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The logo for the Office of Undergraduate Research, on the front cover of this publication, consists of an "impossible triangle" within a starburst. To some, the triangle evokes the challenge of puzzles to be solved or the eternal research question, "How does that work?" To others, the triangle represents the Greek letter Δ, the mathematical symbol for change.

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Foreword

The Office of Undergraduate Research is privileged to share the work of extraordinarily talented and dedicated students herein this, our ninth edition of Washington University Senior Honors Thesis Abstracts.

These abstracts summarize capstone research projects that have allowed students to explore their topics in ways far beyond what is generally expected at this stage of their lives and to contribute their own original conclusions to growing bodies of academic research. The rigor and depth of the research has earned these students the distinction of honors in their departments, colleges and schools while also demonstrating that deep intellectual inquiry, exploration and innovation is a hallmark of the Washington University undergraduate experience.

In recognizing the work of the students and the honors they have earned, we also recognize their mentors, academic departments, colleges and schools, whose guidance and encouragement make these projects possible.

Finally, the Office of Undergraduate Research is greatly indebted to the late Kathryn Hoopes, whose generous bequest in support of undergraduate research continues to provide students with the means to perform outstanding research and us with the means to introduce it to a wider audience.

Congratulations to the Class of 2017. We are honored to present your work.

LINDSEY PAUNOVICH
Editor

JOY ZALIS KIEFER
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The Mainstream and the Alternative: Understanding How the *St. Louis Post-Dispatch* and the *St. Louis Argus* Characterized the 1917 East St. Louis Race Riots

Yash Bhatia

Mentor: Douglas Flowe

This thesis focuses on differential media reporting of the 1917 East St. Louis Race Riots. The *St. Louis Post-Dispatch* and the *St. Louis Argus* were two relevant newspapers at the time of the riots with very different readerships and missions. The *Post-Dispatch* aimed to serve its predominantly white readership as a liberal crusader for justice, while the *Argus* acted as a voice for empowering African-Americans in the region. As such, the *Post-Dispatch* can be seen as a mainstream newspaper supporting majority viewpoints, leaving a void for the pro-black *Argus* to fill as an alternative news source. The main purpose of this project then becomes to investigate the significance of each paper's distinct narrative construction of the Race Riots, as well as understand how an alternative news source developed in opposition to the mainstream. Specifically, what was similar and different in each paper's respective characterization of the riots, and how did it align with their overall mission? By discerning which events and details were highlighted, we can gain a deeper understanding as to each paper's true goals and functions in society, and further speculate the impacts reporting had on both readerships. To tackle these ideas, this project begins with a historical analysis of the riots, focusing on the racial, economic, and political dynamics in East St. Louis that allowed for an eruption of racist violence to occur. Using archival materials, a history of the *Post-Dispatch* and *Argus* is then followed to provide context for reporting on the 1917 Riots and to uncover the relationship between the two papers, with specific attention paid to each paper's depiction of African-Americans. Finally, this project continues using archival materials to dive into the papers' reporting over a three-month period that encapsulated the riots. Overall, there is substantial literature that discusses the 1917 East St. Louis Race Riots as a historical event, as well as literature that dictates histories of the *Post-Dispatch* and the *Argus*. However, there are no scholarly pieces that comparatively analyze these paper's depictions of the riots, which is where this project aims to situate itself.

"You Knew You Were Equal": Black Women Constructing Place in Pruitt-Igoe

Candace Borders

Mentor: Clarissa Hayward

There is an eerie calm that accompanies the abandoned, 57-acre forest where the Pruitt-Igoe Homes once loomed over north St. Louis. Infamous for its high rates of crime and dramatic demolition in 1972, Pruitt-Igoe is both remembered and forgotten. While the project's notoriety has endured in popular thought and scholarly works, the lived experiences of Pruitt-Igoe's tenants have largely gone ignored. Within five years of the housing project's construction, the modern-era project was inhabited by a majority of female-headed households. These Black women existed at the intersection of poverty, segregation, and state-surveillance, caring for their children in a project that is heralded as the symbol of the failure of modern housing design. While two notable "You knew you were equal": Black Women Constructing Place in Pruitt-Igoe exist that touch on motherhood in Pruitt-Igoe, one focuses on women in adolescence and the other engages a problematic Black matriarchy framework. Their complex existence, and the ways in which they navigated and advocated for their families within the space of the housing project, is an essential component in creating a complicated narrative of Pruitt-Igoe's deep impact even after its demolition. Through collecting stories and memories from their children, my research curates a narrative of Black motherhood in Pruitt-Igoe that transcends the often one-dimensional understanding of Black women and their families.

Getting Out: Women in Transition

Abigail Gordon

Mentor: Linda Lindsey

The United States has the highest prison population in the world, with over two million individuals who are currently incarcerated and almost five million under some form of supervisory or custodial control of the criminal justice system. Since the 1980s the amount of women in prison has risen 700%. This dramatic rise in women going to prison means that there is also a significant increase in those transitioning back into society once released. However, 66% of women released are re-arrested within three years. "Getting Out: Women in Transition" explores this transitional period, asking why the recidivism rate is so high and what would make the transition process more successful for specifically women. I interviewed two previously incarcerated women about their journeys and what it means for them to be successful. I found that women's issues upon re-entry are magnified by the necessity to support their family in combination with finding employment and housing, in addition to often battling with addiction. However, these challenges can be significantly alleviated through the productive creation of relationships and the correct transitional programing, leading to a significant decrease in the recidivism rate and an increase in women leading successful lives.

This article is interspersed with videos of the two women that I interviewed in order to allow for their voices to be heard, not just quoted. With the help of Dave Walsh and the greater American Culture Studies department, I created a website to display my article and the videos in an easily relatable and comprehensive medium. I wanted my thesis to reach people, and I believe that this combination of the written word, videos, and online access is the most beneficial way to do so in an academic setting.

Making the Myth: The Racialized Legacy of Voter Fraud in St. Louis, Missouri

Natalie Kirchhoff

Mentor: Denise Lieberman

This thesis examines a prominent example of the "myth of voter fraud" from the November 2000 election in St. Louis, Missouri and evaluates its ongoing political, legal, and cultural ramifications for voters of color. In the twenty-first century, voter fraud has been proven as virtually nonexistent across the United States. Despite this evidence, a divisive partisan debate over the purported threat of illegal voting still shrouds American elections, now motivating state-level legislation that—under the guise of protecting electoral integrity—often serves to limit the voting abilities of minority voters. In this thesis, I examine the cultural and political legacy of modern limitations on African-American voting access in order to reveal how the myth of voter fraud was created and made believable in St. Louis. In the first chapter, I demonstrate how misadministration and institutional bias from the St. Louis Board of Election Commissioners resulted in the disproportionate removal of African-American residents from the city's voter registration rolls. However, the realities of this disenfranchisement were later obfuscated by a partisan narrative of voter fraud that emerged in the wake of a controversial election cycle. I then examine the falsity of these voter fraud rumors in the second chapter, identifying three critical, racially-influenced factors that made accusations of fraud in St. Louis appear plausible. In the final chapter, I analyze legislative and judicial responses to this voter fraud myth, specifically focusing on the legal battle over Missouri's 2006 voter identification law. While the law was ultimately deemed unconstitutional, I demonstrate how the Missouri Supreme Court's failure to specifically acknowledge the suppressive effects that voter fraud accusations and photo identification legislation have on voters of color—a determination that has been both replicated and refuted across the country in the years since—represents a continuation of the United States' legacy of African-American voter suppression. As the nationwide debate over the integrity of American elections and voter identification legislation continues, this thesis thus offers insight into how systemic racial biases still saliently animate the modern narrative of voter fraud.

Before Forty Acres: Reparations for Slavery in the Revolutionary Era

William Krueger

Mentor: Dale Kretz

This thesis aims to contribute to scholarship that considers reparations for African Americans as an independently significant concept in American history and culture. I adopt the social movements historiographical frame to investigate the two earliest examples of reparative payments to African Americans, both of which occurred in the Revolutionary Era, decades before the Civil War. In the first chapter, I investigate the Pennsylvania Quakers' reparative program, which began in 1776 and was motivated by spiritual beliefs, internal activism, and institutional advocacy. In the second chapter, I analyze a series of African-American petitions for emancipation and reparations delivered to the Massachusetts Legislature between 1773 and 1783. I pay particular attention to the arguments and social movement for reparations, and to Anthony Vassall's 1781 petition and Belinda Royall's 1783 petition, which both prompted the Commonwealth of Massachusetts to become the first American government to pay reparations for slavery. The introduction and conclusion connect these two earliest examples of reparations to the present-day reparations debate. I argue that each example represents a distinct strain of reparations thought and activism that is echoed in today's efforts. The Quakers' expansive, self-critical, and community-building program is echoed by advocates of a broad national program with spiritual or transformative potential, such as Ta-Nehisi Coates. The Massachusetts example is echoed in individualistic, narrow conceptions of reparations, which seek to use political avenues to gain justice for victims of discrete wrongs. The most notable modern example of this strain is the reparations paid by the State of Florida in 1994 in response to the 1922 Rosewood Riots. I hope to expand understanding of the history of reparations in America and contextualize the current debate.

Dreams Deferred: The Life and Death of Kinloch, Missouri

Billie Mandelbaum

Mentor: Iver Bernstein

Kinloch, Missouri is an all-black suburb located 12 miles northwest of downtown St. Louis. In 1948, Kinloch incorporated, becoming Missouri's first all-black city and the oldest politically independent African-American community west of the Mississippi River. Despite once being home to over 6,000 African Americans, today Kinloch is largely abandoned; its estimated population is 215 people. Kinloch's derelict appearance may seem like another eyesore on Metropolitan St. Louis' blighted landscape. However, as this thesis demonstrates, the story of Kinloch is not one of inevitable urban decay. Instead, I argue that racist politics and government policies spurred the development and destruction of one of America's few African-American suburbs. I trace Kinloch's history from its development as an all-white streetcar suburb in the late 1800s to its eventual demise in the 1980s as a result of a failed redevelopment plan associated with the expansion of Lambert-St. Louis International Airport. By analyzing primary source documents including early twentieth century real estate advertisements, archival newspaper articles, and government records, I illuminate how recurrent racism and discrimination came to create, maintain, and destroy Missouri's first all-black suburb. Following Kinloch's history from its development to its decline demonstrates how vulnerable black communities are to destruction, and how that destruction becomes naturalized.

Through this study, I seek to alter scholarly conceptions about American suburbs and the relationship between suburbanization and urban decline. Rather than accept conceptions about suburbs as being white, prosperous outgrowths of black, decaying urban cities, I demonstrate how the presumably "urban" issues of race, poverty, and even violence transformed the suburban landscape, thus subverting the urban-suburban dichotomy. While scholars have deemed the "suburbanization of poverty" and emergence of "suburban ghettoes" to be relatively new demographic trends, the story of Kinloch suggests that this is not a new phenomenon. Although Kinloch is a disappearing city—its history largely erased from the public and academic record—valuable lessons for understanding contemporary metropolitan areas lie beneath the community's ruins.

Go Big or Go Home: Unpacking the Hierarchical Political Rhetoric of Donald Trump

Jacob Metz

Mentor: Sunita Parikh

Though presidential candidates have always contextualized contemporary issues and themselves within a broader narrative to show why they along can handle the presidency, one future president relied almost exclusively on his biography to stress why he possessed the skills needed to be successful in the position: Donald Trump. Unlike any other major party nominee or president in American presidential history, Trump relied on status-based rhetoric to present himself as personally and professionally superior to others, from celebrities to other presidential candidates. By utilizing his Twitter account as a platform and performing at his campaign rallies in a manner akin to that of a stand-up comic, Trump presented himself as an appealing and plausible presidential candidate by employing the same rhetorical strategies he used as a reality television star

To address this phenomenon, I rhetorically analyze different Trump tweets and moments during his campaign rallies to present a holistic view of his political rhetoric. These tweets allow for a more extensive portrait of how Trump uses insults to position himself as an individual who possesses more skills and is inherently superior to others. I ultimately argue that Trump uses hierarchical rhetoric to assert his own status over others, making every single political argument about his own status, meaning status is the ultimate metric of what it takes to be the President of the United States. Ultimately, I chose this topic because of my interest in political rhetoric and my curiosity about why certain political messages resonate in contemporary American political culture over others. Though I initially set out to understand how Barack Obama, Black Lives Matter, the Tea Party, and Donald Trump were impacting American politics, I settled on dissecting how Trump currently impacts modern American political culture and shapes our contemporary political moment.

Salivary Secretory Immunoglobulin A Variation between Varsity Swimmers, Varsity Cross-Country Runners, and Non-Athletes

Carlye Chaney

Mentor: E. A. Quinn

This study examined salivary secretory immunoglobulin A (sIgA) variation between Washington University in St. Louis varsity swimmers, cross country runners, and non-athletes to determine if participation in collegiate athletics affects this measure of the immune system. Past work has only examined salivary sIgA variation by studying one type of physical activity at a time, which makes comparison across different types of physical activity difficult. Prior research suggests that endurance training increases salivary sIgA among elite athletes. Therefore, we hypothesized that varsity athletes would show elevated sIgA secretion rates compared to non-athletes. We recruited 52 female participants aged 18-22 years with 13-20 individuals per group. We collected two saliva samples from each participant: baseline and a second sample two weeks later when athletic training had intensified. Participants also completed a survey including the Undergraduate Stress Questionnaire and a Profile of Mood States.

We found no significant differences in salivary sIgA secretion rate between groups and no association with exercise. There was a significant increase in the mean sIgA secretion rate from the first to the second time period. Normative stress levels significantly predicted sIgA in both the first and second samples. Self-perceived normative stress was significantly negatively associated with sIgA, and athletes were significantly less stressed than non-athletes for this measure of stress. This suggests that the increased innate immune function shown through sIgA secretion rates observed in athletes might be due to their decreased stress levels and not to increased physical activity. When the sick and healthy individuals were subdivided by group, athletes had higher secretion rates than non-athletes when healthy, but the values were similar among the sick individuals across groups. The data suggests that athletes may experience immunoprotective effects from increased innate immunity through higher sIgA secretion rates, but also may have a blunted immune response when they do fall ill.

Critical Dialogue as Standard Practice: Exploring Identity Politics and the Impact of Social Justice Education on St. Louis Area High School Students

Lucy Chin

Mentor: Bret Gustafson

For the past 25 years, NCCJSTL's Anytown Youth Leadership Institute has offered a meaningful opportunity through which high school students are able to dialogue across differences and explore their personal identities in relation to contemporary social justice issues. The eight-day residential training program combines facilitated dialogue and experiential learning to encourage self-reflection, ultimately, empowering students to be agents of change in their own communities.

Over the summer, I worked as a program FaciliTrainer at Anytown. I led educational activities for the students and coordinated small and large group discussions. Additionally, I tracked student learning and insight through semi-structured interviews and a mixed method survey administered before and after their camp experience. These methods informed my thesis research, which presents the salient themes and takeaways of camp as articulated by the student participants including simultaneous feelings of concern and excitement for reintegrating their newfound social justice knowledge into their own communities, realizations about the expansive and intersecting nature of social justice issues, and challenging perspectives that arose out of new relationships with students from distinct and diverse backgrounds. Supplementary to analyzing the student insight, this study also analyzes the format of Anytown in order to understand how the camp fosters specific norms and learning objectives. By examining the relationship between camp infrastructure and student experience, I hope to demonstrate the importance of the choices made by camp administrators and illuminate how camp environments actively affect student learning. Ultimately, socialization around one's identity is informed by a number of direct and indirect factors. Though impermanent and somewhat limited in their scope, Anytown can play a crucial role in exposing students to new thought process and shifting their previous socialization experiences, which undergirds the broader relevance of this study.

Spatial Analysis of Debris from the Mound 34 Copper Workshop

Emily Coco

Mentor: John Kelly

Copper is material of ritual and economic prestige whose consumption spans from the Late Archaic to the Mississippian in the Eastern Woodlands region. Mississippian copper working is part of the Southeastern Ceremonial Complex (SECC), which has been defined by shared artistic and stylistic themes between major centers in the Mississippian world. Despite this, the evidence of copper working at Cahokia, a major early Mississippian center, is sparse, which greatly contrasts with those later Mississippian centers that have produced large collections of copper objects. However, because of its prominence during this time period, Cahokia likely played an important role in developing the classic SECC styles seen throughout the later Mississippian period. This role with respect to copper working is difficult to determine given the lack of complete copper objects from Cahokia. The copper workshop at Mound 34 represent some of the only evidence of copper working at Cahokia, making it invaluable to understanding the consumption of this prestige good during the early Mississippian period. Through spatial analysis of piece-plotted artifacts from the 2007 through 2011 excavation seasons at Mound 34, this project aims to understand what copper production techniques were used, how space was utilized, and what products were created at this workshop. The results of this analysis suggest the potential for multiple distinct copper working areas within the workshop. Furthermore, it is likely that copper sheets were produced through a process of hammering and annealing in addition to some secondary manipulation to further shape the sheets. Although no definitive conclusions can be made about the connection between this workshop and the SECC, this distributional study provides important insights into understanding copper working of the early Mississippian period.

Centering Women's Voices: Global Aid and Local Realities of Obstetric Fistula in Uganda

Shivani Desai

Mentor: Shanti Parikh

Within the Western-dominated international health care system, the experiences of women in the Global South are often overlooked, ignored, dismissed, and deprioritized. Medical issues such as obstetric fistula—ones that can be prevented, yet continue to afflict millions of women worldwide—exemplify this cruel reality of structural inequity. Over four months of ethnographic fieldwork in Geneva, Switzerland and Iganga, Uganda, I explore the disparity in understandings of fistula between levels of power and proximity, moving from local realities in Iganga to international perspectives in Geneva. From community care to international policy work, I investigate how these differences in perception affect the aid and care offered to Ugandan women and how the voices of former fistula patients are often left out of decision-making processes. Throughout the paper, I comparatively analyze perspectives, weaving through incongruent narratives of traditional and clinical care, stigma, unsustainable aid structures, and women's needs. At its core, this project seeks to contribute to scholarship on global health and development work by uplifting and giving space to voices that are too often marginalized within international work. Through centering women's voices, policymakers can come to understand authentic needs and how best to strengthen humanitarian health aid.

Balancing Survival and Democracy: Toxic Citizenship and Nuclear Waste in a St. Louis Landfill

Elaine Emmerich

Mentor: Bret Gustafson

Little research—none of it anthropological in nature—has been undertaken to understand the current events at the West Lake Landfill, which contains thousands of tons of uranium waste products as well as an underground smoldering fire. This study, both anthropological and historical in nature, seeks to understand in a more qualitative way how the West Lake Landfill is affecting its surrounding communities and how this shapes the resulting activism, political rhetoric among residents (especially in a presidential election year), and sense of contested democracy in St. Louis. During 18 months of ethnographic fieldwork, seven in-depth ethnographic interviews and 20 public event observations were carried out, as well as participant observation and archival review. I found that local residents' lives are severely impacted by the Landfill's problems, with both the fire and the nuclear waste eliciting fear and anxiety about potential health issues. Residents can be characterized by feelings of powerlessness, politically and personally, in the face of a large corporation and a government bureaucracy; these both resist the demands made on them by citizens. The discourses of local residents revolve around illness and political disillusionment as they seek to protect themselves and their children through the traditional political process and through activism and protest from what is perceived to be a looming threat. In addition to amplifying the voices and experiences of disenfranchised residents at the West Lake Landfill, this project adds to a wider body of knowledge about democracy, protest, and environmental health concerns in a post-WWII, post-Ferguson St. Louis. As the West Lake Landfill issue remains unresolved, additional information on the Landfill's politics and discontents are useful in the ongoing contestation of the Landfill's future. Furthermore, the project documents a specific case that sheds light on a broader moment of contested democracy in American life and politics.

Chinese Medicine in Uganda: Health, Wealth, and Globalization

Amir Hassan

Mentor: Shanti Parikh

In the last few decades, the globalization of Chinese medicine has altered health infrastructures and access to treatment in African countries. While the proliferation of Chinese medicine clinics and pharmaceutical drugs has broadened available therapeutic itineraries by supplementing local and biomedical healing centers, media sources in Uganda have recently raised concerns about "Tianshi" clinics and their illusory advertisements promising panaceas for incurable illnesses. This project is based on research that explores the presence of Chinese medicines and physicians and other imported treatments in urban, peri-urban, and rural sites in Uganda. It also contextualizes the broader implications of the extension of China's soft power globally with the desire to seek out such services within pre-existing understandings of health and disease, social structures that promote the Tianshi model for medicine distribution, and the pursuit of economic mobility. I employ in-depth interviews, informal conversations, community mapping activities, and participant observation in order to construct an ethnography of community perceptions about Chinese medicine in Uganda. Research findings suggest that Ugandans, dissatisfied with other therapeutic regimes, may view Chinese therapy as more accessible and compatible to local notions of health and illness than biomedicine. The commercial structure of Tianshi clinics—allowing one to sell Chinese medicines without prior medical education or professional experience—also offers patients and entrepreneurs the promise of economic mobility and social prestige. The consumption and sale of Chinese medicine lie at the nexus of social and class-based aspirations that motivate Ugandan individuals to enter into entrepreneurial professions, broaden social networks, and improve health outcomes. The use, sale, and imaginations of Chinese medicines can also be understood as the interplay between local agency in navigating a pluralistic system of healing and global processes of China's ongoing political and economic relationship with Uganda.

Exercising Agency in Medical Decision-Making Processes: A Case Study of 67ha, Antananarivo

Sakurako (Sakura) Oyama

Mentor: Carolyn Sargent

The formal integration of traditional and biomedicine has been touted as a prime method to improve access to quality healthcare in Madagascar. However, without a proper understanding of the considerations that influence how individuals navigate medical diversity, efforts at integration will only risk further institutionalizing inequities in access to care, depriving marginalized populations of their medical decision-making capacities. Thus, through conducting interviews with 100 residents of 67ha, Antananarivo, as well as traditional and biomedical practitioners, I sought to gain a more nuanced understanding of the myriad factors that influence Malagasy health-seeking strategies. Research findings suggest that the medical decision-making capacities of vulnerable populations in Antananarivo are seriously compromised by widespread mistrust and misinformation surrounding biomedicine. This is in large part caused by the corrupt actions of healthcare professionals, particularly in the public sector where individuals lacking in financial resources are most likely to seek treatment. On the other hand, by using traditional medicine (TM), marginalized populations can use knowledge passed down from their ancestors to improve their health. Moreover, utilization of TM has historically served as a symbolic action of resistance against Western influence in Madagascar. In order to maximize patient agency in medical decision-making processes, efforts to curb corruption within public healthcare facilities are critical. Further investment in the regulation and research of traditional medicine, particularly its sociocultural and macigo-religious elements, is necessary.

Material Problems: The Public Art Industrial Complex

Amelia Farley

Mentors: Ila Sheren and Angela Miller

This thesis approaches public art as a complex matrix of regulations and relationships—zoning laws, building permits, licensing, ordinances, white papers, insurance, et cetera—that go toward the assemblage of the material monument. I consider public art projects as physical and abstract systems, which organize time and space pursuant to legal bureaucratic protocol. These systems are neither entirely human, nor entirely nonhuman. They consist—just for example—of confederations of labor, energy, aesthetics, legal documents, artists, architects, elected officials, state-appointed committees, economy, public policy, sewage, furniture, lighting, data, and other material and non-material phenomena. Such projects, moreover, are never entirely complete. Beyond the completion of physical construction, public art projects continue to "live" and accrue commercial, political, and symbolic values—which fluctuate in and out of contention over time.

I argue that public art is fundamentally an infrastructural technology. I refer to infrastructure in an expanded field: not just its physical coordinates—highways, capital construction, et cetera—but its materialist legal and economic syntax. This holistic image of infrastructural technology, as the substratum for contemporary urbanism, is the prism through which I view the American public art complex. In order to surface the fluid elements of this system, I approach the American public arts establishment with a materialist methodology, exploring the bureaucratic processes and economic structures that undergird contemporary public artworks. Specifically I compare and contrast recent projects that appropriate funding from the various jurisdictional bodies of the U.S. criminal justice system. I take up traditional Percent for Art (PFA) projects within this context—e.g., commissions at courthouses, city jails, and detention centers—and I also take up publicly funded projects that demonstrate different approaches. As a form of infrastructural critique, I explore how the visible activity of public art is invisibly systematized.

Postnatal Development of the Murine Notochord Structure Quantified by High-Resolution Contrast-Enhanced Microct

Sameer Bhalla

Mentor: Simon Tang

The notochord is essential during the development of the nucleus pulposus of the intervertebral disc (IVD), yet its structure during postnatal maturation remains relatively unknown. The notochord serves as a renewable cell source for the IVD, and the deterioration of the notochord structure has been associated with IVD degeneration and nerve infiltration associated with low back pain. Since the IVD is a fibrocartilaginous joint responsible for load transmission and mobility of the spine, defining the quantitative structure of the notochord during aging is critical for mechanobiological investigations relating to IVD function and homeostasis. Despite its importance, the imaging of the notochord has classically relied on histological techniques, which can introduce artifacts during preparation and spatial bias during sectioning. Magnetic resonance imaging (MRI) does not offer sufficient resolution to discriminate the nucleus pulposus that surrounds the notochord, especially in murine models. X-ray based computed tomography systems offer resolutions down to single- to sub-micron scales, and when coupled with contrast agents, can provide high-resolution three-dimensional imaging of relatively small features such as the notochord. Coupled with the unique characteristic of phosphomolybdic acid to preferentially bind to collagen cationic domains, we utilize a novel technique to quantitatively describe the structure of the notochord with aging in lumbar IVDs of BALB/c mice. These results provide a highly quantitative and sensitive approach to monitoring the notochord, and they reveal a more accurate picture of the IVD during postnatal development.

Novel Histone Deacetylase Inhibitors to Elucidate Repeat Associated Gene Silencing Mechanisms in *Drosophila*

Emily Chi

Mentors: Sarah Elgin, Elena Gracheva and Flavio Ballante

Repetitious elements constitute a major portion of eukaryotic genomes. Silencing mechanisms are required to recognize and prevent their expression in cells. Silencing of repetitious elements can be achieved by formation of heterochromatin. To study this mechanism we utilized a transgenic construct containing 256 copies of a 36 bp *lac Operon* fragment placed upstream of an *hsp70-white* reporter, inserted into the *Drosophila melanogaster* genome. In *Drosophila*, expression of the *white* gene results in a red eye phenotype; sporadic silencing of this gene following juxtaposition with heterochromatin results in a patchy red eye phenotype referred to as Position Effect Variegation (PEV). Previous studies from the Elgin laboratory have shown that insertion of the *lacO-hsp70-white* transgene at the base of chromosome arm 2L results in strong silencing, sensitive to HP1 depletion, indicating heterochromatin packaging. A genetic screen suggested that the *lacO-hsp70-white* PEV phenotype is sensitive to mutations in genes coding for histone deacetylases (HDACs). These results led us to test several small molecule HDAC inhibitors (HDACIs), including novel HDACIs designed and synthetized by the Marshall laboratory (Biochemistry Dept, Washington University). An initial test of 12 potent human HDACIs, with diverse selectivity profiles for the ~10 HDACs present (Apicidin, Entinostat, Panobinostat, PCI-34051, SAHA, Scriptaid, Largazole, SD-L-256, Trichostatin A, Tubastatin A, T247, and Compound 4), performed on the *Drosophila* reporter line showed that the selected drugs did not cause any detrimental effects on fly development, with the exception of SAHA at its maximum concentration. We selected HDAC3 and HDAC6 inhibitors, compounds SD-L-256, Largazole, 6q, and 4l (Marshall lab, unpublished) for a second, more precise drug screen with optimized drug concentrations and fly population densities. Results from this screen suggest that selective inhibition of HDAC3 or HDAC6 differentially affects suppression of *lacO-hsp70-white* silencing. In the future, more detailed investigation is needed to fully characterize the process.

Examining Roles of Transposable Elements and DNA Methylation in Glioblastoma

You Rim (Mikayla) Choi

Mentor: Ting Wang

Transposable elements (TEs) have the ability to move from one chromosomal location to another, contributing to genetic variation over evolutionary time. Although TEs make up roughly half of the human genome, TEs were long considered to be junk DNA due to their repetitive nature and their epigenetically silenced state. However, recent discoveries suggest that TEs are still functionally potent because their innate on/off regulatory potential may shape cell development. Specifically, hypomethylated TEs, present due to aberrant methylation machinery or changes that accumulate through natural selection, can regain regulatory function and promote misregulation of nearby genes, which potentiates tumorigenesis. For example, TEs can function as a novel promoter if their endogenous promoters are reactivated. Furthermore, TEs may act as an enhancer, which promotes transcription through transcription factor binding, or as an insulator, by inhibiting transcriptional chromatin domains. Although few examples of TE misregulation-causing cancer have been well documented, TE's role in glioblastoma development is still an uncharted field. Here, we propose to characterize TE's DNA methylation state across three glioblastoma stem cell lines derived from primary tumors. We will compare methylation profile of fetal brain to glioblastoma samples to identify glioblastoma-specific TE misregulation by utilizing bisulfite sequencing technology and various analysis softwares. We hypothesize that changes in DNA methylation of specific transposable elements could be responsible for the oncogenic potential in primary glioblastoma.

Sorghum bicolor, *Xanthomonas vasicola*, and the Environment: An Interdependent and Dynamic Relationship

Diana C. Fasanello

Mentors: Rebecca Bart and Kira Veley

Little is known about the complex plant-pathogen interactions between *Sorghum bicolor* (L.) Moench and the bacteria that infects it, specifically regarding the role of the environment and how sorghum acquires and maintains pathogen resistance. Breeding for applications like biofuel production may alter or decrease sorghum resistance to bacterial pathogens. To test this possibility, it is important to analyze the roles of the host, pathogen, and environment in the disease triangle, and how they contribute to either infection or resistance. We have identified a field-isolated strain of *Xanthomonas* that infects sorghum and causes disease symptoms through 16S ribosomal sequencing and multilocus sequence typing (MLST) as *Xanthomonas vasicola pathovar holcicola*. In order to examine the role of environment in the disease triangle, sorghum plants were inoculated with *Xanthomonas* and grown under various environmental conditions. Plant responses to inoculation in each setting were characterized either qualitatively, by observing the spread of disease symptoms, or quantitatively, by performing a colony forming unit (CFU) assay. Results from these experiments indicate that decreased relative humidity increases disease symptoms, and oscillating temperature conditions increase disease symptoms. However, this increase in symptoms observed in oscillating temperature conditions did not correlate with increased CFU counts. The effect of temperature was further examined with an *in vitro* study of the growth of *Xanthomonas* outside of plant tissue. Bacteria grown at oscillating temperatures displayed a longer growth period than bacteria grown at constant temperatures. Further research aims include determining the mechanisms behind the observed temperature and humidity effects on disease and bacterial growth, and altering the host side of the disease triangle using cell wall and sugar-accumulating mutants to determine how resistance can be maintained.

Site-Specific Epigenetic Manipulation in Stem Cells

Gregory Fishberger

Mentor: Grant Challen

Epigenetic abnormalities, such as aberrant DNA methylation, have been implicated to play a causal role in the development of many genetic diseases and forms of cancer. DNA methylation has long been thought to be involved in transcriptional repression; however, the direct relationship is not well characterized. Furthermore, the cause and effect relationship between aberrant epigenetic marks at distinct loci and certain genetic diseases is not well established. In this study, we utilized the CRISPR-Cas9 targeting system with a catalytically inactive Cas9 endonuclease fused to the catalytic domain of hDNMT3a to directly investigate the influence of DNA methylation on gene expression. With multiple guide RNAs, we localized the fusion construct to a discrete locus on the *Cdkn1a* gene promoter region in order to induce targeted DNA methylation. Following treatment with dCas9-3a, we observed site-specific DNA methylation at the designated locus and a corresponding decrease in *Cdkn1a* gene expression. The induced methylation and *Cdkn1a* repression remained stable across multiple cell passages indicating the stability of the technique. This novel approach of site-specific epigenetic modulation has the potential to provide highly specialized treatment options for human diseases, as well as the ability to regulate cell differentiation to control cell fate.

Categorizing the Unintended Side Effects of Genetic Transformation

Ryan Z. Friedman

Mentor: Michael R. Brent

In a genetic transformation, exogenous DNA is introduced into cells to target a specific genomic sequence. Anecdotal cases have suggested that transformations may cause unintended collateral mutations outside the targeted region, but this has never been investigated systematically. Here, I analyze these collateral mutations using *Cryptococcus neoformans*, a pathogenic fungus responsible for approximately 625,000 deaths each year. Bioinformatics software was used with the genome sequence data of 29 independently transformed strains to identify single nucleotide polymorphisms (SNPs), small insertions/deletions (indels), large structural variants (SVs), and copy-number variants (CNVs); 30 untransformed control wildtype strains were also sequenced. A total of 26 SNPs and indels were found in the transformed strains and not the wildtype strains, but 10 are false-positives due to direct effects of genetic transformation, mononucleotide runs, or low sequencing coverage relative to the coverage across the genome. The remaining 16 variants have sufficient coverage, substantial evidence supporting an alternate allele to the reference genome, and almost always occur in only one strain. Meanwhile, only four true variants are naturally segregating in the control strains. These data indicate side effects of genetic transformations are rare. Eleven variants occur in exons, seven of which cause missense mutations in proteins, suggesting the side effects may be to compensate for targeted gene deletions or to improve fitness in growth medium. No SVs or CNVs caused by genetic transformation were found. Additionally, I have discovered an unpublished region of divergence in the genome of our freezer stock, *C. neoformans* KN99, from the common *C. neoformans* H99 reference genome, despite being closely related. Consequently, a reference genome has been generated for the KN99 strain. These results show that genetic transformations are safe in their common laboratory use and provide resources for other researchers that use *C. neoformans* KN99 as their stock strain.

HER2 776insYVMA and 780insGSP Insertion Mutations Confer Resistance to Small Molecule HER2 Inhibitors

Ari Gao

Mentor: Ron Bose

The EGFR-family member HER2 drives cancers in various organs and organ systems, especially in the breast and lung. For solid tumors that overexpress HER2 (HER2+), targeted therapies include antibodies such as trastuzumab and, more recently, small molecules inhibitors. However, relapse and progression have been observed in a significant fraction of cases, suggesting the presence of mechanisms of resistance. Our lab previously identified somatic HER2 mutations in breast cancers that conferred resistance to small molecule HER2 inhibitors, and based on patient data from a clinical trial, we speculated that 776insYVMA and 780insGSP (henceforth referred to as YVMA and GSP, respectively), two insertion mutations commonly found in lung adenocarcinomas, might confer similar resistances as well.

To test this possibility, we examined the effect of three small molecule tyrosine-kinase inhibitors (lapatinib, neratinib, and afatinib) on the cell growth and signaling of HER2-negative MCF10A cells transduced with wildtype HER2, HER2 YVMA, or HER2 GSP. Each tyrosine kinase inhibitor (TKI) was introduced into the in-vitro cell media at a range of concentrations, in order to construct a dose-response curve. Cell growth was measured via the Alamar Blue assay, while Western blots were used to detect the quantity of phosphorylated and total HER2, MAPK, and AKT.

We found that YVMA was a potent resistance mutation. Compared with HER2 WT transduced cells and vehicle control, HER2 YVMA conferred near-total resistance to lapatinib and strong resistance to neratinib and afatinib, in both cell growth and cell signaling. HER2 GSP seemed to be a more modest resistance mutation, conferring total resistance to lapatinib but only moderate resistance to neratinib and afatinib. These data are consistent with previously observed clinical outcomes for patients with these mutations, and imply that the HER2 YVMA and, to a lesser degree, HER2 GSP mutations are responsible for a portion of the poor clinical responses to lapatinib and afatinib in breast and lung cancer patients.

Temporal Facilitation of ON Retinal Ganglion Cell Responses to Drifting Gratings

Anurag R. Goel

Mentor: Daniel Kerschensteiner

Visual perception in mammals is modulated by past visual experience. The retina extracts salient features from the visual world and sends them to the brain via the spike trains of 40-50 different retinal ganglion cell (RGC) types. As few studies have explored how stimulus features interact temporally, we sought to investigate how the response of RGCs to brief stimuli evolves over time, and how RGCs respond to a sequence of stimuli presented in quick succession. Conceptually, our experiments seek to determine whether the retina compares present stimulus features to preceding ones and how such temporal stimulus interactions are encoded in RGC spike trains. Using multi-electrode array (MEA) technology, we recorded simultaneously from large ensembles of RGCs to explore visual history effects using between flashed and drifting gratings. We varied parameters of our stimulus such as the difference in orientation between a flashed and drifted grating, and the delay between them, in order to determine how these specific features contributed to our observed results. In addition, we measured spatiotemporal receptive fields and contrast sensitivities of these RGCs.

We discovered a single functional type of ON RGCs, ON_{Fac} RGCs, that exhibits a secondary delayed response to brief flashes of light as well as an enhanced response to a drifting grating if it is preceded by a flashed grating. Our findings suggest this functional RGC type displays previously unreported response patterns as well as time-dependent facilitation and depression, contributing to the developing model of how past experience is encoded in the retina. Although the mechanisms by which these processes arise in the circuitry are unclear, our initial results provide a foundation for further studying temporal interactions of stimuli and prediction in the retina.

Comparison of JAWSII Cell Line and Bone Marrow-Derived Cells in Responsiveness to Tuberculosis Infection

Suhas Gondi

Mentor: Shabaana Khader

Mycobacterium tuberculosis (Mtb), the bacteria that causes tuberculosis (TB), infects one third of the world's population, 5-10% of whom develop active TB, in which the bacteria invades and damages the lungs. One reason for this large global disease burden is the emergence of multi-drug resistant (MDR) strains of TB, which accounts for the majority of deaths. In order to address MDR-TB, a new vaccine must be formulated to protect against the infection. The determination of ideal candidates for vaccine adjuvants to help dendritic cells drive strong cytokine-mediated responses to TB challenge is the aim of the current research. The goal of this study was to determine whether or not the JAWS II cell line could be used as a substitute for the more costly, time-consuming bone marrow-derived cells (BMDC) in adjuvant testing. This study compared the sensitivity and reactivity of JAWSII cells and BMDC to infection with various strains of TB by assessing cytokine levels as a metric of immune activity. The central hypothesis of this study was that if JAWSII can be shown to respond to infection in a similar way as BMDC do, and a well evidenced phenomenon in BMDC can be replicated in the JAWSII cell line, then JAWSII behaves in a way that is both similar to BMDC and is biologically relevant, meaning it can be used in lieu of BMDC for future experiments. The data suggest that the JAWSII should be grown in recommended media, that the JAWSII cell line is basally more active than BMDC, and that the JAWSII system is not as sensitive to infection as BMDC. Therefore, it is unlikely JAWSII is a suitable replacement for BMDC for future experiments. Future directions include running similar experiments with more trials, different cytokines, different concentrations of bacteria, and comparative RNA/cDNA analyses.

Analysis of Human HCCS-Mediated Cytochrome c Biogenesis

Jennifer Hsu

Mentors: Robert Kranz and Shalon Ledbetter

Cytochrome c (cyt c), found in the intermembrane space of mitochondria, is an essential component of cellular processes such as energy production and apoptosis. It acts as an electron carrier, and thus, defects in cyt c or its production, impair respiration. Holocyt c synthase (HCCS), a membrane-associated enzyme, is responsible for mediating the attachment of heme to cyt c. The stability and function of cyt c relies on attachment of heme via two thioether linkages at conserved cysteine residues ($Cys_{15}XxxXxxCys_{18}His_{19}$). We characterized HCCS-mediated synthesis of several cyt c variants containing mutations in and around the conserved motif to understand specific mechanisms of cyt c biosynthesis. Based on previous data from the Kranz lab regarding an enhanced cyt c product release feature of HCCS E159A, we successfully produced several cyt c variants in quantities suitable for biochemical characterization. My first study suggests that heme attachment preferentially begins at Cys18. We also show that mutations at Cys18 result in a cyt c species modified by an oxygen adduct, explaining the absence of Cys18 cyt c variants in nature. For my second related study, we show that residues outside the cyt c heme attachment motif and in the N-terminal alpha helix-1 position Cys15 of cyt c. We provide evidence that deletion of Met13 in alpha helix-1 displaces Cys15 away from heme 2-vinyl, thus preventing Cys15 thioether formation. In support of this conclusion, we show that further mutations to shift the positioning of Cys15 restore the two thioether conformation. My third study explores *in vitro* reconstitution of System III cyt c biogenesis to identify some optimal conditions for HCCS activity and required cyt c domains for HCCS recognition and attachment. My studies have contributed to understanding the mechanism of HCCS, an enzyme required by most eukaryotes.

In Vitro and *In Silico* Evaluation of Novel *Ortho*-Substituted Phenols and Benzodiazepine Derivatives as Potent and Isoform-Specific Human and *Schistosoma mansoni* Lysine Deacetylase Inhibitors

Rong Hu

Mentors: Flavio Ballante and Garland R. Marshall

The study of epigenetics, or heritable changes in gene expression without genomic alterations, has been rapidly expanding due to the discovery of critical epigenetic contributions involved in human diseases. One such epigenetic mechanism is the reversible acetylation of lysine ε-amino groups, a post-translational modification that often occurs on histone tails to regulate transcription. Responsible for catalyzing acetyl group removal, the lysine deacetylase (KDAC) family of enzymes has been found to be linked with the development/progression of cancer, diabetes, and other critical disorders in humans when aberrant expression, activity, or mutations are present. KDACs also contribute to various parasitic diseases, including schistosomiasis, a disease concerning the infection of human intestinal and urogenital tracts by Schistosoma trematodes. Thus, development of potent KDAC inhibitors (KDACIs) against specific human and parasitic KDAC isoforms may lead to innovative therapies for many diseases.

In this study, we focus on the screening of novel KDACIs against four human KDAC isozymes (hKDAC1, 3, 6, and 8) and one *Schistosoma mansoni* KDAC isozyme (smKDAC8) using *in vitro* and *in silico* methods. Synthesized phenol and benzodiazepine derivatives were tested as inhibitors against each KDAC isozyme using electrophoretic mobility shift assays to measure relative half maximal inhibitory concentrations (IC_{50}s).

Experimental results revealed several KDACIs endowed with low nanomolar IC_{50}s and high selectivity against hKDAC6, as well as KDACIs with mid-range nanomolar IC_{50}s and selectivity against hKDAC3. Structure-activity relationships (SARs) were then rationalized through molecular docking simulations, further clarifying ligand-residue interactions relevant to inhibitory potency and isoform-selectivity against human and schistosome KDACs. The obtained data will be used to (1) refine a comprehensive pharmacophore model (recently published by the Marshall lab); (2) design and synthetize novel KDACIs with higher potency and selectivity; and (3) enhance structure-based 3D QSAR models as tools to predict the activity/selectivity of novel/untested compounds through virtual screening applications.

NR Delays Vincristine-Induced Axon Degeneration in Dorsal Root Ganglia Cultures

Xin Huang

Mentors: Stefanie Geisler, Jeffrey Milbrandt and Aaron DiAntonio

Chemotherapy-induced peripheral neuropathy (CIPN) is a common and dose-limiting side effect of anti-cancer therapies. CIPN symptoms include numbness in hands and feed, shooting and burning pain in arms and legs, and muscle weakness, which can extend beyond the time of treatment and may cause permanent disability. Many CIPNs are primarily characterized by axon dysfunction and/or degeneration. Recent work from the laboratories of Jeffrey Milbrandt and Aaron DiAntonio has shown the protective effect of the genetic deletion of SARM1 (sterile alpha and TIF motif containing protein 1) on acute axon degeneration (AxD). In axotomy experiments, SARM1 is regulated by the activation of a MAP kinase cascade and acts through the decrease of NAD+. However, CIPN causes subacute/chronic axonal loss, so it may work through a different pathway than acute injury by axotomy. To gain insight into mechanisms of axonal loss in CIPN, we use the chemotherapy drug vincristine to induce AxD in murine dorsal rot ganglia cultures. We evaluated the effectiveness of drugs that disrupt the SARM1 pathway in axotomy to examine if vincristine acts through a similar SARM1-mediated AxD pathway following vincristine. We show that there is a significant decrease of vincristine-induced AxD with the treatment of NR, and there is additional protection with a combination of NR and JNKi, consistent with previous research on the protective effect of MAPK inhibitors and NAD+ precursors in delaying acute AxD. This suggests that drugs that disrupt the SARM1 pathway can be therapeutic in delaying chronic axonal injury induced by vincristine, and potentially other CIPNs.

Targeting Survival Signaling in T-ALL

Matthew Jotte

Mentor: Daniel C. Link

T-cell acute lymphoblastic leukemia (T-ALL) is an aggressive cancer of the blood and bone marrow in which T-cell progenitors undergo developmental arrest and acquire neoplastic capabilities. Approximately 1,500 adult cases of T-ALL are diagnosed each year in the United States. While initial remission rate approaches 80%, relapse is common and the five-year survival rate for relapsed patients is only 7%, highlighting the need for new therapies. CXCR4, a surface receptor for the chemokine CXCL12, is significantly upregulated in many T-ALLs and is essential for T-ALL growth and proliferation. Activation of c-MYC is common in T-ALL and is thought to play a central role in disease pathogenesis. c-MYC induces proliferative stress in cells resulting in cell death in the absence of pro-survival signaling. We hypothesize that CXCR4 signaling promotes T-ALL growth through upregulation of the anti-apoptotic protein MCL-1. It follows that inhibition of CXCR4 signaling, by decreasing MCL-1 expression, may selectively induce apoptosis in T-ALL cells. We further hypothesize that CXCR4 inhibition would synergize with chemical agents disrupting other survival signaling, such as PI3K- and BCL2-mediated pathways. Here we show that the novel CXCR4 inhibitor BL8040, developed for the treatment of hematological malignancies and currently undergoing Phase II clinical trials for mobilization of hematopoietic stem cells, has anti-tumor activity in T-ALL both *in vitro* and *in vivo*. We also show that inhibition of PI3K and BCL2 proteins with BKM-120 and ABT-263, respectively, is toxic to T-ALL cells. Our data add to a growing body of evidence supporting the targeting of CXCR4, as well as the development of rational combination therapies, in patients with relapsed or refractory T-ALL.

Characterizing the Physiological Impact of Carbon Starvation on the Model Bacterium *Escherichia coli*

Jesse Kao

Mentors: Petra Levin and Corey Westfall

As single celled organisms, bacteria constantly experience stressful changes in their environment. For an enteric organism such as *Escherichia coli*, the sudden dilution of nutrients as they travel through the host's colon and into the environment creates significant challenges that must be dealt with through modifications in growth rate, metabolic flux, and cellular composition.

To understand the impact of sudden changes in nutrient availability on *E. coli* physiology, I have analyzed the impact of rapid depletion of carbon on *E. coli* growth and morphology. In previous experiments, scientists have determined that the slow depletion of carbon as bacteria enter stationary phase results in the formation of short, rounded cells. In contrast, my data indicate that rapidly shifting *E. coli* from carbon rich to carbon free conditions does not lead to stationary-like rounded cells, instead resulting in the surprising detachment of the inner plasma membrane from the cell wall and outer membrane. Further experiments indicate that the detachment phenotype persists in the absence of protein, RNA and lipid synthesis, and is independent of the so-called "stringent response" that is typically seen in *E. coli* when subjected to nutrient stress. Membrane detachment is also independent of osmotic conditions and appears to be specific to carbon starvation; rapid depletion of phosphate and nitrogen starvation does not detectably impair the cell envelope structure.

The re-addition of carbon results in inner membrane reattachment to the cell wall. The rate of reattachment differs based on the carbon source introduced into the system. These add back experiments provide a way to visualize the phenomenon in real time. Characterizing this novel carbon starvation phenotype may provide insight into new mechanisms *E. coli* utilize under carbon depleted environments that may simulate depleted conditions met during bacterial host transmission.

Structural Basis for Mutant RXRA-Mediated Hyperactivity of PPARs in Bladder Cancer

Chiraag Kapadia

Mentor: Vivek Arora

Understanding the structural mechanism by which an oncogenic point mutation promotes aberrant activity is prerequisite to rational drug design. Recent genomic characterization of bladder tumors has suggested several oncogenes relied upon for tumor development and thus ideal for targeted inhibition. The nuclear receptor RXRA contains a hotspot mutation and posits one such candidate oncogene. Growth assays performed by our group demonstrated mutant RXRA drives proliferation in a bladder urothelial organoid model, confirming the recurrent mutation's oncogenic potential. RXRA activates transcription as a homodimer or obligate heterodimer with sixteen other nuclear receptors. The hotspot mutation is located at the heterodimerization interface and contacts binding partners. Co-overexpression of RXRA with known heterodimerization partners revealed mutant-mediated hyperactivity occurred solely when in complex with the PPAR class of nuclear receptors, suggesting mutant RXRA is oncogenic in a narrow range of structural contexts. Based on this structural specificity, I speculate the RXRA/PPAR complex represents a targetable oncogenic dyad.

To define the mechanism of mutant RXRA-mediated hyperactivation of PPARG, the PPARG ligand-binding pocket and transactivation helix (responsible for transcriptional machinery recruitment) were mutated. Hyperactivity occurred independent of ligand binding but relied on the PPARG transactivation helix, suggesting an allosteric relay induces PPARG into an active conformation. To identify the residues comprising the allosteric relay, long-timescale molecular simulations and subsequent Markov state modeling of RXRA/PPARG were performed. Predicted metastable states for the mutant heterodimer illustrate the PPARG transactivation helix to predominantly adopt conformations similar to the agonist-bound crystal structure, in contrast to conformations adopted by the wild-type dimer. The PPARG terminal tyrosine on the mutant heterodimer occupied a distinct region in space compared to the wild-type heterodimer, suggesting a functional relevance for this residue. Elimination of the PPARG terminal tyrosine prevented mutant-mediated hyperactivity. These insights will guide future chemistry efforts to inhibit.

Identifying Kinase Genes Involved in Regulation of the Stem Cell versus Meiotic Fate Decision in the *C. elegans* Germline

Vahag Kechejian

Mentors: John Brenner and Tim Schedl

Germline stem cells make a decision between maintaining the stem cell fate or entering meiosis. In the nematode *Caenorhabditis elegans*, germ cells adjacent to the somatic niche, the distal tip cell (DTC) of the adult germline, maintain the stem cell fate through the action of the GLP-1 Notch signaling pathway, while germ cells away from the influence of the DTC enter meiosis. *glp-1* maintains the stem cell fate through repression of the GLD-1 and GLD-2 pathways, which function redundantly to promote meiotic entry. The mechanism whereby *glp-1* signaling represses the GLD-1 and GLD-2 pathways is not completely understood, although it is known that regulation of the GLD-1 and GLD-2 pathways is post-transcriptional. I postulated that individual kinase genes, which act post-translationally, may function to promote meiotic entry in the *C. elegans* germline by promoting GLD-1 and/or GLD-2 pathway activity or inhibiting *glp-1* activity. With the exception of *glp-1*, due to genetic redundancy, loss of function of known single genes does not have a significant effect on the stem cell versus meiotic fate decision. Therefore, I used a sensitized genetic background, *glp-1*(*ar202*), to identify kinases, following RNAi knockdown, that result in a tumorous germline due to failure to switch to the meiotic fate. RNAi of 276 *C. elegans* kinase genes identified 26 that show incompletely penetrant germline tumor phenotypes. A deletion mutant for one kinase, *unc-82*, crossed into *glp-1*(*ar202*) background, significantly increased germline overproliferation, confirming that *unc-82* acts to promote GLD-1 and/or GLD-2 activity or inhibit *glp-1*. Future experiments will determine if deletion mutants of any of the remaining kinase genes results in the formation of germline tumors.

Investigating Localization and Activity-Dependent Translation of Astrocyte mRNA

Rohan Khazanchi

Mentors: Joe Dougherty and Kristina Sakers

While it is well understood that synaptically-activated, rapid, local translation of new proteins in neurons mediates changes at the synapse, it is unclear whether astrocytes also exhibit subcellular translation. Astrocytes are highly polarized cells in the central nervous system, and their hallmark functions include processing and responding to changes at tripartite synapses. I hypothesized that astrocytes utilize local protein synthesis as a response to synaptic changes. This function may compensate for their elaborate somatic arbor, in which one process may contact many thousands of synapses. The lab's preliminary data supports this hypothesis by showing that ribosomes and ribosome-bound mRNAs exist in peripheral astrocyte processes (PAPs). I first focused on validating the presence of PAP-enriched mRNAs, identified via a novel biochemical translatome profiling method coined "PAP TRAP" (translating ribosome affinity purification). To localize and validate the presence of mRNAs in PAPs, *in vivo*, I performed fluorescent *in situ* hybridization (FISH) and used confocal microscopy to visualize the mRNAs. Through these experiments, I observed clear subcellular localization of multiple astrocyte-specific mRNAs at PAPs.

Having demonstrated that PAP-enriched mRNAs are truly localized peripherally, I hypothesized, based on astrocyte functional roles in the CNS, that synaptic activity regulates local translation of these mRNAs. I carried out experiments to visualize and measure protein translation in peripheral processes via puromycylation and quantification of puromycin immunofluorescence. I treated acute mouse brain slices with known modulators of synaptic activity and demonstrated that astrocytes do indeed up- and down-regulate peripheral translation in response to treatment-induced changes at tripartite synapses. Overall, this novel work proposes a mechanism of how astrocyte dysregulation and dysfunction could contribute to the pathogenesis of diseases of synaptic connectivity (i.e., schizophrenia, Alzheimer's, autism spectrum disorders).

The Effects of Plant Community Diversity and Drought on Soil Microbial Communities and the Subsequent Effect on the Invasion Success of Common Exotic Species

Karen Myers

Mentors: Scott Mangan and Claudia Stein

Invasive species threaten ecosystems worldwide by outcompeting and eliminating native species, leading to losses in local biodiversity. Ecological theory predicts that ecosystems that are more diverse are less susceptible to invasion, but experimental evidence is ambiguous and the mechanisms underlying this diversity-invasion relationship have not been established. I set up a greenhouse experiment to investigate how soil biota, obtained from plant communities differing in species richness under drought and ambient water conditions, affected the invasion success of three common invasive species. The three invasive species, *Cirsium vulgare*, *Dipsacus fullonum*, and *Lespedeza cuneata*, differ in their phylogenetic relatedness to the resident plant communities. The results showed that soil microbes are largely pathogenic and that drought and phylogenic relatedness play a role in mediating the relationship between diversity and invasion. The change in soil communities due to drought generally decreased the biomass of the three invasive species, caused the biomass of *D. fullonum* grown with inoculum from a drought polyculture to drop significantly compared to plants grown with inoculum from the ambient polyculture, and reversed the effect of changing soil biota due to diversity for *L. cuneata*. Additionally, *Cirsium vulgare*, the most closely related species to the resident plant communities, was suppressed by soil biota originating from *Asteraceae* monocultures whereas *D. fullonum* was facilitated by these soil biota. This suggests that the microbes in these soils were largely family-specific, and that phylogenetic relatedness affects the role that community diversity plays in invasion. The relationship between community diversity and invasion is not universal and is instead mediated by microbial populations and their changes due to diversity, phylogenetic relatedness, and drought.

Investigating the Effects of Hypoxemia on Traumatic Brain Injury

Umang Parikh

Mentor: Stuart Friess

Traumatic brain injury, brain injury caused by an external force, remains a high cause of death and disability. In preclinical settings, hypoxemia, or episodes of low oxygen levels in the blood, immediately after traumatic brain injury (TBI) has been observed to exacerbate clinical symptoms. It is yet unknown whether hypoxemia several hours after the initial injury has an effect on injury in the white matter of the brain. We developed a clinically relevant mouse model of TBI and delayed hypoxemia. We placed mice in hypoxic conditions for 30 minutes, 24 hours after controlled cortical impact (CCI), a standard way of inducing reproducible TBI. Mice which were injured and exposed to hypoxemia had significantly elevated levels of axonal injury compared to injured mice alone. These results were consistent across two markers of axonal injury. Our model of delayed hypoxemia following TBI allows for quickly processing potential candidate therapeutics for preventing and protecting against axonal injury and cell death. We then investigated whether there were sex-dependent differences in responses to injury and hypoxemia. We explored differences between female and male mice, as well as between female mice in proestrus, one of the four stages of the reproductive cycle of mice, compared to female mice in the other three stages. There were no significant differences in measures of axonal injury, microglia activation, or astrocyte activation.

Identifying Novel Regulators of Necroptosis

Vinay Penna

Mentors: Wayne Yokoyama and Swapneel Patel

Necrosis had long been considered a form of dysregulated cell death caused by disease. Recent evidence has revealed that some forms of necrosis have defined molecular pathways. Necroptosis is the most studied of these pathways and involves receptor interacting protein kinase 3 (RIPK3). Necroptosis has been implicated in a variety of diseases including inflammatory bowel diseases, pancreatitis, and ischemia-reperfusion injury. Despite its suspected involvement in these maladies, little is known about the molecular pathway of necroptosis as only a few key proteins have been identified. We hypothesize that there are other genes involved in this process which have yet to be associated with necroptosis as other cell death pathways have many more molecular players. In order to discover novel regulators of this pathway we conducted a broad genetic screen, using a genome wide CRISPR/Cas9 library to search for genes whose loss led to resistance to necroptosis. We packaged the CRISPR/Cas9 machinery into a lentiviral delivery system, which was used to infect mouse embryonic fibroblasts (MEFs). The infected cells are subject to either control stimulus or necroptopic stimulus. Virtually all of the wild-type cells died when subject to necroptosis. Surviving cells likely have a resistance phenotype generated by the loss of key genes. Treated and control groups were then analyzed via PCR amplification and deep sequencing. Subsequent computational analysis of the sequencing results provided a list of genes with potential involvement in necroptosis, including those already implicated in the pathway such as *RIPK1*, *RIPK3*, *MLKL*, *CYLD*, and *TNFRSF1A*. We then selected a number of candidate genes and subjected them to further molecular analysis. We believe that this CRISPR/Cas9 based screening strategy will be a powerful tool for identifying novel regulators of necroptosis.

Elucidating the Role of Small Nucleolar RNA 114-12 in Acute Promyelocytic Leukemia

Amrita Ramesh

Mentors: Daniel Link and Alun Carter

Recent studies show a significant dysregulation with functional implications of small non-coding RNAs in patients with acute leukemia (AML). The canonical role of small nucleolar RNAs (snoRNAs), a subcategory of non-coding RNAs, is to modify ribosomal RNA. However, there are orphan snoRNAs without any known ribosomal RNA target. Studies have shown that there is an overexpression of snoRNA114-12 in M3-AML. This study aimed to determine the biological effect of inducing overexpression of snoRNA114-12 in various models. An overexpression system was generated to model the endogenous genic environment from which snoRNAs are normally processed. The construct was then utilized to analyze the effect of snoRNA114-12 overexpression on cellular growth dynamics. Our system successfully and robustly leads to the overexpression and correct processing of various snoRNAs. Our results show that snoRNA114-12 overexpression in K562 cells, an erythroid cell line, induces apoptosis via the intrinsic pathway. Relatedly, ongoing studies are aimed at studying the effect of snoRNA114-12 overexpression in hematopoiesis and proliferation. Preliminary data suggest that snoRNA114-12 confers a granulocytic bias during the differentiation of CD34+ hematopoietic progenitor cells, and is associated with an increase in colony number. Our study provides valuable insights into the effect of snoRNA114-12 overexpression on cellular biology. Overall, our data suggests that snoRNA114-12 induces apoptosis in erythroid precursors and may confer a bias against erythroid differentiation. Further studies will aim to elucidate the mechanisms underlying the contribution of snoRNA114-12 to M3-AML.

Effects of Endogenous and Human 4R to 3R Tau Splicing

Smruti Rath

Mentors: Timothy Miller and Kathleen Schoch

Tau protein deposition has been implicated in the progression of several diseases collectively referred to as Tauopathies. This study investigated the effects of reducing 4R Tau *in vivo* to understand the mechanisms by which Tau neurofibrillary tangles affect the progression of disease. In order to do so, antisense oligonucleotides (ASOs) were utilized for the purpose of 4R to 3R Tau splicing in mice expressing either mouse (mTau) or human tau (hTau). These ASOs are short nucleotide sequences that were designed with a modified backbone to bind to Tau mRNA and alter its splicing.

Three cohorts of hTau mice were tested for decreased disease pathology. Treatment groups were saline, scrambled oligonucleotide, and 4R to 3R splicing oligonucleotide. Mice received the drug for 28 days (25 μg/day) via an osmotic pump to the right lateral ventricle. Following drug treatment, mice were injected with PTZ (Pentylenetetrazole) to induce seizures which were observed and scored. The mice were then euthanized for brain tissue collection and Tau protein levels were measured by quantitative real-time PCR. A cohort of mTau mice was also treated to observe location of Fyn and Tau protein isoforms in the synaptosome using Western Blot techniques.

The splicing oligonucleotides successfully reduced 4R Tau levels, and the scrambled oligonucleotide from the second cohort of hTau mice maintained similar levels of Total Tau. Current results indicate that 4R to 3R splicing in hTau mice did not significantly reduce Tau pathology. Results also did not indicate a significant decrease in Fyn protein levels in the Synaptosome following splicing treatment. Future directions include using more cohorts of hTau mice to test for decreased seizure pathology with 4R to 3R splicing. Co-immunoprecipitation will also be carried out to determine binding of Fyn to 4R and 3R Tau in the Synaptosome of mTau mice.

Quantifying Pancreatic Islet Architecture: Endocrine Cell Type Distribution Effects on Hormone Secretion

Courtney Richman

Mentor: David W. Piston

Coordination among cells within the islets of Langerhans is required to maintain blood glucose homeostasis. The major islet cell types are the insulin-secreting β cells, glucagon-secreting α cells, and somatostatin-secreting δ cells. Dysregulation of islet secretory activity can result in serious pathophysiology, notably diabetes. With the incidence of diabetes reaching epidemic proportions, investigation of the mechanisms underlying islet function is increasingly salient. Due to the clinical success of insulin therapy in the treatment of diabetes, most islet research has focused on the β cells. However, glucagon is also emerging as a critically important component of blood glucose regulation. This study takes a quantitative approach to understanding islet architecture and its implications for hormone secretion towards elucidating hypothesized modulatory effects between islet cell types. In particular, the cellular neighborhood around α cells was examined to investigate the regulation of glucagon secretion. This analysis relied on immunofluorescence imaging of islets from mouse (n = 5, 10 islets) and human (n = 2, 5 islets) populations. Islets were stained for insulin, glucagon, and somatostatin. Z-stack images were obtained using multi-channel confocal fluorescence microscopy, which enabled 3-D assessment of cell type distribution and proximity. This analysis produced data that demonstrate a clear specificity for α-α proximity and for α-δ associations, a novel finding that is significant given the known inhibitory effect of somatostatin on α cell secretion. Furthermore, we found a correlation between the number of inactive α cells in mouse islets and the number of α cells bordered by δ cells. These surprising data suggest a new hypothesis for local paracrine or juxtacrine effects from δ cells in the regulation of glucagon secretion from α cells. The results of this study support a model of proximity-mediated intercellular modulation of islet hormone secretion and introduce new hypotheses of the specific mechanisms involved in this process.

The Relationship between Electroreceptor Anatomy and Signal Localization in Weakly Electric Fish

Da Yeon Ryoo

Mentors: Alejandro Vélez and Bruce Carlson

African weakly electric fishes of the family Mormyridae communicate using discrete electric pulses. These signals are produced by an electric organ and received by electroreceptors on the skin surface. Differences in signal amplitude and phase detected across electroreceptors on the fish can be used to localize a signal source. Interestingly, different patterns of electroreceptor distribution are found within the family Mormyridae. Some species have electroreceptors distributed broadly throughout their body, while other species have clusters of receptors located on both sides of their head. The purpose of this study was to determine how the receptor distribution affects electric signal localization. I predicted that species with distributed electroreceptors will better track the electric field lines to the signal source, due to the ability to better detect differences in signal amplitudes and phases across broadly distributed electroreceptors. I conducted playback experiments in a circular tank to track the approach patterns, in response to synthetic electric signals, of species with distributed and clustered electroreceptors. I measured the length, velocity, duration, turn angles, and shelter exit angles of the approach responses. Species with distributed electroreceptors had signal localization patterns that were longer in duration, longer in length, and slower in velocity than species with clustered electroreceptors. Additionally, the approach patterns of species with distributed electroreceptors better tracked the electric field lines produced by the signal source than species with clustered electroreceptors. I hypothesize that these differences in signal tracking pattern reflect adaptations for different social environments. Species with distributed electroreceptors are often territorial and highly aggressive while species with clustered electroreceptors are often social and form shoals. Because the electric pulses provide information about sender identity, approaching a signal source by tracking the electric field lines may allow receivers of species with distributed electroreceptors to obtain more information about the sender.

Circadian Rhythms of the Murine Placenta Change over Gestation

Sarah Speck

Mentor: Erik Herzog

Preterm birth is the leading cause of infant mortality across the globe, occurring in 11 percent of births in the United States. Given that shift workers, who make up about 15 percent of the work force, experience reproductive problems including an increased risk of preterm birth, we believe that a disrupted sleep-wake cycle and overall circadian rhythms may be the cause. To determine how circadian rhythms are linked to the timing of birth, I studied the circadian rhythms of the murine placenta, hypothesizing that changes in these rhythms predict the timing of birth. To evaluate these rhythms, I cultured placental explants from pregnancy day (P) 9.5, P15.5, and P18.5 from transgenic PERIOD2::LUCIFERASE (PER2::LUC) mice. This knock-in mouse model permitted me to measure the expression of the clock protein PERIOD2 as reported by bioluminescence. I found that the amplitude of placental rhythms decreased from mid- to late gestation, accompanied by a tendency of period to decrease. To identify the driver of these changes, I also isolated the two major layers of the late-gestation placenta: the labyrinth zone and the decidua. I found that the amplitude and period of rhythms of the overall placenta more closely resembled those of labyrinth zone rhythms, and that the phase of placental rhythms the day prior to delivery was intermediate between the two layers. These results indicate that the labyrinth zone drives overall placental rhythms during late gestation, while also communicating with the decidua. If the circadian rhythms of the reproductive system are involved in the timing of birth, disruptions to any of these characteristics of placental rhythms may also be linked to preterm birth.

Local versus Global: A Characterization of Marrow Adipose Tissue in Two Models of MAGP1 Deficiency

Sarah E. Turecamo

Mentor: Clarissa Craft

Microfibril-associated glycoprotein-1 (MAGP1) is an extracellular matrix protein that interacts with fibrillin and is involved in regulating the bioavailability of signaling molecules such as TGFβ. Mice with MAGP1 deficiency (*Mfap2*$^{-/-}$) progressively develop increased adiposity, insulin resistance, and reduced cancellous bone mass. In this study, MAGP1-deficient mice were used to study the relationship between peripheral adiposity and marrow adipose tissue (MAT), a fat depot located within the bone marrow space that has been shown to respond to metabolic disease. By two months, *Mfap2*$^{-/-}$ mice had reduced cancellous bone and were hyperglycemic. At 10 months, *Mfap2*$^{-/-}$ mice became insulin resistant and showed a five-fold increase in MAT relative to the WT group. As the MAT expansion was coincident with the development of insulin resistance rather than the progressive cancellous bone loss, a Prx-Cre model was used to conditionally delete MAGP1 from the limbs to further explore this relationship. Mice with a deletion of MAGP1 in the limbs (Prx1-Cre; *Mfap2*$^{-/-}$) did not show any changes in peripheral adiposity, insulin response, or MAT volume. However, by 24 weeks, Prx1-Cre; *Mfap2*$^{-/-}$ had cancellous bone loss. This suggests that changes in MAT are not regulated by the bone microenvironment expression of MAGP1, but are rather tied to global metabolic functioning.

Sparse SCN VIP Projections to the PVN Indicate Paracrine Signaling

John Webb

Mentor: Erik D. Herzog

The suprachiasmatic nucleus (SCN) is the body's master circadian pacemaker. How the SCN communicates time-of-day information to the rest of the brain and body remains poorly characterized. My aim was to determine how the SCN communicates time-of-day information to the paraventricular nucleus of the hypothalamus (PVN), an upstream regulator corticosterone release, which has a 24-hour rhythm in the blood. Vasoactive intestinal polypeptide (VIP)-expressing neurons in the SCN have previously been shown to be crucial for coordinating rhythms both within the SCN and body but little is known about their projections to the PVN. I injected a Cre-dependent Brainbow virus unilaterally into the SCN of two VIP-Cre/+ mice and traced the projections within the PVN and sub-PVN. I found that a typical SCN VIP neuron sends divergent projections within the PVN and sub-PVN, but that the large majority of neurites (~75%) bifurcate only 0 to 1 times and that 85% of processes had two or fewer terminals in the PVN. Using a nearest neighbor analysis, I found that most terminals were within 40 μm of each other. By tracing the projections to the ipsilateral and contralateral side of the brain, I also found that VIP neurons have high bilateral connectivity. To determine what cell types receive SCN VIP neuronal input, I double-labeled for SCN VIP neurons and PVN corticotrophin-releasing factor (CRH) neurons and found that SCN VIP neurons sent sparse projections to PVN CRH neurons. These results indicate that individual SCN VIP neurons each target a small population of cells in the PVN or sub-PVN. I concluded that VIP neurons communicate to the PVN through paracrine signaling.

Feeling the Beat, in Rhythm and in Speech: Oscillatory Entrainment in Beat and Speech Perception

Rebecca Yang

Mentor: Jonathan Peelle

We have a natural tendency to time our movements with the various sounds and rhythms of the outside world. These actions require some perception of pulse in order to match movements to various external stimuli—we term this entrainment. Neural models of this phenomenon have focused on the role of cross-frequency coupling in auditory cortex, advocating for a hierarchical oscillatory organization that can rapidly adjust and phase-lock to the temporal regularities of auditory stimuli. A growing body of evidence advocates for the role of this synchronization in speech, with studies suggesting that entrainment occurs for metered speech, such as nursery rhymes. However, the literature has not yet examined whether these regularities persist for normal, non-rhythmic speech.

In this study, we administered a speech entrainment task as a behavioral assessment of intrinsic oscillatory responses to speech. In addition, we collected cognitive measures of short-term working memory and beat reproduction tasks from 19 adults in order to see if cognitive and rhythmic abilities were positively correlated with tapping regularity. Raster plot analysis was used to visualize consistencies in speech tapping across subjects. Our data show evidence for nonrandom tapping to speech stimuli that tended to cluster around particular, regularly occurring time points within the sentence. Because elements of regularity in speech have been shown to inform listeners' expectations about the incoming speech signal, these expectations may be used to detect regularity or entrain to underlying temporal cues of a given acoustic stimulus. Our results are consistent with the notion that resting oscillations are in essence, "reset" by the incoming speech signal and modulate to match its corresponding amplitude envelope. Ultimately, our findings support existing research that advocates for the role of the synchronizing oscillations, which characterize much of brain-wide activity and auditory processing in particular.

Investigating the Impact of Trace Metals on Methanogenesis in Two Missouri Fens

Addison Nakatani

Mentor: Jeff Catalano

Methane (CH_4) is a particularly strong greenhouse gas, having 25× the warming potential of CO_2. To understand the biological processes and controls contributing to CH_4 in the atmosphere, one important source is wetlands as they are the leading natural CH_4 producer. This investigation looks into the effect of Co and Ni on CH4 production. These trace metals are necessary in various enzymatic pathways required by methanogens in order to produce CH_4, and have relatively low concentrations in fens. The low concentrations of Ni and Co in anoxic natural environments is seen in water concentrations and extractable solid-phase metals. For this experiment, the wetland environment was replicated in microcosms using soils sampled from fens located in Johnson's Shut-Ins. Known metal concentrations of Co and Ni were then added to these microcosms. The Co and Ni dissolved in the liquid of the microcosms showed concentrations of Co and Ni higher than what is optimal for methane production, causing the control with no metal additions to produce the highest amount of methane. These results suggest the concentrations of Co and Ni added were too high causing an inhibition of methanogens; however, a larger sample size with lower concentrations of Co and Ni would gain a clearer depiction of the optimal concentrations required for methanogenesis in fen environments.

Eating Disorders as a Lens Social Change in China

Mallory Giger

Mentor: Zhao Ma

The rate of eating disorders in Chinese women has historically remained much lower than surrounding countries. Following the reform era, however, the incidence of these disorders has increased drastically. The aim of this paper is to examine the sociocultural changes that have led to this recent penetration of eating disorders in Chinese society. This paper first examines the changing body ideals for women, looking at the recent skinny idolization following the Mao era, and the implications this change has on the current mindset of Chinese women. The paper will then analyze the changing social roles of women by examining the developing educational opportunities and the elimination of domestic duties, and discuss how these changes lead to psychological pressure driving disordered eating. Finally, the paper will look at the diagnosis and treatment of eating disorders, and how the delay in adequate treatment has contributed to the rising rates of the disorders seen today. These three factors show how the post-Mao environment in China has created increased psychological pressure on women, leading to the high incidence of eating disorders occurring today.

Does Domestic Intellectual Property Right Strength Affect Pharmaceutical Innovation?

Jacob (Jay) Kaplan

Mentor: Maria Canon

Intellectual Property Rights have been a contentious issue for the past few decades. The conventional reasoning for the legal basis of patents is that it is worthwhile to grant an inventor monopoly rights for a certain innovation that can be easily mimicked, thus guaranteeing the inventor the fruits of her labor. The economic basis for patents is that if an inventor or firm knows that they cannot be granted a patent for a potential invention, then they will not be able to profit and thus there will be no incentive to innovate. While granting a monopoly may spur innovation in certain cases, monopoly pricing undoubtedly lowers consumer welfare. In addition, while the idea that patents spurring innovation seems logical in most industries, economic research has not strongly supported this argument. The question I address in this paper is whether domestic intellectual property right strength is of importance specifically for pharmaceutical innovation. I use pharmaceutical research and development expenditure as a proxy for innovation to run panel regressions on 23 OECD nations. I do comparison regressions between pharmaceutical R&D and total R&D to see if patent strength is of more importance to the pharmaceutical industry. I use two indexes of patent strength as independent variables, one for general patent strength and one specifically for the pharmaceutical sector. I find that for pharmaceutical patent strength, higher levels lead to an increase in innovation, with a positive marginal effect only occurring at relatively high levels of patent strength. In the comparison regressions using total R&D, I find that at lower levels increasing intellectual property strength increases innovation up to a certain point, and that for most developed countries the optimal patent strength has already been reached.

The Marginal Propensity Out of After-Tax Income and Implications for Tax Policy

Isaac Norwich

Mentors: Steven Fazzari, Bruce Petersen, and Maria Canon

The election of President Trump, coupled with Republican control of Congress, makes significant tax reform in the U.S. more likely than at any time in at least a generation. While Paul Ryan and Congressional Republicans have their own ideas for optimal tax policy, there are other arguments as to how tax reform can help reduce income and consumption inequality in the United States. My paper explores the marginal propensity to consume out of after-tax income as one factor that determines the economic effect of tax changes. Using data originating from the Panel Study of Income Dynamics between 1998-2012, I estimate the marginal propensity to consume (MPC) for income quintiles. Households in the sample are split into five groups based on their after-tax income for a given year. The MPC is estimated from a fixed effects regression that controls for demographic factors. The estimated MPC is 1.0 for the quintile with the lowest income, which includes households with up to $30,500 in after-tax income (in 2012 dollars). The MPC steadily declines for each successive quintile, with an MPC of 0.78 for those with income above $93,244 (in 2012 dollars). The dataset does not adequately capture those at the top end of the income spectrum (the highest single income observation is $6,324,707), and thus the MPC cannot be estimated for the highest earners. Given the inverse relationship between income and MPC, it is reasonable to assume that the MPC would be even lower for the true top tail of the income spectrum. Nevertheless, my results suggest that tax reform, if aimed at boosting short-run aggregate consumption, should target those at the bottom of the income spectrum.

Policy and Practice: Discrepancies between the Law and Implementation of Intercultural Bilingual Education in Jujuy, Argentina

Alena Antonowich

Mentors: Odis Johnson Jr., Cindy Brantmeier, and Ebony Duncan

This investigation examines the discrepancies between policy and practice of intercultural indigenous education in the province of Jujuy, Argentina. The right of indigenous peoples to an education in their own language with respect to their own culture and worldview is protected by law nationally, however it appears that the implementation of this Intercultural Bilingual Education (IBE) is often full of challenges and not prioritized by the government. Using multiple interviews, academic works, and official laws, this investigation shows that the lack of IBE programs in the province of Jujuy is the result of a lack of resources, qualified teachers, and governmental initiative. As a result, indigenous groups in Jujuy have begun their own initiatives to create a school of intercultural education: la Escuela Superior de Educación Intercultural de Jujuy. My conclusion is that, realistically due to the lack of funding and governmental concern for IBE programs, the best ways to increase access to intercultural education or provide IBE schools in Argentina is to increase political participation and representation of indigenous groups, or to create more schools like ESEI de Jujuy that start independently, although without government support and sufficient funds this is difficult to fully execute.

Reworking Cohesion: The Uses and Limitations of Panethnic Labels for Asian Americans and African Americans

Jaydee Lee

Mentor: Garrett Albert Duncan

This project discusses and examines the uses and limitations of identity politics, specifically the panethnic labels of "Asian American" and "African American" identity, in the United States. "Panethnicity" refers to the political-cultural coalitions that are made up of various groups of distinct national and ethnic origins. These terms have done much to help to mobilize, organize, and advance the racial groups to whom these terms refer in the United States to face oppression and marginalization. U.S. racial minority groups that use these labels, however, have had to position themselves in certain ways to accept essentialized, or oversimplified and unchanging, notions of race that necessitate a kind of self "sameness." Doing so ignores the diversity within these groups as well as the different needs that various members of these groups might have. When examining the label "Asian American," there are high tensions over who is included and excluded. This occurs as a result of the manner by which individuals and institutions give priority to East Asians are over other Asian ethnic groups in the U.S. This prioritization excludes many others who have different histories of exclusion, which brings into question the limitations of this term. Especially since the tragic events of September 11, 2001, South Asians find themselves simultaneously defined as a "model minority" and as a "terrorist." We can also turn to the term "African American" as unable to fully cover the needs and concerns of recent black immigrants to the United States, for instance, who may maintain ties to their Diasporic ethnic heritages. The gaps in where the terms "Asian American" and "African American" fail their respective populations help us examine how socially constructed these racial term is. They further push us to struggle with the systematic structures that benefit from these labels. To examine how and why certain groups are positioned as racially different, we must look into how racial formations occur to draw out where and who employ them.

When Race Does(n't) Matter: Forging a Collective Memory of 9/11 in Suzanne Collins' *The Hunger Games* Trilogy

Andie Berry

Mentor: Julia Walker

September 11, 2001 stands as a singular moment in which the United States' carefully constructed image of invulnerability and exceptionalism was completely compromised. In the aftermath of the terrorist attacks, American citizens experienced a prolonged moment of silence as the country tried to absorb the shock. As the attacks approached their fifth, tenth, and fifteenth anniversaries, writers began to publish work that investigates the national trauma left by 9/11, but rather than provide realist accounts, many writers used imaginative, speculative narratives to address the turmoil of the events without repeating the exact gruesome nature of the attacks. National traumas often produce literary dystopias which manifest the cultural anxieties that are agitated by crisis. Yet, the dystopian genre that emerged after 9/11 is uniquely written for younger audiences and the abundance of works written for minors solidified into a young adult dystopian genre. Meanwhile, demographics are experiencing a "browning" phenomenon in which birth rates are leading a shift so that by 2060, if not earlier, the United States will be a majority-minority nation. While young adult dystopian novels such as Suzanne Collins' *The Hunger Games* trilogy grapple with the anxieties of post-9/11 America, the presence of racial minorities remains superficial and fraught even in an imagined future. As racial and ethnic minorities start to outnumber the white majority, the social worlds created in young adult dystopian narratives ignore this emerging population and fail to reflect this population's diversity. By connecting the dystopian genre, trauma, and race, I consider three primary questions. First, what attributes are specific to the dystopian genre and how does the young adult subgenre complicate that structure? Second, what is the connection between the dystopian genre and trauma; how can trauma theory help to clarify how the dystopian genre narrates the past? Third, can race be considered a national trauma in the United States and if so, what space does it inhabit in the fictional future of *The Hunger Games*? By understanding the hidden role that race plays in structuring the unnamed trauma at the core of Collins' novel series we can see how our cultural responses to 9/11 repeat—without unpacking—the unacknowledged traumas in America's history.

Shamed

Jacob Nason

Mentor: Richard Chapman

Shamed is a dark comedy loosely based on the true story of "slut shaming" at George Washington High School that created controversy in Charleston, West Virginia in April and May 2013. This screenplay focuses on the lives of Megan Hooper and George Westfall, the student body vice-president and principal of the fictional William Sherman High School. A coming of age story, this thesis project explores the psychological and metaphysical nature of growing up in a rural, conservative community. Although the film's subject matter is the political divisiveness caused by sex education in Charleston, West Virginia, the screenplay also serves as a critique of the aggressive bipartisanship in contemporary American politics. Magical realism is used throughout to establish visual metaphors and to assert a tone of cynical shock towards the events depicted.

Mother Confessor

Emma Quirk-Durben

Mentor: Richard Chapman

For my thesis project, I wrote a screenplay about an early female pioneer in journalism and the film industry, Adela Rogers St. Johns. Much of the screenplay is inspired by material from St. Johns' autobiographies. The screenplay also tells the story of trailblazing female comedian Mabel Normand, who directed many of her own films during the silent period and was a lifelong friend of St. Johns. The film takes place in the beginning of the twentieth century, which led me to research the early days of Los Angeles and the film industry for my story's backdrop. My screenplay also features the beginnings of the gossip industry, as well as William Randolph Hearst's sensationalizing mode of journalism. St. Johns worked in both of these industries and was known for being what was then called a "sob sister," indicating a highly emotive style of writing associated with women. I explored how this sob sister style of writing paved the way for New Journalism of the 1970s and the author-centered style of journalism that is now commonplace. My screenplay highlights St. Johns' varied work as a journalist, a gossip columnist, a screenwriter, and a short story writer. Ultimately, my screenplay positions St. Johns as a vital figure in the history of Hollywood as the creator of a sustaining Hollywood myth. St. Johns wrote the original story that, through many versions, is now well known as A Star is Born. St. Johns' story of the tragic consequences of a young female star's rise to fame has become one of the quintessential and enduring Hollywood archetypes.

Neither Irish nor English: The Scottish Presence in Ulster

Cira Danda

Mentors: Derek Hirst and Christine Johnson

By the end of the Tudor reign, the British government fully adopted plantation as the most effective method of colonizing Ireland with the ultimate goal of "making Ireland British" as discussed by scholar Nicholas Canny. The Ulster Plantation represents the most prominent of these schemes throughout the island. The massive influx of Protestant English and Scottish settlers threatened the political and economic position of the Catholic, Old English nobility as well as that of the few Irish lordships remaining in the region. It also inspired resentment among the native Irish inhabitants, ultimately resulting in the 1641 Rebellion—a violent Irish-Catholic uprising against their Protestant neighbors. This thesis argues that out of the 1641 Rebellion and the failure to create a "British" identity, the Scottish settlers in Ulster developed their own distinctive "Scots-Irish" identity. The project examines the formation of this identity through an analysis of Scottish settlement within Ulster from the start of plantation under James I through the 1641 Rebellion. More specifically this thesis first analyzes the Scottish role in the plantation's early development and their relationships with both the English and the Irish during this time followed by a discussion of the Scottish nobility's successes in establishing predominantly Scottish communities and preserving Scottish culture within Ulster. Finally, the project concludes with an analysis of the Scottish role in the violent upheaval of the 1641 Rebellion.

When Development Goes Wrong: The Drainage of the Marshes of Southern Iraq in Historical Perspective

Rahmi Elahjji

Mentors: Nancy Reynolds and Timothy Parsons

Until the early 1990s, the marshes of southern Iraq were the largest continuous system of wetlands in the Middle East. In the aftermath of the Gulf War, Saddam Hussein's regime undertook a massive development project to drain the marshes by diverting water flow from the Tigris and Euphrates river systems. The reason behind this, as professed by the Iraqi state, was to repurpose this marshland for agricultural improvement. This project, however, came at a massive ecological and human cost, disrupting one of the region's major ecosystems and displacing hundreds of thousands of people. While development might have been the professed goal of the venture, compelling evidence indicates that Saddam's regime intended to punish the communities of these marshes as retribution for their perceived support of the 1991 uprisings in Iraq. This thesis interrogates this drainage scheme in the context of the wider, global history of the development project. Employing a variety of sources including ethnographies, environmental studies, and both local and international media coverage of the event, this thesis argues that historical systems of knowledge production and developmental interventions within the marshes made the framing of the drainage scheme as a development project possible. Further, this thesis contends that these two historical strands of knowledge production and developmental intervention allowed the state to pursue a policy of environmental violence, defined as a type of violence committed against both a defined environmental landscape, like the marshes of southern Iraq, and against the human societies that live there, like the Marsh Arab communities. In the case of this marsh drainage project, the Iraqi state employed environmental violence as both an instrument of state repression and as retribution for insubordination by certain political and ethnic minorities.

The Ideology of Project *SUCCESS*: The Role of Cold War Anticommunism in the 1954 CIA Coup in Guatemala

Benjamin (Ben) Greenho

Mentors: Krister Knapp and Elizabeth Borgwardt

Over the course of nine days in June 1954, the Central Intelligence Agency (CIA), the primary intelligence agency of the United States, carried out a covert operation designed to overthrow Jacobo Arbenz, the President of Guatemala. During this operation, known as Project *SUCCESS*, the CIA overcame multiple unexpected setbacks to successfully remove Arbenz from power, putting an end to his efforts to implement a state-led program of land redistribution in Guatemala. This thesis seeks to analyze the events that occurred before, during, and in the aftermath of Project *SUCCESS* through the lens of Cold War anticommunist ideology, or the belief held by many American policymakers after World War II that the Soviet Union posed both a geopolitical and ideological threat to the United States because it was actively attempting to subvert other countries by supporting the spread of Communism around the world. Specifically, this thesis argues that the Cold War anticommunist ideology of the various mid-level CIA actors involved in Project *SUCCESS* was the driving force behind the operation. As a result of this anticommunist ideological framework, and supported by the national security policies of U.S. President Dwight D. Eisenhower, these CIA actors developed and executed Project *SUCCESS* in order to eliminate what they perceived to be the Communist-inspired threat of Arbenz's land reform. In its three chapters, this thesis analyzes how these mid-level CIA actors' anticommunist ideology had a pervasive influence on U.S. actions in Guatemala during the 1950s, beginning with the CIA's first unsuccessful attempt to remove Arbenz from power in 1952, continuing through the planning and implementation of Project *SUCCESS*, and later impacting the State Department's attempts to shape Guatemala's political and economic future after 1954.

Saving the State through Enlightenment: *The Independent's* Statist View of Women's and Children's Education

Keun Hee (Jeff) Kang

Mentors: Steven Miles and Ji-Eun Lee

In 1876, Japan forced the Chosŏn government—the dynasty that ruled the Korean Peninsula from 1392 to 1897—to sign the unequal Kangwha Treaty (*Kanghwato Choyak*), which imposed Japanese extraterritoriality and coerced the Korean state to become Japan's most-favored-nation for foreign trade. Japan had enforced on Chosŏn the same unequal treaties that the West had imposed on it: an imperialistic act for eventual colonization. Such severe foreign intervention and pressure caused the Korean state to suffer greatly from political instability in the late nineteenth century. Desperate to save the Korean state from the hands of imperialism, various individuals, factions, associations, and entities embracing different political ideologies rose to encourage the government to initiate reforms across the country. *The Independent*, the first Korean private, vernacular, and bilingual newspaper, was one of such entities founded in 1896 that argued for rapid and far-reaching reform—especially in education. The newspaper asserted that compulsory education would save the Korean state from imperialism and protect its sovereignty by enlightening the population. Moreover, it stated that women should not be excluded from educational opportunities; as educated wives and mothers, women would foster harmony in their households and properly raise their children to become intellectual, patriotic, faithful, and dutiful citizens—willing to sacrifice themselves for the common, greater good—of the state. This thesis analyzes such perspectives of *The Independent* on women's education and what it meant by proper guidance and parental responsibilities. Through this analysis, it argues that the newspaper's outlook on educational reforms—appearing to be progressive on the surface —did not uphold individualism and but embraced statist ideals, as it fundamentally advocated for the introduction of compulsory education for women to sponsor state interests and push the population to a generic goal.

Public Credit in the Early American Republic: An Examination of the Influences of Debt Policy and Debate on Institutional Government Relationships, 1790-1815

Ari Moses

Mentors: Peter Kastor and Venus Bivar

Only seven months after the creation of a Constitutional government, the country's chief financial officer, the Secretary of the Treasury Alexander Hamilton, recognized the looming financial problem facing the nation: the issue of public credit outstanding. This thesis answers the questions how the federal government functioned and funded itself in its first decades and what the role of credit was in creating lasting institutional relationships. It focuses on how the government funded itself through its first three large economic events, the Assumption of State Debts in 1790, the Louisiana Purchase in 1803, and the funding of the War of 1812. This thesis diverges from current economic history of the United States as it focuses on debt funding and not the internal revenue system of America. By analyzing Treasury records, statements given to and given in Congress, personal correspondence, and national legislation, this thesis seeks to better understand the role of the American debt system in relation to the economic growth of the nation. This thesis argues that access to foreign credit was paramount in shaping the relationships between the federal and state governments as well as the executive and legislative branches. The need for foreign capital inspired the first contentious constitutional debate and funded enormous land purchases. The absence of foreign credit, coupled with the decline of the internal revenue system, almost left the nation insolvent in 1814 as the government could no longer fund itself through domestic means. This thesis asserts that access to international debt markets was essential to stabilize and grow the U.S. economy between 1790 and 1815.

The Body Catalogued: Public Anatomy Museums in Nineteenth-Century New York

Rachel Multz

Mentors: Margaret Garb and Corinna Treitel

Anatomy museums were a form of popular entertainment during the nineteenth century. There were private museums run by medical schools or hospitals, and public museums that were run by individuals who sought to profit from those curious about the human body. This thesis analyzes the catalogues (logbooks of specimens they had on display) of three public anatomy museums that were opened in different decades of the nineteenth century in New York City. These museums largely restricted entry to men only. The catalogues reveal the various ways that these proprietors wanted nineteenth-century New Yorkers to view human bodies, and to reinforce biological hierarchies based on race, class, and ethnicity. The catalogues tended to emphasize sexual morality of women and particularly of men. Within the museums, the 'Pathological Rooms' showed grotesque specimens of diseased genitalia to frighten men into observing nineteenth century sexual morals. The museums also reinforced the negative stereotypes that existed about African Americans, Native Americans, and indigenous peoples, typically justifying inequalities and injustice with biological explanations. In addition, they showcased specimens of 'monstrosities' such as fetal abnormalities or adult deformities. This type of showmanship is what anatomy museums are known for, and it is one of the many characteristics of these museums that led them to fall out of favor with the public and the medical community. This thesis seeks to shed light on this forgotten yet important aspect of the history of anatomy and the history of New York City.

Kurdish Women Rising: Gender Construction in Ideological Discourses from the PKK to Rojava

Jenna Pearlson

Mentors: Nancy Reynolds and Timothy Parsons

After its founding in 1978, the Kurdistan Workers Party (PKK) successfully mobilized many Kurdish women around its nationalist campaign against the Turkish state. Themes relating to gender equality have continued to gain importance within the movement, especially since the 1990s, as Kurdish women's participation in the movement increased. The developments regarding the role of women in the PKK had an impact on the formation of Rojava, or Western Kurdistan, the de facto autonomous state created by the Democratic Union Party (PYD) in Syria after the outbreak of the Syrian Civil War. In Rojava, certain principles of gender equality previously articulated by the PKK have been implemented and expanded upon. Building on feminist studies strategies of exposing the interconnection between ethnic/nationalist processes and gender relations, this thesis examines the Kurdish movements from a gender perspective. By analyzing the writings of Abdullah Öcalan, interviews of Kurdish women, and documents from Rojava, this thesis seeks to better understand conceptualizations of gender equality in the Kurdish movement and contextualize these developments within the history of Turkey and Syria. This thesis argues that the PKK facilitated women's participation in the Kurdish movement and that the resulting contributions of women to that cause elevated the importance of gender equality within the ideological and political discourse of the Kurdish movement and within its organizational structure. Additionally, this thesis argues, based on ideological and historical developments within the Kurdish movement, that the events in Rojava are inherently linked to the PKK and therefore the histories and identities of the two movements are interwoven even though they primarily occur in different nation-states.

Lesioned Legacies: United States Mustard Gas Experiments During World War II

Benjamin Pockros

Mentors: Elizabeth Borgwardt and Kenneth Ludmerer

The U.S. military intentionally subjected thousands of their own servicemen to toxic mustard gas as the country prepared to wage and to defend against chemical warfare during World War II. Military officials and physician researchers coerced, threatened, and outright forced some of the most vulnerable soldiers—teenagers, low-income draftees, or people of color—to "volunteer" for a variety of dangerous experiments. Some historians have excused the coercive nature and injurious results of these experiments due to the absence of clear legal standards applicable to research on human subjects in the 1940s. This thesis presents clear evidence of contemporaneous research protocols involving informed consent and principles of "beneficence"—a concept related to the later, clearer Hippocratic oath principle of "do no harm." The designers and executors of the mustard gas research program knowingly transgressed these ethical boundaries. By analyzing archival testimony by veterans exposed to the toxin, as well as laboratory reports from these once-confidential experiments, this thesis seeks to analyze how and in what ways the relevant ethical standards and the U.S. mustard gas research program intersected. Additionally, this thesis explores some of the implications of the fact that these human research subjects were disproportionally soldiers of color. This thesis shows how, given the prevailing mid-century social values around issues of race and ethnicity, white researchers rationalized transgressions of widely-accepted ethical research standards by exploiting the enhanced vulnerability of minority soldiers. The resulting analysis—in many cases based on never-before published evidence—transposes more traditional categories of race and ethnicity onto a wider canvas of vulnerability and exploitation, even as it moves traditional analyses of law and criminality into a greater forum of normative transgressions.

Lives of the Livestock Industry: Immigration in Kansas City's Railroad and Meatpacking Industry

Roland Vaca

Mentors: Margaret Garb and Douglas Flowe

Following the conclusion of the Civil War, investors in Kansas City and from the east coast and Midwest developed Kansas City into one of the nation's leading livestock centers. The industry drew immigrants from Europe and migrants from the American south and southwest to Kansas City. This thesis investigates the work experiences and living conditions of German, Irish, Croatian, Mexican, and African American populations that migrated to Kansas City to seek employment on railroads and in packinghouses. My research tracks the growth of ethnic communities created by the immigrant workforce and explores the rise of religious and cultural institutions. The thesis analyzes the relationships between immigrant groups and their employers, and among the immigrant laborers, as successive waves of immigrants replaced previous groups residentially and in employment. This thesis argues that employment in the livestock industry attracted immigrants to Kansas City, the workers' relationship to the industry affected the establishment of ethnic communities, and most significantly, that although cross-cultural relations within packing plants were initially tumultuous, meatpacking eventually served as an interracial unifier.

Identities at Stake: How Empathetic Virtual Reality Reshapes Personal Identity

Jin Seok Park

Mentor: Pannill Camp

A common understanding of virtual reality (VR) places emphasis on its function as a machine that builds empathy. Current academic research relies on behavioral science to back this claim, which is insufficient in that its conclusions are heavily based on external observations, such as experiments where VR experiences led to a display of empathetic behavior. In order to understand how the mind motivates such action, I attempt to evaluate VR's potential to generate empathy with a more theoretical approach by analyzing the frameworks of the mind proposed by two different philosophers: David Hume and Edmund Husserl. Although they formulated their ideas in the eighteenth and twentieth centuries, respectively, their works provide valuable insights into how the mind reacts to external perceptions. By applying the ideas of Hume's empirical ego and Husserl's transcendental ego to VR experiences, I posit that VR has the potential to reshape our notion of personal identity, particularly when the experience is geared towards building empathy. Specifically, the empirical ego helps us understand that personal identity is a collection of perceptions that are easily susceptible to change when new perceptions are introduced. On the other hand, the transcendental ego shows that the idea of personal identity is made up of the stances that we have intentionally formed regarding our experiences, which are less affected by individual experiences. By applying these frameworks to real and imagined VR experiences, I conclude that VR has the potential to reshape our personal identity and that the increase in empathetic behavior is not the sole effect of the technology but one of the many manifestations of such reshaping. Ultimately, I hope to demonstrate the value of philosophical frameworks in seeking to understand how a new technology may affect how we act but also how we think and define ourselves.

Origen For or Against Plato? An Analysis of Origen of Alexandria's Engagement with Non-Christian Philosophy

Natalie Runkle

Mentor: Peter Martens

Origen of Alexandria (185-254 CE) was among the first Christian thinkers to rigorously engage with non-Christian Greek philosophy. Nevertheless, as a result of his active discourse with traditions like Platonism and Stoicism, much of Origen's work sparked controversy during his lifetime and after his death. This thesis enters into such controversies by investigating how Origen himself appraised non-Christian thought in his writings. My analyses of key passages from Origen's *On First Principles, Against Celsus*, and *Commentary on the Song of Songs* identify three themes in his evaluation of non-Christian traditions: first, their supposed appropriation of concepts from Hebrew scripture; second, what he contends is their dependence upon God; and third, their fall from grace, which he believes was engineered by spiritual entities who led philosophers astray. By examining Origen's stance on non-Christian thinking through the lens of these three themes, I conclude that while he venerates much of non-Christian philosophy, he nevertheless prioritizes his Christian convictions above all else. This conclusion contributes to an ongoing debate in Origen scholarship as to whether he accepted non-Christian philosophy at the expense of Christianity, or whether he held fast to Christianity while repudiating non-Christian philosophy. My thesis takes a middle route by building on previous scholarship and offering potentially corrective interpretations of key texts. My conclusions may also help clarify assessments of Origen's supposed orthodoxy or heresy, which tend to be clouded by the condemnations of the Council of Constantinople in 553 CE. By bringing to light Origen's multidimensional assessment of non-Christian philosophical schools, this thesis reveals the need for investigation of his relationship to these traditions and, by extension, of the interplay between early Christianity and non-Christian philosophies of the era.

Unboxing the Casket: A History of the Sixteenth-Century Limoges Enameled Jewel Box in the Saint Louis Art Museum

Yusi (Joyce) Zhou

Mentor: William Wallace

The object at the heart of this thesis is a sixteenth-century enameled casket from Limoges, France, in the collection of the Saint Louis Art Museum. The casket features 13 enameled plaques: 11 rectangular panels depict narratives from Ovid's *Metamorphoses* and two trapezoid gable panels contain profile portraits of individuals surrounded by ornamental vegetation. On flat sheets of copper primed with black enamel, the enameller formed figures and landscape in the grisaille enamel technique, with accented details in gold. Little is known about the casket, which was only exhibited for a few months after it was acquired in 1988 and has only been surveyed in an informal setting by two museum professionals. By proposing the casket's date of production, function, owner, and original format, I explore how sixteenth-century French nobles used decorative objects to further their political, economic, and social goals. Drawing on historical and art-historical scholarship, formal analyses of the object, and comparisons with similar examples, I propose that the enamels were part of a now-deteriorated casket and that a member of the sixteenth-century French nobility commissioned the object and presented it as a marriage gift to his or her future spouse. Using the casket and its Ovidian imagery as a starting point, the thesis examines how early modern decorative objects help us understand the motivations for art patronage by the nobility, the gender roles within aristocratic marriages, and the ways in which the urges and desires of aristocratic women were perceived, controlled, and appeased in the interest of producing a legitimate male heir.

Advise and Rule: Foreign Experts and Advisers in the Independence of the Levant

Aaron Christensen

Mentor: Timothy Parsons

When the French Mandate in Lebanon and Syria ended in the mid-1940s, the nascent Syrian and Lebanese governments faced a wealth of new challenges from the domestic opposition and residual French influence in administration. The national governments sought assistance in the form of foreign advisors and experts hired in large numbers into state administration after independence. This thesis combines primary sources from the archives of French, British, and American diplomatic services to understand these advisors' activities through several different national points of view. The recruitment of foreign economic and administrative advisors enabled independence from France while placing Lebanon and Syria under new foreign influence. The United States, United Kingdom, and other powers sent advisors to assist Syria and Lebanon, with the hidden goal of building influence and winning privileges in the independent states. To the national governments of Syria and Lebanon, foreign advisors were tools to consolidate control of their countries in accordance with their vision and interests. However, the political opposition viewed the recruitment of foreign experts as a betrayal of their countries' newfound independence and as a relic of the French Mandate. In this way, the recruitment of foreign advisors became a contested issue in the struggle for defining the future of the Levant.

This research fits with other historical literature on the independence of the Levant by detailing how foreign countries and their advisors were both a site of contestation in the politics of the Levant and powerful actors seeking to influence the future of the region. Finally, this project also fits within a growing body of literature, primarily focused on sub-Saharan Africa, that examines the role of administration and development advisors in decolonization. This literature holds that far from being neutral technocrats, advisors and experts had a deeply political role in setting the terms of independence.

The Voice of Kenya: Competing Visions of Nationhood in a Post-Colonial State

Shaun Kai Ern Ee

Mentor: Timothy Parsons

Throughout the struggle for independence and after its final attainment in December 1963, Kenya's national identity remained in flux, but by 1966 it had become a unitary nation-state that assumed the Western values of stability and accumulative growth. Yet although hindsight suggests that this was certain, the adoption of this sociopolitical form was not predestined, but instead shaped by various constraints. Many other possibilities lived and died in the corridors of independence, such as multi-racialism, ethnic patriotism, *majimboism* (federal nation-statism), and redistributive nation-statism. During the period from 1959–1966, the Ministry of Information and Broadcasting (MIB) became a key site of contestation, used by Kenyan politicians and bureaucrats to articulate their competing visions of the fledgling nation. MIB had partial control of print media and (following 1964) total control of broadcast media, and these actors hence saw it as a pivotal tool in influencing Kenya's media landscape and shaping the national imagination.

Ultimately, only one coalition amongst these actors won out, foreclosing all other possibilities and cementing Kenya's status as an accumulative and unitary nation-state. This victory rested on the unification of three elements: the ambitions of individual bureaucrats, the centralized structure of the state, and the universalizing power of broadcast media to reach across linguistic boundaries. A coalition of end-of-empire colonial officials and African bureaucrats supported this strain of nation-statism partly because it fit their conception of modernity, and partly because it suited their national ambitions. The state and broadcast media formed a highly centralized broadcast-bureaucratic complex that they then used to consolidate their vision. This broadcast-bureaucratic model of nationalism stands in contrast to Benedict Anderson's print-capitalist model, and provides an alternative way to conceptualize nationalism in the post-WWII era of decolonization.

Treasures in the Salt Flats: Bolivian Perspectives on Lithium Extraction

Gillian Greenberg

Mentor: Bret Gustafson

Bolivia's lithium reserve, the world's largest, has brought the country into the spotlight as demand for lithium-ion batteries grows. A state-run project to extract lithium and produce batteries broke ground in 2008 and continues to work towards industrial scale production. This research, based on two months of fieldwork, explores the local and national perceptions of the project. The study finds that Bolivians frame lithium within their country's history of natural resource extraction as a way to conceptualize why this project—government-run with an emphasis on creating lithium-ion batteries within Bolivia—is different than past extractive industries. It also explores how the Bolivians evaluate the project based on its ability to generate economic development both at regional and national scales. Finally, it examines how lithium provides a mechanism through which regional civic organizations negotiate their relationship with the state by using the lithium project as a way to gauge the government's dedication to regional economic development. Ultimately, this research demonstrates how local support for lithium extraction has been conceptualized through its capacity to change Bolivia's history with extractivist industries and produce economic development.

"*Weile Zhengyi*" ("Strive for Justice"): The Role and Impact of Chinese NGOs in Legal Aid Provision and the Protection of Migrant Workers' Rights

Carl Hooks

Mentor: Zhao Ma

This original study explores how non-governmental organizations (NGOs) in China provide and advance legal aid services for rural-to-urban migrants. Discriminatory rules in China's state-sponsored legal aid system continue to prevent millions of vulnerable migrant workers from receiving needed legal aid. Zhicheng Public Interest Lawyers (Zhicheng), a preeminent legal NGO headquartered in Beijing, provides a rich case study of how Chinese NGOs protect migrant workers' rights and compensate for gaps in government services. By analyzing eight weeks of qualitative research conducted at Zhicheng in the summer of 2016—consisting of interviews with numerous lawyers, participant observation, and collection of NGO documents—this study argues that Chinese legal NGOs both function as important supplements to official legal aid centers and offer superior services for migrant workers. Depending on organizational factors, NGOs may even exert positive influence on labor rights legislation. These findings may help scholars conceptualize symbiotic models of interaction between legal NGOs and the Chinese government. They also offer insights into the national evolution of legal aid and civil society in modern China. Going forward, broader empirical investigations of legal NGOs that account for China's recent NGO laws will be necessary to overcome the inherent limitations of a case study.

The NPO-Public School Partnership: An Alternative, Short-Term Solution to South Africa's Failing Education System

Emma Milford

Mentor: Jean Allman

Under-resourced public schools in South Africa, especially those in low-income rural areas, face extreme structural inequalities, and they not only require more funding to provide integrated services, but they also require stronger accountability, transparency, and financial monitoring of those who handle the school's financials. Poor financial management of school budgets has resulted in corrupted, misguided, and delayed school funding, all of which have negatively impacted learners' ability to flourish in public schools. Instead of tackling this problem with increasingly strategic methods, the Department of Basic Education has lowered its standards of achievement, which not only prevents learners from reaching their full potential, but also reduces the number of learners prepared for further education. While the responsibility of uplifting schools that are struggling financially should ultimately be in the hands of the public education system, I propose a short-term solution that partners nonprofit organizations (NPOs) with underserved schools based on community-driven approaches to empower learners in their studies, encourage empathetic relationships, and to help address the financial needs of schools, all while also working to address the community-identified structural inequalities. This model of development is based on my field research with Thanda, a rural sustainable development nonprofit in KwaZulu-Natal, South Africa, and supported by the existing literature on nonprofit involvement in social services.

Econometric Modeling of the 2016 U.S. Presidential Election: Why the Results Are Far from Unusual

Alexandra Orsky

Mentor: Sukkoo Kim

In the wake of the 2016 Presidential Election, pollsters and the pubic alike are trying to piece together how Donald Trump won against all expectations. Two main hypotheses have emerged: 1. There has been a systematic shift in demographics, and 2. Voter turnout in the election was drastically different than it has been historically. This paper assesses the validity of both claims through econometric modeling and presents empirical evidence that the election results are, contrary to popular belief, consistent with demographic trends and voter turnout since 1972.

Emerging Nuclear Threats: Preventing Non-State Terror Groups from Pursuing Nuclear Programs

Samantha Pitz

Mentor: Andrew Sobel

The current threats to the national security of states have evolved from other aggressive states to the abundance of non-state terror groups wreaking havoc and destruction. Non-state terror groups aim to eliminate the power and influence of states from their region. The decentralized nature of non-state terror groups creates a unique and challenging task for states in the prevention of escalating offensive forces. States aim to prevent non-state terror groups from pursuing a nuclear program, because if or when these groups construct or obtain a nuclear weapon, they will launch it and cause mass destruction, psychological terror, and disorder in the states affected. In order for states to prevent non-state terror groups from pursuing a nuclear weapon, they should aim to secure further access to nuclear materials, even low-grade radiological material. States should also aim to deter the non-state terror groups from pursuing a nuclear weapon program by undermining the group's constituent support for an escalation in violence. Past deterrence theories, originating from the Cold War era, fail to explain current national security threats outside a bipolar world system. By assessing the current national security threats through past principles, this project will aspire to demonstrate the gap in academic literature between nuclear deterrence and the obstacles non-state terror groups have created in recent years.

The Politics of Plague: Neoliberalism, Hindutva, and the Exploitation of an Emerging Civil Society

Jessica Thea

Mentor: Shefali Chandra

Surat, a port city on the western coast of India, sent the world into a panic when a small outbreak of bubonic and pneumonic plague rattled the city in September of 1994. Although the outbreak lasted only a little over three weeks, it provoked an unprecedented global reaction, one that surged throughout the international community. India, a newly neoliberal state, became vulnerable to international actors looking to exploit the health crisis and obtain a presence throughout the region. The outbreak served as a perfect storm to allow for international intervention, as it came during a period of economic liberalization and furthered sociopolitical instability. International powerhouses used NGOs (non-governmental organizations), or service and humanitarian non-profit groups, as mechanisms for surveillance and policing in the city of Surat. This project looks at the intersection of neoliberal economic policies and vulnerable sociopolitical conditions, and the consequent establishment of global surveillance vis-à-vis NGOs in Surat. Turning to the long-term implications of the plague, this thesis serves to analyze the retreat of the reach of the state due to neoliberalism and politics of Hindutva, and analyze the gap in power exploited by local and international actors. Connecting the rise of NGOs with the rise of the Bharatiya Janata Party, a political party in favor of neoliberalism and the reduction of state intervention, I argue that these sociopolitical changes in turn led to the violent, anti-Muslim pogroms in Gujarat in 2002, leaving the citizens of Gujarat in a state of disarray.

Phenomenal Accent Patterns: A Computational Approach to Exploring the Application of Theoretical Frameworks from Music Theory to Linguistics

Alicia Chatten

Mentor: Brett Hyde

In theories of musical rhythm, there is a distinction between phenomenal accent and metrical accent. Phenomenal accents require overt acoustic cues, such as an increased duration, frequency, or amplitude compared to surrounding sounds. Metrical accents, however, are part of an abstract organizational structure and do not require the presence of an acoustic contrast.

This project employs typological analysis within the framework of Optimality Theory to examine the feasibility of incorporating this distinction into theories of linguistic rhythm. In the analysis of both the patterns predicted by the optimality theoretical constructs and the patterns in attested, real-world data, the picture that emerges is one that identifies the mapping of a variety of phenomenal accent patterns to a smaller number of more general metrical accent patterns.

These comparisons opened into two routes of investigation—the first in the building of two computer programs to predict language typologies, and the second in a thorough examination of documents of language description to establish a typology of attested patterns with which to compare the predictions. When these routes are taken in conjunction, generalizations can be made about the relationships between the two types of patterns that allow us to account for the wide variety of attested patterns in mapping the phenomenal accent patterns to their related metrical accent patterns. This broader typological picture can inform future work on both metrical theory as well as comparative linguistics.

Auxiliary Contraction in English: Syntactic and Prosodic Constraints in a Large Set of Data

Grant Shillington

Mentor: Kristen Greer

Auxiliary contraction (AC) is a frequently employed, optional process in English that causes certain auxiliary verbs to lose syllabicity and attach to material in their surrounding environment. It displays a wide array of environments in which it is ungrammatical and still others where acceptability is degraded. Previous work has focused on finding syntactic or prosodic constraints to explain patterns of blocked AC, but has thus far focused on narrow subsets of existing data. This paper investigates a much wider array of data for blocked AC and evaluates various syntactic and prosodic accounts. It ultimately provides theoretical support for syntactic over prosodic constraints in general, and extends a previous account—that of Kaisse (1983)—to explain the wider range of data investigated. It does so in consideration of theoretical stances on the nature of AC—as enclisis or proclisis, phonological reduction or suppletive allomorphy. The theoretical space is broadly divided into patterns that vary by auxiliary and by surrounding environment, reiterating past consensus on phonological constraints for bi-auxiliary variation and supporting a view of AC as suppletive allomorphy. Consideration of surroundings is subject to a thorough investigation and typology of data found in previous work on AC. Several prosodic accounts are presented and limitations are discussed. Syntactic accounts appealing to the notion of government are also evaluated and concerns with these views are presented. A word-order account—that of Kaisse—is presented as the most promising, and is extended to make it compatible with the wide array of data investigated. Finally, lingering concerns are addressed with an eye toward future improvement upon views presented here.

Discrete Morse Theory and Some Applications

Conner Basich

Mentor: John Shareshian

In this paper we introduce a novel discrete Morse theoretic proof of a question posed by Ehrenborg and Hetyei. Next, we revisit and discuss the main result of Hamstrom and Jerrard. Finally, we discuss the difficulties in using their scheme to prove a conjecture posed by Adiprasito and Benedetti.

Manifesting Polynomials with Small Galois Group as Rational Points

Philip Bonneville

Mentor: John Shareshian

In a 2002 paper, Nils Bruin and Noam Elkies use what appears to be a novel approach to find trinomials of the form ax^n + bx + c (for n = 7,8) with small Galois group over Q:. They parametrize such polynomials, up to equivalence, as (the rational points of) a copy of the projective line and then examine covers of this line that correspond to distinguishing different orderings of the n roots modulo a subgroup H of S_n. Using a correspondence between rational points on such a cover and trinomials with Galois group, a subgroup of H, they are able to use a technique for finding rational points on a curve to determine which trinomials of this form have a specified Galois group.

Since the basic theory of varieties over an algebraically closed field is unable to capture the arithmetic behavior at issue here, I describe how the language of scheme theory might be used to precisely state and justify this correspondence. I also examine a connection of this correspondence with work of Guralnick and Shareshian on enumerating covers of the Riemann sphere with small genus, in light of Falting's Theorem.

Two Partitioned Numerical Methods for Solving the Hodgkin-Huxley Equations

Zhengdao Chen

Mentor: Ari Stern

The Hodgkin-Huxley model, a system of four-dimensional ordinary differential equations, is a fundamental mathematical model of the dynamics of a neuron's membrane voltage. Simulating neurons' activities using the Hodgkin-Huxley equations is computational expensive compared to using some other neuronal models, and there have been interests in looking for efficient numerical methods for solving the Hodgkin-Huxley equations. We aimed at looking for numerical methods that can solve the Hodgkin-Huxley equations with high stability, and studied two partitioned methods in particular. First, we adapted the Störmer/Verlet method for Hamiltonian systems to the Hodgkin-Huxley equations, resulting in a method coinciding with a modified version of the trapezoidal method. Second, we created a type of Strang splitting method. In numerical experiments, we found that the Störmer/Verlet method has higher stability than Euler's method and the Fourth Order Runge-Kutta method, two commonly used numerical methods, and that the Strang splitting method has even higher stability than the Störmer/Verlet method. Theoretically, both the Störmer/Verlet method and the Strang splitting method can be shown to have second order convergence. Furthermore, when applied to solve the van der Pol equations, a simpler nonlinear dynamical system chosen for theoretical analysis, both of these methods can be shown theoretically to preserve the size of the limit cycle to the second order because of their sympleticity.

On Solutions to $\varphi(n) + s = \varphi(n + s)$

Ethan Farber

Mentors: Matt Kerr and John Shareshian

We investigate the set of solutions to $\varphi(n)+s = \varphi(n+s)$, where φ is Euler's totient function and s varies over the positive even integers. Our main theorems describe the effect of the factorization of s upon the type and abundance of solutions, and we prove in certain cases the nonsubstance of all or part of the solution sets. We generalize the question to the setting of polynomial rings, and confront some interesting transformations of the problem in that setting.

The Multivariate Extension of the von Neumann Inequality

Anna Gautier

Mentor: Greg Knese

For any one variable function $f\mathbb{C}[n]$, and a contractive matrix T ($\|T\| \leq 1$), $\|f(T)\| \leq \sup_{z\in\mathbb{T}} |f(z)|$. This inequality, called the von Neumann Inequality, consistently holds true when extended to two variable polynomials, but not when extended to three or more variable polynomials. It becomes interesting to consider the viability of the von Neumann Inequality over subsets of three or more variable functions using certain structures rational functions in three or more variables. By capitalizing on special properties of stable, multi affiane, five degree polynomials, there is a necessary condition to determine if a function of that class satisfies the von Neumann Inequality.

Nonabelian Group Based Cryptography

Timothy (Tim) Huber

Mentor: John Shareshian

Concerns over the security of RSA public-key cryptography with the potential development of quantum computers renewed interest in novel cryptosystems that do not rely on commutative groups. We provide an introduction to public-key cryptography along with an explanation of the AAG and Ko-Lee key agreement protocols with their originally proposed platform group, the braid group. We will then discuss two successful attacks against the AAG cryptosystem with consideration for practical concerns and known empirical results.

Analysis of Peer-Led Team Learning (PLTL) Data for Calculus Using Linear Mixed Effects Models

Youngsuk Kim

Mentor: Jimin Ding

This paper presents the effectiveness of Peer-Led Team Learning (PLTL) program for Calculus held for the last four consecutive semesters. Linear mixed effects models were developed for all cohorts. Random effects were introduced to model the correlation within students and professors across courses. It was revealed that the struggling students, as measured by their performance in the first midterm exam, benefited more from participating in PLTL than those who performed better in the first exam. However, high performers also gained reasonable benefits by actively participating in the PLTL program. This result will likely impact decisions of future PLTL participants.

A Lexicographic Ordering on Simply-Connected, Non-Hausdorff 1-Manifolds

Kwok Hao Lee

Mentor: Rachel Roberts

I begin an investigation of the extent to which the theory of group actions on the reals, as well as the theory of simplicial trees, can be extended to a theory of group actions on simply-connected, second countable, but not necessarily Hausdorff 1-manifolds. Such a theory would have implications in the theory of codimension 1 foliations. As a first step, I propose a lexicographic ordering on simply connected, non-Hausdorff 1-manifolds.

Generating Functions for Enumerating Chains of Partitions with Distinct Parts

Renee Mirka

Mentor: John Shareshian

This paper continues investigations by Stanley and Butler in which they enumerate chains of partitions. We consider pairs of partitions composed of distinct parts and their corresponding Young diagrams and look for interesting properties of their generating functions. A proof of the generating function is provided when the difference between a pair of diagrams is fixed in one of three ways: a single box, k boxes in a row, and one box added to two consecutive rows whose lengths differ by one. In particular, we provide an explicit, rational formula when these generating functions are divided by the generating function for partitions made of distinct parts. We conclude with a conjecture for the generating function of adding k disjoint boxes to a Young diagram with distinct parts.

(Re)Sounding Evil: Aural Infection in *Macbeth*

Daniel Washelesky

Mentors: Henry Schvey, Jami Ake, and William Whitaker

In the past two decades, Shakespeare scholars have begun creating what Bruce R. Smith calls a "cultural poetics of listening," focusing on how sound shapes identity in Shakespearean theatre. In 2013, Ying-chiao Lin was the first to apply these theories specifically to *Macbeth*. While Lin acutely calls attention to Macbeth's soundscape and "desiring ears" as the "core source of the ultimate catastrophe," she devotes little time to the complicated process of Macbeth's infection, which is crucial to the emotional journey of the play. In an attempt to better understand the "ambiguous cosmological forces" at work, this paper explores Macbeth's aural-spiritual penetration in depth, tracing its relations to early modern acoustic anxieties. I begin with a survey of early seventeenth-century acoustic physics, focusing on the liminal power granted to sound/voice and the privileged position of hearing over sight. I look at the ear as a site of both power and danger, and argue that over the course of the play Macbeth goes from extreme aural receptivity to total deafness, while Scotland transforms from a visual to an aural country. I analyze how the witches embody both the Protestant fear of ear-infecting devils and the equivocal figure of Echo as imagined by Classical and early modern writers. In the process, I use this historical context to examine the play's emotional journey and hamartia, demonstrating how Macbeth's aural sensibility makes him tragic rather than simply evil.

An Alternative Understanding of the Amoralist

Jaeyoung Lee

Mentor: Julia Driver

In this paper, I attempt to provide an alternative account of the amoralist challenge to Internalism, which provides the Internalist with a more amenable understanding of the amoralist. With this alternative understanding of the amoralist, Internalists can allow for the existence of amoralists without having to give up the core Internalists commitment. I understand the core Internalist commitment to be that there is a necessary relationship between moral beliefs and motivation. Through examining various Internalist positions, I identify several desiderata we wish an Internalist theory would meet beyond accepting the core Internalist position. I attempt to incorporate these insights into my own Internalist views and address them in relation to the amoralist challenge.

An amoralist is someone who allegedly makes a sincere moral judgment and is not motivated by this judgment. The conceptual possibility or actual instances of amoralists would therefore pose a critical challenge to the core Internalist commitment. I explore the ways in which this challenge has been developed and provide a more concrete picture of how the amoralist can be posed as a challenge to the core Internalist commitment.

Finally, I develop my own Internalist view, which puts judgment and the structure of our practical deliberation at the center of the necessary relationship between moral judgment and motivation. I argue for this position by examining the role of judgment in our practical deliberation and the entailments of judging something to be a reason within one's own practical deliberation. I then offer an account of the amoralist from this position that suggests that an amoralist can be understood as merely recognizing these moral reasons without judging them to be reasons for himself. I argue that this "recognition thesis" is able to grapple with the various ways in which the amoralist challenge has been posed.

Conceptualizations of Quality of Life in Geriatric Medicine: Utilizing Quality of Life as a Measure of Effectiveness of Care

Helena Xeros

Mentor: Anya Plutynski

What does it mean to age well? What is health and well-being in old age? These questions are both normative and empirical; thus, this thesis uses interdisciplinary methods to answer them. I conducted interviews with geriatric physicians and reviewed the philosophical literature on quality of life in medicine to allow me to address the unique challenge of articulating an understanding of quality of life as we age. In geriatrics, the focus is on ameliorating the health challenges associated with aging, and improving quality of life. But quality of life is a moving target. While there is no consensus on the definition of quality of life in bioethics, or the general philosophical literature, there are measures that experts in health policy use to improve medical decision-making and evaluate the comparative effectiveness of health care. Geriatric medicine provides a unique challenge, as assessing health in old age is a matter of descriptive and functional information, as well as subjective judgment. My aim is to argue for some objective features that can be used at the policy level to evaluate effectiveness of health care providers.

The Role of Episodic Memory in the Experience of a Sameness of Self

Meghan Bach

Mentor: Pascal Boyer

The criteria allowing for the experience of personal identity, or for the experience of a sameness of self through time, has been controversially debated for centuries with the majority of considerations focusing on episodic memory as the critical constituent; there seems something inherently unique about our ability to remember our personal past experiences that allows us to both know and feel that the self that existed in the past, and will continue to exist into the future, is the same self that exists in the present. In this paper, I therefore examine whether episodic memory is a necessary criterion for the experience of personal identity. To consider the true relationship between episodic memory and personal identity, I first discuss theoretical considerations of personal identity and its potential criteria, and later investigate how episodic amnesia specifically affects the experience of personal identity by discussing neuropsychological case studies of episodic amnesia patients. I conclude that episodic amnesia is a necessary criterion not for the experience of a sameness of self through time, but rather for a critical component of personhood that exists within social interaction.

On the Moral and Legal Responsibility of Dissociative Amnesiacs

Elias R. Feldman

Mentor: Carl F. Craver

In this thesis, I argue that dissociative amnesia has been mistreated in the legal context. A person suffering from dissociative amnesia will black out in response to intense and unusual stress and learn when they regain consciousness that they have committed a crime. Dissociative amnesiacs seeking acquittal will present non-insane automatism defenses in court, which requires both that the source of the automatism be external and that the action be carried out with "complete involutariness." We will see how courts have evaluated these cases almost exclusively on the basis of the external source requirement, and have paid negligible attention to the complete involutariness requirement. The courts have assumed without question that a person is rendered completely involuntary in a dissociative state, and have generally acquitted such individuals (either as insane or non-insane, depending on the dissociation's cause). In this respect, I believe the courts have erred. Considering that dissociative amnesia is characterized first and foremost by a temporary loss of autobiographical memory, I argue that autobiographical amnesia does not deprive a person of volition to any morally relevant extent, leaving both their capacities for prudential and moral reasoning intact, and thus an individual with autobiographical amnesia does not satisfy the complete involuntariness requirement of an automatism defense. I also argue that a person with autobiographical amnesia continues to persist through this state as a single self, and so any action they are responsible for in their amnesic state they will continue to be responsible for at the termination of this state. Together, these two points demonstrate that a person with dissociative amnesia is responsible for the actions they commit in the dissociative state and can be held responsible in a court of law.

Random Measurement for Multipartite Entanglement Detection

Fan Chen

Mentors: Harald Weinfurter, Ludwig Maximilian University of Munich, and Kater Murch

Detecting entanglement in a multi-qubit system has been a challenging task since currently the commonly known methods are experimentally and computationally expansive. Recently, a novel and efficient method of entanglement detection via random measurement is proposed. This thesis reviews the theoretical background and presents the experimental realization of the method.

Changing U.S. Extreme Temperature Statistics

Justin M. Finkel

Mentor: Jonathan Katz

The rise in global mean temperature is an incomplete description of warming. For many purposes, including agriculture and human life, temperature extremes may be more important than temperature means and changes in local extremes may be more important than mean global changes. We define a nonparametric statistic to describe extreme temperature behavior by quantifying the frequency of local daily all-time highs and lows, normalized by their frequency in the null hypothesis of no climate change. We average this metric over 1,218 weather stations in the 48 contiguous United States. In the period 1893-2014 there were statistically significantly fewer all-time record lows than would be found in the null hypothesis of unchanging climate. Record highs, by contrast, do not significantly differ from the null hypothesis. The metric is evaluated by Monte Carlo simulation for stationary and warming temperature distributions, permitting description of the statistics of historic temperature records by equivalent warming rates.

Classical Magnetic Frustration

Eugene J. Tsao

Mentor: E. A. Henriksen

We present a classical analogue to the spin glass state realized experimentally via a system of freely rotating bar magnets that is capable of exploring dipole wave dynamics and macroscopic frustration. We report low amplitude wave transport in a 1-dimensional chain, and observe a variety of metastable states in the square, triangular, kagome, and honeycomb lattices. We confirm features observed in the physical 1-dimensional chain and square lattice through a Monte Carlo simulation of interacting finite-length dipoles.

Forecasting Cryptocurrency Volatility

Daniel Wasserman

Mentors: Mina Lee and Li Yang

The advent of Bitcoin has sparked massive growth in cryptocurrencies in recent years. The prices of Bitcoin and other cryptocurrencies are relatively volatile, which deters people who are risk-averse from investing in them. Many smaller cryptocurrencies are even more volatile than Bitcoin. A model that can predict cryptocurrency volatility based on price motion would benefit potential cryptocurrency investors by providing them with extra information about risk. A random forest machine learning model is used to predict cryptocurrency volatility; this model is compared to the GARCH volatility model that is widely used in modern finance as a benchmark. A discussion regarding model accuracy reveals how predictable cryptocurrency volatility actually is. Finally, comparisons of models with different feature selections give insight as to what factors can significantly influence cryptocurrency volatility.

The Effect of Symbols and Media Framing on Emotion, Attitude Change, and Attribution of Responsibility

Antonia Drummond

Mentor: James Gibson

Americans are constantly inundated with news stories and images from the media, yet we know little about how such exposure influences attitudes. Extant literature has shown significant correlations between attitude change and text framing, as well as between attitude formation and image presentation. However, the literature on framing in news stories is inconclusive and almost never includes the effects of image presentation. This study attempted to analyze the effects of images and textual framing when the two are paired together—a common news media format. Respondents were presented with either an episodic or thematic vignette about the display of Confederate symbols in the United States, paired with either a "positive" or "negative" image of a Confederate flag rally, or with no image. I measured respondents' emotional engagement, attribution of responsibility, and attitude change between conditions. I hypothesized that respondents in image conditions would have the strongest emotional reactions, that respondents in thematic conditions would be most likely to attribute societal responsibility to preventing violence against African Americans, and that high emotional engagement and societal attributions of responsibility would lead to attitude change toward opposition to the display of Confederate symbols. This study has two main findings. First, images may not have as strong of effects as predicted. Secondly, the effects of demographic variables showed that news stories may serve to reinforce, rather than change, attitudes. Contrary to my hypotheses, I found that episodic text, regardless of image, was most likely to elicit engagement in some emotions among respondents. However, societal attributions of responsibility did lead to attitude change toward opposition to Confederate symbols, as did reported sadness and hope.

The Politics of Capacity: No Child Left Behind

Sophia Keskey

Mentor: Andrew Reeves

I explore the conditions under which states decide to comply with federal intervention involving funding. I focus on the assessment component of No Child Left Behind (NCLB), legislation requiring states to create tests and report student achievement in order to receive federal education funds. I argue that both political indicators—governor partisanship, the election calendar, and teachers' union strength—and compliance costs were central to NCLB compliance decisions. State wealth, Black and Hispanic/Latino populations, student achievement on exams, and state education funding from the federal government affect the cost of compliance, and therefore played a substantial role in decisions to comply. To test the relative influence of these political factors and measures of state capacity, I create an original dataset to test my hypotheses. Using logistic regressions, I find that capacity is significantly related to compliance, although student proficiency did not play a role. Gubernatorial partisanship, teachers' union strength, and the presence of an election year also demonstrated significant influence over the decision to comply. My findings suggest that compliance with perceived federal mandates is a function of both capacity and political consideration.

Can Human Rights Treaty Ratifications Influence Neighboring Country Practices?

Matthew Malis

Mentor: Matthew Gabel

In assessing the effects of international human rights treaties (HRTs) on state practice, most research looks only to the practices of ratifying states. The present study seeks to examine the effect one state's HRT ratifications can have on human rights practices of other states within its network. Ratifications are expected to influence foreign government practices through two causal mechanisms. First, rights-affirming states are theorized to ratify HRTs as a signal to their neighbors of future intent to prioritize human rights concerns in other areas of foreign policy, and to impose material costs for poor human rights practices. The credibility of the signal derives from the ex-ante costs of ratification, and the ex-post costs of failing to act in accordance with international human rights concerns following ratification. Second, in much the same way that a country's own ratification of human rights treaties can prompt domestic groups to mobilize to demand compliance, those same groups are expected to mobilize in response to ratifications among neighboring governments.

Using time-series cross-sectional data from 1976-2015, each country-year's network ratification rate is calculated as the average portion of available HRTs ratified by neighboring countries, weighted according to various connectivity criteria. The relationship between that rate and a country's subsequent human rights practice, as measured by the Political Terror Scale, is tested. Separate analyses are conducted across the U.N's core human rights treaties and their optional provisions allowing for stronger reporting mechanisms, and across networks of trade, defense alliances, arms transfers, geography, shared language, and shared religion. The results are mostly inconclusive, with some model specifications producing the anticipated effects and others yielding results to the contrary. Implications of these findings for future research are discussed.

Political Rhetoric and Media Partisanship: Language Resemblance versus Media Bias

Erica Sloan

Mentor: Randall Calvert

In a democracy like our own, the media ideally function to effectively disseminate information on political issues, with language that treats equally the viewpoints of both Democrats and Republicans. An existing literature on media bias seeks to determine how, when, and why the media may, instead, favor the perspective of one party at the expense of the other. In this paper, I explore the underlying rhetorical mechanisms driving the appearance of such media favoritism through a comparative phrase frequency analysis of congressional and media language on three highly partisan social issues: gun control, abortion, and gay rights. Based on the results of the analysis, demonstrating the particular types of partisan language adopted and avoided by the media, I argue that language resemblance between Congress and the media is an insufficient measure for media bias—despite literature that conflates one with the other. By illuminating the nature of both congressional and media language, the phrase frequency analysis serves to shed light on the complex, circular relationship between the two.

Greener Grass: Exploring Enviro-Chemical Injustices Posed to Migrant Farm Workers

Neil Stein

Mentor: William Lowry

Though they do not receive as much attention today, the struggles of migrant farm workers have been, for many years, a topic that has captured the attention of media and society. Most commonly associated with dynamic leaders like the late Cesar Chavez, the leader of United Farm Workers, migrant labor supporters fought passionately for environmental health and safety standards to be equally applied to all workers, regardless of origin or nationality. The primary thrust of Chavez's work, as well as mine, centers on the plight of migrant workers in grape orchards and vineyards. My research is focused on the years since his passing in 1993, tracking the changing agricultural industry in California. By means of a Geospatial Information Systems (GIS) analysis conducted on a variety of longitudinal data sources, this paper analyzes how chemical agents are affecting migrant and undocumented workers, and finds a positive relationship between the growth of the California wine industry and the increase in chemical exposure risk to migrant populations.

A Candidate by Any Other Name: Religious Identity and Electoral Outcomes

Max Yanowitz

Mentor: Justin Fox

Voters use myriad information cues when making decisions. I explore the role of candidate religion and electoral outcomes via an original survey experiment. In the U.S., Protestants are typically viewed as conservative while Jews are perceived to be a liberal group. I manipulate a candidate's religion (no religious cue, Protestant, Jewish) as well as their last name (Smith, Cohen) to form six candidate profiles. While the direct religion cues are explicit, the name cue of Cohen, a traditionally Jewish name, allows for a subtler cue, which is less likely to tip off respondents. I find that respondents perceive both Protestant candidates as more conservative than the control (no religious cue, Smith), the religiously un-cued Cohen candidate as more liberal, and both explicitly Jewish candidates as ideologically the same. I then demonstrate that these induced perceptions impact feelings of favorability towards the candidate, and that these effects differ between conservative and liberal respondents. I hypothesize that respondent self-monitoring muted partisan reactions or adverse responses to the Jewish candidates, then comment on the broader implications of stereotypes in politics.

Overcontrol Tendencies and Development of Psychopathology

Margot Barclay

Mentor: Kirsten Gilbert

Self-control is often considered an adaptive trait, particularly with respect to school engagement and academic functioning. However, an excess of perfectionistic tendencies has the potential to cause serious distress and dysfunction over the course of development. This excess is reflected in overcontrol, a temperamental cognitive processing style in which one inhibits and monitors errors in an attempt to avoid making mistakes. For this reason, it is useful to develop ways to identify early behavioral indicators of overcontrol and to understand how these behaviors may predict outcomes of psychopathology. In this study, we observationally coded videos of children at T1 (ages three to five years old) performing the Impossibly Perfect Circles task. From our coding scheme, we developed a composite of overcontrol that included measures of perfectionism, compliance, intensity, and diligence. Regression analyses predicting internalizing (depressive and overanxious) symptoms and social withdrawal at T5 (two years later) demonstrated that overcontrol by itself was not associated with these outcomes. However, when looking at the interaction between overcontrol and inhibitory control, we found that the interaction was significantly associated with a greater onset of depressive symptoms, overanxious symptoms, and higher social withdrawal. Specifically, high levels of overcontrol and low inhibitory control predicted less impairment across outcomes. There was also a trend showing high levels of overcontrol and high inhibitory control predicting worse psychopathology. While self-control may be adaptive to a certain extent, it may lead to more impairment in the context of high inhibition.

The Influence of Social Dialogue on Mental Health Help Seeking

Samantha Breen

Mentor: Tammy English

Underutilization of mental health service use is a well-documented problem, especially for Asian Americans who have been shown to have relatively high distress levels. This study examines if having more social discussions on mental healthcare increases help seeking behavior. Prior research suggests that a person's discussions with their social network and their perceived benefits about the effectiveness of treatment are important predictors of help seeking. We predicted that 1) the frequency of positive social dialogue about mental healthcare is positively associated with help seeking intention and that this effect is more robust when social discussions are with closer social partners, 2) Asian Americans will report fewer conversations about benefits of mental health relative to European Americans, and 3) Asian Americans will have lower help seeking intention. Results from 177 undergraduate online questionnaires indicated that help seeking intention was significantly positively correlated with frequency of positive social dialogue about mental healthcare for "total social network" and "very close social partners," marginally significant for "somewhat close partners," and not significant for "remote social partners." In this sample, group differences between Asian Americans and European Americans were not significant for help seeking intention and frequency of positive social dialogue about mental healthcare, although it was marginally significant that Asian Americans had fewer "somewhat close partner" discussions. Additional analyses indicated that Asian American students reported significantly more distress, school concerns, and religious concerns and significantly fewer "total social partners" and "very close social partners" relative to European Americans. We also found that perceived benefits was significantly correlated with help seeking intention and frequency of positive social dialogue about mental healthcare. These results reveal that transforming a stigmatized notion of mental health into positive social dialogue may improve utilization rates and research must continue to identify effective methods to increase help seeking in minority groups.

Interaction between Genetic Risk for Anxiety Disorders and Future Anxiety

Kimberly Johnson

Mentor: Ryan Bogdan

The heritability of anxiety disorders range between 30-50%, but efforts to identify specific polymorphisms contributing to this risk have been largely unsuccessful. However, a recent meta-analysis of genomewide association studies identified loci predictive of anxiety disorder (*LOC152225* rs1709393) and anxiety factor scores *(CAMKMT* rs1067327). In addition to replicating these findings in independent samples, it is important to understand what, if any, biological mechanisms implicated in the etiology and pathophysiology of anxiety may mediate these associations. Using data (n = 451) from the ongoing Duke Neurogenetics Study, we examined whether *LOC152225* rs1067327 and *CAMKMT* rs1067327 genotypes were associated with individual differences in threat-related amygdala activity measured using BOLD fMRI. After accounting for gender and ancestrally-informative principal components, we found an additive effect of *CAMKMT* rs1067327 whereby the number of risk alleles was associated with increased threat-related reactivity in the right centromedial amygdala. Further, we found that increased right centromedial amygdala reactivity significantly mediated the association between rs1067327 genotype and future anxiety in the context of recent life stress. These findings provide a putative neural mechanism through which *CAMKMT* rs1067327 genotype conveys anxiety risk.

Comparisons of Intrinsic Motivation of Novel Stroke Rehabilitation Interventions for Upper Extremities (UE)

Dorothy Kalmbach

Mentor: Jack Engsberg

An estimated 80% of individuals with stroke experience upper limb dysfunction and 60% of stroke survivors will not regain full use of the affected arm. Improvement in motor function is possible even in the chronic phase of stroke through motor rehabilitation. Rehabilitation is a lengthy process and has little chance of success if a patient is not dedicated to his or her regime. Highly motivated patients are more likely to adhere to a rehabilitation program, and motivation has been linked to better therapeutic outcomes in many studies.

This study evaluated how motivating participants of experimental stroke rehabilitation interventions found their upper extremity (UE) rehabilitation regime and compared those scores to the data gathered in the Human Performance Laboratory (HPL).

A literature review was conducted. Interventions were sorted into the categories gaming, gaming with assistance, robotic rehabilitation, mixed reality, and conventional therapy. Six studies from the HPL were used. Mean I/E subscale scores of the IMI were gathered for each category and compared to scores from the HPL using Glass's Delta for effect size.

HPL interventions were significantly more intrinsically motivating than conventional therapy ($\Delta = 0.640$). All other categories produced a higher mean score for reported I/E than did the HPL. These results were not statistically significant for categories gaming or gaming with assistance. Mixed reality and robot training reported higher I/E scores with medium effect sizes of $\Delta = 0.686$ and 0.674, respectively.

All interventions had above-average I/E scores. Personality traits of the participants can likely account for these higher-than-average levels of IM. Though the HPL did not outperform these categories, it is comparable to other gaming interventions and has the unique advantages of affordability and accessibility these lack. Characteristics of the mixed reality and robot training interventions may account for their high I/E scores.

Prior Perceived Difficulty and Its Effect on Eventual Performance

Nicholas Kohler

Mentor: Michael Strube

With the rise of social media and other course evaluation websites, many students perform extensive research on their courses before enrolling, hoping to determine whether the course will be easy or difficult. Additionally, mentors of all types often introduce historically difficult coursework in a negative way, placing emphasis on the rigor of the subjects. This prior knowledge could have a significant effect on students' eventual performance in said courses. To determine whether or not this is the case, participants in this study were given an anagram task of 15 questions. One group was told the task would be difficult, and the other told nothing. The results show that participants told a final test would be difficult did much worse than their peers. $F(1, 74) = .016$, $p < .05$. Perhaps it is not to anyone's advantage to introduce difficult fields to young aspiring students in such a negative way.

Training Self-Control? A Meta-Analysis

Amanda Kube

Mentor: Joshua Jackson

Self-control is related to many important outcomes throughout a lifetime such as a lower likelihood of divorce, a longer life, and better academic and occupational outcomes. Many studies have found that self-control can be depleted similarly to a muscle. This phenomenon was deemed ego-depletion and prompted studies on how to strengthen this muscle. Recently however, a large-scale registered replication and meta-analysis found no evidence that self-control is depleted like a muscle. As a result, this finding calls into question whether self-control stamina, or capacity, can be successfully trained. The current study is a bias corrected, random-effects meta-analysis of 20 tests on training self-control capacity. Similar to the meta-analysis on cross-sectional studies of self-control depletion, bias tests were conducted using tests of funnel plot asymmetry, p-curve analyses, tests of insufficient variance, and R-Indexes. The analysis produced a significant overall effect of training on self-control capacity such that doing daily activities like improving posture, regulating speech, or avoiding sweets over a period of one week to four months resulted in higher levels self-control on subsequent self-control related tasks. Thus, participants were less depleted after performing a single self-control related task after engaging in training than they were before engaging in training. Moreover, there was little to no evidence of bias in the literature. However, several inconsistencies in the use of covariates suggest the existence of some bias. Overall, the study suggests that training can increase capacity for self-control. However, more well powered and stringent studies on training self-control are required to truly understand this effect.

Examining the Intergenerational Stake Hypothesis: Relationships and Closeness in Grandparent-Grandchild Dyads

Rachael Spalding

Mentor: Brian D. Carpenter

The intergenerational stake hypothesis posits that older people tend to feel more positively about their relationships with younger people in their family because they have a greater perceived "stake" in the relationship. The purpose of the current study was to explore the intergenerational stake hypothesis in the context of grandparent-grandchild relationships. Pairs of grandparents and grandchildren ($n = 79$) completed a brief survey that asked questions about relational closeness, shared activities, and relationship quality. Both self- and proxy- reports were gathered from each participant. No significant differences were found between grandparent and grandchild self and proxy reports on measures of more objective features of the relationship, such as shared activities and contact frequency. On average, grandparents reported significantly more favorable self-reports of emotional closeness than their grandchildren ($t(78) = 4.71$, $p < .001$, $d = .61$). However, proxy reports revealed that grandparents were actually quite accurate at predicting their grandchildren's relational closeness responses ($t(77) = .44$, $p > .05$). Moreover, difference score calculations identified a portion of the dyad sample (39 dyads) that appeared to refute the hypothesis in their relational closeness responses. Results from this study suggest that the generational stake phenomenon exists in the grandchild/grandparent relationship, at least in terms of perceived emotional closeness. However, as evident from these proxy report findings, the degree to which grandparents are aware of their grandchildren's perspectives may deviate considerably in ways that are not yet fully accounted for by the generational stake hypothesis.

Speech-Reading Comprehension in Impaired Audiovisual Environments

Jessica Williams

Mentor: Mitchell Sommers

The purpose of this investigation was to examine the accuracy of speech comprehension when presented with stimuli of degraded auditory and/or visual quality. Thirty-nine college-aged students from Washington University in St. Louis watched a series of nine videos in a counterbalanced within-groups 3x3 research design. Each video contained a certain auditory quality (Normal Hearing, Mild Hearing Loss, or Moderate Hearing Loss) and a certain visual quality (No Blur, Gaussian Blur of 22 units, or Gaussian Blur of 44 units), constant background white noise, and a series of 12 sentences, each with three target words. Subjects were asked to repeat each set of three target words to the researcher. By ranking the different characteristics of the American English speaker's speech sounds, including voicing, nasality, affrication, duration, place of articulation, hearing threshold, and frequency, phonemes and visemes were ranked by hypothesized difficulty of perception. Spearman Rank tests showed that frequency was inversely related to phoneme comprehension. Significant interactions were found between the hearing loss and blur variables, but further studies comparing these results to findings from auditory-only and visual-only conditions will further elucidate the relationship of hearing and vision in yielding audiovisual benefit.

Teacher-Child Relationship Quality and Development of Depression from Preschool to Late Childhood

Julia Winemiller

Mentor: Andy Belden

Early teacher-child relationships can protect against or exacerbate risk factors for a variety of academic and mental health outcomes. While there is evidence that strong teacher-child relationships in adolescence protect against depression, to our knowledge there are no studies that have investigated associations between early teacher-child relationship quality and depression in preschool through late childhood. The current study used prospective data from a longitudinal study of N = 305 preschool students recruited with an overrepresentation of depressive symptoms, a non-depressed psychiatric group (ADHD/ODD, Anxiety), as well as healthy typically developing group. Conflict in the teacher-child relationship one year after baseline mediated the relationship between depression severity at baseline and depression severity seven years after baseline. Teacher-child closeness and depression severity one year after baseline were not significant mediators. Given that chronic stress is a major risk factor for depression, these results might be explained by the chronic stress experienced in a conflictual teacher-child relationship. These results have important implications for future research on the development of depression as well as interventions involving early teacher-child relationships.

Social Comparison, Subjective Socioeconomic Status, and Entertainment Television

Yuru Zhang

Mentor: Michael Strube

Social comparison is important for gathering relevant social information to fulfill the human drive of evaluating one's opinions, beliefs, and abilities accurately. Previous research studies have found that social comparison processes may be induced through media exposure. The current study examines how self-evaluations of one's socioeconomic status (SES) are affected by images of wealth and status in entertainment television media and also investigates some individual differences as moderators. Participants (N = 210) were assigned to watch one of three 10-minute TV drama clips of either high, low, or control SES content and complete questionnaires assessing subjective SES, similarity to target, self-esteem, social comparison orientation, materialism, and household income. The result for the influence of clip content on changes in participants' SES evaluations was only marginally significant. In addition, no significant interactions were found between individual differences and clip content on self-evaluations of SES. However, this is a promising area of study and future research should examine other sources of SES media content (social media) and other potential moderators (perceived control).

Histories of the Secular: Medical Mindfulness Meditation in the United States

Matthew Drew

Mentor: Cassie Adcock

What gives a research psychologist the authority to assert that the Buddha's true teachings were not religious, but in fact were scientific and universal? Furthermore, what gives this psychologist the authority to recommend "mindfulness" as part of a patients' treatment, a child's school day, a prisoner's sentence, or a soldier's training? Medical research in mindfulness mediation has grown considerably since its infancy in the 1980s, but few scholars have given it the treatment it deserves. Scholars tend to tell the story of mindfulness as one of immigration and assimilation, where Buddhist mindfulness moved from Asia to the U.S. in the mid-twentieth century, and is secularized by the scientific medical research. This narrative downplays the fact that American cultural values and practices were integral to the formation of contemporary medical mindfulness. Additionally, by telling a story of "secularization," it ignores the complex history through which categories of "religion" and "secular" were created and subsequently imposed on Buddhist practices. Using a genealogical study of history, I investigate how multiple discourses converge in the creation of medical mindfulness and I argue that secular medical mindfulness is heavily enmeshed within specific American histories. In Chapter 1, I argue that Protestant medical discourse portrayed internal, calm, mental religious experiences as healthy, while casting off emotional and physically intense experiences as diseased. I show how this discourse permeated the early psychology of religion. In Chapter 2, I examine how nineteenth-century "spirituality" discourse located the "East" as a source of universal, non-religious "spirituality," and laid the foundation for secular medical mindfulness's relationship to Buddhism. In the final chapter, I show how these two discourses meet in medical research on mindfulness meditation and mindfulness programs offered in formally secular institutions. This winding, diverse history shows how secular practices present specific moral and cultural values as ahistorical universals.

Effects of Grammatical Gender on Developing Lexical Representations in a Second Language

Rebecca Feltman-Frank

Mentor: Joe Barcroft

Grammatical gender is cited as support for the Sapir-Whorp Hypothesis (a 1929 hypothesis that postulates that languages affect the way the world is perceived) through demonstrations of how gendered objects and animals impacts the lexical representations of such items for both first language speakers and second language learners. While multiple studies have supported the grammatical gender impacts on conceptual representations for second language learners, the time course of the development of cognitive changes is still not well understood. Although the 2002 study of Phillips and Boroditsky suggests a continuous development of lexical changes during second language acquisition, the 2009 study by Kuriniski and Sera suggests that conceptual changes occur during the first year of acquisition and remain constant with increasing proficiency. Our study used participants from an immediate and advanced level Spanish classroom in a task where participants were asked to rank the similarity between different object/animal—person pairs (some of consistent gender and some of inconsistent gender) on a scale from 1-9 (1 = very dissimilar, 9 = very similar) in order to evaluate whether grammatical gender differentially impacted conceptual representations for different levels of Spanish proficiency. Results indicated that the difference in grammatical gender impacts on conceptual representations were insignificant between the immediate and advanced levels; however, the discovery of methodological issues associated with the task served as a calling to evaluate previous research with caution and highlighted the need to clarify the variable findings in this field with future research that carefully addresses methodological issues highlighted in our study.

Efectos del género gramatical en el desarrollo de las representaciones léxicas en una segunda lengua

Rebecca Feltman-Frank

Mentor: Joe Barcroft

La hipótesis de Sapir-Whorf (una hipótesis de 1929 que postula que la lengua afecta la manera en la que percibimos el mundo) aplica al género gramatical con las demonstraciones de cómo los objetos o animales con géneros asignados impactan las representaciones léxicas de estas palabras para ambos hablantes de la lengua materna y estudiantes de segundas lenguas. Mientras que existen algunos estudios que demuestran los impactos del género grammatical sobre las representaciones conceptuales para estudiantes de una segunda lengua, todavía no se entiende bien la trayectoria del desarrollo de estos cambios cognitivos. Aunque el estudio de 2002 de Phillips y Boroditsky sugiere un desarrollo continuo de los cambios léxicos durante la adquisición de segundas lenguas, un estudio de 2009 hecho por Kuriniski y Sera sugiere que los cambios conceptuales ocurren durante el primer año de la adquisición y permanecen constantes con el aumento de la competencia. Nuestro estudio involucró participantes de una clase de nivel intermedio y avanzado de español en una tarea en la que los participantes tenían que evaluar la similitud entre diferentes parejas de objetos/animales—personas (algunas del género consistente y otras del género inconsistente) con una escala desde 1 hasta 9 (1=muy disimilar, 9=muy similar) para evaluar cómo el género gramatical impacta las representaciones conceptuales para los niveles de competencia diferentes del español. Al comparar los dos niveles, los resultados indicaron que la diferencia entre los impactos del género gramatical sobre las representaciones conceptuales no fue estadísticamente significante; no obstante, el descubrimiento de algunas cuestiones metodológicas sirvió como una llamada para evaluar las investigaciones previas con cautela y destacó la importancia de clarificar la razón por la que se han producido resultados variables en estudios sobre este tema con investigaciones del futuro que abordan los problemas metodológicos destacados en nuestro estudio.

Rupture of All Convention: The Dehumanized Art and Particularistic Politics of the Avant-Garde in Spain

Courtney Richman

Mentor: Ignacio Infante

In the early twentieth century, the Spanish avant-garde flourished. With the goal of redefining reality through stylistically experimental art forms, the movement revolutionized the role of art in Spanish society and ruptured all aesthetic and sociopolitical conventions. However, the sociopolitical significance of this artistic revolution has been disputed by renowned cultural commentators, including the Spanish philosopher José Ortega y Gasset. In his treatise on the subject, *La deshumanización del arte* (*The Dehumanization of Art*), Ortega argues that the avant-garde movement generated works without any clear connection to the human experience, making this movement incapable of transcending pure aestheticism. Based on the prominence of Ortega's criticism, this definition of the avant-garde has informed the way in which the movement has been conceptualized historically. This study seeks to characterize the role of the avant-garde in Spain by putting Ortega's aesthetic theory into dialogue with his political ideas and representative works of the Spanish avant-garde. An examination of the tension between Ortega's aesthetic theory and his political ideas—as they manifest in his book addressing the political state of the nation, *España invertebrada* (*Invertebrate Spain*)—suggests that his interpretation of the avant-garde is significantly biased by his own political agenda. Analysis of the surrealist works of the Andalusian poet and playwright Federico García Lorca (1898-1936) and the materialism-based visual arts of the Catalan painter Antoni Tàpies (1923-2012) reveals the intricate and intentional connection between art and politics in these works and contributes to the understanding of the avant-garde across time, artistic mediums, and geographical regions. Ultimately, this analysis of the Spanish avant-garde exposes the limitations of Ortega's aesthetic theory and contributes to the understanding of the movement as politically particularistic, aesthetically experimental, and capable of redefining the reality of Spain.

Ruptura de toda convención: El arte deshumanizado y la política particularista de la vanguardia en España

Courtney Richman

Mentor: Ignacio Infante

Al principio del siglo XX, la vanguardia española floreció. Con el propósito de redefinir la realidad a través de formas de arte caracterizadas por un estilo experimental, el movimiento revolucionó el rol de arte dentro de la sociedad española y rompió toda convención estética y sociopolítica. Sin embargo, el significado sociopolítico de esta revolución artística ha sido disputado por comentaristas culturales de renombre, incluyendo el filósofo madrileño José Ortega y Gasset. En su tratado sobre el tema, La deshumanización del arte, Ortega argumenta que la vanguardia genera obras sin ninguna conexión evidente con la experiencia humana, lo que hace este movimiento incapaz de transcender esteticismo puro. Debido a la prominencia de la crítica de Ortega, esta definición de la vanguardia ha informado la manera en que el movimiento ha sido conceptualizado históricamente. Esta tesis trata de caracterizar el rol de la vanguardia en España al poner en diálogo la teoría estética de Ortega con las ideas políticas de este filósofo y obras representativas de la vanguardia española. El estudio de la tensión entre la teoría artística de Ortega y su teoría política—como se manifiesta en su libro abordando el estado político de la nación, España invertebrada—sugiere que la interpretación de la vanguardia que propone Ortega es sesgada de manera significativa por su propia agenda política. El análisis de las obras surrealistas del poeta y dramaturgo andaluz Federico García Lorca (1898-19360 y las obras plásticas basadas en el materialismo del pintor catalán Antoni Tàpies (1923-2012) revela la conexión intricada e intencional entre el arte y la política que domina estas obras y contribuye a la comprensión de la vanguardia a través del tiempo, medios artísticos y regiones geográficas. Al fin y al cabo, este análisis de la vanguardia española expone los límites de la teoría estética de Ortega y contribuye al entendimiento del movimiento como políticamente particularista, estéticamente experimental y capaz de redefinir la realidad de España.

Automobility and Racial Injustice in Spatial Production

Julia Curbera

Mentor: Carol Camp Yeakey

Automobility—the centering of society around automobiles and their supporting infrastructure—has configured urban life across the United States by entrenching distinctive ways of production, circulation, and social relations in the built environment. Through the twentieth century history of St. Louis, MO, discourses and politics surrounding the automobility were closely tied to racist and anti-urban sentiments driving spatial production. The construction of interstate highways through African-American neighborhoods, rapid suburbanization and segregation of postwar planning policies, along with racist politics of the city's current mass transit development, are deeply implicated in the city's system of automobility. Automobility presents "a site of special struggle over how the city is configured and for whom." The question that this research seeks to answer asks: how has St. Louis created a geography based on automobility, and how has this geography of automobility marginalized minority communities? To answer this question, this study contests the persisting essentialization of the automobile in modern society, and evaluate the history of racialized and anti-urban politics of automobility that influenced spatial production in the St. Louis region through this framework. From this historical view, connections will be made to current transportation and demographic data and political trends to evaluate persisting effects of automobility. This research ultimately aims to provide a basis of knowledge of automobility and racial politics in the production of space in St. Louis to better understand implications and barriers involved in creating an urban environment based on principle of social justice.

The American Nightmare: Sexism, Xenophobia, and the Treatment of Domestic Workers in Urban America

Hannah Lacava

Mentor: Carol Camp Yeakey

Urban upper-class households in the United States, like all households, are places where many societal constructs regarding race, class, and gender play out. Unlike most American households, urban upper-class households serve not only as a private sphere, but also as a workplace for 1.8 million domestic workers, 95% of whom are female, foreign born, and/or people of color. Because of their unique position working in the private sphere, domestic workers are vulnerable to many injustices, including exclusion from safety protections, limited access to health insurance, and no regulation for overtime pay. In order to paint a clear picture of abusive patterns of behavior, this study will begin by chronicling a history of domestic professions, documenting long-held attitudes and beliefs regarding domestic workers' place in society. Moving into the modern era, this thesis utilizes personal narratives, statistical figures, and media to explore instances of verbal and sexual abuse in urban upper-class homes. The research question posed is how does the societal normalization of sexism, racism, and xenophobia affect the interpersonal treatment of urban domestic workers in the workplace. This thesis further examines the wider constructs of sexism and racism, as well as the way they interact to gain an understanding of the lived experience of urban domestic workers. Ultimately, this thesis utilizes the aforementioned data to analyze and discuss several questions regarding the state of domestic workers in twenty-first-century urban America.

More than Gates: The Physical and Invisible Barriers to Gated Communities and Their Consequences on the Broader Community

Hailey Oliff

Mentor: Carol Camp Yeakey

Gated communities are residential areas that have walls, gates, and guards that work to regulate the movement of people and vehicles into and out of the area. The creation of these gates is largely founded on fear of crime, street traffic, and outsiders. Gated communities are a controversial form of residential developments because they work to physically and symbolically exclude individuals from elite communities. This thesis will address the following questions: what are the physical and invisible barriers to gated communities; what are the implications of these junctures in the urban landscape; and what are alternatives to gated communities? These questions will first be answered by addressing when and how gated communities become a touchstone of American urban design and how they have evolved since. A case study of three elite gated communities in New Tampa, Florida highlight the physical and invisible blockades to entering these secluded communities. Further, I will analyze the special, political, economic, and social consequences resulting from gated communities and their effects on the broader community. Finally, gated communities are challenged by way of a comparison to the New Urbanism design practice. New Urbanism is considerably different to the retreatist method of gated communities and offers an alternative urban design to the physical and invisible barriers present in modern cities.

Urban Green Spaces: Who Benefits? The Integration of Nature in Urban Communities

Sarah Taylor

Mentor: Carol Camp Yeakey

This thesis examines the effects of green spaces on urban environments and communities, assessing extensive literature and studies to answer the following research question: do green spaces benefit urban communities? A historical background of the concept of urban green space is provided, from the emergence of the first urban public parks to their integration into contemporary international environmental movements to combat climate change. In light of recent rapid urban population growth, it is important to better understand how to improve the health of urban residents. Results show that urban green spaces offer environmental, physical, mental, and social health benefits, but these benefits are not spread evenly across urban populations. Increasing green areas may generate gentrification, displacing lower-status residents, and poor implementation may produce other negative effects. This thesis also analyzes two studies: the High Line in New York City, a linear park on the old elevated railroad track, and community gardening in St. Louis, a local method to increase access to fresh healthy food while improving the aesthetic of dilapidated neighborhoods, utilizing vacant land, and strengthening community ties. The conclusion reached is that green space initiative must be implemented with continuous input from residents. This thesis does not claim that green spaces are the solution to urban poverty, segregation, crowded housing, crime rates, homelessness, or various other problems associated with urban life. Green spaces are only one of many strategies to improve urban communities, and must be realized in congruence with other economic and social programs.

Widening the Scope: Exploring Student Experiences Responding to Sexual Violence on Campus

Katherine (Katie) Chew

Mentor: Jami Ake

Research on the issue of sexual violence on college campuses has often focused on perpetrators and survivors of violence, including their actions, experiences, and health outcomes. This project focuses instead on the experiences of college students as third parties that become aware of violence within their peer groups. Semi-structured interviews with 12 Washington University in St. Louis students revealed a variety of nuanced experiences responding to incidents of sexual violence. One common theme among the interviews included a complex process of balancing the needs of all individuals within one's peer group in order to make decisions about how to respond in the aftermath of an assault. Knowledge about the dynamics of sexual violence and campus resources for survivors, as well as group norms and the quality of participants' relationships with other affected parties, impacted the choices students made about how to balance the needs of various individuals. The interviews highlighted the substantial role that third parties play in responding to incidents of sexual violence. Specific conclusions about this response role were combined with participants' perspectives on the experience of navigating campus support systems to suggest new approaches to assault prevention and response on college campuses. These new approaches include a greater focus on providing support to third parties who are impacted by violence, increased training initiatives that focus on giving students the tools to support one another, and developing institutional responses to violence that focus more community level solutions than individual support or sanctions.

Trouble in Paradise: Investigating Rape-Collusive Attitudes, Beliefs, and Practices on a Boarding School Campus

Gaelyn Golde

Mentors: Jami Ake, Mary Ann Dzuback, and Kim Webb

In this exploratory study, I posited: how, if at all, are rape-collusive attitudes reinforced or perpetuated on a boarding school campus? Typically, adolescent and teenage students learn behaviors and codes of conduct within the family unit—at boarding schools, that responsibility is handed to the administration. What happens when an administrative body stands in for a parent? Does the boarding school environment merit focused, individual study separate from college or residential high school communities? Sexual violence preventative programming is often implemented at the college level, but students entering college are not blank slates. How are incoming college freshmen already products of their environment? Is there opportunity to intervene earlier and target rape culture more effectively?

Through a survey distributed through alumni and current student channels and follow-up anonymous interviews, I conducted a case study at a single Northeastern boarding school to gain an understanding of the current campus climate from the perspective of students and alumni. I focused primarily on three areas of student life: sexual education programming, administrative policies regulating student sexual practices, and student attitudes and beliefs surrounding sex and sexuality. Due to my small sample size, no conclusive findings could be asserted. Instead, I looked for emerging patterns in the responses, which could gesture towards opportunities for further research.

I found that boarding schools rest at a unique nexus of study: between adolescence and adulthood, and independence and dependence. The responses to my survey allowed me to conclude with narrower, finer-tuned research questions that could dictate further studies, and also illustrated a small piece of a larger rape-collusive epidemic within a population that is often ignored as its own inimitable environment.

Invisible Violence: Battered South Asian Women's Experiences in the American Legal System

Bianca Jahnavi Kaushal

Mentors: Jami Ake, Linling Gao-Miles, and Mary Ann Dzuback

This project examines the experiences of battered South Asian women in St. Louis and their journey through the legal system to obtain justice against their South Asian abusers. Through a partnership with Saweraa, St. Louis's only South Asian domestic violence agency, I connected with nine current or past clients. In addition to their in-depth narrative interviews, I interviewed the Saweraa's only staff member in order to understand her strategies for supporting clients through the legal system.

Throughout the project, I move from the macro to the micro to explain why battered South Asian women in St. Louis struggle to obtain justice. In my first chapter, I trace the development of the Nonprofit Industrial Complex by pairing historical analysis of the Battered Women's Movement with direct observations of mainstream domestic violence agencies. This reveals a disjunction between the priorities and capacity of mainstream agencies and the needs of battered South Asian clients. In my second chapter, I articulate the structural necessity for Saweraa, a sparsely staffed organization that provides wrap-around services to clients. I develop a theory of a "perfect advocate" who coded herself as an ally while deftly maneuvering the legal system. Finally, I address the clients themselves, and explain how their interactions with a "perfect advocate" shield them from the cultural incompetence of the legal system and mainstream agencies. Combined, these interviews demonstrate how the interpersonal effectiveness of a "perfect advocate's" work conceals the deep inadequacies within the legal system. Ultimately, her advocacy style removes burden from the legal institutions to meet the needs of marginalized populations in culturally-competent ways. The project concludes with recommendations on how Saweraa can sustain itself in the current funding climate without forgoing a commitment to wrap-around services. I also advocate for courts and legal-adjacent intuitions like DV agencies to adopt a margins-to-center approach.

Elevating Spaces, Changing Communities: Black Women's Participation in the Metropolitan Chicago YWCA, 1915-1925

Ryan Paige

Mentors: R. Marie Griffith, Lerone Martin, and Mary Ann Dzuback

Founded in the latter half of the nineteenth century, the Young Women's Christian Association (YWCA) has stood for many years as a premiere organization focused on social reform for the empowerment of women and girls. Today, the YWCA and its male-oriented counterpart (YMCA), are known for providing enrichment programming for marginalized youth, especially those of color. However, during World War I and the Roaring Twenties, the YWCA often excluded and discriminated against African-American women, with segregated branches of the organization receiving unequal resources from the National Board. This was especially the case in the city of Chicago, a destination for thousands of black migrant families seeking to escape the racial oppression occurring in the southern region of the United States during this time. This study is a part of a small but growing body of research on the involvement of black women in urban YWCAs during a period of legal segregation. Through examination of African-American publications and documents from the organization's governing board in Chicago during this time period, this research suggests that the participation of African-American women in predominately white organizations, such as the YWCA, was due, in part, to the limitations placed upon them by their intersectional identities. Not fully supported in neither black- nor woman-based spaces, African-American women had to rely upon the privileges of membership within the YWCA as a stepping stone toward having their voices heard and valued by society as a whole.

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Gender Equality Champions: Investigating the Impact of Cognitive Dissonance on Negotiation Outcomes for Female Employees

Suzanna Deng and Ricardo Perez

Mentor: William P. Bottom

Prior research has determined that women, on average, achieve worse negotiation outcomes than men in comparable situations. One study examined a promising intervention strategy: bestowing the title of "equality champion" onto individuals who have not earned it to motivate behaviors that align with this label. The authors of this study attribute this change in behavior to cognitive dissonance. The present study examined the impacts of such labels in the context of women's negotiation outcomes. After completing individual difference measure questionnaires, participants were asked to complete a gender attitudes questionnaire and informed that they were gender equality champions regardless of their responses (champion condition), asked to complete the questionnaire and received no feedback (salience condition), or not asked to complete the questionnaire (control condition). Then, all participants completed a computer-simulated negotiation and completed subjective evaluations of the negotiation process. We hypothesized that participants in the champion condition would offer the most equitable negotiation outcomes and favorable subjective evaluations of their negotiating partner. We also expect participants in the salience condition to offer similar outcomes to the champion condition, though to a lesser degree. We expect those in the control condition to offer the least equitable outcomes. We also anticipate that these effects will be especially pronounced for male subjects. Finally, we anticipate that subjects high in competitiveness, extroversion, and neuroticism will offer less equitable outcomes to the female employee while those high in empathy and agreeableness will offer more equitable outcomes. Preliminary findings indicate that there is a gender difference in the control condition; female participants earned less utility in the negotiation than male participants, though this difference in outcomes was not present in the salience or champion conditions. Furthermore, participants with personalities high in competition seeking earned more utility in the negotiation.

The Effects of Pro-Marijuana Legislation on Opioid Mortality Rates in the United States

Eduardo Jacobo, Varun Parekh and Jackson Smith

Mentor: Bernardo Silveira

This paper empirically investigates the relationship between pro-marijuana legislation and opioid mortality rates. In order to model the effects of legislation in the periods both before and after its passage we used a differences-in-differences model. Our model used data from the United States Center for Disease Control and Prevention's data sets regarding opioid deaths per state. With 445 total data points, our model consists of a panel of 36 states observed from 1999 to 2015. Each year, we indicate whether the state had passed legislation that made marijuana more accessible in any of the following ways: decriminalized marijuana by reducing penalties for those found to be in possession, legalized marijuana strictly for medical purposes, legalized marijuana for recreational purposes, or legalized the establishment of dispensaries through which marijuana can be sold legally. The four categories of pro-marijuana legislation serve as the independent variables in our model. The dependent variable in the model is opioid deaths per one million people. Our results indicate that marijuana decriminalization increases opioid deaths per million by 1.22286, a 37.61% increase over the 3.251521 predicted deaths per million for a state without marijuana decriminalization. Medical legalization, recreational legalization, and legalization of sales through dispensaries were not found to have a statistically significant impact on opioid deaths.

When Does Size Matter? An Empirical Study of Consumer Demographics and Product Package Choices

Miranda Lan, Lillian Ross, Laira Torres-Ruiz, Yuchen (Christina) Ye, and Tianqi (Tony) Zhu

Mentor: Tat Chan

The consumer packaged goods (CPG) market is one of the largest industries in the United States. In 2015, the industry recorded $635.8 billion in sales within the United States (MNI Targeted Media). CPG products are packaged in small sizes, such as single units, or large sizes, such as multiple units, with the latter typically priced at lower price per standardized unit (e.g., ounce). Consequently, it is more beneficial for consumers to purchase large size packages if there is low inventory-holding and transportation costs. Our research explores how demographic factors may influence the package size purchase decisions made by consumers on household items. The dataset consists of five years (2011-2015) of available household purchase data from the Nielsen-Kilts Consumer Panel Dataset, which comprehensively tracks purchase information for 40,000-60,000 U.S. households, along with demographic, retailer, and product information. Our research focuses on the beer category and defines the size of a purchase as "small" or "large" based on total ounces of a given package. The demographic variables that are evaluated include income and race. In order to control for exposure to price differences, each household purchase was tracked to the store level at the week of purchase, and controlled for with an average price ratio between large and small package sizes. We hypothesize that consumers in the lowest income class will purchase smaller size packages because of the lower total prices, while the highest income class will purchase smaller size packages due to just-in-time convenience purchasing. Alternatively, we hypothesize that consumers in the middle income class have a higher probability of purchasing large package sizes in response to the low holding costs and higher transportation costs. Additionally, we anticipate store price promotions to have a greater impact on package size purchases among the lower and middle income households, in comparison to the higher income households, because the former are more price sensitive. With the effects observed in our analysis, we look at the broader applications of this knowledge in the CPG industry and draw implications for future business decisions.

Garbage In, Garbage Out: Model Uncertainty in Wealth Simulations

Daniel Schleien, James Larkin Smith, and James Soldati

Mentor: Philip H. Dybvig

Wealth managers commonly employ wealth simulators to illustrate the risk-return tradeoff, helping investors visualize projected returns with a given amount of risk. However, clients demanding these high-priced, specially-curated services may wish to reject static modeling assumptions that could misrepresent their terminal wealth. Using a hypothetical example of investing for retirement 30 years from now, we simulated the sensitivity of terminal wealth distributions to various modeling assumptions. Considering different capital market assumptions and levels of risk tolerance, we analyzed variance in terminal wealth given different investor goals and strategies. Our results reflect the strong influence but unreliable predictive power of model assumptions. Because portfolio reallocation decisions largely rely on continually updating capital market assumptions and changing levels of risk tolerance, our models demonstrated higher terminal wealth on average when investors frequently refreshed inputs and maintained their convictions in turbulent markets. Furthermore, assuming a randomly changing real interest rate better reflects portfolio uncertainty compared to a constant real interest rate that grossly misrepresents true market conditions. Even when accounting for this uncertainty, the empirical record does not facilitate a sufficient estimate of parameters such as the rate of mean reversion of interest rates to accurately predict terminal wealth. Ultimately, wealth simulators may easily fall victim to the "garbage in, garbage out" conundrum, leading to potentially misinformed investing decisions. Our paper instead encourages wealth managers to provide clients with simple, transparent, and practical modeling scenarios when they simulate returns in uncertain capital markets, as investing decisions made today bear large impact on future results.

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A NO_X Denuder: Using GroG Impregnated with Cobalt Oxide to Strip NO_X

Blake Actkinson and Stone Yan

Mentors: Rajan Chakrabarty and Brent Williams

Nitrogen monoxide and nitrogen dioxide, collectively known as NO_X, play an integral role in atmospheric chemistry. NO_X is an atmospheric pollutant that has detrimental effects on human health, air quality, and visibility. When present in high levels, NO_X inhibits the formation of OH radicals and ozone, key components of many atmospheric chemical cycles. Additionally, NO_X emissions from combustion sources interfere with certain types of aerosol optical measurements, since NO_X absorbs strongly at certain wavelengths. A denuder was made to strip NO_X compounds from an incoming aerosol stream to reduce its interference in such optical measurements. Cone shaped nozzles allow for the subduction of aerosol into the inner chamber of the denuder, upon which the aerosol traverses down one of four stainless steel mesh channels and reacts with packed catalyst. Fine firesand and chamotte particles known as GroG were coated with cobalt nitrate hexahydrate and oxidized to cobalt oxide at 300°C. Adsorption of NO was observed at flow rates of 1900 SCCM of 150 ppm NO. NO concentrations at the denuder outlet were measured using a Model 42i-TL Trace Level NOx Analyzer. The percentage of NO removed from the inlet stream after five minutes was 36.8%. This suggests that for a 1% reduction in flowrate, 28% reduction in outlet NO concentration is achieved. The denuder holds promise for enabling more accurate characterization of aerosol composition.

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