporids show relatively little variation within the family, making their identification challenging in isolation of other specimen information. This is particularly true for the skulls of *L. californicus* and *L. townsendii*, which show broad overlap in basic cranial metrics including greatest skull length. To further study the differences between the cranial anatomy of these three species, cranial measurements were collected from 38 *L. americanus*, 130 *L. californicus*, and 118 *L. townsendii* specimens housed in the mammalogy collections of the Natural History Museum of Utah, University of Colorado Museum of Natural History, and Denver Museum of Nature and Science. Crania of *L. americanus* were distinguished from those of *L. californicus* and *L. townsendii* by having a shorter greatest length from the inion to the anterior surface of the first incisors ($p < 0.0001$). To characterize differences between *L. californicus* and *L. townsendii* specimens, a linear discriminant analysis (LDA) was performed using 15 commonly preserved cranial measurements as a predictor of species identity. Measurements that explained the highest variance in the model included those that characterized the dimensions of the rostrum and basicranium. A jackknifed validation was performed to evaluate the LDA and resulted in 95% accuracy. These results suggests that LDA of cranial metrics may be used to distinguish crania of *L. californicus* and

L. townsendii with a high degree of accuracy. Potential applications include identifying cranial material of these species in poorly documented specimen collections or in zooarchaeological contexts where there is range overlap of these species.

POSTER: BIOLOGICAL SCIENCES

A Look into Frugivorous Interactions with *Psychotria* and *Palicourea* Genera on Barro Colorado Island, Panama

Noelle Beckman, Jerry Schneider, Elsa Jos, and Madison Smart
Utah State University

Seed dispersal is a vital ecological process that influences plant population dynamics and ecosystem structure. Many plants rely on frugivorous animals to disperse their seeds. This study examines the interactions between frugivorous birds and fruiting plants of the *Psychotria* and *Palicourea* genera on Barro Colorado Island, Panama. Specifically, we investigate the preferences and interaction levels of avian seed dispersers with these plant species. Data were collected using camera traps located near fruiting plants, capturing interactions categorized by levels of engagement. Preliminary results indicate that red-capped manakins and keel-billed toucans had the highest interaction levels with certain *Palicourea* species, with red-capped manakins being the only species to remove fruit from all observed plant species. Further data analysis is ongoing to quantify interaction scores and summarize trends. This research contributes to understanding the ecological relationships between frugivores and plants, with implications for seed dispersal effectiveness and tropical forest dynamics.

POSTER: BIOLOGICAL SCIENCES

Comparison of Different Methods to Analyze the “Autistic” Zebrafish Transcriptome

Marina Sidenko and Jim Hutchins
Weber State University

Autism spectrum disorder (ASD) is recognized as a “different wiring” of the brain, leading to challenges with social interactions, rapid behavioral

changes, and repetitive interests. Although there is not one gene or environmental factor solely responsible for ASD, one current hypothesis is that there is a failure of weak synaptic contacts to be pruned and therefore an overproduction of synapses relative to the neurotypical brain. The hyperactivation of specific intracellular pathways that help synapses avoid pruning, such as mTOR and Akt, may tilt the developing brain toward the ASD phenotype. We are studying the possible overproduction of synapses between the ganglion cells of the retina and the optic tectum using zebrafish (*Danio rerio*) as a model of ASD. In this model, zebrafish are treated with valproic acid (VPA). VPA is a commonly used drug in the treatment of bipolar disorders, epilepsy, and schizophrenia. ASD characteristics have been found in children born to mothers who consume VPA during pregnancy. Using zebrafish treated with VPA, we aim to quantify the levels of gene expression among key genes involved in the formation and pruning of synapses. Here, we compare quantitative RT-PCR, gene arrays, and RNA sequencing as three potential approaches that can yield the necessary results, with each method offering distinct strengths and weaknesses.

POSTER: BIOLOGICAL SCIENCES

Investigating the Role of mTOR-Akt Signaling in Retinotectal Arborization and ASD-like Behaviors in Zebrafish Exposed to Valproic Acid

Norah Mead-Fajardo, Sylvia Martinez, and Selafina Ngalu

Weber State University

Autism spectrum disorder (ASD) is a neurodevelopmental condition associated with social interaction deficits, repetitive behaviors, and communication challenges. An environmental factor that is linked to ASD is prenatal exposure to valproic acid (VPA). VPA is a medication that is commonly used to treat epilepsy and mood disorders. Exposure to VPA during early brain development has been shown to increase the risk of ASD. However, the molecular mechanisms behind this are not well understood. This project aims to investigate the role of the mTOR-Akt signaling pathway in ASD-like behaviors using a zebrafish model that has been exposed to VPA. Our primary focus is on retinotectal arborization, which is a process of synaptic pruning essential for proper brain wiring during development. Zebrafish offer an ideal model because of their transparent embryos and rapid development. This allows for direct observation of neural structures. Because of difficulty seeing the

tectum, we will employ the FlyClear protocol to remove pigmentation from the zebrafish larvae. This will ensure clear imaging of the brain. Embryos will be treated with VPA from 0 to 48 hours postfertilization, and the development of retinotectal arbors will be analyzed using a confocal microscope. We will also explore the effects of rapamycin, which is an inhibitor of the mTOR pathway, to determine whether it can reverse VPA-induced neural and behavioral abnormalities. By examining the role of mTOR and Akt in ASD-like behaviors, this research aims to improve understanding of the molecular mechanisms involved in ASD and evaluate potential therapeutic strategies.

POSTER: EDUCATION

A “Formula” for a Perfect Youth Soccer Story

Faoiltiarna (Lilly) Schlenker, Cassidy Lamm, Halle Taylor, and Whitney Blanchard

University of Utah

A rise of interest in sports-related youth literature in the United States is pushing educators to seek out increasingly more sports stories for their libraries. One sport in particular gaining recent national popularity is soccer, and thus soccer-related literature is also increasingly popular. Many of these soccer stories are memoirs or biographies by and about well-known athletes and retell their journeys as player; this style of book can often be more difficult, and potentially too didactic, for young readers who may be newer to both reading and soccer. In this study, we examined fictional stories that potentially combine the authenticity of true soccer with the excitement and reading level of the middle-grades. We examined the in-print young adult literature where soccer plays an integral role to the plot. Using our predesigned and pilot-tested codebook and codes, we began by recording trends in elements such as plot, settings, and themes. We considered character traits related to gender, ethnic, and socioeconomic diversity, and went beyond to examine positions played, skill level in soccer, attitudes towards soccer, and relationships between characters. We further recorded the amount and types of “soccer” present in each title, from informal play to practices and games to simply talking about soccer. Thus, this content analysis provides a unique and accurate lens into the current state of youth soccer literature, considering the intersectionality of identities and elements of the sport itself leading to a stronger understanding of current middle-grades sports literature in general.

POSTER: EDUCATION**The Effectiveness of Mastery Quizzes****Willow Park and Caleb Hiller***Southern Utah University*

Success rates of introductory chemistry classes remain a challenge in many academic institutions. In this study, we introduce the concept of midterm quizzes as a supplementary tool to aid students in mastering challenging topics before exams. These quizzes, implemented in the days leading up to exams, allowed for multiple attempts with the best score retained. Various question pools ensured comprehensive coverage of course material. To incentivize participation, a percentage of the examination score was tied to performance on these quizzes. Comparison of classes with and without midterm quizzes revealed significant improvements in examination scores. Student feedback indicated perceived benefits in examination preparation and overall course performance. This study underscores the efficacy of midterm quizzes in enhancing student success in introductory chemistry courses. There is the potential to expand it out to other disciplines as well.

POSTER: ENGINEERING**Ritual Sequence at the Byzantine Church Complex:
Mapping Liturgy of the Word and Eucharist onto the
Byzantine Church Complex at Horvat Beit Loya****Emily Pederson and Brandon Ro***Utah Valley University*

This research explores the spatial and ritual relationship between liturgical practices and architectural evolution within the Byzantine church complex at Horvat Beit Loya. Specifically, it seeks to map the sequence of the Liturgy of the Word and the Eucharist onto the church's evolving floor plan, focusing on two key construction phases: Phase 1 and Phase 2. Analyzing archaeological evidence, historical texts, and architectural analysis has informed the results of reconstructing how ritual movements were shaped by and influenced the spatial configuration of the church. Although previous research has explored Byzantine church architecture and liturgical tradition, limited research has directly mapped ritual practices onto evolving floor plans. This study

addresses that gap by synthesizing historical liturgical sources with architectural and archaeological findings. In particular, it considers how architectural modifications—such as the addition of the north chapel in Phase 2—may reflect evolving liturgical needs. Methodologically, this study employs a comparative and inductive approach, integrating primary textual analysis of early Christian Fathers with archaeological site data. Floor plan analysis of Phases 1 and 2 will help map ritual sequences, identifying key architectural elements like the nave, apse, and ambulatories as central to liturgical movements. Expected results include a ritual map of both the Liturgy of the Word and the Eucharist rituals on the Beit Loya church complex's floor plan. Additionally, results may include a clearer understanding of how sacred architecture facilitated ritual practices and how modifications reflected theological or liturgical shifts. This research contributes to architectural history, Byzantine religious studies, and the broader discourse on how space and ritual interact to shape sacred experiences in historical Christian worship.

POSTER: HUMANITIES, PHILOSOPHY, AND FOREIGN LANGUAGE

Ethical Analysis of Discriminatory Restrictions of Euthanasia and Physician-assisted Suicide

Brielle Bratton, Ben Baumann, and Maddison Griffin

Snow College

We have been tasked with creating an ethical analysis regarding the discriminatory factors concerning physician-assisted suicide and euthanasia laws, specifically the 75+ age restriction mentioned in the proposed D66 from The Netherlands. The methods of research we will be conducting include but are not limited to traveling to Rome, Italy, to talk to scholars and ethicists in the Vatican who are leading experts in their field of end-of-life care and the ethical dilemmas surrounding it. We will also be meeting with Nobel prize winners to discuss our research. We have also done research online through scholarly articles written by the scholars we will be meeting with in Rome and research done through worldly scholarly organizations online. We have learned through our professor different ethical views that have broadened our scope of understanding of bioethical philosophy for this topic as well. Our main question regarding our research is “How we can avoid and have the ability to define discriminatory factors in euthanasia laws?”

POSTER: HUMANITIES, PHILOSOPHY, AND FOREIGN LANGUAGE

Human Corpses and Consent

Miranda Slusser, Amy Sullivan, and Savanna Thompson

Snow College

A research group, consisting of three students of Philosophy 2050 at Snow College led by Dr. Gregory Wright, must complete the primary assignment of a semester-long research project, culminating in a written report and a live presentation given to peers, professors, Snow College students and faculty, and the Utah Academy of Science, Arts, and Letters (UASAL). The research group will work together to research and address numerous questions consisting of ethical dilemmas surrounding the use and treatment of human corpses, especially as concerning the Body Worlds exhibit, to offer real-world recommendations to the stakeholders related to the case. The project began on January 8, 2025. The student committee will be traveling to Rome, Italy, on February 28, 2025, to March 9, 2025, to conduct further research, including the opportunity to interview world-renowned experts in ethics, to gain further insights through their expertise to incorporate in the research and recommendations presented. The initial presentation will be given while abroad to a body of peers, professors, and experts in the field of ethics. There will be the opportunity to engage in questions and answers toward the end of the presentation, where the valuable feedback received will contribute further to the research. With the research conducted in Rome and the feedback received after their initial presentation while there, the research group will further edit and refine their presentation and report, in preparation of presenting to the UASAL Conference held on March 22, 2025. With the knowledge gained through engagement after the second presentation, the group will revise and edit their written report.

POSTER: KINESIOLOGY AND HEALTH SCIENCES

Neural Devices

Kaleb Smith, Olivia Malouf, and Esther Simpson

Snow College

Should the FDA evaluate the ethics of neuro-implantable devices for functional recovery before granting approval? If so, at what point in the

process? This report examines these questions by exploring the broader implications of this technology.

POSTER: KINESIOLOGY AND HEALTH SCIENCES

Eating Disorders: Treating the Underlying Mental Illness

Darci Barker

Salt Lake Community College

Eating disorders rates have increased by affecting or potentially affecting 28.8 million Americans. The wide ranges of eating disorders, such as anorexia nervosa, bulimia nervosa, binge eating disorder (BED), or avoidant restrictive food intake disorder (ARFID), can be treated in various ways, including psychotherapy, medical care/monitoring, nutrition counseling, and medications. Findings show cognitive behavioral therapy (CBT) and interpersonal psychotherapy (IPT) are the most effective. With exception for other forms of eating disorders. Residential treatment for severe cases has also been found to be more beneficial than program treatment. Furthermore, underlying mental illnesses, such as obsessive-compulsive disorder, anxiety, or depression, often contribute to the development of eating disorders. By addressing these mental health conditions, rather than the eating disorder itself, patients can experience better long-term recovery outcomes. Taking this integrated approach by focusing on mental health while continuing to target eating disorders like CBT and residential care yields the best outcomes for recovery.

POSTER: HUMANITIES, PHILOSOPHY, AND FOREIGN LANGUAGE

Medical Miracles: Examining the Ethical Implications of Government Intervention

Joshua Cox, Hattie Stubbs, and Kathrine Crouch

Snow College

Utah's Health and Human Services Committee, comprising members from the Utah Senate and the Utah House of Representatives, is reviewing laws that deal with parents and their rights in their children's

medical care, specifically, parents refusing life-saving medical attention for their children and choosing to hope for a miracle. Although this type of situation is not common, it has occurred multiple times. In this thought experiment, assume that the Utah Health and Human Services Committee has tasked our bioethics team to review and analyze current laws and provide our thoughts and suggestions for new laws. After an initial review of the case, we believe that it is the duty of the State to preserve the health, wellness, and/or life of a child—even if it is against the wishes of the legal guardian with or without religious reasons—when medical intervention would beyond a reasonable doubt improve the minor’s condition. In the case where competent medical professionals agree that the odds of success are low, the rights of the guardians are upheld fully; they are to make a decision for their child’s care. Given this, we recommend the state provide general education for the guardians regarding medical procedures prior to the guardian’s decision going into effect.

POSTER: KINESIOLOGY AND HEALTH SCIENCES

Physiological Effects of Pickleball and Skill Level

Zachary Holt, James Zagrodnik, and Ryan Zimmerman

Weber State University

The Sports & Fitness Industry Association announced that pickleball was the fastest growing sport in the U.S. the last 3 years, with an 185% increase over this timespan. To date, only two studies have been conducted on the game and its impact on peoples’ health and physiological changes. It is unknown whether pickleball players at different skill levels respond physiologically differently during game play. The purpose of the current study was to identify the physiological effects of pickleball based on skill level. To date, 191 recreational pickleball players have participated in this study. Each participant wore a Hexoskin biometric shirt during play, which continuously measured physiological variables, including heart rate, breathing rate, and cadence. The study protocol included a 5-minute resting period, followed by 30-45 minutes of recreational pickleball play against opponents of matched skill levels. Pickleball players across all skill levels reported similar levels of perceived effort and high enjoyment while playing. However, physiological responses such as increased breathing rate, heart rate, and cadence were significantly correlated with skill level, with higher-skilled players demonstrating greater values in these measures, including

percent maximum heart rate. These findings suggest that higher-skilled players exhibit greater movement intensity and require a higher level of cardiorespiratory fitness and stamina to sustain play compared with their lower-skilled counterparts. This study highlights the elevated physiological demands placed on higher-skilled players during pickleball. As skill level increases, so does exercise intensity, enabling players to achieve the health-enhancing benefits associated with moderate physical activity through pickleball participation.

POSTER: KINESIOLOGY AND HEALTH SCIENCES

Implementing Walk with a Doc at Weber State University

Saori Hanaki, Kelsey Hansen, and Amber Palmer

Weber State University

Despite the recommendation to exercise for improved health and disease prevention, many people do not comply. Suggested barriers to exercise have included low energy and lack of motivation, education, time, and confidence among others. Suggested motivators to exercise have included social groups, a partner to exercise with, and verbal communication from a healthcare provider. As a solution to the problem, plan to implement a successful Walk with a Doc (WWAD) program at Weber State University.

POSTER: KINESIOLOGY AND HEALTH SCIENCES

Exploring the Impact of Weber State University's Lifelong Learners Program on Physical Activity Among Elderly Students

Jeffery Kurt Ward

Weber State University

This qualitative study explores the impact of Weber State University's Lifelong Learners Program (LLP) on the physical activity levels, motivations, and social engagement of older adults. Using a phenomenological case study approach, semistructured interviews were conducted with LLP participants aged 62 years and older. The study aimed to understand how program participation influences exercise

habits, supports adaptation to age-related physical changes, and fosters social connections.

POSTER: PHYSICAL SCIENCES

Raman Imaging of Carbon Materials

Seth Stringham and Dustin Shipp

Utah Valley University

Graphene, a single-atom-thick layer of carbon, is a focal point in various research fields because of its unique properties. With researchers developing new methods to create this material, it is crucial to establish tools to confirm the authenticity of graphene samples. This study investigates the use of spatial Raman imaging to identify variances and detect defects in carbon-based materials. By applying spatial imaging techniques to various samples, we aim to map structural irregularities and variations across the sample surfaces. Hyperspectral Raman imaging provides detailed insights into vibrational properties, enabling the visualization of layer thickness and the detection of defects such as impurities or dislocations. This approach could enhance the ability to identify and analyze imperfections in graphene, improving material quality control and advancing research in carbon-based materials for various applications.

POSTER: PHYSICAL SCIENCES

Indirect Detection of Dark Matter in Dwarf Spheroidal Galaxies

Spencer Brickey, J. Leonardo Yucra, and Jonathan Cornell

Weber State University

Dwarf spheroidal galaxies (dSph) are particularly promising targets in the search for gamma-rays from dark matter annihilation because of their low astrophysical background, high dark matter to baryonic matter ratio, and proximity to the Milky Way. In this work, we estimate the effect J-factors of 22 dSph for dark matter annihilations: s-wave, p-wave, d-wave, and Sommerfeld-enhanced. We present constraints on the cross section for these various annihilation types using Fermi-LAT data as analyzed by the publicly available tool MadHAT.v2

POSTER: PHYSICAL SCIENCES

A Pilot Study Investigating Virtual Reality for Chemical Education

Kaden Jensen and Matthew Prater

Southern Utah University

Connecting 2D molecular structures to their 3D counterparts can be exceptionally challenging for students studying chemistry, especially in the context of stereochemistry and symmetry. Many students struggle with visualizing the spatial arrangement of atoms, which is crucial for predicting molecular properties. Virtual reality (VR) can be useful to bridge this gap of understanding by allowing students an immersive experience to interact with the 3D structures next to their 2D drawings. As no user-friendly application existed, we built a new VR program to help students internalize this important relationship. Our application was specifically designed to simplify difficult spatial reasoning by allowing them to rotate the 3D models. We used student survey data to examine student perceptions of the utility of this learning modality.

POSTER: PHYSICAL SCIENCES

Benefits of Utilizing the ACS Manual Throughout CHEM 1210

Caleb Hiller, Claire Neuberger and Fernanda Perez

Southern Utah University

The America Chemical Society (ACS) standardized test is widely used to measure students' comprehension in chemistry courses. At the completion of each semester students in CHEM 1210 take this exam and receive their percentile rank. Traditionally, students rely on the ACS Study Guide only in the last couple of weeks of school, a method that has proven ineffective in improving final grades. This study investigates whether integrating the ACS Study Guide throughout the course improves student performance. Selected problems from the guide were assigned alongside regular coursework. Additionally, students completed surveys after each midterm, allowing us to determine its perceived effectiveness. After the first examination, 53.3% of students believed that the ACS Study Guide should be incorporated into future iterations of this course as a valuable practice tool. However, its

effectiveness in preparing for the first midterm was rated as an average of 6.17/10. Although students recognize its potential benefit for the final examination, they find that it adds more to their workload for the course. As one student noted, "I really think the ACS homework is a practice for the ACS test, but I don't think it is much more help for regular exams than just the regular homework we have to do."

POSTER: PHYSICAL SCIENCES

Effects of Heavy Metal Uptake in the Growth and Development of *Lactuca sativa* L.

Audrey O'Donnal, Riley Jackson, and Braden Robinson

Utah Valley University

Heavy metal pollution concern in Utah soils is increasing with a greater number of local excavations have been subject to study. The intention of this research is to add to the hypothesis that heavy metal exposure affects plant growth. Research so far has indicated that plant exposure to heavy metals can directly affect plant growth and development. To test this, two different experiments, using *Lactuca sativa* L were performed. First, we sowed 10 seeds into 12 individual pots with soil contaminated with 200 ml of a 50-ppm stock solution containing chromium (Cr), bismuth (Bi) cobalt (Co), copper (Cu), zinc (Zn), nickel (Ni), and cadmium (Cd). An additional 12 pots were sown in soil contaminated with 200 ml of a 10-ppm stock solution using the same metals; 12 pots were not contaminated to serve as our control. 12 petri dishes contained only sterilized water to serve as a control. To further define which heavy metal could be impacting the seeds, we tracked the germination rate of 960 seeds by placing 20 seeds in an individual petri dish containing a 10-ppm stock solution and a 50-ppm stock solution from one of the aforementioned heavy metals. Germination rates were tracked over a period of two weeks.

POSTER: SOCIAL SCIENCES

The Paradox of Protest: Political Dissatisfaction and Satisfaction with Democracy

Kendra Pinegar

Brigham Young University

This paper examines the relationship between dissatisfaction with government performance, political protests, and democratic satisfaction. Although protests are often seen as a symptom of failing democracies, this paper argues they can instead reinforce satisfaction with democratic institutions by empowering citizens and showcasing the protection of democratic rights. Using data on political mass mobilization and democratic satisfaction, the study finds a nuanced, nonlinear relationship: protests initially correlate with decreased satisfaction, but frequent protests eventually enhance it, reflecting increased appreciation for democratic protections. These findings highlight the need to distinguish satisfaction with democracy from evaluations of government performance and offer new insights into the role of protests in democratic systems.

POSTER: SOCIAL SCIENCES

Perceived Financial Threat and Fear of Financial Crime

Heeuk Dennis Lee, David Kim, and Liz Homez Gonzalez

Weber State University

The current study examines the relationship between perceived financial threat and fear of financial crime. Fear of crime has received substantial attention in the criminological literature; however, only a limited number of empirical studies are available on fear of financial crime. Also, most existing studies that measured fear of crime have relied upon young adult samples from colleges. As financial crime victimization has become an essential area of research, more empirical studies into the fear of financial crime among the general public are needed. Using an online American fear survey from a market research firm, results indicate that perceived financial threat was positively associated with fear of financial crime among participants. Limitations and future studies are discussed.

POSTER: SOCIAL SCIENCES**Gym Culture and Self-Perception****Joshua Mullen, Kimberly Jones, Adilen Yanez Maciel, and Tom Hanson***Salt Lake Community College*

For many years the gym has been seen as a place to improve one's body image. Research has backed this up and says that the gym does help improve body image. However, it seems that after a certain amount of years, and the more experience you gain, the effects wear off and sometimes start negatively affecting body image. One reason this could be is because of the presence of fitness influencers on social media. Some influencers have started trends that focus on how the gym made them start hating their bodies. Our research aims to figure out the correlation between one's self-perception and the amount of time spent in the gym. We will recruit our participants by hanging up flyers in gyms in the Salt Lake area. Participants will fill out our survey that contains multiple inventories relating to physical activity, commitment to exercise, and self-perception. After collecting and interpreting the data, we will see whether there is any correlation between one's self-perception and how long the participant has been active in the gym.

POSTER: SOCIAL SCIENCES**Temporal Discounting in Dating****Jayden Back, Rebecca Lake, Sam Luker, Annalee Howes, and Nick Marsing***Snow College*

In everyday life, there are countless different relationships when it comes to work, school, or family; but when it comes to romantic relationships, many factors are involved in choosing a relationship with a romantic partner. Why do people choose these romantic partners, and why do some enter a romantic relationship faster than others? This research is intended to investigate temporal discounting within romantic relationships. Temporal discounting refers to a person taking a smaller reward sooner instead of waiting longer for a larger reward. What would a person sacrifice to have a "discounted" relationship sooner? The research's goal is to find out what each participant would want in a potential partner (traits, characteristics, etc) and at what point they are

willing to give up some of those ideals. To acquire the data needed to perform this research, a survey was created that asked a series of different questions. The first part of the survey gathered general information about the participants (age, location, education, religion, etc). The second part gathered data on relationships as well as specific qualities or ideals a person would want in a potential or current partner. Scenarios were given, in the third part, to evaluate whether the person would be willing to give up certain lifestyle situations to have a romantic relationship sooner. A unique aspect of the research, which is also assessed within the survey, is the specific focus on religion. The research and survey accentuate the differences of how religion, mostly the Latter-Day Saint religion because of its popularity in Utah, may be encouraging for younger or sooner marriage. The data shows whether religious members are more willing to give up key characteristics or ideals to be in a romantic relationship sooner.

POSTER: SOCIAL SCIENCES

Bridging the Gap: A Communication Privacy Management Approach to Student-Faculty Interaction in Higher Education

Sarah Steimel and Chloe Robison

Weber State University

This study examines the criteria undergraduate students use to develop privacy management rules when deciding whether to share personal struggles and stress with their instructors, guided by Communication Privacy Management Theory (CPM). CPM highlights individuals' belief in owning their private information and the rules they create to regulate its disclosure, emphasizing the vulnerability in sharing personal matters. High-stress levels among college students have documented impacts on academic performance, mental health, and well-being; while faculty-student relationships and social support have been shown to alleviate stress, the factors that shape students' decisions to confide in faculty remain underexplored. This qualitative, interpretive study employed semistructured interviews and focus groups with 40 undergraduate students to investigate which criteria students use to develop privacy management rules with instructors. Data analysis, grounded in CPM, revealed four main themes influencing students' privacy management decisions: (1) culture, norms of higher education and past experiences inform disclosure choices; (2) motivations, help-seeking for academic

support and relationship-building and reciprocity with professors; (3) context, factors such as course policies, physical environment, relevance to class content, and the professor-student relationship influence openness; and (4) risk-benefit assessment, students weigh potential stigma, face risk (embarrassment), and role risk to social and professional standing. By understanding these CPM-informed factors, educators can better support student well-being and enhance academic success through informed communication practices.

POSTER: SOCIAL SCIENCES

Gaps in Gun Safety: A Dual Lens Approach to Addressing Gun Safety in Utah through Policy and Community Action

Kaisha McFall and B. Meglen

Utah Valley University

This research explores the critical gaps in gun safety resources and education across Utah, focusing on the interplay between legislative policies and community-based interventions. Utah ranks among the highest in the U.S. for accidental child shootings and gun-related suicides, highlighting the urgent need for targeted gun safety measures. The state's relatively lax firearm regulations make it one of the easiest places in the country to access guns, presenting both opportunities and challenges in implementing effective safety strategies. Using a dual-lens approach, this analysis combines a legislative review with a social work perspective. Through a review of existing studies, legislative documents, and public health data, the research identifies four key factors contributing to gun safety disparities: misinformation, insufficient funding, misleading legislation, and harmful feedback loops. By examining these factors, the analysis uncovers regional and demographic trends that perpetuate safety gaps. Key strategies for improving gun safety include advocating for safer firearm designs, such as locking safety triggers and "smart" guns, as well as passing policies like extreme risk laws, which would temporarily restrict firearm access for individuals deemed a threat to themselves or others. This research aims to equip policymakers, community leaders, and educators with evidence-based interventions to address gun safety issues, reduce firearm injuries, and improve responsible ownership across Utah. By integrating both policy and community-driven perspectives, the research highlights actionable

solutions that could build a more robust, comprehensive safety culture statewide.

POSTER: SOCIAL SCIENCES

The Boo Factor: Comparing Emotional Reactions to AI-Generated vs. Human-Made Ghost Stories and Paranormal Experiences

Alison Romero, Christopher Lowery, Emma Woods, Jade Ernst, Melissa Oman, Veronika Tait and Nick Marsing

Snow College

This study explores the emotional impact of ghost stories generated by artificial intelligence (AI) compared with those written by humans, investigating whether AI can replicate the emotional depth and authenticity traditionally associated with human storytelling. Conducted by students at Snow College, the research utilized skin conductance response (SCR) to measure participants' physiological reactions, along with surveys to gather subjective feedback on engagement and fear levels. Participants listened to five stories, including two human-made and two AI-generated ghost narratives, with a neutral story used as a baseline. The findings revealed no significant differences in emotional intensity between the two story types, with both evoking comparable levels of fear and suspense. Additionally, participants struggled to consistently differentiate between AI-generated and human-written stories, suggesting that AI-generated narratives were perceived as equally compelling. These results underscore the growing ability of AI to create emotionally relevant content, which raises important questions about the role of AI in creative fields and its potential to mirror human emotional expression.

POSTER: SOCIAL SCIENCES

Generations Against Innocence

Sarah Goodman, Camden Jorgensen, and Isaac Atkinson

Snow College

Researchers have studied factors that affect views, opinions, and sentences given inside the courtroom. Based on research surrounding

media exposure of jurors before trials, theories developed about the impact of television crime shows, including “Perry Mason syndrome” and the “CSI effect.” Building on this, research was conducted to see how generational courtroom crime television shows affect potential jurors’ views of innocence. The approach was to control what media participants viewed paired with descriptive and quantitative surveys. Volunteers were separated into three groups. One experimental group watched older crime shows (pre-2000s) while another watched modern crime-based shows. The control group watched neutral tv shows. Participants were given pre- and post-surveys of mock trials, in which they declared a verdict. The mock trials did not provide enough evidence to prove the defendant guilty beyond a reasonable doubt. Results are currently being analyzed, and initial study findings show no evidence that consumption of any specific tv show significantly impacts viewers’ presumption of innocence. Confounding factors may be preconceived beliefs about innocence and justice, which were partially demonstrated in the pre-survey. Although the answers occasionally changed from the pre-survey to the post-survey, there is not enough evidence to postulate causation. Overall, this study has not found conclusive evidence that viewing specific courtroom crime shows impacts people’s presumption of innocence thus far. There is an indication that pre-existing beliefs may have a heavier influence than media consumption. Although there is no correlation between particular shows and an assumption of innocence or guilt, the preliminary nature of these findings warrants further study. The role of media as a potential influence on juror decision-making remains an open question. Knowing the impact of media on juries is crucial to understanding our justice system and ensuring that it limits bias.

POSTER: SOCIAL SCIENCES

Crunching Numbers: The Effect of a Calculation Task on the Stress Response

**Kelsey Peterson, Isabella Hixon, Brecken Spencer, Ethan Garff,
Kaitlyn Jensen, Shonda Ewell, and Claudia Jorgensen**

Utah Valley University

When exposed to stress, the sympathetic nervous system activates the stress response, altering body temperature and increasing respiration, sweating, and heart rate. Stress is associated with poor health outcomes and mental illness. College students face many potential sources of stress, including financial, social, and academic pressures. Music

interventions have been shown to mitigate the stress response and improve mental well-being, but research on the influence of specific music qualities is sparse. We performed a within-subject repeated measures experiment in which heart rate, electrodermal skin response, and body temperature were recorded while undergraduates performed a potentially stressful calculation task. The participants performed the task without music and then completed the task two additional times with music exposure, first with either fast-paced or slow-paced music genres and second with the opposing condition. We observed no impact of music genre on the physiological measures. Because the data suggested an impact from practice rather than music genre, we performed a follow-up experiment to assess the effect of practice specifically. One group was exposed to two consecutive fast-paced music tracks and the other was exposed to two slow-paced tracks. We found a significant reduction in both error rate and skin conductance change score, suggesting that the stress response may decrease with practice. We now hope to establish whether the calculation task is indeed stressful, which will have implications for both our previous experiments and understanding the stress response to a common academic stressor. The current experiment compares baseline physiological measures during a non-stressful task (viewing a nature slideshow) with physiological measures during the calculation task without music. We hypothesize that performing the calculation task will alter heart rate, skin conductance, skin temperature, and heart rate variability. We predict a positive correlation between self-reported stress levels and error rate.

POSTER: SOCIAL SCIENCES

High Concentrations of Air Pollution for Marginalized Groups in Salt Lake Valley

McKay Jones and Janessa- Michelle Purcell

Utah Valley University

Several studies report higher concentrations of particle matter (PM 2.5) and other harmful chemicals for marginalized groups in Salt Lake Valley. Because of the state's overreliance on highways, high rates of wildfires and droughts, pollution from mining and industry, and an ever-shrinking Great Salt Lake, Utah faces countless threats to the health of its citizens. The west Salt Lake Valley houses Utah's most ethnically diverse population, which has a 10-year lower life expectancy than the eastern Salt Lake Valley. Historical factors including colonization and

redlining contribute to this environmental justice issue. However, most scientific and health studies that focus on these marginalized groups remain inaccessible for these people. Therefore, systems thinking and systems mapping methodologies were used as an approach to understand the structural inequalities that contribute to this east-west disparity. Systems mapping utilizes casual-loop diagrams, icebergs, existing intervention matrices, and stakeholder maps that prove more obtainable and usable for frontline communities. Information was gathered through interviews, scholarly articles, podcasts, periodicals, and other sources of lived experience. Because Utah's government may reject federal environmental regulations, local mobilization proves most effective for promoting healthier policies. Increased representation of minorities in positions of power can bring wider awareness to this environmental injustice. Our research recommends improved public transportation infrastructure, strategic investment into grassroots organizations, and a general upliftment of frontline communities' storytelling to address this social issue. Through a combination of a comprehensive literature review and consulting methods of existing interventions, this poster can be used to strategically design more sustainable solutions.

POSTER: SOCIAL SCIENCES

Choice Overload: Post-decision Satisfaction Amongst Online Daters

Janessa Dyches, Taryn William, and Ozkar Jensen

Snow College

This research examines how the abundance of options on dating apps causes choice overload. With the constant flow of media and easy access to apps, users often face an overwhelming number of options. Although this can simplify partner selection, it can also lead to fatigue and difficulty making decisions. We hypothesized that having more potential matches would result in increased choice overload and lower satisfaction with the participants' selected partner. A total of 104 participants from the ages 18-54 years completed an online survey via SurveyMonkey, where they were randomly assigned to one of the two groups: one viewing 40 profiles, the other viewing only 10 profiles. Participants selected their match and rated their satisfaction on a 1-10 scale. Each participant was then asked to record the amount of time it took for them to make a decision. After making their selection, participants answered post-survey questions regarding their initial intentions, including

whether they would be interested in going on a date with their chosen match and what they were looking for. Contrary to our hypothesis, participants in the 40-option group had slightly higher satisfaction (7.1/10) than those in the 10-option group (6.48/10). It was expressed that minimal choice overload occurred, although the 40-option group discussed their preference for more personalized filtering, while those in the 10-option group found the limited options frustrating and not fit for their preference. These findings suggest that while a handful of options can be overwhelming, too few options might be more frustrating than beneficial. Future research should test varying pool sizes, explore the impact of personalized filtering, and refine methods to measure decision-making accuracy.