



Undergraduate Research and Creative Collaborations Symposium

Friday, April 30, 2021




Brandeis

SCHOOL OF ARTS AND SCIENCES

UNDERGRADUATE RESEARCH
CREATIVE COLLABORATIONS

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WELCOME FROM THE DEAN OF ARTS & SCIENCES

Dear students, colleagues, alumni, donors, and friends,

I am thrilled to welcome you to the first annual Undergraduate Research and Creative Collaborations Symposium. This symposium has been my dream since I started at Brandeis as Dean of the School of Arts and Sciences in August 2018, and I am delighted that it is now a reality, despite the pandemic. Brandeis has a longstanding commitment to undergraduate research and creative work, and this event showcases our students' contribution to knowledge across all academic fields for the first time.

I would like to thank the Davis Educational Foundation along with our numerous campus partners and supporters for their assistance in presenting this event. Margaret Lynch, Director of Undergraduate-Faculty Research Partnerships, and Wendy Cadge, Senior Associate Dean for Strategic Initiatives, deserve special praise for their efforts. Of course, my deepest gratitude goes to our brilliant students, many of whom are presenting their work for the very first time, and their dedicated faculty mentors.

Finally, I want to thank you for attending. I am delighted that so many members of our Brandeis community have come together to support our budding scholars. I hope you will all enjoy the opportunity to learn more about research and creative work at Brandeis, and I encourage you to visit the URCC website to explore other undergraduate research initiatives and opportunities at Brandeis.

Dorothy Hodgson
Dean, School of Arts and Sciences
Professor of Anthropology

WELCOME FROM THE DIRECTOR OF UNDERGRADUATE-FACULTY RESEARCH PARTNERSHIPS

Dear Symposium presenters and attendees,

Welcome to the first all-disciplines 2021 Brandeis Spring Undergraduate Research and Creative Collaborations Symposium! Through this event, undergraduates will present and share their innovative research and creative projects with Brandeis students, faculty, staff, friends, and supporters. Students from all class years and all Divisions (Creative Arts, Humanities, Social Sciences, and Sciences) are participating and represent the wide-ranging scope of disciplinary and interdisciplinary research and creative inquiry at Brandeis.

This celebration of undergraduate research and creative inquiry was organized by the Undergraduate Research and Creative Collaborations Office (URCC) and its Campus Partners. The URCC, a new office launched in 2020, was created through the efforts of Dorothy Hodgson, Dean of the School of Arts and Sciences, and Wendy Cadge, Senior Associate Dean of Strategic Initiatives in the School of Arts and Sciences. The URCC strives to build a centralized infrastructure of resources, information, support, and funding in an effort to increase access to and equity of opportunities so that all Brandeis undergraduates who wish to do so can engage in research or creative inquiry.

This event would not be possible without the hard work and support of many partners. The URCC thanks

- the Davis Educational Foundation for grant funding to support this event and for funding to build the Undergraduate Research and Creative Collaborations Office and its programs
- the students' faculty mentors and other mentors for all of the support, guidance, and expertise they offer to Brandeis undergraduates
- Brandeis undergraduates for their continued resilience and perseverance during the past year
- our donors for their generous support of undergraduate research and creative inquiry
- and our campus colleagues.

Please refer to the acknowledgments page at the end of this program booklet for a more comprehensive and detailed list of thanks. Thank you for your help in supporting undergraduate research and creative collaborations at Brandeis!

With best wishes,
Margaret

Margaret A. Lynch, PhD
Director of Undergraduate-Faculty Research Partnerships
School of Arts and Sciences
margaretlynch@brandeis.edu

SYMPOSIUM INFORMATION

How to Participate in the Symposium

This event is for all in the Brandeis community, as well as donors, friends, family, and invited guests. If you are an undergraduate who wants to learn more about how to get involved in research or creative inquiry, this event is for you! You can learn about what it's like to do research directly from you peers.

Participation in this online event requires registration with the Symposium event platform and access to Zoom. See the URCC Symposium website for step-by-step instructions, sign up guides, the student presentation schedule, and more.

1. Sign up and register with Symposium: https://symposium.foragerone.com/

2. Access the event through the Direct Event link:
https://symposium.foragerone.com/brandeis-undergraduate-research-symposium/

Overview of the Event Schedule

Wednesday, April 28, 2021
Starting on this date, attendees who have signed up with the Symposium platform and registered for the Brandeis event (see above for a link to instructions) can access the Brandeis event to preview presentation posters slides, performances, or videos. Using the Symposium platform comment feature, those who have registered will be able to comment on presentations and ask questions asynchronously.

Friday, April 30, 2021 from 1:00-3:00 PM (U.S. Eastern Daylight Savings Time)

- Most student presenters have a live 30-minute presentation session in Zoom.
- The Zoom links are in each student's presentation in the Symposium event platform.
- The student presentation schedule is on the URCC student presentation schedule page.

- In addition, the presentation abstracts in this booklet are arranged according to presentation time. Most students will present in one of seven overlapping presentation slots beginning from 1:00 PM and ending at 3:00 PM ET.
- To help identify presentations that match your interests and general field of study, there are icons denoting the academic division(s) in which a project is based: Creative Arts, Humanities, Social Sciences, or Sciences. You can also search this program's text for specific keywords through your PDF reader's search function.


Sciences


Social Sciences


Humanities


Creative Arts

May 1-May 11, 2021:
Presenters and attendees can continue their event engagement and conversations using the Symposium platform. You can continue to view a student's presentation components such as posters, slides, performances, or videos. Using the Symposium platform comment feature, those who have registered will be able to comment on presentations and ask questions asynchronously.

If you have any questions or concerns about accessing the event, feel free to reach out to the URCC Graduate Administrative Fellow, Doug Bafford (bafford@brandeis.edu).

PRESENTATION SCHEDULE

PRESENTING 1:00-1:30 PM EDT

Sadie Antine '21

Faculty Mentor: Amy Lee

Mechanism of eIF3-mediated repression of BTG1 translation

Transcript-specific translation involves distinct mRNAs encoding RNA sequence and/or secondary structure that are bound by distinct RNA-binding proteins, which modulate their translation in response to environmental stimuli, such as developmental cues and cellular stress. BTG1 mRNA contains a large stem loop within its 5' untranslated region (UTR) that binds to the 800-kDa, 13-subunit eukaryotic initiation factor 3 (eIF3). BTG1 expression is highest during G0/G1 of the cell cycle and functions to modulate cellular quiescence by binding to transcription factors. eIF3 functions in translation initiation as a scaffolding protein that promotes translation. Interestingly, eIF3 acts outside of its canonical function by binding to BTG1 mRNA and repressing its translation. The mechanism of how eIF3 represses BTG1 translation was previously unknown. Here we report the mechanism by which eIF3 mediates repression of BTG1 translation through use of biochemical and cellular methods. This research highlights how an initiation factor known to promote translation can repress translation of a distinct mRNA.

Yuran Shi '21
Co-authors: Mihael A. Gerkman, Qianfeng Qiu, Shuren Zhang

Faculty Mentor: Grace Han

Sunlight-activated phase change materials for controlled heat storage and triggered release

We report the design of photo-responsive organic phase change materials that can absorb filtered solar radiation to store both latent heat and photon energy *via* simultaneous phase transition and photo-isomerization. The activation of photo-switches by long wavelengths ≥530 nm in the visible light range at a low irradiance is achieved, in the absence of high-intensity light sources, by the *ortho*-substitution of azobenzene units. The facile transition from crystalline to liquid phase is enabled by appending an aliphatic group on the photochromic moiety. The sunlight-activated liquid phase exhibits an exceptionally long heat storage without crystallization for nearly two months, and the release of energy is triggered by a short irradiation at 430 nm. The successful demonstration of photo-controlled latent heat storage accomplished by solar irradiation opens a new horizon on solar energy harvesting by functional organic materials, as a complementary system to photocatalysts and photovoltaic materials.

Wanchen Zhao '21

Faculty Mentor: Angela Gutchess

Boundary extension: how culture and semantic consistency interact

Boundary Extension (BE) is a memory error in which people remember more of a scene than there actually is (Intraub &Richardson, 1989). The magnitude of this error can be magnified by semantic consistency (Mamus &Boduroglu, 2018); furthermore, cultures may differ in their sensitivity to consistency. Our preliminary data on Turkish (Easterners) and American (Westerners) subjects found evidence that Turks exhibited more boundary extension than Americans and that the effects of congruency reversed across cultures for the close-up to wide-angle: Americans display more BE on semantically congruent scenes while Turks more so on incongruent scenes. In our current study, we investigate the how semantic congruency of scenes affect people differentially from Chinese and American cultures. In Experiment 1, we conduct memory test on objects on blank backgrounds; in Experiment 2, we do so with objects on semantically congruent (e.g. a chef in a kitchen) or incongruent (e.g. a man skiing in a desert) backgrounds. We expect to find a significant interaction between culture and semantic congruency in Experiment 1, specifically, significant difference in BE magnitude on incongruent scenes but not on congruent ones across cultures. If culture mediates the effect of semantic congruency on BE magnitude, then with the lack of semantic information, we expect to find insignificant difference in BE in Experiment 2 where we present main objects without backgrounds.

Ziyao Li '21

Faculty Mentor: Irving Epstein

The Generation of Turing Patterns on Growing Zebrafish Skin with Only Cellular Interactions

The idea of spatially periodic and temporally stationary patterns arising from interaction between reaction and diffusion was proposed by Alan Turing to explain the chemical basis of morphogenesis. Zebrafish, a model organism for experimental investigations into Turing patterns, show clear parallel stripes. However, the lack of movement of chromatophores defies traditional Turing pattern formation mechanisms. Interplay between short-range competing and long-range promoting interactions between pigment cells - melanophores (black) and xanthophores (yellow) - was proposed as an alternative to a reaction-diffusion scheme. In this work, we propose a minimal in silico model, where the long-range promotion signal is replaced by a survival signal. Our Survival model produces stationary patterns and undergoes a Turing instability. We also examine the effect of domain growth on both Promotion and Survival models. In both cases, domain growth alone is capable of orienting the Turing patterns, giving parallel stripes that are perpendicular to the growing boundary. Some patterning that was once thought to require inducing factors other than cellular interactions has been shown to be

accomplished by domain growth alone. While both models are simplified representations of the multifaceted interactions between pigment cells, they reveal complex organizational behavior and may help to guide future studies.

Joshua Aldwinckle-Povey ‘23

Faculty Mentor: Alexandra Ratzlaff

The Origins of CLARC: Connecting Brandeis to the Wider Archaeological Sphere of Boston

The Classical Studies Artefact Research Collection (CLARC) is Brandeis' own collection of artefacts from across periods of time and regions, including artefacts from Ancient Greece, Rome, the Middle East and ranging from coins to oil lamps, votives and statues. My research work within the collection is focused on provenance information of the objects in our care - in other words, answering the questions 'How did this get to us?' and 'Where did it come from?' My work involves several skills: digitisation, organisation, archival research and contacting others both inside and out of the university among others.

Although there is no defined end to the work I’m conducting at this stage, I am currently researching the work of Cyrus Gordon at Brandeis with the aim of displaying an exhibit featuring his work on campus as well as continuing to trace origins of items in our care. This exhibit combines archival and scholarly research as well as provenance research I’ve been conducting this year. My presentation will discuss the research I’m currently conducting, introduce you to CLARC from my perspective and demonstrate the importance of Brandeis and our work within the wider word of archaeology within the Boston area. I also look forward to sharing more about what I’ve learned from my experiences with this work too.

Gabriela Giordano ‘21

Faculty Mentor: Susan Lovett

DNA Replication and Repair: Characterization of YoaA

Effective DNA replication and repair is crucial to the survival of all organisms and necessitates the cooperation of many macromolecules. In *Escherichia coli* (*E. coli*), it has been found that YoaA, a putative 5’ to 3’ helicase, interacts with DNA Polymerase III (Pol III) which is the cell’s main replication machinery, and aids DNA repair. I seek to further characterize YoaA’s interaction with the Pol III subunit HolC and explore the effects of this protein-protein interaction in vivo. Additionally, I look to identify the types of DNA damage and repair to which YoaA responds. To accomplish this wide-reaching characterization of YoaA, I used Yeast Two-Hybrid Analysis to test for protein interaction and various growth assays testing for phenotypic expression of mutant *yoaA* strains. I found that the last 18 amino acids of YoaA are responsible

for binding to HolC and that this region affects *E. coli* viability, as a strain with the region deleted suppresses the toxicity of *yoaA* overexpression. Initial phenotypic assays suggest that YoaA does not respond significantly to point mutations or recombination events, which represent some instances of repair which may require helicase activity. How YoaA aids in DNA repair and to which types of damage it responds remains unknown. Characterization of YoaA, along with better knowledge of repair pathways can strengthen our understanding of DNA damage.

Sanjitha Subramaniam '23

Co-authors: Gowri Vijayakumar, Subadra Panchanadeswaran, Sarah Halford

Faculty Mentor: Gowri Vijayakumar

Between Pandemics: From HIV Prevention to COVID-19 Relief

Since the onset of the COVID-19 global pandemic, marginalized groups across the world are disproportionately affected. Nevertheless, their experiences continue to be sidelined. Through a qualitative analysis of grassroots organizations working with sex workers, sexual minorities and transgender people, all of which formed around the peak of the AIDS epidemic, this paper details some of the challenges of the pandemic for these groups, as well as demonstrating how, even in an environment of limited resources, organizations repurposed their existing connections and skills to navigate the onset of COVID-19. Wide-spread crises exacerbate previously existing hardships in marginalized communities and put them at greater risk for hospitalization (Banerjee and Rao, 2021). This is caused by structural inequities present, pre-existing conditions, lower socio-economic status and lifestyle conditions, and more (Gichuna, et. al, 2020). Over a period of six months, interviews with nonprofit organization leaders were conducted to discuss the HIV/ AIDS epidemic in South Asia in regards to funding, resources, the government's role, and the crisis aftermath to help us better understand the COVID-19 pandemic and ways to highlight silenced voices in the aftermath of this pandemic. Social movement organizations (SMOs) have helped facilitate coordination for 'mutual aid,' as these networks help marginalized communities provide support for one another through mental health support services, resources, shelter, food, and more (D'Alisa, et al., 2015). The research conducted examines the roles of SMOs, funding agencies, government, and grassroots organizations in uplifting voices of marginalized groups to better provide support in the aftermath of the current COVID-19 pandemic.

Amanda Cao ‘22

Faculty Mentor: Irving Epstein

The Effects of Obstacles on Turing Pattern Formation

Morphogenesis is the development of complex shapes in living organisms. Alan Turing proposed a mechanism that explains this phenomenon through a relatively simple reaction-diffusion system. Simulations of the reaction-diffusion systems produced spatial patterns that are similar to those seen in biological systems. The patterns developed through a diffusion-driven (Turing) instability can be characterized as Turing patterns. Our focus was to identify the effects of obstacles on such Turing pattern formations. We utilized COMSOL Multiphysics to simulate the Lengyel-Epstein reaction-diffusion model to generate Turing patterns on domains growing at different rates and manipulated the shape and size of various obstacles to identify the effects of obstruction on Turing pattern growth. Overall, we observed notable disruptions in pattern morphologies when obstacles are present. For instance, at growth rates where concentric rings are expected to form, an obstacle in the domain caused perpendicular lines to emerge. In addition, we observed that the closer the obstacle is to the center of the domain, the more the pattern deviates from the expected pattern. The results will guide experimental studies, to see if the behavior is robust enough for noisy systems. Alongside experimental implications, these findings offer more insight on how Turing patterns form throughout morphogenesis in biological systems.

Leah Trachtenberg ‘21

Faculty Mentor: ChaeRan Freeze

Bunnies and Nachashim: Jews in Playboy Magazine

This project will focus on Jewish contributions to Playboy Magazine, in particular, how the presentation of Jews and Jewishness in Playboy Magazine through the inclusion of Jewish writers like Isaac Bashevis Singer and Lenny Bruce, American and Israeli models, and editorial staff influenced the shaping of the American sexual imaginary. Based on close readings of Jewish literature and examination of photographs in Playboy and Playboy readers' reactions to these publications, as well as interviews with Jewish editors, this study will explore how Jews shaped American views of sexuality and media influence of Judaism in the cultural production of the magazine. This project determines how despite these works being intended for a general American audience, drawing on universal themes of sexuality and morality, the contributors include aspects of Jewish tradition in ways that

transform Playboy and America's approaches to sexuality and gender. A study of the pictorials including Jewish models and the 1970 pictorial, "The Girls of Israel" will highlight Playboy's adherence to stereotypes of Jewish American women as undesirable and frigid while also challenging these same stereotypes. It will also explore the relationship between the cultural producers and models with second-wave feminism, which blossomed in the late 1960s. This project will provide a new vista on Jewish erotica through the formation of a sexual imaginary that perpetuates and challenges stereotypes of American Jews.

Isabel Cepeda '21
Co-author: Vera Valakh

Faculty Mentor: Sacha Nelson

The role of HLF, TEF, and DBP in seizure propensity

Homeostatic plasticity is a set of mechanisms that keep neuronal activity within a functional range. Developmental epilepsies are suggested to be cases in which homeostatic plasticity can become maladaptive (Nelson & Valakh, 2014). Given that mice lacking the PAR-bZIP transcription factors *HLF, TEF,* and *DBP* (TKOs) experience spontaneous and audiogenic seizures, we investigated the role of these transcription factors in seizure propensity in mice. We found that *HLF* and *TEF* are upregulated after activity deprivation due to TTX exposure. Further, this upregulation increases with the duration of TTX exposure. Survival analysis reveals that rescuing *HLF* or *TEF* is sufficient to restore WT survivability by reducing the frequency of spontaneous death (SD) due to seizure. Rescuing *DBP* can produce a partial recovery. We then tested whether rearing TKOs in an enhanced auditory environment would reduce spontaneous death propensity. Interestingly, TKOs reared in this environment (TKO_{reared}) showed the same survivability as $TKO_{unreared}$. Finally, as a more sensitive measure of seizure occurrence than SD, we tracked the frequency of seizures using video analysis. We find that TKOs living past p40 continue to experience non-lethal seizures. Overall, these findings contribute to our understanding of the pathophysiology behind seizure propensity in mice lacking *HLF, TEF*, and *DBP.*

Thu Le '22

Faculty Mentor: Thomas Pochapsky

Computationally-guided P450cam engineering for novel substrate regioselectivity

Cytochrome P450 monooxygenases are heme-containing enzymes that activate molecular oxygen while selectively binding and orienting the substrate for reaction. P450cam (CYP101A1) from soil-bacterium Pseudomonas putida is the most thoroughly investigated P450 catalyzing the hydroxylation of D-camphor to 5-exo-hydroxycamphor, and also the engineering target of our project. With computational-driven guidance from our collaborators, we aim to express a mutation that can hydroxylate camphor with predictable altered regioselectivity. We want to

understand P450cam internal signal propagation between key residues using molecular dynamics simulations of point mutations and then use information from that virtual test bed to investigate potential mutations, as well as informing the simulations based on experimental results. P450cam quadruple mutant (V248G, G249A, V296I, V397I) is not stabilized in presence of natural substrate camphor and is not readily reduced compared to wildtype. Turnover of the mutant in NADH showed no change in primary product and some decrease in functionality. There was agreement on camphor being more loosely bound or further from the heme group in the mutant with the computational results. More recently, a swap mutant (Y97F/F88Y) is done on quadruple mutant background using Gibson assembly in order to increase active site hydrophobicity and force substrates to bind close to the heme. 2D 1H-15N TROSY data shows more specific residue disturbances. The overarching goal of this project is to prove viability of computer-assisted intelligent protein engineering and improve P450 enzyme chemistry understanding for pharmaceutical and medical purposes.

Alexandra Bazarsky '23

Faculty Mentor: Charles Golden

Using ArcGIS to Interpret LiDAR Data and Identify Maya Archaeological Sites

I worked remotely with Professor Golden in a working group of faculty and graduate students at Brandeis and Brown University to identify archaeological sites on the Mexican-Guatemalan border as a member of the Proyecto Arqueológico Busiljá-Chocolja. To conduct this research I utilized ArcGIS and LiDAR (light detection and ranging) data collected in 2019 by the National Center for Airborne Laser Mapping (NCALM) in both Guatemala and Chiapas. ArcGIS is a Geographic Information System software that allows analysis of spatial and mapping data. LiDAR has been employed to survey the Maya Lowlands because it makes it possible to model the ground surface and ancient architecture beneath dense tropical forest, and identify the impacts on the landscape. This, in turn, allows archaeologists to better understand Maya power structures because the distance between urban centers, rural settlements, and fields is documented. The research from this past summer resulted in the identification of 11,913 landscape artifacts including walls, terraces, structures, among others. Since January, I have focused on researching the Santo Domingo Valley in Chiapas, discovering why the area has little to no identified ancient settlement. With these same data, I am using a process called predictive modeling to analyze the area. I hypothesize that because of fights between political powers and landscape differentiation, the Maya chose not to settle in the area. Within the field of Anthropology, this project presents broader implications as this wide-scale documentation of archaeological sites around the Usumacinta River allows for advances in research regarding settlement patterns.

Leah Naraine ‘22

Faculty Mentor: Suzanne Paradis

The role of Rem2 in the hippocampal circuit

Rem2 is a small Ras-like GTPase which is highly expressed in the brain. The Paradis lab has previously characterized numerous cellular functions of Rem2, such as regulating the dendritic arbor and promoting excitatory synapse formation. To understand the signaling mechanisms by which Rem2 regulates these cellular processes, previous lab members performed studies to identify proteins that interact with Rem2. One such study demonstrated that Rem2 associates with and inhibits the kinase activity of CaMKII. Another such finding suggested strong interactions between Cul 1 and Rem 2. Cul 1 is the scaffold component of the SCF ubtitquine E3 ligase (Wang 2020). The SCF complex regulates neuronal pruning (Wong et al. 2013) and inhibits neuroblast overgrowth (Li et al. 2014). Considering the possible interaction between Rem 2 and Cul 1, determining how these two proteins interact is integral for a deeper understanding about regulation of dendritic arborization and other crucial neuronal functions. Therefore, understanding the relationship between Rem2 and Cul1 interactions will lead to testable hypotheses about Cul1 function in neurons. Preliminary findings suggest that Rem2 and Cul1 are both present within the HEK cells that were cultured and utilized. If continued research suggests that there is no association between Cul 1 and Rem 2 I will also explore cellular association between Rem 2 and syntaxin 8 for similar purposes. These experimental routes will facilitate scientific findings that continue to add to the body of knowledge about cellular functions of Rem 2.

Isabelle Graj ‘21

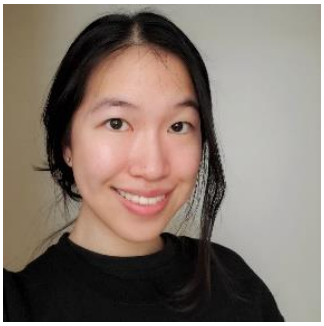
Faculty Mentor: Sabine von Mering

Energy Democracy: Community-Owned Energy & Environmental Justice

This paper uses an environmental justice framework, as described by David Pellow (2004), to investigate whether community-owned energy is a viable solution to the climate crisis, and what barriers there are to its widespread adoption in the U.S. A historical review of electrification and its impact on Indigenous communities helps identify the nodes of social injustice in the U.S. energy system. The analysis of an Electric Cooperative in Arizona indicates that community ownership has the potential to uplift the demands of Indigenous Sovereignty, if advocated for with an environmental justice approach. Massachusetts municipal-owned utilities (Munis) and state climate and energy policy suggests that Munis are not currently used as a tool for environmental justice, and that there are steps Massachusetts can take to promote

community-owned renewable energy infrastructure and alternative models of energy democracy. This research concludes that a community that owns the transmission lines serving them has more control and decision-making power over its energy. This allows the needs of a community to be prioritized in their energy projects and liquidates the leverage of fossil fuel and utility companies in their area. In order for that to positively affect climate change, the community must also prioritize renewable energy and be committed to ending its reliance on fossil fuels. The U.S. government must stop subsidizing fossil fuels, help communities end wholesale contracts with fossil fuel producers, remove barriers to acquiring local ownership of energy infrastructure, and provide funds for local renewable energy projects, particularly in frontline communities.

Alyssa Fu '22



Faculty Mentor: Amber Spry

From Liberal Arts to Liberal Beliefs? Education Levels and Political Ideology in the US

Our nation has recently become polarized between our two most prevalent political ideologies. There are a multitude of factors attributed to the widening gap between liberals and conservatives. Existing literature has illustrated a connection between different education levels and political ideology, but we must understand the causes in order to find appropriate solutions. Adults with graduate degrees tended to lean liberal on political issues overall. Because of the skills taught in universities, the higher a person's education level is, the more likely they will become increasingly politically liberal, and more accepting of change. To investigate this relationship, we devised a dataset containing our own original questions to gather information from 800 respondents in a National Public Opinion Survey. We analyzed our results using ordinary least squares (OLS) regression analysis, but did not find strong support for the hypothesis that education levels would be associated with stronger expressions of liberal ideology. Therefore, the main independent variable of education was not shown to have a meaningful influence on and may not be a good predictor of political ideology after all. Acknowledging that there are various other factors that could influence a person's political beliefs, we then included analyses for two control variables: gender and religiosity. Our findings suggest people are less influenced by their levels of schooling than their own socialized identities or the groups that they self-sort into. Contrary to popular belief, higher education does not necessarily "liberalize" citizens.

Leah Fernandez ‘22

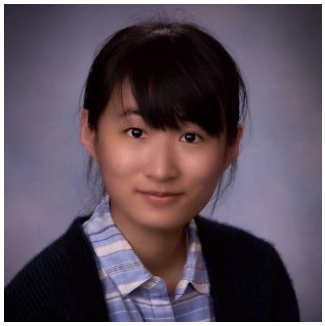
Faculty Mentor: Thomas Shapiro

Investigating Educational Access for Incarcerated Juveniles with Disabilities in Massachusetts

Under the Individuals with Disabilities Education Act (“IDEA”), young people with disabilities are eligible for special education services. Incarceration in a juvenile center does not preclude them from these amenities, though current practices are significantly lacking. Children and youth with disabilities are increasingly overrepresented in the juvenile justice system of the U.S., elevating the importance of the implementation, effectiveness, and execution of these services. Youth involved with the juvenile justice system present with a higher rate of disability, including mental illnesses and learning disabilities, than non-system-involved youth. This is due to a variety of factors, but most significantly the school-to-prison pipeline. My interests lie in investigating the current programs and services for incarcerated juveniles with disabilities in Massachusetts. Through work with the Committee for Public Counsel Services (CPCS), Office of the Child Advocate, and the Juvenile Detention Alternatives Initiative (JDAI) I have identified a small but intergal issue and have come up with a system to help advocates understand the system to gain access to EIP and disability documents to ensure that the educational needs of these juveniles are being addressed. I would like to thank Michael Bien and his family for their support through the Jane Kahn ‘77 Undergraduate Research Fellowship. I am very honored to be the recipient.

PRESENTING 1:15-1:45 PM EDT

Alexandra Cao '21



Faculty Mentor: Stephen Van Hooser

Paired feed-forward excitation with delayed inhibition allows high frequency computations across brain regions

The transmission of high-frequency temporal information across brain regions is critical to perception, but the mechanisms underlying such transmission remain unclear. Long-range projection patterns across brain areas are often comprised of paired feedforward excitation followed closely by delayed inhibition, including the thalamic triad synapse, thalamic projections to cortex, and projections within hippocampus. Previous studies have shown that these joint projections produce a shortened period of depolarization, sharpening the timing window over which the postsynaptic neuron can fire. Using computational models of neural circuits, we extend these findings by showing that pairing excitatory inputs with delayed inhibition can facilitate the transmission of high-frequency computations, even at temporal frequencies that are highly filtered by neuronal membranes. By examining circuits modeled after low-convergence retinogeniculate projections and high-convergence projections to cortex, we show that paired excitation and delayed inhibition can account for area-dependent differences in the limits of high frequency transmission throughout the brain. Further, these projections can coordinate computations across multiple brain areas, even amid ongoing local activity. We suggest that paired feedforward excitation and inhibition provides a hybrid signal – carrying both information about input value and a clock-like trigger – to allow circuits to rapidly respond to input, regardless of when it arrives.

Alden Sanford '21

Faculty Mentor: Donald Katz

Impact of Nicotine Exposure on Taste-Based Decision Making

Nicotine is commonly thought to be an appetite suppressant, but mechanisms that might potentially underlie this anecdotal effect have received little study. It is possible that nicotine might simply reduce thirst, which would thereby alter consumption behavior. Alternatively, nicotine might directly alter taste perception, causing a change in food-directed decision making. We decided to test these hypotheses in rodents by looking at changes in consumption and lick microstructure in a brief-access task (BAT), offering tastants varying in quality and hedonics to rats recently given single acute doses of nicotine or saline via subcutaneous injection. Results from this study indicated that nicotine reduced consumption of all presented solutions, except for water. The reduction in consumption increased as palatability of the solution decreased. We then tested if chronic exposure to nicotine would alter this reduction

and exposed rats to 4 injections of nicotine and recorded BAT data on the 4th day. This data revealed that the global reduction in consumption was maintained in the chronically exposed group indicating that this reduction is a product of nicotine itself, not just the novel state. This work suggests multiple mechanisms for the appetite-suppressing nature of nicotine.

Lauren Komer '21

Faculty Mentor: Dmitry Troyanovsky

Lulu

In 1895, German expressionist playwright Frank Wedekind wrote the tragedy of Lulu, a woman who has historically been portrayed as either an irredeemable monster or a helpless victim. This adaptation of Wedekind's work is inspired by the first of the two Lulu plays, Erdgeist (Earth Spirit). Since its inception, directors have struggled to contend with and fully express the complexities of Lulu's contradictory natures on stage. Taking the form of an interactive video performance, this project fearlessly (and literally) looks internalized misogyny in the face and delves into the dark and stunning expanse of Lulu's mind and soul/s. The project seeks to reimagine womanhood, to recreate a version of Lulu which escapes the bounds of Wedekind's limited definitions.

Is it possible for women to ever rid themselves of internalized misogyny? Or is it so ingrained into our beings that it will forever and always be an aspect of our identities?

The discussion will also be centered around the methodology of auteur directing and the process of creating provocative, accessible, and engaging online theatre.

Audience members are able to view the entire performance piece at https://www.luluxoxo.art

Content Warnings include references to sex, self-harm, death, gun violence, blood, and mental illness.

Aishwarya Khanna '21

Faculty Mentor: Cindy Thomas

Patient-centered Approaches to Combining Lung Cancer Prevention Efforts in Clinical Practice

Lung cancer is the leading cause of cancer death among men and women in the United States. Smoking cessation is a health behavior that can prevent death and disease, particularly lung cancer, and have a direct impact on reducing its incidence rate in the United States. Large scale public health campaigns have been effective at reducing overall smoking rates in the United States. However, more work can be done at an individual level to reduce lung cancer incidence by encouraging smoking cessation. The National Screening Lung Trial found that lung cancer screening (LCS) with low-dose computed tomography (LDCT) reduced lung cancer mortality by 20% in high risk individuals that include those with a history of tobacco use. Annual screening

combined with smoking cessation further reduced mortality among participants. Stakeholder organizations, such as the Centers for Medicare and Medicaid released unprecedented policy that required a documented encounter of shared decision-making using a decision aid and tobacco counseling during LCS deliberation for provider reimbursement. Despite these endorsements, tobacco cessation counseling is not routinely occurring alongside LCS deliberation. This study aimed to examine tools patient and provider-facing materials for tobacco cessation and LCS to identify areas where the two prevention strategies may be integrated and identify areas where patient-centered improvement measures can be implemented. The results of this study have implications for creating future LCS and tobacco cessation guidelines and new health behavior promotion materials in order to effectively combine two lung cancer prevention strategies and reduce the incidence of lung cancer.

Ilana Stein ‘22

Faculty Mentor: Sara Shostak

Embodied Experiences of Coping During the Pandemic

A leading explanation for racial inequalities in health, the John Henryism hypothesis describes a personality disposition to engage with high effort coping in response to social and economic challenges and distress (James,1994). My senior thesis project uses in-depth interviews with a diverse sample of college students to explore their lived experiences of situations in which they have felt challenged, constrained, and/or supported. Furthermore, the interview guide poses questions about experiences of COVID-19, as it aims to investigate how the pandemic has affected students at this historic moment. The interview concludes with the 12-item John Henryism Scale of Active Coping, which will allow an evaluation of whether students with high vs. low John Henryism offer different narratives of their experiences. This research project will be among the first qualitative assessments of the John Henryism Hypothesis, particularly focused on the emerging adult. As well, it is an important first step in understanding psychosocial responses to the pandemic among college students. My research will foreground individual narratives that will help contextualize circumstances deemed to be a determinant of health. When the project is completed (December 2021), it should inform interventions to support students and buffer them from the harmful effects of high effort coping in unequal environments.

Max Weinstein ‘21


Faculty Mentor: William Flesch

The Transcendental Skepticism of Percy Shelley

My project is on the poetry and thought of Percy Shelley and I'd like to show that Shelley is a far more consistent, nuanced, and insightful thinker than he is often given credit for. I particularly focus on Shelley's treatment of the infinite, perfection, the sublime and the transcendental. All

of these are related for Shelley, and most readers tend to view his work as either optimistically exclaiming their virtue, or despairingly lamenting their unattainability, depending on the poem they choose. What I argue is that Shelley almost never presents a one-sided discussion of this issue, and is constantly skeptical of "solutions." The most amazing part of Shelley's formulation of the problem is that for him the infinite was graspable, attainable, and accessible on earth, but this could not prevent him from turning to despair; the problems of life, and death, and love do not vanish even at the most sublime moments. This was an agonizing problem that Shelley dealt with over and over in manner after manner until his premature death, leaving behind the unfinished pessimistic masterpiece The Triumph of Life, which again postulates the real-life infinite, but only as a prophecy of endless despair.

My methods involve direct analysis of Shelley's poetry, specifically from the longer poems, as well as an analysis of a broad variety of Romantic scholars and critics since the 50's who appreciate Shelley's power and skepticism, and offer deep insight into his own materials and influences.

Yonatan Zur '21

Faculty Mentor: Susan Lovett

Recruitment of YoaA in DNA damage response pathways in Escherichia coli

DNA damage is ubiquitous to all cells. When left unrepaired, it can impede polymerization during the DNA replication process. Damaged DNA causes the formation of single-strand DNA (ssDNA) gaps that form double-stranded breaks if they are not repaired. Therefore, repair mechanisms are essential to maintaining the genomic integrity of the cell. Helicases, which are essential to the repair process, are responsible for unwinding double-stranded DNA to open up the damaged DNA for repair proteins. In Escherichia coli (E. coli), YoaA is a newly characterized putative 5'-3' helicase believed to have a role in DNA repair. It is thought to associate with the DNA Polymerase III complex when the polymerase encounters damaged DNA it cannot replicate. YoaA is believed to unwind the damaged DNA, allowing for easy access by repair proteins. Expression of YoaA has been shown to promote resistance to DNA damage by 3'azidothymidine (AZT), a chain terminator that causes the formation of single strand DNA gaps. My objective was to determine whether YoaA is involved in different types of DNA damage and whether it is active during the homologous recombination repair process. I performed survival assays to determine the impact of YoaA on R-loop induced damage and damage induced by acidic conditions. I also utilized a lac duplication reporter system to investigate whether YoaA is involved in homologous recombination. While the assays showed that YoaA is not involved in these pathways, they broadened the understanding of this newly discovered gene and its role in DNA repair.

Priya Iyengar ‘21
Co-authors: Mara Rue and Natasha Baas-Thomas

Faculty Mentor: Eve Marder

“Blessed Are the Flexible, for Change Is Inevitable”: Characterizing the Localization of Modulators in Cancer borealis Cardiac Ganglion to Understand Circuit Flexibility

The heart contractions in the Cancer borealis, commonly known as the Jonah crab, are driven by nine neurons that make up the cardiac ganglion (CG). The CG contains five large motor neurons and four small pacemaker neurons that fire synchronously to produce a spontaneous, patterned motor output that is stable yet flexible in its response to perturbations. Recent immunostaining of the CG in our lab revealed synapses clustered around the neuron cell bodies, which implicates the soma as a key site of synaptic integration and is unexpected in invertebrates like the Jonah crab. Understanding the organization of these chemical synapses and where relevant neuromodulators act to affect the output and respond to perturbations are key to elucidate the underlying mechanisms responsible for the circuit’s flexibility. In this study, we characterized the location of several inhibitory and excitatory modulators in the CG through double-label immunohistochemistry. Inhibitory modulators GABA and AST-B showed a nearly complete colocalization with chemical synapses of the large cells. In contrast, the excitatory modulator proctolin was minimally overlayed with the chemical synapses of the large cells. This suggests that excitatory neuromodulators might not directly release onto large cell somata synaptic sites to provide excitatory input to the circuit. Future directions involve characterizing more excitatory modulators as well as quantitative analyses of overlapping localizations.

Jessica Lu ‘21
Co-authors: Kelsey Clements, Yunpeng Zhang, Nannan Chen, and Leslie Griffith

Faculty Mentor: Leslie Griffith

Mutations at CaMKII Threonine Autophosphorylation Sites on *Drosophila melanogaster* Affect Sleep Behavior and CaMKII Expression Levels

CaMKII has been suggested to play a significant role in both memory and sleep behavior. There are three highly conserved threonine where autophosphorylation of CaMKII occurs: Threonine 287, 306, and 307. In my experiments, *Drosophila melanogaster* will be used as a model organism. I will ask if the mutation of these phosphorylation sites affects CaMKII expression and sleep behavior in *Drosophila melanogaster*. Using CRISPR/Cas9 technology, Attp-3P3-RFP-Attp flies were created which replaced regulatory coding regions

with a visible marker. Recombination-competent plasmid clones with mutated threonine sites at locations in the endogenous CaMKII locus were created. The mutant plasmids were injected into Attp-3P3-RFP-Attp flies to create the new transgenic mutant flies: T287T, T287A, T3067S, T287A/T3067S. Flies were screened by loss of visible marker and gene mutation verified by sequencing. CaMKII is expressed in high density around the mushroom body. To determine the CaMKII protein expression in the adult brain, dissection was performed, and the results show that only the triple mutant (T287A/T3067S) had a decrease in CaMKII expression in the mushroom body. Next, to observe the sleep pattern of mutant flies, DAM activity monitor sleep analysis revealed that triple mutant (T287A/T3067S) flies have altered sleep patterns during the light periods. Female flies had decreased total sleep and fragmented sleep, while male flies only had fragmented sleep. The results demonstrate that there may be a correlation between mutations T297A/T3067S in the threonine autophosphorylation sites and altered sleep patterns.

Jason Frank ‘22

Faculty Mentor: Brian Horton

Fairies and Funnies: Gay men in Standup Comedy

Though the past two decades have had a groundswell of queer representation, standup comedy has not yet seen a gay male star in the same way that film, music, and theatre have. The intention of “Fairies and Funnies” was to create a historical account of gay male standup comics with the goal of understanding their particular challenges and successes. I watched and listened to hours of content (both primary sources and retrospective), beginning in the ‘70s and coming up through the modern-day in an attempt to understand both the moments of success and the setbacks that gay men experienced in this time. I learned that despite an audience for the gay male comic style existing, shown by the love of comedians like Paul Lynde and Charles Nelson Reilly in the ‘70s, the AIDS crisis created a mediascape in which the only acceptable way to be a gay man was to tell your story through the lens of tragedy. Media hyperfocused on the process of either “coming out” or dying, in an attempt to make the gay male story legible for straight audiences, and that focus stood in opposition to standup comedy’s roots in observational storytelling, which requires the audience to sympathize not with a story but with a point of view. Though this project was brief, it is important, as we develop more gay male presence in the comedy world, to acknowledge the history that allowed this possibility.

Luana Lima ‘21

Faculty Mentor: Shantanu Jadhav

Coordination of prefrontal-hippocampal networks for associative memory and decision making

The hippocampus (HPC) and prefrontal cortex (PFC) are known to have vital functions in memory and decision making. The hippocampus is essential for memory encoding, consolidation, and retrieval, and the PFC is critical for long term memory and decision making. Together, these two regions form a network that enables decisions to be made on the basis of the retrieval of memories and past experiences. The overall aim of our research is to investigate the physiological mechanisms that underlie memory-guided decision making by using rodent models. In particular, this research project focuses on the role of PFC and HPC in olfactory associative memory. It is not known how these regions are involved in the retrieval of odor place associations, or whether they are necessary for accurate decisions in these tasks. We have used electrophysiological methods to record spiking activity in rats to establish that both networks are active and correlated with memory retrieval in an odor-place association task. Additionally, we have used optogenetic methods to interrupt PFC activity and observed impaired performance in the task. We have hypothesized that performance will decrease when PFC activity is inhibited at specific coordination times with HPC activity, indicating that the PFC-HPC coordination is important for accurate decisions in the odor place association task. We aim to confirm this hypothesis, and examine physiological effects of prefrontal inactivation in the hippocampal-prefrontal network during behavior.

Erin Magill ‘22, Ruth Rosenblum ‘22, and Keren Ruditsky ‘21
Co-authors: Irina Dubinina, Alex Lưu, and Sophia Malamud

Faculty Mentor: Sophia Malamud

Creating a Corpus of Child Speech by Monolingual and Bilingual Russian Speakers

The purpose of the BiRCh project is to build a million-word corpus (language database), consisting of speech transcripts aligned with audio, of Russian spoken by monolingual and bilingual children and their families in spontaneous interactions. A team of research assistants, including us (Erin Magill, Ruth Rosenblum, and Keren Ruditsky), has been working on annotating the transcripts for speech disfluencies, parts of speech, and other grammatical information, as well as syntactic structure of utterances. The project uses audio recordings of natural language speech collected from families with children of age 11-69 months in Russia and Ukraine, Germany, and the US and Canada. So far, we have 1 million words transcribed and partially annotated. As the building stage of the corpus is nearing completion, we have started using the corpus data to research the acquisition of requests, case and gender agreement, and passive constructions. We expect to observe different patterns of Russian language acquisition

in the various countries, since the Russian speech of bilingual children is likely to be influenced, among other factors, by their simultaneous acquisition of a second language. This work is novel in that it is a first attempt at creating a corpus of spontaneous Russian monolingual and bilingual child speech. It opens opportunities for research both on language acquisition and theoretical linguistics, including follow-up studies on existing work. Outside of linguistics, research on bilingual language acquisition can help improve language education, as well as play a role in destigmatizing immigrant speech.

Nathan Weber '21

Faculty Mentor: Alexandre Bisson

Stressing Cells Out: Exploring the Haloarchaeon Haloferax mediterranei's Honeycomb-like Response to Phosphate-deprived Conditions

The formation of cytoplasmic organelles within prokaryotes is a matter of controversy among cell biologists as it reveals layers of complexity in microorganisms that were not long ago believed to lack complex internal organization. This controversy was furthered by analyses revealing that archaea are more genetically similar to eukaryotes than their prokaryotic companions bacteria, revealing a tree of life with one branch for bacteria and another for eukaryotes and archaea. In this study, we investigated the molecular origins of a previous observation of possible organelle-like structures- intracellular honeycomb patterns visible by staining nucleic acids in phosphate-deprived cells of the haloarchaea *Haloferax mediterranei*. By deleting the genes responsible for polyhydroxyalkanoate (PHA) synthesis, we discovered that these Zones of DNA Exclusion (ZDEs) were PHA granules, which "crowded out" DNA from certain areas of the cytoplasm due to their hydrophobicity. To study the spatio-temporal cytoplasmic reorganization as a consequence of PHA granule formation, we adapted a suite of reagents and techniques in order to label PHA granules in living cells under the microscope. Our work establishes a framework for future research into dynamics of PHAs and their associated proteins in living haloarchaea.

Miranda Gavitt '21

Faculty Mentor: Tijana Ivanovic

Reovirus outercoat degradation: a model for cathepsin activity in endosomes

Ebola virus (EBOV) membrane fusion accompanying cell entry is difficult to study *in vitro* due to the numerous cellular factors required. EBOV enters the host cell via the endocytic pathway. pH-dependent cathepsins in the late endosome cleave the viral fusion glycoprotein (GP) to prime the virus for interaction with other cellular factors and ultimately fusion with the endosomal membrane. Studying EBOV membrane fusion in purified endosomes would provide an authentic context for the needed cellular factors. To do so requires isolated functional endosomes.

Mammalian orthoreovirus (reovirus), a small nonpathogenic virus, relies on the same cathepsins to prime the particle for endosomal escape. Cathepsins degrade a viral protein σ3, activating the membrane penetration protein μ1. Failure to degrade reovirus σ3 or EBOV GP aborts either infection.

This project aimed to use reovirus to probe the function of cathepsins in live cells and in purified endosomes as a reporter of endosome activity. Disrupted endosomes cannot regulate their pH, making pH-dependent cathepsin activity a good indicator of intact endosomes. Towards this, virus particles have been designed to site-specially label reovirus outer coat protein, σ3. Additionally, cells have been engineered to stably express GFP-tagged endosomal markers for later isolation. Tracking of σ3 degradation in live cells via both anti-σ3 antibody staining and FRET-pair labeled particles has provided the basis for tracking σ3 degradation in isolated endosomes that will indicate that cathepsins are active and endosomes are intact. Isolation of functional endosomes containing unprocessed virus particles will form a basis for future EBOV endosome assays.

Laura Grunenkovaite '22
Co-authors: Alison Philbrook and Piali Sengupta

Faculty Mentor: Piali Sengupta

Characterization of a temperature sensitive mutation in a *C. elegans* kinesin motor protein

Cilia are built by the process of IFT (intraflagellar transport), which traffics proteins in and out of the growing cilium using kinesin and dynein motors. Disruption in cilia morphology can lead to diseases such as renal disease, retinal dystrophy and anosmia. To acutely disrupt cilia morphology and examine the effects on sensory responses, we engineered a conserved temperature-sensitive mutation in a kinesin motor protein (kinesin-*ts*) based on literature from *Chlamydomonas* and characterized this mutant in *C. elegans.* First, we quantified the time course of IFT disruption in kinesin-*ts* mutants. We found that after a 1-hour shift from 20 to 27°C, IFT in kinesin-*ts* mutants is not completely stopped. However, after a 45-minute shift to the non-permissive temperature of 30°C, we found that kinesin-*ts* mutants stop IFT completely but resume IFT after a period of recovery. Next, we investigated how the kinesin-*ts* allele affects cilia morphology. Temperature shifts to both 27°C and 30°C severely truncate cilia in kinesin-*ts* mutants. We characterized the time course of this truncation and show that after a 3-hour recovery period, cilia are able to regenerate. Lastly, we investigated how the localization of signaling proteins is affected by cilia truncation and acute IFT disruption. Overall, our engineered kinesin-*ts* allele acutely truncates cilia and halts IFT when shifted to a non-permissive temperature; however, after recovery, IFT resumes, and cilia regenerate. This work allows us to examine the consequences of disrupted

IFT or morphology on sensory responses. Additionally, future experiments will investigate the mechanisms that drive this cilia regeneration.

PRESENTING 1:30-2:00 PM EDT

Sophie Trachtenberg ‘21

Faculty Mentors: Wendy Cadge and Sara Shostak

Moral Injury and Providing Care During the COVID-19 Pandemic: A Qualitative Study of Nurses and Respiratory Therapists in the United States

The COVID-19 pandemic has placed extraordinary stress on frontline healthcare providers—particularly nurses and respiratory therapists— as they encountered significant challenges and risks while caring for patients at the bedside during this time. The purpose of this research was to explore their experiences, as related to changes in staffing models, observations regarding health equity, and strategies for providing additional support. This study took a qualitative approach to explore nurses and respiratory therapists’ experiences providing direct care to COVID-19 patients during the first surge of the COVID-19 pandemic at a quaternary care institution located in Boston, Massachusetts, USA. Twenty semi-structured interviews were conducted with sixteen nurses and four respiratory therapists via Zoom or by telephone. Interviews were transcribed verbatim, identifiers were removed, and data was then coded and analyzed thematically. Five major themes were extracted: a fear of the unknown, concerns about infection, feeling professionally unprepared or inadequate, isolation and alienation inside and outside of the hospital, and inescapable stress and distress. Our analysis links these themes to the concept of moral injury and provides insight into possible interventions and resources needed to help support the physical and mental well-being of frontline healthcare providers before, during, and after times of crisis.

Chelsea (Chengrui) Wu ‘22

Faculty Mentor: Hannah Snyder

THE MEDIATING EFFECTS OF STRESS ON EXECUTIVE FUNCTIONING AND INTERNALIZING DISORDER DURING COVID-19

With the introduction of many new stressors caused by COVID-19, there has been an increasing prevalence in internalizing psychopathology (depression and anxiety) in the US population. However, not everyone who is in the same stressful context (i.e., COVID-19) experiences and perceives stress equally. Recent research has suggested that executive functioning (EF) may play a role. Specifically, poor EF may contribute to stress generation and perception of stressors as uncontrollable, which may lead to the development of internalizing psychopathology. Therefore, the current study aimed to examine how EF is associated with depression and anxiety symptoms, and the potential mediating effects of stress frequency and perceived controllability during the COVID-19 pandemic. We hypothesized that better EF would act as a

protective factor against internalizing psychopathology by reducing the frequency of dependent stressors and increasing perceived control over dependent stressors.

154 undergraduates were recruited via online advertisements for an 8-week longitudinal study (April to June, 2020). All procedures were approved by the Brandies IRB. For the current research, self-report questionnaire data were collected at the first (T1), middle (T2) and final (T3) time-points, on stressful life events (ALEQ-R), executive functioning (BDEFS), and symptoms of anxiety (PROMIS Level-2 Anxiety) and depression (PROMIS Level-2 Depression).

Analyses shows that higher EF predicted higher perceived control and lower stress frequency. Higher stress frequency also predicted higher depression. Therefore, mediating effect of stress frequency on the link between EF and depression is supported. Everything else is insignificant, matching the previous research.

Christine Le '23

Faculty Mentor: Guillermina Ramirez-San Juan

Prey Recognition in the Didinium-Paramecium Predatory Relationship

Ciliates are free living unicellular organisms that are covered by thousands of hair-like structures known as cilia. Cilia beat to generate flows necessary to carry out essential life activities such as swimming and feeding. While ciliates have no nervous system they execute complex behaviors such as hunting and escaping. Our research looks to understand how flows generated by cilia enable cells to recognize their prey or predator. Furthermore, we aim to understand the precise roles of motile cilia during hunting activities. This will provide us insight on how cell behavior can arise from only geometry and patterning of motile cilia. A custom-made imaging system was used to track and record cells swimming in various circumstances. The imaging system was supplemented by a well developed software to extract various descriptors of motion associated with particular behaviors for analysis. Through elucidating the dynamics of the ciliates, the precise characteristics associated with diverse swimming patterns will be identified. We expect there to be a significant difference in the motion descriptors associated with the hunting/hunted and resting behaviors of both ciliates. Through the study of the swimming patterns, we can expand the understanding of how the ciliates detect their prey or their predator. To build on the idea of how ciliates recognize their prey or predator, a "cell obstacle course" can be constructed to create a controlled and constrained cell environment.

Katie Ferguson '22
Co-author: Michael Sennett

Faculty Mentor: Douglas Theobald

Analysis of the Evolution of PETase Proteins

This project aimed to elucidate the evolution of proteins that are able to break down PET plastic (PETases). Several amino acid sites were identified in the sequence of the most specific PETase protein which are likely to be important for this ability. Phylogenetic trees were created using Bayesian statistics to show the evolutionary history of PETase proteins. Several models were created and compared. They were used to analyze the rate of change of specific amino acid sites. Some sites had very high or low rates of change, and some had rates that were significantly different in the PETase clade compared to the rest of the tree. Sites which showed high purifying or diversifying selection were identified based on how their rate of change varied between clades of the tree, with special attention paid to amino acids near the active site or binding site as those may have a greater impact on activity. The identified sites may help determine the mechanism of PETase and show what aspects are most important for its stability and ability to break down PET. The data and analysis produced by this project is guiding current research attempts to create a more active or more thermostable protein capable of PETase activity.

Patrick Li '21

Faculty Mentor: Judith Herzfeld

LEWIS Subatomistic Force Field: Development and Performance of New Potential Forms

LEWIS is a force field based on semiclassical modeling of valence electron pairs: valence electron pairs and kernels (comprising nuclei with their core electrons) are treated as independently mobile particles that influence each other according to interactions that reflect the underlying wave properties of the electrons. The wave properties of electrons include antisymmetry which results in exchange contributions to the interactions between electron pairs. The present work considers different forms for the exchange contributions. Several sets of literature data are developed as training data for testing these different functional forms. Three generations of potential functions with adjustable parameters were derived and parameters were partially optimized by Differential Evolution. For a given set of parameters and a specific potential function, we used the Monte Carlo method with the Metropolis algorithm at 100 K, to find the lowest energy configuration of each species. Then we compared calculated geometries and energies with their literature values to analyze the performance of LEWIS. The results identify the feature of the exchange energies that is essential for describing barriers in bond torsion, specifically that the curvature of the exchange energy at interatomic

distances needs to be negative so that electron pairs at either end of a bond prefer an eclipsed conformation.

Julia Apiki ‘21
Co-authors: Avital Rodal, Cassandra Blanchette, Amy Scalera, Erica Dresselhaus, Mónica Quiñones Frías, Rylie Walsh, Agata Becalska, Matthew Zunitch, Berith Isaac, ShiYu Wang, Tania Lemos, So Min Lee, Kate Koles, Andrea Guerrero, and Sultana Bhuiyan

Faculty Mentor: Avital Rodal

Extracellular Vesicle Cargo Traffic and Function at Synapses is Regulated by Endocytic Machinery

Studying the complex and highly interconnected membrane trafficking pathways in neurons is necessary to understand their role in pathological as well as physiological processes. Our lab uses the Drosophila neuromuscular junction (NMJ) as a model to understand more about these processes and how they are regulated in the nervous system. My thesis is specifically focused on the trafficking and contents of extracellular vesicles (EVs), which are membrane bound vesicles that are released from cells to traffic cargoes with roles in intercellular communication and pathology. Recent work from our lab identified a new role for endocytic machinery in regulating the levels and function of EV cargoes at synapses, including amyloid precursor protein (APP) which is a key player in Alzheimer’s Disease, and Synaptotagmin 4 (Syt4), which has important physiological roles at the synapse. We found that getting rid of nwk, an endocytic protein, reduced the toxic impact of APP in the nervous system. We also characterized the Drosophila L1CAM adhesion molecule homolog Neuroglian (Nrg) as a novel neuronal EV cargo and found that it is regulated similarly to known EV cargoes by endocytic machinery like nwk and by manipulation of the recycling endosome GTPase Rab11. Nrg was also found to decrease levels of known EV cargo Syt4 at the NMJ pre and postsynaptically. These results help to elucidate the complex mechanisms of membrane traffic and characterize key EV cargoes at the NMJ.

Isaac Rose-Berman ‘22

Faculty Mentor: Lucy Goodhart

Levels of Importance: What Tweets, Google Searches and Polling can tell us about the Issues Voters Prioritize

When citizens decide who to vote for, their choices are a distillation of their beliefs and the importance of those beliefs. Knowing what policy or other preferences someone has alone doesn't tell you how they will vote; you also need to know what they prioritize. While changing peoples’ beliefs can be difficult, changing the salience of those existing beliefs is less hard. For

decades, political scientists have studied this ""agenda setting,"" to try to understand how politicians and the media can manipulate the issues citizens care about with the intention of changing how they vote. The Internet and social media have provided various new tools to study this phenomena. While prior researchers were often restricted to polling, making their analyses susceptible to the flaws that come with it, Google searches provide unparalleled and accurate insights into what people are thinking. Twitter, meanwhile, offers a uniquely massive and detailed database of what politicians and voters are saying publicly. (While not everyone is on Twitter, essentially every politician is.) This project uses both of those sources, combined with in depth polling, in an effort to discern the real relationship between what politicians say and the salience of different issues in the minds of voters.

Tess Kowalski '21
Co-author: Susannah Adel

Faculty Mentor: Suzanne Paradis

The developmental role of class 4 Semaphorin ligands and Plexin-B receptors in mammalian hippocampal inhibitory synapse formation

The Paradis lab is interested in studying critical synaptic molecules to uncover the specific mechanisms which regulate our synapses. There are two types of synapses in our brains; excitatory synapse which increases activity in downstream neurons, and inhibitory synapses which suppress activity in down stream neurons. Understanding how our synapses develop is vital to research which aims to understand neurological disorders such as Epilepsy, Schizophrenia, and Autism spectrum disorders. These disorders can be caused through changes in synapse formation or neuronal circuit formation. Thus, it is important to characterize the critical molecules which regulate synapse formation in hopes to make possible therapeutics or signaling models for these disorders. My experiments study two important molecular families, the Semaphorin class 4 ligands and their Plexin-B transmembrane receptors. Both of these molecules have been shown in previous studies to play an important role in axon guidance as well as synapse formation. My research showed how the Plexin-B receptors (Plexin-B1 and Plexin-B2) work in separate ways to regulate inhibitory synapse formation in the mammalian hippocampus. My research also showed the requirement of the ligand Sema4A during inhibitory synapse formation in the CA1 region of the hippocampus. Building a signaling model for these two molecular families will be critical for future research on treatments for specifically epileptic disorders.

Gabi Burkholz ‘21

Faculty Mentor: Darren Zinner

Outbreak Prevention and Response Methods at Overnight Summer Camps Before and During the COVID-19 Era

Outbreak readiness is an important aspect of summer camp operations, especially for residential summer camps where everyone is living together in a confined area. If a camp is not prepared for an outbreak of any kind, it can be incredibly dangerous for campers and staff alike. Many camps across the United States have plans in place to combat illnesses such as widespread fever, influenza, and the common cold. In the wake of the global COVID-19 pandemic, many camps closed their doors for summer 2020 in the interest of public health, and attempted to recreate the essence of camp in a virtual setting, as well as gauge the future operations and sustainability of their businesses with the long term outcomes of the pandemic still unknown. Overnight summer camps are now reimagining every aspect of their programming and operations in order to comply with state and federal COVID-19 guidelines, and are utilizing nonpharmaceutical interventions such as social distancing, cohorting, and quarantining protocols in order to protect their camp communities and prevent and mitigate COVID-19 outbreaks this summer. This study will compare the prevention and management outbreaks at residential summer camps in the United States via public health policy before and after the onset of the pandemic, as well as looking at the mental, emotional, and social benefits of residential summer camps, analyzing field-wide quantitative and qualitative data, and looking ahead to a historic summer 2021.

Leah Kunins ‘21
Co-author: Mara Rue

Faculty Mentor: Eve Marder

Effect of prolonged exposure to extreme pH on pyloric neurons of the crab Cancer borealis

Despite wide-ranging effects of pH on ion channels and chemical processes, the pyloric rhythm of the stomatogastric ganglion (STG) of Cancer borealis is robust to changes in saline pH. However, previous studies have primarily focused on short-term effects of pH changes over fifteen minutes. To better understand how pyloric neurons respond to saline pH changes, we investigated their response and recovery from single and multiple applications of low pH over the span of thirty minutes to an hour. The STG was dissected from a crab and the pyloric rhythm was recorded extracellularly; in some cases pyloric neurons were recorded intracellularly. After thirty minutes baseline at physiological pH 7.8, we exposed the STG to pH 5.5 for either thirty minutes or an hour followed by an hour wash (pH 7.8). We then exposed the STG to two additional thirty minute cycles of low pH followed by wash to observe if the pyloric rhythm could adapt to multiple perturbations. The pyloric rhythm was affected after ten

minutes and depolarized and crashed between twenty to thirty minutes in pH 5.5. Once the STG was back in pH 7.8, the system took an equal, if not longer time to recover and in some cases never returned to baseline activity. The stomatogastric nervous system exhibits a surprising delay in it's response and recovery from prolonged low pH exposure. Further studies will use intracellular recordings to determine the effects of pH on neuronal membrane potential, and if low pH can cause permanent damage to neurons.

Sabrina Chow '21

Faculty Mentor: Thuy Lam

Predictors of Mental Well-Being in Higher Education: An Exploratory Analysis of Brandeis University and 40 Institutions in the United States

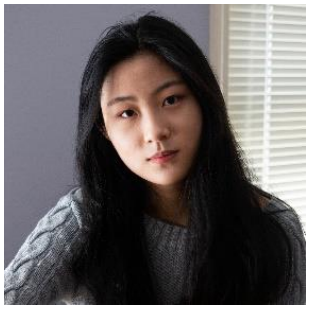
Background: College is an influential time period for young adults as they transition from adolescence to adulthood. Research looking at well-being has focused on adolescents and older adults, but not college-aged students. The purpose of this study is to identify predictors of mental well-being in undergraduate students at a midsized private university in the Northeast and at 40 institutions of higher education across the United States.

Materials & Methods: A cross-sectional web-based survey of undergraduate students was disseminated at Brandeis University and 40 higher education institutions across the United States. Data on well-being, mental health, and other aspects of college life was collected on predictors and assessors of mental well-being using the National College Health Assessment IIc. Multivariate linear regression models were used to determine significant predictors of mental well-being in both Brandeis and National college students.

Results: Sex and gender, sexual orientation, race, mental disorder diagnoses, exercising, and utilization of mental services on college campuses were primary predictors of mental well-being in undergraduate students.

Summary and Significance: This is the first known study that examines predictors of mental well-being in college students. These results demonstrate a need for improved mental health services on college campuses to address the growing mental health concerns of college students. Future studies should examine additional aspects of overall well-being in this understudied population.

Iria Wang ‘22
Co-authors: Todd Zenger, Maria Mironova, and Max Goblirsch



Faculty Mentor: Gabriella Sciolla

Simulation for the New Inner Tracker in the ATLAS Experiment at the Large Hadron Collider

In 2026, the Large Hadron Collider (LHC) will be upgraded to the High-Luminosity LHC, increasing the rate of high-energy proton-proton collisions at the surrounding experiments. The ATLAS experiment at the LHC will be upgraded with a new tracking detector, the Inner Tracker (ITk), to accommodate this. The ITk is the innermost detector in ATLAS and is composed of concentric cylindrical layers of silicon detectors: five layers of pixel detectors surrounded by four layers of strip detectors. To validate the new design of the ITk and quantify its expected performance, a detailed simulation of the new detector needs to be created. The simulation is built with a C++ framework that allows for a simple description of the detector elements and its properties using flexible XML markup language. This allows us to simulate particles passing through sensors, providing a detailed estimation of the signals induced on readout electronics as well as the particles' interaction with the passive detector material. The strip detectors are already described in this framework, and before the simulation can be used in the mainstream ATLAS software release the framework must be extended to include the full detector. The geometry of the pixel detectors has been virtually constructed through the XML description, and is currently being integrated into the main simulation framework.

Jake Haveles ‘21

Faculty Mentor: Amy Singer

Landing as Levantine: Armenian, Greek, and Syrian Migration to Greater Boston Area

Focusing specifically on Christian communities from the Ottoman Empire and its former territories – primarily Armenians, Greeks, and Syrians – my research captures fragments of these migrants’ early lives in the Greater Boston Area in a short, but incredibly important timespan from 1900 to 1911. Boston and its nearby mill and factory towns were second only to New York as the primary destination for these migrants. While the numbers of these migrants paled in comparison to those coming from “Europe,” they nevertheless were subjects of great fascination and inquiry for the cities, towns, and employers that received them. In this early period, migrants from the Ottoman Empire – described in some instances as haphazardly “European” and in most others “Oriental” or “Asiatic” – would have particular importance in how white citizenship came to be legally defined in the United States in the early 20th century. Whereas the limited research that exists on Near Eastern migrants has predominately focused on discrete ethnic or national groups, often in comparison to the experiences of more formally

"European" migrants, mine differs insomuch as it looked at these communities in relationship to each other and how they were externally narrated as a collective. Using a wide array of digitized archives – including over 2,000 newspaper articles, the 41-volume Dillingham Commission reports, hundreds of naturalization documents, immigrant business handbooks, popular literature, and a number of other miscellaneous sources – I was able to gain significant insights into these migrants' lives and how they were perceived by the Bostonians that encountered them.

Ellie Tang Kleiman '21

Faculty Mentor: Yuri Doolan

The Cultural is Political: Institutional Memory and Asian American and Pacific Islander Communities at Brandeis University

Building upon the foundational work already being done around preserving people of color histories and the Brandeis BLK Archives Project in particular, this project aims to bring to light the history of Asian American and Pacific Islander students and multiracial coalition-building at Brandeis University. Like the histories of all people of color at Brandeis, such a story has been largely excluded from conventional tellings of our institution's past. During summer 2020, I particularly focused on the Brandeis Third World Coalition's takeover of Pearlman Hall in 1975 by conducting archival research and oral history interviews with Asian American alumni. I published a zine and article on the Black Space Portal that recount the takeover and events leading up to it in detail. Currently, I am continuing alumni oral history interviews, researching the online newspaper archive, and revisiting the Brandeis Archives & Special Collections in order to create an expansive digital timeline that covers the history of AAPI students and student activism from 1971 to the present day. The timeline will be published on the Black Space Portal in May, in collaboration with Brandeis Archives staff. I argue that this research reveals patterns of racism and marginalization in the university's history alongside visionary acts of solidarity and activism among Asian American and BIPOC students, which can provide valuable lessons and inspiration for student organizers today.

Ilana (Kai) Blumen '21

Faculty Mentor: Sebastian Kadener

The impact of overexpression/knockdown of TDP-43 and Cabeza on circular RNAs in D. melanogaster

Abstract available upon request

Caroline O ‘22

Faculty Mentor: Rosalind Kabhrel

Podcasting and Theater as Juvenile Diversion

This project recognizes that the need for diversionary and recreational programs exists for those who are in the juvenile justice system. The arts is becoming an increasingly recognized part of restorative justice for juvenile offenders, restorative justice being the newer system of justice that focuses more so on the rehabilitation of offenders between themselves and the communities. As this research focuses on juveniles, we find that rehabilitation is a more appropriate approach than a punitive one. This restorative justice takes form in many ways, one of them being the arts. Although the idea of using the arts such as creative writing, music, and theater have been since criticized for their effects on successfully diverting juvenile offenders, this research finds that emphasizing creative storytelling and theater as a productive means of helping juveniles from committing or returning to said crime. This research has since discovered that the arts, and more particularly, storytelling and creative writing, helps juveniles not only develop more introspection on their actions, but also helps heal from past traumas that might have influenced their paths. The arts compels them to reclaim some individuality, develop more responsibility, and proves overall central to offender accountability. Using this research, the goals of this work is to create a program in which juveniles can attain a better future through the relatively newer form of creative podcasting.

PRESENTING 1:45-2:15 PM EDT

Amy Ollove ‘21

Faculty Mentor: Adrianne Krstansky

Foolish Sanity

Foolish Sanity is a theatrical film piece that combines scenes and monologues from various classical and modern plays into the format of a comedy sketch show. Through these pieces, Foolish Sanity explores what happens when the Fool is given the dimensions and humanity they are so often denied due to others perceiving them as seemingly, ‘mad’. The archetype of the Fool represents a necessary function of theater itself; to tell truths, especially of social injustices. The Fool is known to: break the “4th wall” of the theatrical stage space and speak directly to the audience, tell truths others neglect to hear, utilize comedy as a way to connect with others, hold a label of mental illness or disability, often through terms like ‘insane’, ‘mad’, or ‘crazy.’ You will find that in Foolish Sanity there are instances where the Fool is unable to reach the audience directly or refrains from humor. We urge you to question whether this is of the Fool’s own volition or if it is due to the oppression placed upon them by society, perhaps not only because of their label of disability but also for being a woman in a male dominated society. Why is the truth-telling, comedic relief archetype of the Fool often deemed mentally ill and how does this label permit and inhibit them? Content Warnings: This piece contains themes of mental illness, suicide, and sexual harassment.

Jonathan Sochaczevski ‘22
Co-author: Chazz Yeargans

Ball Talk with Jon Soch - The Golden Triangle

Throughout the last six months, I have been analyzing most major American sports with an extreme focus on the NBA, in that time I have discovered a “formula” on how to win an NBA championship that I have dubbed the Golden Triangle. The Golden Triangle, the guide to winning an NBA championship by the Ball Talk podcast. The Golden Triangle is a revolutionary idea in the NBA that has without fail always produced a championship, and dictates how every NBA general manager should be building their teams to win championships. Many teams are constructed with major flaws in their roster, these teams may consider themselves title contenders but they are not, due to the lack of one major piece. To find the Golden Triangle I looked through the composition of teams to make the NBA playoffs since the 2015 playoffs, a major rule change was passed that season so looking before then would not be useful. Through my analysis I found that every team to make the conference finals and win one

(1) game in that round featured a three level player and a hybrid post player, I also found that every team that featured a hybrid guard, dual forward, and hybrid post player won the championship without any exceptions.With these findings team will be able to better build winning teams and players will have a better idea of what skills they need to develop to be a championship level player in the NBA.

Anna Ginsburg ‘21

Faculty Mentor: Sheida Solemani

The Natural World and the Personal World: An Exploration in Painting

I am using the medium of painting to explore the themes of human's relationships to the natural environment. Although this is a broad topic, I chose to focus on cultural mythologies and how they shape our view of nature. My interest in exploring my own multiethnic heritage comes from a lifelong journey of learning to construct my own identity from the various cultures of my family. I have used the lens of my own heritage as a mixed-race person exploring East Asian and Southeast Asian worldview and myths in combination with other ways of knowing. The environment is often viewed through the secular lens of science, and I would like to complicate and explore this view by incorporating subjective, personal aspects. I also hope to follow ideas of ecological ways of knowing — that is, understanding the word as a vast ecosystem rather than separate parts — and interconnectedness of ourselves, our societies and land on which we live. I want to try and think about ways of portraying the natural world beyond landscape paintings, and move into understanding nature as a symbol or person in and of itself. I have used primarily oil paints as I have been working with them for the past five years and I would like to continue my exploration of the material.

Julian Ho ‘21

Faculty Mentor: Pito Salas

MicroDB - Highly Available Data Store for Service-Oriented Architecture

MicroDB is a distributed data store for providing highly available, isolated data access to existing R-DBMS or other data stores designed for a service-oriented architecture. We describe the motivation behind MicroDB, the design and implementation of its access and replication layers, and how it can aid in tackling challenges associated with migrating to a fully service-oriented architecture from a monolithic architecture. Lastly, we will present experimental results and comparisons with existing solutions.

Most organizations' architecture has a very centralized approach in providing data access to different services. It can be in the form of a shared centralized relational database/database cluster, filled with inter-connected tables each containing data produced/consumed by different services. This design has the benefit of allowing easy queries on relational data across different tables by leveraging R-DBMS features. However, a major drawback is that as the organization grows, this architecture becomes quite difficult to scale, especially on a global scale.

To tackle the problems created by an organization's growth in demand, a different data access strategy is needed. MicroDB presents a scalable way to provide access to existing data stores with minimal changes in architecture/codebase. We demonstrate that MicroDB can provide better scalability and service reliability versus a traditional R-DBMS cluster in a service-oriented architecture.

Ziyi Guo '21
Co-author: Ryan Young

Faculty Mentor: Shantanu Jadhav

Communication Subspaces for Local Field Potential Defined Network States

Distributed neural circuits across multiple brain regions coordinate activity and communicate with each other to process information and adapt to an ever-changing environment/world. The hippocampus (HPC) and prefrontal cortex (PFC) are essential for learning and are thought to work in an integrated fashion to support cognition and memory-guided behavior. How networks of neurons across these regions dynamically communicate with each other to support learning and memory is still not entirely understood. Here, we establish low-dimensional dynamics of spiking activity during distinct hippocampal oscillation patterns such as theta and ripple oscillations, which correspond to broad behavioral states (e.g., movement) and distinct periods of inter- and intra-regional communication. We found the dimensionality of interaction to be differentially modulated by oscillatory activities of varying strengths. Remarkably, inter-areal HPC-PFC communication is significantly lower-dimensional than intra-areal HPC-HPC communication, implying that HPC-PFC interactions is driven by small subsets of neural populations. We further confirmed these communication subspaces to be specific to the ongoing oscillatory pattern, but with similar directionality and correlation with neural firing for all patterns, suggesting an optimized strategy for recruiting covarying cells during HPC-PFC communications. Linking the temporal dynamics of subspace components to behavioral variables revealed that learning can modulate the fluctuation of regional communication structures.

Karen Phuong ‘22

Faculty Mentor: Douglas Theobald

Molecular Phylogenetic Analysis of the SARS-CoV-2 Spike Protein Reveals the Virus’ Bat Origins

SARS-CoV-2 is a zoonotic betacoronavirus that causes COVID-19, an infectious, respiratory disease, and is believed to have originated in bats. Phylogenetic research published during the first 6 months of the COVID-19 pandemic on the SARS-CoV-2 spike protein, which is responsible for host cell binding and entry, suggested that the virus was transmitted to a series of intermediate hosts such as pangolins before infecting humans. We investigated SARS-CoV-2’s zoonotic origins using maximum likelihood phylogenies of the spike codon sequence with that of closely related betacoronavirus sequences. The spike codon phylogenies indicated that SARS-CoV-2 was most closely related to bat coronaviruses and did not pass through an intermediate host prior to human transmission. Maximum likelihood phylogenies of the genome, open reading frames, and other viral proteins such as the nucleocapsid also confirm this conclusion. Furthermore, we analyzed the mutational rates at each site of the SARS-CoV-2 spike protein and isolated 14 amino acid differences present in evolutionarily conserved regions of this viral protein between SARS-CoV-2 and the most closely related bat coronavirus. To understand the molecular changes that enabled viral transmission from bats to humans, future studies will look at these mutations and how they affect host cell binding and entry in vitro.

Haley Brown ‘22

Faculty Mentor: Daniel Breen

A Case for Secession: A Constitutional and Comparative Analysis

The word “secession” in the context of the United States has been unduly corrupted by the South’s 1860 attempt to splinter off, thus cementing an image of “secession” as inextricably tied to the institution of slavery in the collective American imagination. But secession is and has not been a practice exclusive to the American South nor to slavery apologists; rather, secession has historically been used as a tool to remedy political corruption, protect self-determination, and uphold democratic values. In our research, we seek to argue that secession is an American right through the use of three lenses: one legal, another historical, and, a third, comparative. For the legal lens, we work to deconstruct the arguments made by Justice Chase in the 1869 Supreme Court case of Texas v. White, which is commonly understood as having settled the question of secession’s legality once and for all. We also look to 19th-century treatise writers in their contemplations of secession. For the historical lens, we shed light on the lesser-known disunion movements in New England prior to the Civil War, which aimed to use secession as a tool rather

than a weapon. After laying the historical groundwork, we will turn to a comparative approach that looks at international secession movements as precedent. While our research is primarily theoretical in nature, we aim to construct an ideological framework that could be used in the future should the need arise.

Aaron Kalpakian '21

Faculty Mentor: Susan Birren

Satellite Glial Cells and their Impact on the Development of Sympathetic Neurons in Wildtype and Hypertensive Animals

The superior cervical ganglia (SCG) houses satellite glia which influence neuronal development and postganglionic neurons that innervate the heart. These cell types contribute to sympathetic drive, integrating neuronal activity from the CNS to innervate peripheral targets. There is evidence that these neurons contribute to the development of neurogenic hypertension, however, the contributions of satellite glia on this development are not well understood. By studying this relationship, our understanding of the sympathetic circuit can improve along with how it malfunctions in neurogenic hypertension. This project outlined the impacts that SGCs have on cultured postganglionic sympathetic neurons by quantifying their cholinergic synaptogenesis and calcium activity using both WKY and SHR strains. My results show that cultured SHR neurons have increased cholinergic synapses compared to WKY neurons; and that SGCs have different effects on synaptogenesis between strains. I then modified SGC activity using a DREADDs system to determine if increased SGC activity impacts neuronal development. My results show that there is increased synaptogenesis that moves towards significance; however, further research needs to be done due to low sample size. Lastly, I tested if this chronic SGC activation would impact baseline and nicotine-induced neuronal activity. Despite obtaining results, the sample size is too small to make conclusions. Overall, this project indicates that there are differences in neuron development in hypertensive models, with or without SGCs. Further research is needed to determine if chronic activation of these SGCs further impact synaptogenesis and neuronal activity along with their contribution to the development of neurogenic hypertension.

Daniel Hariyanto '23

Faculty Mentor: Benjamin Rogers

Strange phase separation behavior at high temperatures

In recent years, phase separation of proteins and nucleic acids into liquid droplets within cells has attracted tremendous interest from both biologists and physicists. These droplets are believed to play essential roles in the formation of membraneless organelles like the

nucleolus, Cajal bodies, and stress granules, and are increasingly implicated in neurodegenerative diseases like Alzheimer's and ALS. At the Rogers Lab, I employ nanostructures called DNA nanostars to study this behavior. These nanostars can nucleate into liquid droplets via complementary base pairing with other nanostars and mimic the multivalent interactions implicated in biomolecular condensates. Currently, it is widely believed that DNA nanostars tend to nucleate into liquid droplets at low temperatures and dissolve into a dispersed gaseous state above a certain transition temperature; this is the traditional phase behavior for many condensates in general. In my research, I found evidence showing that, under certain conditions, these nanostars can also phase separate at high temperatures in addition to phase separating at low temperatures. This strange reentrant phase behavior opposes the conventional wisdom of nanostar phase separation, indicating that phase behavior is much more complex than originally appreciated. In this ongoing research, I highlight the minimum conditions required to induce this reentrant phase behavior and am currently testing a hypothesis that will help shed light on some unknown driving forces behind phase separation, with important implications for aberrant function and material properties of biomolecular condensates.

Jay Collay '21

Faculty Mentor: Keridwen Luis

Unnatural Histories: Selected Themes in English-Language Queer Histories Before 1969

This study examines commonalities in English-language texts dealing with queer history before 1969. The goal of this research is to expand the field of queer historiography by understanding what stories and methodologies preceded more modern histories, and especially to understand what existed before the narrative of an upward arc from the flashpoint of the Stonewall Uprisings. Material surveyed includes magazines, poetry, sexology books, novels, diaries, pamphlets, newspaper articles, and academic papers in order to collect items that are often overlooked in timelines of queer politics and culture. These materials are brought into conversation with extant historiographical theory to understand how historiography and queer theory may benefit each other.

Evidence is grouped under three major themes: absence, gay lists, and mythology. Each subject chapter is expanded upon through examples of representational materials. Absence recognizes that queer history's lack of institutions and generational transmission repeatedly create silence and gaps over time, and examines how these silences may exist as sites of potential. The chapter on gay lists analyzes over time the phenomenon of creating lists of names of famous queer people as a manifestation of revisionist/reparative history. Mythology explores the deployment of legend and antiquity by queer voices for political and emotional purposes. The primary ideological focus of this study is historical exploration as an expression of desire.

Eric Blum ‘22

Faculty Mentor: Joel Christensen

Greek Particles: Creating a Learner-Friendly Database of Contemporary Scholarship

During my Schiff Fellowship, I have explored Greek epic from the perspective of linguistics, focusing on a particular class of words known as “particles.” The class of words consists mostly of adverbs and conjunctions, corresponding loosely to English words like “and,” “even,” “but,” and “however,” yet they encode a great deal of meaning. While there are few definitions which satisfy the nature of what a particle is, my own heuristic definition is “a word which, although short and quickly understood in the original language, is difficult to translate while retaining both brevity and complexity.” Appreciating how Greeks parsed particles is fundamental to understanding how the receivers and the creators of Greek texts understood their language.

My primary result has been a website, Particuliterate.com, which publishes entries for many of the most common and interesting particles in Homer. The website is oriented towards both intermediate language students and advanced researchers, providing concise and clear explanations supported by extensive bibliographies, as well as a glossary. I also wrote and presented a paper at an undergraduate conference. In this paper, I show that the particle pô does not have only one meaning, ‘not yet,’ but also a second, ‘in no way.’

After the end of my fellowship, I will continue my work with the website, writing more particle entries as well as brief essays concerning particles more generally as a class of words. Planned topics include methods of translation, syntactic versus pragmatic approaches, and the respective roles of the diachronic and synchronic.

Angela Self ‘22

Faculty Mentor: Wendy Cadge

Is Christianity in Decline in the United States?

Americans are increasingly unaffiliating themselves with Christianity. The purpose of this research project is to understand why this phenomenon is occurring among the youngest adult cohort of Americans, also known as “Generation Z'' aged 18 to 23. The participants in this study previously identified as “Christian” and now identify as “religiously unaffiliated”. Participants must also reside within the United States. I ask them about their past experiences in their religious communities and their current relationship with their religious identity or lack thereof.

The first phase of this research is a survey that seeks to understand past and present religious behavior, beliefs, and engagement with religious communities. The second phase consists of in-depth interviews with participants who have previously completed the survey. The interview portion focuses heavily on the experience of unaffiliating with Christianity and the reasons behind this decision. The current status of this research is ongoing, as I have been approved by

the Brandeis Institutional Review Board. Data collection will be conducted over the summer and into the fall of 2021. Preliminary data suggests that generational replacement and shifting cultural attitudes towards same-sex relationships have contributed significantly to the rise of the religiously unaffiliated. This study will help researchers better grasp why Americans are leaving Christianity behind.

Ethan Crouse '21

Faculty Mentor: Donald Katz

Individual Taste Preference Improves Palatability Decoding in Gustatory Cortex

An important task in the history of taste research has been to find representative measures of the relative palatability between tastants. Historically, individual tastant lick-counts during an active tastant delivery protocol have been used to establish relative palatability rank ordering. However, there is increasing evidence that consumption metrics other than gross lick-count, such as first bout-length, may better represent hedonic palatability in rats. In addition, in previous unpublished work by Katz lab, it's been shown that significant variability exists between animals in the activity of the gustatory cortex during the palatability encoding phase during taste experience. We hypothesized that differences in relative palatability preferences may be represented in this variability. Using lick-microstructure metrics gathered during a brief-access task, we established significant differences in palatability preference between rats and showed that the dynamic activity of neurons in GC during the palatability phase could be better correlated with individualized rank orders over general ones. In future palatability research, this analytical technique can be employed to allow for more discriminate analyses of palatability between individual rats, and may reveal characteristics of the taste response which were previously masked by the generalization of tastant preferences across animals.

Janis Li '21
Co-author: Mara Rue

Faculty Mentor: Eve Marder

Exploring the Effects of Neuromodulatory Input on the Crustacean Stomatogastric Ganglion's Adaptive Response High Levels of Extracellular Potassium

The crustacean stomatogastric ganglion (STG) is a relatively simple central pattern generator that produces two well-studied robust rhythmic motor patterns in the absence of sensory feedback. One of the patterns, the pyloric rhythm, is responsible for controlling the muscles along the pyloric region of the crab's stomach. Upstream neuromodulatory input from other ganglia support the pyloric rhythm by enhancing neuronal oscillations through an inward modulatory current (IMI). This modulation can be removed by a process called decentralization,

which blocks/severs the connecting nerves. Previous studies have tested the response of the STG's pyloric rhythm towards changes in ionic concentration, particularly 2.5x potassium concentration ([K+]) in its extracellular environment, which have led to the eventual crashing or silence of neural activity, followed by a gradual recovery.

We are interested in understanding the role of upper neuromodulatory input in the circuit's robustness and how its removal may affect how the pyloric rhythm adapts during repeated exposures to heightened levels of extracellular [K+].

Data provided by Mara Rue shows that repeatedly exposing the circuit to a 2.5x [K+] environment, through 20-30 minute superfusions, causes the rhythm to consecutively increase its rate of recovery and decrease its chances of crashing. However, experiments that are decentralized before the repeated exposures have shown that removing upstream neuromodulatory input decreases the rhythm's response recovery in 2.5x [K+], but does not eliminate the recovery altogether.

Avraham Lepsky '22

Faculty Mentor: Paul Miller

A Model for Overshadowing in Conditioned Taste Aversion

Conditioned taste aversion is a psychological phenomenon in which a subject develops a strong negative association with a certain taste because they felt sick or nauseous afterwards. It has been suggested that the formation of these associations in the brain is competitive, since a more recent taste stimulus can reduce the degree of aversion to a prior taste. We investigated whether a model based on competing units, representing distinct populations of neurons, could describe conditioned taste aversion and its key features. Our model was composed of two self-excitatory and cross-inhibitory units in a winner-takes-all circuit and an input stimulus applied equally to both units. We then added a series of intermittent stimuli to represent taste recall and a decay function to represent the decay in synaptic plasticity between the presentation of a taste and the arrival of nausea. Incorporating the decay in synaptic plasticity over time led to a bias in the formation of aversions towards the most recent taste stimulus without fully blocking the aversion to the oldest taste. Overall, the model is able to predict qualitative features of conditioned taste aversion. Further additions to the model will help reproduce experimental results by tuning the time at which each taste was presented to the degree of aversion.

Yuezhu Chen ‘22

Faculty Mentor: Yuri Doolan

The Russian Influence on Harbin Society in 1930-1976

This oral history research project aims at finding the influence of Russian / Soviet culture on Harbin society in 1920-1976 by interviewing Harbinians aged 48 to 96 years old. During the research, I materialized the word “influence” into three categories: architecture (housing), education, and food. By conducting the interviews, I used an ethnographic approach to explore the similarity and differences on the interviewees' personal experiences of Russian influence. From “Laomaozi” (Harbin dialect that refers to Russians), “Maozifang” (Russian Houses), to today’s “Lieba” (a kind of Russian bread that is now one of the special foods of Harbin), I tried to connect the pieces in the interviews and reappear Harbinians’ lives in the last century. By asking questions and recording their first-hand experiences and interactions with the Russian people and cultures, I documented how this foreign semi-colonization affected Harbin people’s lives, filling in the gap in the historiography of existing literatures in English which mainly focus on the political perspectives. At the same time, this research discovers how the changes in Sino-Soviet relations affected the lives of Harbin common people and local culture. The mixed identity of being a Russianized-Harbinian was also unveiled in the conversation with the interviewees, as well as my self-identity.

Sonia Presti ‘21
Co-author: Meghan Harris

Faculty Mentor: Michael Marr

The efficiency of cellular internal ribosome entry site mediated translation at non-AUG start codons

During cellular stress global translation is reduced through 4E-BPs and eIF2 phosphorylation, which inhibit cap-dependent translation and limit ternary complex formation respectively. Upregulation of cap-independent translation promotes synthesis of stress response proteins, which are often important for cell survival. Cap-independent translation is mediated by internal ribosome entry sites (IRES) which are secondary structures in 5’ untranslated regions (UTRs) of select mRNAs that directly recruit ribosomes. We suspect that during cap-independent translation eIF5B acts as an alternative ternary complex. Previous research revealed that eIF5B is a GTPase with similar structure to eIF2 and can bind initiator tRNAs with relaxed specificity. A former member of our lab showed that insulin receptor (INR) IRES and insulin-like-growth factor receptor (IGFR) IRES are resistant to eIF2 inhibition. Another member of our lab previously found that overexpressing eIF5B in mammalian cells increases cap-independent

translation mediated by INR and IGFR IRESs. In order to determine if eIF5B promotes IRES mediated translation of mRNAs by using non-AUG start codons, we performed in vivo dual luciferase assays to calculate the percentage of non-AUG IRES activity. Surprisingly we found that translation regulated by cap-dependent beta-globin (BG) UTR is more resistant to non-AUG start codons than INR and IGFR IRES mediated translation.

PRESENTING 2:00-2:30 PM EDT

Lucy Frenkel '21

Faculty Mentor: Raymond Knight

How Do Intrafamilial, Extrafamilial, and Mixed Offenders against Children Differ from each other and from Rapists?

Historically, intrafamilial child sex offenders have been seen as less in need of treatment, and needing shorter court sentences than extrafamilial child sex offenders. We assessed the validity of this using self-report and archival ratings. We addressed the problem of crossover offenders.

Participants were selected from de-identified cases who were incarcerated in Virginia, Minnesota and Massachusetts between 1994 and 1999 and who were administered the Multidimensional Assessment of Sex and Aggression. Ratings were also derived from their archival files. Variables assessed included: antisocial tendencies, atypical sexuality, interpersonal competence, education/salary achievement, offender attitudes and single-interest variables.

Our results indicated that whereas rapists differed from child sex offenders on every domain, there were no observed differences between intrafamilial and extrafamilial child sex offenders on antisocial tendencies, atypical sexuality, education/salary and offender attitudes. This did not align with a prior meta-analysis (Seto et al., 2015). Differences were found on individuals' male caregiver hostile control, age at first sexual offense, sexual orientation and interpersonal competence. These results were consistent with the prior meta-analysis. Detecting crossovers using both prior adjudicated and unadjudicated crimes did not change the results.

Although we found significant differences on several variables between intrafamilial and extrafamilial child sex offenders, these variables do not warrant the differential treatment of these individuals that currently exists in our legal system. Our results, however, like the previously conducted meta-analysis, indicate certain differences which might be critical for treatment.

Caroline Greaney ‘21

Faculty Mentor: John Plotz

Unearthing Traces of the 1918 Flu Pandemic in Tolkien's Middle-earth

Many scholars have argued that Tolkien’s war-related trauma emerged in various forms throughout his Middle-earth legendarium. However, few have considered how he used the process of “sub-creation,” or fantasy world-building, to process the 1918 flu pandemic that emerged just as World War I was ending and to illuminate contagion’s hidden violence in human society. This project compares Tolkien’s sub-creation to the experimental poetry and fiction of his modernist contemporaries, emphasizing that Tolkien was aligned with other writers of his time in exploring pandemics’ principal characteristics: their historical concealment beneath war narratives; their pervasive, miasmic form; and the omnipresent dread, madness, and despair they produce at both the individual and the collective level. Examples discussed include the devastating Great Plague hidden in Tolkien’s appendices to The Lord of the Rings, the "viral weaponry" employed by Sauron, and the madness of characters Húrin and Denethor. I ultimately conclude that Tolkien differed from his modernist contemporaries in that his ability to situate instances of illness and contagion within the vast history of a secondary world enabled him to more effectively capture pandemics’ subtle, yet extremely detrimental effects on societies over time. This conclusion points to fantasy literature’s unique role in highlighting and investigating pressing social, political, or biomedical issues that may not receive enough recognition.

Isaac Paddy ‘22

Faculty Mentor: Maria-Eirini Pandelia

Biochemical Characterization of SAMHD1 protein homologs, gives insight into nucleotide metabolism and chlorophyll biosynthesis

Human SAMHD1 is a metal-dependent hydrolase that plays a key role in HIV restriction, innate immunity, cancer, and the cell cycle by depleting cellular dNTP levels. Recently, SAMHD1 was proposed to be the molecule responsible for neurological complications associated with COVID-19. It is a sophisticated phosphohydrolase, for which however, the underlined molecular mechanisms are still not entirely understood. Recently, SAMHD1 homologs were identified in plants, in which mutations to the associated genes caused chloroplast deficiency, leaf discoloration and reduced grain yield as a result of impaired photosynthesis. The overall goal of the proposed study is to develop a hypothesis about the molecular mechanisms by which SAMHD1-like proteins in

plants abrogate chlorophyll biosynthesis and elucidate the unknown connection between nucleotide metabolism and photosynthesis. Two mutually dependent questions will be addressed as a way to assign function to these SAMHD1 homologs: a) the chemical nature of the active metal center, b) whether activity is allosterically driven, and c) the range of substrates it can act upon. Preliminary results indicate that SAMHD1-like homologs from *Rhizophagus Irregularis* and *Oryza sativa* are soluble and show key differences in sequence structure for allosteric activation. These findings set the stage for understanding the possible common mechanisms in humans and plants, which are now employed for potentially controlling nucleotide levels and chlorophyll biosynthesis in a manner that has not been previously thought.

Jocelyn Gould '21

Faculty Mentor: Jill Greenlee

A 'Pandemic Effect'? Women's Candidate Emergence Amid the COVID-19 Crisis

Socially and economically, the COVID-19 pandemic wreaked havoc on women's lives, but it is less clear whether the crisis also harmed the advancement of women's political candidacies. In this senior thesis, I address the question: Did the COVID-19 pandemic negatively impact the rate of women running for state-level office in the 2020 elections? I use the variation in filing deadlines for primary candidates across state legislatures to attempt to isolate the impact of the pandemic on women's candidate emergence. I create an original dataset of major party candidates for state house seats in 2018 and 2020 in six focus states and compare the proportion of candidates who are women in states with filing deadlines months before and after the pandemic hit the United States. My statistical analysis finds no evidence that the pandemic decreased women's interest in running for office in 2020. I find that the onset of the pandemic is not associated with any significant change in the proportion of candidates who are women and is positively associated with an increase in the geographic spread of women candidates across individual districts. These findings suggest that once women have decided that they could see themselves running for office, their political ambition is resilient even to major social and economic disruptions. Future research into the causes of the patterns I observe could uncover important information about how to support and encourage more women to run for office, even once the pandemic ends.

Tamar Moss ‘21

Faculty Mentor: Richard Schroeder

Reducing Heat Exposure in Phoenix: A Proposal for School-Based Cooling Centers

Temperatures vary across cities due to the urban heat island effect (UHI). Higher temperatures increase risks of heat-related illnesses and death, and disproportionately impact socioeconomically vulnerable populations. In my thesis, I explain what UHI is, how it is formed, who it most impacts, and how it can be mitigated. I focus on Maricopa County, Arizona, because of the area’s especially high temperatures and large vulnerable population. I describe the socio-spatial pattern of UHI, provide historic context for why vulnerable groups are disproportionately exposed to high temperatures there, and summarize existing heat mitigation initiatives in the county.

One heat mitigation initiative is a network of public air-conditioned cooling centers. To increase accessibility of cooling centers to vulnerable populations, I examined the possibility of using local elementary schools as public cooling centers during summer months. Using a GIS-based optimization approach, I prioritized schools for cooling center establishment. I used Landsat satellite imagery to locate the hottest parts of Phoenix, and data from the U.S. Census Bureau to generate a socioeconomic vulnerability index. To create a heat risk index, I reclassified and combined temperature and vulnerability scores. I calculated the number of highly vulnerable people within a 15-minute walk of each school. I prioritized schools for cooling center establishment based on the number of highly vulnerable people each could serve. Results from this project could inform the siting of new cooling centers, so to best address heat injustices and provide a source of respite where it is needed most.

Kacy Ninteau ‘21

Faculty Mentor: Christine Bishop

Palliative Care in Nursing Homes During the COVID-19 PHE

COVID-19, the disease caused by the novel coronavirus SARS-CoV-2, has a devastating impact on older adults, especially those who live in nursing home facilities. Palliative care, a medical specialty which addresses suffering induced by serious illness, is a potentially powerful tool for managing the devastating effects of COVID-19 in this population. Yet, the crisis amplified existing barriers to palliative care in nursing homes, as well as created novel barriers to this type of care. This study reports the results of exploratory, qualitative interviews with six Directors of Nursing (DONs) in Massachusetts nursing home facilities. Overall, we found that facilitators of palliative care include knowledge diffusion from outside providers, in-house staff certified in palliative care/hospice, and high-quality advance care planning conversations. We

also report that many residents signed do-not-hospitalize orders and opted to receive in-house palliative care rather than being hospitalized for symptoms of COVID-19 or other serious illnesses during this crisis. Finally, a lack of personal staff knowledge around palliative care, a lack of PPE, insufficient guidelines from regulatory agencies, facility lockdowns, and patient isolation acted as barriers to palliative care during this time. Future work should focus on improving in-house staff's ability to deliver palliative care without relying on outside providers. This will likely decrease the time residents wait to receive palliative care, lower hospitalization rates, and make in-house staff more prepared for future crises which require facility lockdowns.

Rachel Sussman '21
Co-authors: Mercedes Villalonga and Hannah Snyder

Faculty Mentor: Robert Sekuler

Feeling Rushed? The Impacts of Perceived Time Pressure, Stress, Affect, and Test Anxiety on Executive Functioning

Executive functioning (EF) shapes how we navigate everyday life and approach difficult tasks. Therefore, it is important to understand the factors that benefit or disrupt EF. One such factor is time pressure, the sense of having insufficient time to perform an action. Studies show that time limits reliably impair EF. However, little is known about how the perception of time pressure (PTP) alone, in the absence of real time limits, impacts cognitive processes like EF. Using a Flanker task to index the EF inhibition, I induced PTP by manipulating the duration of inter-trial intervals (ITIs) across the experiment. Specifically, I shortened ITIs to increase PTP and lengthened ITIs to decrease PTP. I found that PTP strongly impacted task performance, with increasing PTP fomenting distress and impairing performance effectiveness, performance efficiency, and inhibitory control. Decreasing PTP reversed these effects. In conflict with the Attentional Control Theory (Eysenck et al. 2007), baseline test anxiety did not affect performance effectiveness or performance efficiency. Multiple regression analyses revealed that the shared aspects of stress and negative affect predicted changes in inhibition following increasing, but not decreasing, PTP. These findings validate the use of PTP to promote distress and show that EF is sensitive to changes in PTP.

Kate Danziger '22

Faculty Mentor: Colleen Hitchcock

Environment Massachusetts Spring Internship

During this spring semester, I interned for Environment Massachusetts, a nonprofit organization that works to protect the places that all of us love and promote core environmental values, such as clean air to breathe, clean water to drink, and clean energy to power our lives. To accomplish social change, they focus on timely, targeted action that wins tangible improvements in the quality of our environment and our lives.

As an intern, I focused my efforts on the 100% Renewable campaign, a campaign to convince Massachusetts campuses, cities, and state leaders to commit to 100% renewable energy. I spent much of my time working to get Massachusetts legislators to cosponsor the 100% Clean Act (HD.3551, SD.2205), an act that will transition Massachusetts to 100 percent clean electricity by 2035 and 100 percent clean heating and transportation by 2045. I made phone calls and sent emails to Massachusetts Representatives and Senators, met with a number of Representatives and legislative aides, phone banked to members of Environment Massachusetts for grassroots support, wrote and submitted letters to editors and an op-ed, and conducted research on solar energy, legislators, and Boston mayoral candidates.

This opportunity has been extremely meaningful, and I am grateful to have had the opportunity to work for Environment Massachusetts campaigning for a cause that I care deeply about.

Alex Rich '21

Faculty Mentor: Anne Berry

Age-Related Variability in Reward Based Learning and Memory

Dopamine has been shown to play an important role in reward-based learning and memory. Aging is accompanied by changes in the dopamine system. However, there is a lack of research tying together the changes seen in the dopamine system that comes with age, and the resulting impacts on reward-based learning and memory. We hypothesized that older subjects would show a reduction in both reward-based learning and memory when compared to younger subjects. We also hypothesized that poor performance in older adults would be accounted for by alterations in dopamine function. We used a novel task, the Real-estate Selling Task, which measured both probabilistic reward learning and incidental memory encoding for houses associated with monetary losses, gains and neutral outcomes. The subjects also had separate PET scans to evaluate dopamine synthesis capacity using the tracer [18F]Fluoro-l-m-tyrosine. After analysis of the real-estate task, we found that older adults showed reduced reward learning compared to younger adults. From the memory portion, we found that older adults showed a bias for memory of rewarded houses and young adults show a bias for punished houses. This finding contradicts our hypothesis, however, may be linked to the positivity effect seen in aging. In respect to dopamine synthesis capacity, we found individual differences in reward-based learning was correlated with dopamine synthesis capacity in the ventral striatum. These findings provide insight into the relationship between dopamine's role in healthy aging adults.

Shinji Rho ‘21

Faculty Mentor: Jeff Gelles

Investigation into cooperative DNA binding by the Gal4-VP16 transcription factor

Gal4-VP16 is an artificial transcription activator with a Gal4 DNA binding domain and a VP16 activation domain, helpful in studying eukaryotic transcription mechanism due to its high transcriptional potency. While numerous papers have shown that Gal4-VP16 has a synergistic effect on transcriptional response when multiple binding sites are present on target DNA, its mechanism of synergy has not been well established. I investigated whether Gal4-VP16 dimer binds cooperatively in vitro, since cooperative binding mechanism may contribute to transcriptional synergy. I expressed and fluorescently labeled a tagged Gal4-VP16 construct designed to have minimal effect on protein function. I then conducted single-molecule experiments with fluorescently labeled Gal4-VP16 to observe activators binding to target DNA molecules with five binding sites. During the experiment, fluorescently labeled Gal4-VP16 bound specifically to its binding site. In addition, experimental traces of activator fluorescence at individual DNA locations qualitatively agreed with numerical simulation results that modeled independent binding, assuming all activators bound exclusively as dimers. This observation suggests that the synergy does not arise from cooperative Gal4-VP16 dimer binding, but instead occurs later in the transcription process. Future quantitative analyses will require optimization of single-molecule experimental conditions and may offer a deeper insight into the activator binding mechanism.

Madeleine Cahn ‘21

Faculty Mentor: Caitlin Gillespie

Achilles=Loves Patroclus: Isopsephisms on P. Oxy. XLV.3239 as Cultural Contact in Greco-Roman Egypt

One ancient Greek number system assigns a distinct value (one of 1, 2, ..., 9, 10, 20, ..., 90, 100, 200, ..., 900) to each letter of the alphabet. Its users made riddles and poems based on equivalences—called isopsephisms—between words or phrases whose letter values add up to the same number. My project analyzes P. Oxy. XLV.3239, a three-column, fragmentary, Greek papyrus from 2nd century CE Oxyrhynchus, Egypt, identified as a list of isopsephisms. Scholars have studied this papyrus only to understand the individual isopsephisms, with occasional references to a sympotic context. My critical edition features a translation and notes about specific issues within the text and three interpretive essays contextualizing the papyrus in its time and place and within modern scholarship, showing that

1. Non-literary sources (school exercises, economic records, etc.) like this papyrus provide a window into unedited daily life, if only of the literate elite, and free scholars from the demands of studying literature, allowing them to focus on the details of the texts.

2. The alphanumerical and riddling aspects of isopsephisms in general and the format of this list in particular suggest a long history of Greco-Egyptian cultural exchange.

3. The isopsephisms' content reveals many aspects of elite daily life in Oxyrhynchus under the Roman Empire, from cows to wine to myth, and suggests, but does not prove, the document's use in a symposium.

In the end, my project proves that the intersection of classics and math is much more than Roman numerals.

Samuel Smith '21

Faculty Mentor: Paul Miller

Analysis of Attractor Basins in Finite Size Networks of Randomly Connected Firing-Rate Units

Attractor networks evolve to stable states of activity called attractor states. It is becoming increasingly clear that networks that beave in this manor are relevant to understanding neural networks. Firing-rate models were used to analyze global properties of these networks. Previous results showed that in random networks of non-bistable, firing rate units the number of states contained in a network is dependent on the matrix properties and the cross-connection strengths. This project builds on that result by analyzing the entire attractor landscape of these networks and analyze how the attractor basins are distributed. In these networks the entropy reaches a peak after the peak in the number of states. In addition, at low cross-connection strengths networks tend to be dominated by one or a small number of states. However, as the cross-connection strengths increase the distribution of basin sizes can be approximated as a power law. A similar result was seen for networks that obeyed a small world architecture rather than being entirely random. However, despite their much-decreased total number of states these networks displayed comparable entropy to those obeying a strictly random architecture. Implying that these networks have much more evenly distributed attractor basins than random networks, though the same pattern of networks with low cross-connections being dominated by a small number of states persists..

Logan Shanks '24

Faculty Mentor: Amber Spry

The School To Prison Pipeline: The Intersection of Social Identities

In Polling the American Public, I used STATA to explore how race influences attitudes towards in-school suspension. I hypothesized that Black and Brown people have negative attitudes

towards in-school suspension, because their subject-position makes them vulnerable to gendered racialized violence by the state. The results overall supported the idea that that race does not have a statistically significant influence on attitudes towards in-school suspension; therefore, the null hypothesis that there is no relationship between race and attitudes towards in-school suspension can be accepted based on the regression analysis. While people of all races held similar opinions about in-school suspension, the bar graph revealed racial minority variables (Black, Asian, Hispanic) experience race discrimination and all race variables (Black, Asian, Hispanic, White) experience gender discrimination. This allows us to infer from the bar graph and regression survey results that minorities do face discrimination because of their identity in spheres of hegemonic influence, such as the American classroom. This leads us to question why attitudes were not strongly negative towards in-school suspension if minorities are aware of the disadvantages they face in society because of their marginalized identity. There is a lack of awareness about how mass incarceration is directly fueled by the systematic pushout of minority students from the classroom, hence in-school suspension. It is imperative to reimagine a world that is more inclusive and transgress against policies that negatively affect the lives of all people.

Stephanie Brody ‘21

Faculty Mentor: Bruce Goode

Mechanistic Dissection of Bud14 regulation of Yeast Cell Morphology

Cell polarization allows cells to orient their growth and movement and is integral to cell and tissue morphogenesis in diverse biological contexts. A well characterized model of cell polarization is the budding yeast Saccharomyces cerevisiae. These single-celled fungi undergo polarized growth, which requires directed delivery of biosynthetic components and organelles from the mother cell to the growing daughter cell, or bud. For more than 20-years we have known that a polarized actin cable network directs secretion to allow polarized growth in budding yeast, and yet many of the crucial details of the underlying mechanism behind formation of this polarized actin network have remained unclear. In this work, I have addressed this question and uncovered new functions for the yeast-specific protein, Bud14, in directing polarized cell growth. Bud14 was previously identified as a regulatory subunit of the yeast Protein Phosphatase 1 (PP1/Glc7), and then as a binding partner of Bnr1, one of the two yeast formins (a family of actin-assembly proteins) that assemble the actin cable network. I introduced targeted mutations in the BUD14 coding sequence to specifically disrupt sequences involved in its direct interactions with the formin Bnr1 and the phosphatase Glc7. Using this approach, I have found that Bud14-Glc7 interactions are required for regulating cell morphology, whereas Bud14-Bnr1 interactions are not. Furthermore, I identify a new role for Bud14 in controlling the localization and dynamics of the second yeast formin, Bni1, and show that there is a correlation between hyperaccumulation of Bni1 at the cell tip and an elongated cell morphology.

Pamela Vargas De Los Santos '21

Faculty Mentor: Rebecca Gieseking

Benchmarking DFT Functionals for Coinage Metal Nanoclusters

Recently the coinage metal clusters have become of great interest due to their numerous applications as catalysis in electrochemistry, biochemistry, and sensing technology. Particularly copper clusters have been shown to act as catalyst for the hydrogenation of CO2 to methanol. Gold nanoclusters have numerous therapeutic medicines, bioimaging and sensing, antimicrobial, tumor targeting and cancer treatment applications. The highly selective nature of Ag clusters shows great promise as a substitute for conventional probes and sensors. DFT presents an inexpensive avenue for the study of metal nanoclusters, however, a comprehensive analysis of the DFT functionals performance for the coinage metals has yet to be established. Thus, this paper benchmarks the accuracy of an array of hybrid meta general gradient approximation (GGA), hybrid GGA, meta GGA, GGA, and local-density approximation for predicting optimized geometry and relative binding energies. Doing so by establishing unique high-level reference data from set CCSD(T) optimizations that can be used to benchmark the coinage metal clusters a long wide range of charges and sizes against an array of DFT functionals and MP2 method. The reference data set from complete-basis set extrapolation (CBS) of CCSD(T) established from the large-scale optimization at the CCSD(T) level, supplemented by CCSD(T) SPE calculations using BP86 and PBE optimized geometries.

PRESENTING 2:15-2:45 PM EDT

Renata Leighton ‘21

Faculty Mentor: Cameron Anderson

Boundless: Devising Theatre from Life

Boundless is a senior thesis project for the Department of Theater Arts that focuses on devising original work from real life in a collaborative setting.

As performing artists, we learn from the start that our bodies are our instruments, but what happens when our relationship to ourself falls out of tune? Both a memoir and a call to action, Boundless reflects on the complex experience of developing body dysmorphia as a performer, while interrogating the role artists play in perpetuating toxic narratives about which bodies are valuable and which ones are not. Tackling issues from body representation onstage to body shaming offstage, movement, text and theatrical art installation depict a journey from pain to healing. Devised from the real lives of an ensemble of artists, Boundless explores both the struggles and joys of learning to love one’s body in its most raw, vulnerable and real form.

This project also focuses on the process of creation and how we can reimagine the hierarchy of theatre making and root our work in consent, connection and community. Traditional theatre spaces have a history of dangerous power dynamics, consent violation and an emphasis on product over process. Boundless aims to discover what is possible when we create together outside of those bounds.

Feng Chen ’21 and Hangyu Du ‘21
Co-author: Pengyu Hong

Faculty Mentor: Hongfu Liu

Network-based Virus-Host Interaction Prediction with Application to SARS-CoV-2

COVID-19, caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), has quickly become a global health crisis since the first report of infection in December of 2019. However, the infection spectrum of SARS-CoV-2 and its comprehensive protein-level interactions with hosts remain unclear. There is a massive amount of under-utilized data and knowledge about RNA viruses highly relevant to SARS-CoV-2 and proteins of their hosts. More in-depth and more comprehensive analyses of that knowledge and data can shed new insight into the molecular mechanisms underlying the COVID-19 pandemic and reveal potential risks. In this work, we constructed a multi-layer virus-host interaction network to incorporate these data and knowledge. We developed a machine learning-based method to predict virus-host interactions at both protein and organism levels. Our approach revealed five potential infection targets of SARS-CoV-2 and 19 highly possible interactions between SARS-CoV-2 proteins and

human proteins in the innate immune pathway. The performance of IMSP was also better compared with the other five baseline models. Given a new virus, IMSP can utilize existing knowledge and data about other highly relevant viruses to predict multi-scale interactions between the new virus and potential hosts. In this way, IMSP could facilitate and give directions to the virus researches. The pre-proof version of this work is now available at https://doi.org/10.1016/j.patter.2021.100242.

Vishni Samaraweera '23

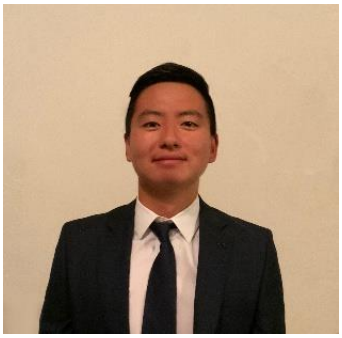
Faculty Mentor: Margaret Morganroth Gullette

"Finding the Missing Voices" in the Nursing Home Eldercide

All throughout the traumatic Covid-19 pandemic, few TV or newspaper reporters have been interviewing nursing home residents and documenting their stories, despite the thousands of stories on nursing homes appearing in the media. Nursing home residents have been suffering from eldercide, a public health crisis plaguing this country in which elderly residents have died, according to WSRC Scholar, Dr. Margaret Morganroth Gullette, my Partner, due to negligence and poor conditions/care. I am working on a chapter titled "Finding the Missing Voices" in Dr. Gullette's work-in-progress, "American Eldercide".

My role has been to find the voices that have been neglected. I have been reading news sources and documenting those that directly quote residents. The data I have been collecting is matching the predicted hypothesis that very few (about 1%), residents were being interviewed and quoted throughout the pandemic. Instead, spouses and adult children of nursing home residents have been more frequently interviewed and have shared both moving and sorrowful experiences that highlight the devastation their loved ones have faced in the past year. Collecting firsthand quotes and stories from nursing home residents has helped to humanize and characterize them in the greater story of eldercide that has occurred during Covid-19. Regardless of elderly populations' age, (or race, gender, cognitive or physical ability) their stories and experiences are essential to this historic story.

Chase Chen '21



Faculty Mentor: Lizbeth Hedstrom

The Role of E3 Ubiquitin Ligases in mTOR Regulation

The mechanistic target of rapamycin (mTOR) pathway is the master regulator of cell growth and proliferation. mTOR is a serine/threonine kinase that forms two distinct protein complexes in mammals, mTOR complex 1 (mTORC1) and mTOR complex 2

(mTORC2). Hyperactivation of mTORC1 is seen in obesity, diabetes, certain cancers, and neurodegenerative diseases, making mTORC1 inhibition a promising strategy for treating these diseases. Our laboratory recently discovered a novel small molecule mTORC1 inhibitor, CB3A. Preliminary results suggest that CB3A action requires TSC2, the main negative regulator of mTORC1, and also increases ubiquitination of TSC2. Here I investigate the role of candidate ubiquitin E3 ligases in TSC2 ubiquitination. I identify a candidate E3 ligase that associates with TSC2 in a CB3A-dependent manner. These findings suggest a possible model for the mechanism of CB3A-induced inhibition of mTORC1.

Lydia Harris '21
Co-author: Robert Jarrett

Faculty Mentor: Robert Steneck

Lobster Sheltering Behavior with Low Oxygen Environments

The aim of this research was to test whether lobsters in the Gulf of Maine are shifting their sheltering behavior due to an invasive algae, Dasysiphonia japonica, possibly lowering the oxygen levels in coastal boulder shelters. This study included a lab experiment aimed to replicate field conditions, and a field study to determine whether the inside of boulder shelters had lower oxygen levels than their surroundings. In the lab, an experimental tank was set up with two PVC shelters, each connected to a separate inflow tank containing either ambient or low oxygen water. For each trial, a single lobster was placed in the experimental tank and filmed for at least 100 minutes to determine whether lobsters would actively avoid a lower oxygen shelter environment. The results from this experiment were inconclusive; low oxygen did not appear to have a significant effect on lobster sheltering behavior. For the field study, oxygen probes were placed on the inside and outside of a boulder shelter for 2 days. Another probe was used manually to measure oxygen levels inside and outside of 10 shelters. On average, the inside of shelters had 0.84 mg/L less oxygen than the outside, and oxygen levels decreased during nighttime hours. Even though shelter oxygen levels were lower, it's unclear whether the observed habitat shift is due to this low oxygen environment. Future research will focus on the physical and chemical properties of the invasive algae to see if these influence boulder shelter avoidance in lobsters.

Lillian Xue '21
Co-author: Jihyun Choi

Faculty Mentor: James Haber

Dmc1-mediated Break-Induced Replication and Mismatch Repair in Meiotic Budding Yeast

During the repair of a double-stranded chromosome break, an essential step of homologous recombination is searching for homologous DNA sequences and invading the target to close the break. In meiosis, recombination depends on a meiosis-specific recombinase Dmc1, and employs the mitotic recombinase Rad51 as an accessory factor. Properties of these recombinases have been characterized in vitro, but their cellular strategies working along with relevant mismatch repair proteins remained unexplored in meiosis. In budding yeast, we analyzed break-induced replication (BIR) events in a meiosis context, in which the invading stand and its donor template share a 108 bp region of homology, and the donors carry increasing densities of evenly spaced mismatches. We found that the divergent donor substrates reduced BIR events more in meiosis mediated by Dmc1 compared to the same event in diploid and haploid mitosis. We also noticed that the rates of mismatch assimilation into the BIR repair product were consistently lower in meiosis. Homozygous knockout of mismatch repair protein Msh2 in strains with mismatches elevated the repair rate by nine-fold, but the trend of mismatch correction was almost the same as the wild type. Nearly all mismatch correction in meiosis depends on the proofreading activity of DNA polymerase Polδ and independent from Msh2. Collectively, we propose that Msh2 is rewired from correcting single-nucleotide mismatches to promoting heteroduplex rejection during meiosis to counterbalance the higher mismatch tolerance of Dmc1 when forming the D-loop. Our findings also provide insights into how non-allelic recombination might be limited in gametogenesis.

David Qi '22
Co-author: Ben Ballintyn

Faculty Mentor: Paul Miller

The Development of Methods of Testing the Effectiveness of Hidden Markov Models

A Hidden Markov Model (HMM) uses several activity states with properties that are initially unknown to describe the behavior of a memoryless system via a set of observable events that have fixed emission probabilities of occurring in each state while the system switches between the states based on constant transition probabilities. It has applications in modeling virtually any system with observable output that can be used to iteratively determine these probabilities. HMMs, however, require exponentially greater computational resources when starting from observation sequences with higher numbers of possible events per time bin, such

as action potentials in neuronal networks, and thus require proportionately greater amounts of input data to be removed. The Miller Lab has recently developed an HMM algorithm that can help to resolve these issues, and thus tests were conducted to determine when the new algorithm is better able to reproduce the model parameters used to simulate a given observation sequence compared to older algorithms. Our preliminary analyses have found that the HMMs produced generally needed less than 100 iterations to attain local maxima with respect to the log-likelihoods of the spike trains given model parameters, although the results have not shown any clear differences in accuracy with respect to emission or transition probabilities across the two algorithms given that neither sets of predicted probabilities come within two standard errors of the actual probabilities across iterations. Further research in this field would help to better elucidate the properties of HMMs and optimize them for working with complex systems.

Ben Helzner ‘23

Faculty Mentor: Kate Moran

Between Persons and Community

The possibility of moral responsibility in a determined world has long been an open philosophical question. Research for this project was based on familiarization with the literature and analysis of the prevailing incompatibilist (the impossibility of moral responsibility in a determined universe) and compatibilist (the possibility of such a thing) theories. In arguing for a compatibilist view of moral responsibility, this paper moves beyond the current theories while synthesizing their most promising aspects. This paper points out both the deficiencies of prevailing theories and how such a synthesis buttresses the central claim of compatibilism: that it is not a metaphysical ability to do otherwise, but instead some psychological aspect of certain beings (persons) which makes them morally responsible.

Personhood necessitates a community of persons which (1) have some fundamental common ground, (2) can act under principle, (3) have concern for the veracity of principles within their community, and (4) have some level of accurate introspection. Under such a relationship, there are two ways of discussing action: principled and meaningful reasons. Principled reasons appeal to values and ideas— they justify action. Meaningful reasons refer to mechanisms and causal explanations — they explain action. Meaningful reasons can make an action comprehensible — not justifiable. Meaningful reasons have their use, but only principled reasons can tell us the moral worth of an action. Resting moral responsibility upon this relationship does not degrade it — if anything, it should make us more appreciative of the connection with and care we have for one another.

Luochen Liu ‘22

Faculty Mentor: Amy Lee

Investigation of ribosome-specialized translation of vesicular stomatitis virus using rpL40-binding nanobody

All viruses must use the host protein synthesis machinery to translate their mRNAs. Enigmatically, viral infection induces host protein synthesis shutdown to evade the host immune response and direct the translation machinery to preferentially engage viral mRNAs. Thus, it is critical to understand how viral mRNAs utilize specialized translation pathways in order to engage the cellular ribosome. To further understand viral translation regulation, I study a negative-sense RNA virus prototype known as vesicular stomatitis virus (VSV). Previous work in the lab has shown that the translation of many negative sense viral RNAs, including VSV, measles, and rabies, are dependent on a ribosome-specialized mechanism driven by rpL40, a protein constituent of the large ribosomal subunit. RpL40, localized on the surface of 60S, contains a zinc finger domain, which is buried in the ribosome, and surface-exposed N and C terminus. Here, I use viral infections and in vitro biochemistry to determine how different ribosome composition is regulated by the cell to control mRNA translation.

Jason Walter ‘23

Faculty Mentor: Eugene Kogan

The Cuban Missile Crisis: A Case Study of Negotiation and Leadership

For the past year I have been working under the direction of Dr. Eugene B. Kogan on a research project about President Kennedy’s leadership during the Cuban Missile Crisis. The goal of our work is to distill lessons from Kennedy’s handling of the crisis that could be applied to high-stakes negotiations in the future, in politics as well as any other field. I spent much of my time analyzing declassified government documents and writing short briefings on topics requested by Dr. Kogan, allowing us to build a broader picture of the crisis from an objective point of view and to contrast happenings in the U.S. with developments in the USSR, Cuba, and the United Nations.

My findings helped to give texture and depth to many aspects of the missile crisis that are often glossed over in discussions about it today. The consolidation of information regarding whether Kennedy knew about the presence of tactical nuclear weapons on the island, where else nuclear weapons were positioned in the world, and what plans the U.S. had for Cuba before the crisis began collectively creates a greater appreciation of what was truly at stake and how events could have ended differently. Furthermore, it brings home the importance of crisis communication and the civilian-military relationship, setting the stage for further discussion of theories of international relations and showing the unique advantages of historical research.

Claire Ogden ‘21

Faculty Mentor: Patricia Alvarez Astacio

“Hybrid:” Documenting Arts Pedagogy Amid a Pandemic

During the Fall 2020 semester, Brandeis experimented with “hybrid” university infrastructure to mitigate the spread of COVID-19. This dramatically altered all aspects of university life, as students and faculty now spend the majority of their time socially distanced and on screens. Under these restrictions, professors and students have been trying to find the best ways to connect, teach, and learn. As one of the primary realms of in-person instruction, the Fine Arts department stands as a salient example of the pedagogical experimentation that has taken place in this uniquely mediated environment.

“Hybrid” is an ethnographic documentary that follows Anna, a Brandeis arts student, and Fine Arts Professor Joe Wardwell as they navigate the Senior Studio class during the pandemic. The film immerses viewers in the hybrid classroom, showing the challenges, rewards, and innovative techniques that allow faculty to create a safe and engaging learning experience. The documentary moves between different classes and perspectives, and it shows in-person and Zoom footage alike. By exploring the multiple experiences and dynamics in hybrid classrooms, “Hybrid” shows us that, even during a pandemic, connection and learning are possible. The film prompts audiences to think about the importance of the arts during times of crisis.

Anna Greenberg ‘21

Faculty Mentor: Kerry Chase

The Arias Effect: How Autonomous Mediation Brought Peace to Central America

This paper investigates the Esquipulas Peace Agreement, a historic peace deal that ended the Central American wars of the 1980s. As a case study of successful regional mediation, I examine the diplomatic mechanisms behind Esquipulas and its impact on peace-making in the Northern Central American region. The Costa Rican president and Nobel Peace Prize winner, Óscar Arias Sánchez, was a central actor in the negotiations. The inability of the Organization of American States (OAS) to solve the Central American crisis created a vacuum for President Arias to lead the peace negotiations as an involved insider. This unique form of mediation, which I label ‘The Arias Effect,’ brought peace and facilitated democratization in the region. President Arias’s credibility stemmed from his personal relationship with the key actors and the casual informality he brought to the intense rounds of mediation. The end result was a successful resolution of the Sandinista-Contras war and a comprehensive peace package that initiated a ceasefire between the two groups and democratic elections. By exploring the Central American crisis and the positions of the five Central American leaders during the Esquipulas negotiations,

the paper uncovers conditions under which strong regional diplomacy resolves intrastate conflict and sparks international development. My research on the Esquipulas case shows that the Arias Effect--strong regional diplomacy--not only brought short-term peace to the region but also stimulated longer-term institutional innovation in the regional organization of OAS.

Han Kang ‘22

Faculty Mentor: Steve Van Hooser

Carbon Fiber Microdrive Array

Carbon fibers have been shown to be a promising material for use in in-vivo neurological recordings. Carbon fibers are on the order of a few microns in diameter. This size allows for high spatial resolution recordings. Additionally, carbon fibers cause less of an immune response when inserted for recording compared to the widely used nichrome wires. Engineering these electrodes proves to be difficult as the fibers break more easily when compared to metal electrode wires. So far, work has been done to create electrodes that have reasonable impedances, the key being gold plating and the method used to cut the tip of the electrodes. Thus far, the carbon fiber electrodes that have been created have been primarily used in acute in vivo recordings in the cortex of ferrets. More hurdles must be crossed in order to be able to do chronic recordings in vivo. The primary interest of recording is the lateral geniculate nucleus. This is a small area deeply embedded in the brain and guiding electrodes that can flex to the LGN poses a difficulty. Additionally, the electrodes used during acute experiments are not properly housed for chronic use. In an attempt to address both concerns, a tetrode microdrive array system will be adapted for carbon-fiber electrodes.

Danni Cao ‘21

Faculty Mentor: Sacha Nelson

Characterization and potential mechanisms behind enhancer trap silencing in the mouse brain

Gene regulation in the brain, well-described in early development, continues throughout the lifespan. Little is currently known about gene regulation during adult brain maturation and even less about cell-type specific mechanisms. The Nelson lab developed a set of genetic tools to label specific cell-types in the mouse brain using an enhancer-trap green fluorescent protein (GFP) reporter. However, while GFP expression patterns in the enhancer-trap mouse lines are stable over many generations, we observe loss of GFP in individual mice as they age in a cell-type specific manner. In addition, the silencing is not due to cell death and does not occur in non-CNS tissue. The GFP and tTA mRNA also decrease in concordant with the loss of GFP. We hypothesize that the silencing could be due to either global regulation in the genome as the enhancer trap is more sensitive to changes and serve as a “canary in the coal mine” to detect post-development changes, or the changes could be more specific to the transgene. We utilized

the Assay for Transposase-Accessible Chromatin Sequencing (ATAC-seq) to examine accessibility changes in cells before and after silencing to examine which hypothesis is correct. We also explored possible mechanisms behind this phenomenon by knockouting DNA methyltransferases 1 and 3a and observed delayed silencing. Thus, we can conclude that DNA methylation is involved in initiating silencing. Overall, all efforts suggest that gene regulation in post-development is not fixed and continually being refined.

Carter Yee ‘21

Faculty Mentor: Matthew Fraleigh

Tessaku: Examining the Kibei Poetry of Tule Lake

This thesis examines the Japanese language poetry written by Kibei Nisei in Tessaku, a literary magazine published within the Tule Lake Relocation Center during the World War II Incarceration of Japanese Americans. By translating and studying this work, I hope to contribute a better understanding of the experiences of the Kibei, the generation of Japanese Americans born in the United States but educated partially in Japan. The Kibei-produced poetry in Tessaku is incredibly varied in its subject matter, but has a number of key themes which emerge, including home, nostalgia, identity, and politics among others. I analyze this poetry from both a historical and literary point of view, and attempt to draw connections between the writers’ positionality and their writing. My thesis is informed by the theses and dissertations of other scholars in the field of Japanese American studies, in addition to archives, newspapers, interviews, and War Relocation Authority records. My thesis challenges dominant narratives surrounding Japanese Americans incarcerated during World War II, and complicates ideas around resistance and what it means to be a “political” writer. The voices of Kibei Nisei, a marginalized group even within the context of the camps, have been silenced in the past, but are not only worthy, but deserving of further study. Now is the time for us to read their words.

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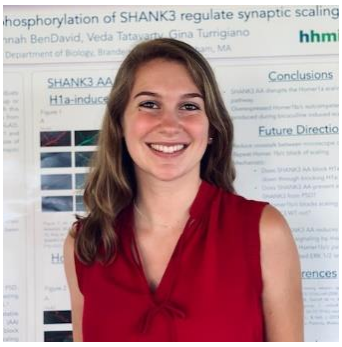


Hannah BenDavid '22
Co-author: Dan Leman

Faculty Mentor: Gina Turrigiano

Knockout of Autism-associated SHANK3 causes changes to activity states in mice

Homeostatic synaptic scaling is a form of synaptic plasticity that adjusts the strength of all of a neuron's excitatory synapses up or down to stabilize firing (Turrigiano, 2008). An Autism Spectrum Disorder (ASD)-associated protein, SHANK3, has been shown to create a scaffold at the synapse that is essential to synaptic scaling. Previous work in our lab has shown that sleep facilitates downward firing rate homeostasis, and that this process is mediated by synaptic scaling down (Torrado Pacheco et. al, 2021). In contrast, wake has been shown to facilitate upward firing rate homeostasis following visual deprivation (Hengen et. al, 2016). Sleep disorders are frequently associated with ASD in humans. Given that SHANK3 has been implicated in Autism and synaptic scaling, it seems likely that SHANK3 dynamics underlie the homeostatic changes associated with the sleep/wake cycle. In this study, we investigate the link between SHANK3 and sleep by using previously recorded observational footage of SHANK3 knockout mice. These 3-hour video recordings were reanalyzed using DeepLabCut, a neural network behavioral tracking program, to measure the movement of the animals. By creating a movement threshold, we were able to define periods of putative sleep, quiet wake, and active wake, assessing changes to activity state as a function of SHANK3 knockout. SHANK3 knockout mice spend more time in quiet wake, less time in active wake, and similar amounts of time in sleep as compared to wild-type littermates. Future directions include performing observational experiments over 48 hours to observe multiple circadian periods.

Yoo Ra Sung '23

Faculty Mentor: Yuri Doolan

Reclaiming Lost Dreams: Uncovering Intergenerational Trauma in Korean and Korean American Women Through Oral History Methodology

Often characterized as a forgotten war, the Korean War remains in an ambiguous place in social memory. More aptly, Bruce Cummings refers to the unresolved conflict as the "unknown war," reflecting the dearth of scholarly works on an event which dramatically reshaped the postwar world order. Therefore, it is crucial to apprehend reverberations of the Korean War which have damaged

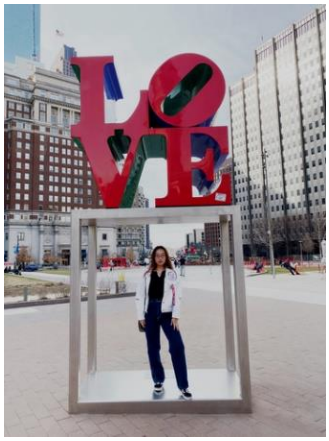
and silenced women throughout multiple generations, and continues to define the positionality of the Korean diaspora today.

Many Korean feminist scholars have examined postcolonial South Korean citizenship and geopolitical migration to illuminate the gendered and sexualized dimensions of the war. Building on this archive, my project traces the individual histories of Hyun Woo, Hyun Jin, and Lim Mi Sook, women connected by blood and family, through oral history interviews. The stories of their interconnected lives produce a deeper understanding of war, violence, and trauma.

Through my research and analysis, I argue that gender roles and family responsibilities created a hostile environment which drove Korean women to seek refuge beyond their homeland. I postulate that in attempting to survive, Hyun Woo, Hyun Jin, and Lim Mi Sook all created inheritances of trauma perpetuating an intergenerational burden of emotional labor. Furthermore, I assert that there is much to be gleaned from the silences and gaps in family history. In answering two important questions, “Where does the residue of trauma originate from?” and “How has trauma impacted the lives of Korean women?” I aim to provide answers leading to the beginnings of recovery.

Christina (Jingyi) Xing ‘21

Faculty Mentor: Thomas Fai



Engineered Length Control Systems Through Reinforcement Learning

The single-cell green algae Chlamydomonas reinhardti has two flagella, and the lengths of these flagella are observed to be constant and equal through most of their life cycles. Their length control can be probed experimentally: when one of the flagella is severed, the other flagellum will shrink and the two lengths will equalize at a lower level. They then grow back together at a steady rate and ultimately reach the original length. Recently, a mathematical model was proposed that explains this length control and the observations of severing experiments in terms of motor-driven transport and a limiting pool of molecules within flagella [TG Fai, L Mohapatra, P Kar, J Kondev, A Amir, Length regulation of multiple flagella that self-assemble from a shared pool of components, eLife, (2019).]. We aim to contrast this biophysical mechanism with engineered models of length control, such as those achieved by machine learning algorithms such as reinforcement learning. We will explore whether engineered length control mechanisms are consistent with the results of severing experiments, and explore the effect of coupling multiple structures through a common pool of molecules. We will address the question of whether an algorithm learned in the case of a single flagella is able to control the lengths of multiple coupled flagella. By solving this question, we will better understand the differences between engineered and physical models for the length

control, and potentially gain insights into engineering more robust mechanisms of length control.

Carl "Cactus" Warmuth '21

Faculty Mentor: Paul Morrison

Six-Shooters, Saxophones, and Slurs: The Dual Depictions of American Racism in Spaghetti Westerns and Japanese Noir

Following WWII, Westerns and film noir held major places in Hollywood. Not long after, so-called "Spaghetti Westerns" dominated Italian genre cinema and noir landscapes shadowed the films of the Japanese studio Nikkatsu. For both, there was an exoticism to the American lifestyle, especially given Italy and Japan's homogeneity, their recent departures from fascism, and the emergence of the civil rights movement. It is only fitting, then, that both tackle the principal American problem: racism. Unlike Hollywood Westerns, Spaghetti Westerns had no inherent inclination to glorify the United States' colonial past or present. Instead, these Italian filmmakers, despite their reliance on gore and gags to sell tickets, approached white oppression of Native Americans and Mexicans with often clearer heads than their American counterparts. While abundant in the genre, this theme is most meticulously explored in the work of Sergio Corbucci, in particular his films Django and Navajo Joe (both 1966). In Japan, Nikkatsu put the emphasis on African Americans. Films like Crazed Fruit (1956), The Warped Ones (1960) and Black Sun (1964) show increasing interest in grappling with discrimination toward Black people and the place of jazz in American and Japanese culture. Finally, the film A Colt is my Passport (1967) shows the confluence of these two genres, being produced by Nikkatsu but featuring a Spaghetti Western score and scenery. By being imitations of thoroughly American genres, Spaghetti Westerns and Nikkatsu noir not only elucidate foreign understandings of American racism, but reflect where those understandings came from.

Marina Dreeben '21 and Sahil Duvadie '23

Faculty Mentor: Colleen Hitchcock

Citizen Science Best Practices at the Boston Harbor Islands

Boston Harbor Islands National and State Park (BHI) includes 34 islands and peninsulas on the coast of Boston under the management of 11 governmental and nongovernmental agencies. Staff at the National Park Service alongside other organizations including the Stone Living Lab, Department of Conservation and Recreation, and the New England Aquarium have implemented numerous citizen science projects on the Boston Harbor Islands. Citizen science refers to public participation in collecting and analyzing scientific data, and it provides unique opportunities to gather data over large geographic areas and time spans while creating educational and stewardship opportunities for participants. The goal of our project is to

complete a review of existing citizen science research and develop a rubric for evaluating those projects based on the validity of the data they produce, their ability to inform management decisions, and the educational benefits they offer to participants. Using the evaluation tools and criteria in this rubric, we will assess BHI citizen science projects that use iNaturalist, a platform that allows users to collect biodiversity data by uploading photos of organisms they observe. Specifically, we will analyze one project that uses iNaturalist for structured biodiversity sampling and another project that uses iNaturalist to collect unstructured, opportunistic data. These findings will then be sent back to the National Park Service to improve their existing projects and serve as a guide for creating new projects.

Hunter Kessous '22

Faculty Mentor: Keridwen Luis

Female Genital Mutilation/Cutting Knowledge and Attitude Amongst Community Educators

The objective of this research is to assess the knowledge, attitudes, and training among community educators working to eradicate female genital mutilation/cutting (FGM/C). Interviews were conducted with leaders of 14 non-governmental and grassroots organizations, and we surveyed 79 community educators on knowledge of FGM/C, attitudes towards the practice, and training they received, if any, in preparation for their work. Interviews were used to improve the survey by making it more relevant to existing interventions. The survey indicates significant associations between attitudes towards FGM/C and certain demographic factors. Community educators who are not native to the country in which they work to end FGM/C are more likely to believe that FGM/C decreases promiscuity than those who are native. Additionally, participants who were born in North America were more likely to agree that it is okay to perform FGM/C on a consenting adult. Survey respondents also reveal significant associations between certain demographics and the participants' work in community education. The majority of respondents who were born in Africa have worked alongside a community to create an alternative rite of passage, compared to none of the North American and few of the European and Asian participants. Testing also revealed that men are more likely to be paid for their work in FGM/C intervention than women.

Amy Wang '21
Co-authors: Elli Xiao and Shayna Field

Faculty Mentor: Teresa Mitchell

Are Soft Sciences Theories More Easily Rejected than Hard Science Theories?

Introduction: The ongoing replication crisis has highlighted a high prevalence of irreproducible research among published scientific studies, and disagreement among researchers may reduce

public trust in science. Furthermore, there may be differences in the perceived rigor between hard and soft science disciplines. This study presented participants with evidence that conflicts with an existing theory, and explored whether people preferred to reject the theory or the evidence. We investigated whether preference for the theory changes depending on the scientific discipline (chemistry, biology, psychology, and economics), level of disagreement (5%, 25%, and 40%), and time point (2019 versus 2021). We predicted that theory acceptance would be higher in the hard sciences and at lower levels of disagreement.

Methods: Participants were recruited through Amazon's Mechanical Turk and were randomized to receive one of three levels of disagreement. Participants read eight questions (two per scientific discipline) regarding a conflict between a theory and evidence. They selected whether they would accept the theory only, accept the evidence only, or accept both. This study was conducted initially in July 2019 (N=147) and replicated in March 2021 (N=135).

Results: Participants were more likely to accept the theory in the soft sciences compared to the hard sciences and at lower levels of disagreement than at higher levels. There were no differences in responses between the two time points.

Discussion: The data suggest that the COVID-19 pandemic did not change perceptions regarding science conflict. Additional studies should be conducted to present more questions per scientific discipline.

Elise Hallstead-Williams '21
Co-author: Nikita Alimov

Faculty Mentor: Bruce Goode

Biochemical Dissection of Cofilin/Aip1 Actin Disassembly Mechanism

In order for cells to maintain viability, cytoskeletal structures, specifically actin filaments must be dynamically remodeled through their interactions with other proteins. Cofilin and actin interacting protein 1 (Aip1) which are both actin binding proteins, have been implicated in the rapid turnover of actin filaments but the mechanistic details through which this process occurs have remained elusive. A mutant Cofilin allele, cof1-19, has been shown in previous studies to have defects in its interactions with Aip1, leading to a decrease in its ability to sever actin filaments (Okada et al., 2006). Visualizing these defects in actin filament severing and disassembly in real time hasn't been done until this study and further mechanistic questions of how Cofilin and Aip1 induce filament disassembly have been answered. Using multi-wavelength total internal reflection fluorescence (TIRF) microscopy we confirm that cof1-19 does have defects in binding and severing actin filaments by visualizing in real-time its severing behavior. Additionally, we show that Cofilin's ability to induce actin filament severing depends on its ability to bind actin filaments as well as its ability to properly

interact with Aip1. We also show that cof1-19 has defects in interacting with Aip1 that are independent of its defects in binding to actin filaments.

Michelle Cho ‘21

Faculty Mentor: Timo Street

Recharacterization of Endoplasmic Reticulum Molecular Chaperones BiP and Grp94 Binding Model Reveals a Complex Three-Chaperone System with J-Domain Co-chaperone

Molecular chaperones are critical to cellular stability and protein homeostasis. Many of these, such as the endoplasmic reticulum (ER) chaperones BiP and Grp94, have been found to cooperate, being able to bind to each other as well as client proteins. Recent findings have indicated an organizing mechanism between BiP and Grp94 whereby the ADP conformation of BiP can bind to Grp94, but the ATP conformation of BiP cannot. BiP and its family of heat shock proteins (Hsp70s) are regulated by co-chaperones known as J-proteins, such as ERdj3, which utilize a highly conserved J-domain (JD) region to stimulate BiP conformational changes via ATP hydrolysis. While this suggests a three-chaperone cooperative interplay between the J-domain, BiP, and Grp94, the mechanistic details of this interplay are poorly understood. In the first part of my thesis, by critically analyzing binding data for BiP and Grp94, I show that a previously used conformation-specific equilibrium binding model is insufficient to explain the interactions between BiP and Grp94 under ATP conditions. I then developed a modified non-equilibrium model that better explains a diverse set of experimental data on the BiP-Grp94 interaction. In the second part of my thesis, I examine how the JD influences the binding between BiP and Grp94. The JD has a complex influence on BiP and Grp94. At low concentration, the JD promotes binding between BiP and Grp94 whereas at high concentration the JD suppresses binding. To better understand these results, I performed numerical simulations to model the three-chaperone system interactions of J-proteins with BiP and Grp94.

Nabeeha Haq and Kate Ross ‘21

Faculty Mentor: Elanah Uretsy

African Migrants in Guangzhou: A Comparative Analysis of Immigration Policy in the US and China

As globalization becomes more accessible, a significant increase in migration from low- and middle-income countries to high-income countries has occurred. People migrate for a variety of reasons, ranging from employment to family relocation to escaping oppressive political regimes. Migration is a difficult process often met with challenges stemming from cultural integration. Many migrants encounter racism and xenophobia while facing an unwelcoming infrastructure that does not easily allow for legal immigration and exempts them from the social benefits of citizenship. These issues are enhanced in China with no legal path to migration. China has been a destination for African migrants seeking income opportunities over

the past two decades. We will compare the experiences of African migrants in China, where there is no pathway to citizenship or support services, to illegal immigrants to the US, who face similar threats but have the benefit of services designed to support their needs. In both cases, inequities in healthcare access for migrants are exacerbated. Facing issues with language barriers and cultural integration, migrants are unable to access healthcare with limited patient autonomy received. Many are left uninsured or out of social welfare programs entirely, forcing them to pay out-of-pocket costs. Emigrating to a new country poses new challenges and barriers that every individual must overcome. However, the difficulties they face differ on the basis of the host country. We will analyze the hardships that migrants face integrating into China compared to the U.S. to suggest solutions to the inequities migrants face searching for healthcare.

Allison Sukay '24

Faculty Mentor: Margaret Gullette

The Power of Monuments

As a high school junior standing before a column memorializing the lynching of an unnamed man in my hometown of Johnson County, Indiana, I was confronted by my own ignorance of the history of racial terror. The National Memorial for Peace and Justice in Alabama, erected in 2018, answers the question '*why are monuments important?*' by utilizing the power of public space and art to tell the truth about white supremacy's racialized terror.

This Spring, I was asked by my scholar partner, Margaret Morganroth Gullette (WSRC), to investigate the creation of monuments for people whom history forgets. By investigating accounts of the community dialogue surrounding the memorialization of lynching, I found that the willed ignorance of history proved to be one of the largest obstacles in the creation of monuments. The Equal Justice Initiative believes such monuments create a unified and honest public memory that recognizes the trauma and causes of racial inequality. The resulting community awareness has already proven to be an extremely powerful tool in the movement to face contemporary issues of racial inequality.

The current ignorance of ageism's role in the recent deaths of more than 127,000 patients living in nursing homes during the COVID-19 pandemic offers a compelling opportunity to apply this research. A movement's ability to stop injustice is only as comprehensive as the recognition of the trauma that a society has been willing to tolerate—a task for which the creation of a powerful monument has been shown to be uniquely successful.

Lance Babcock ‘21
Co-author: Joseph Lopes

Faculty Mentor: Guillaume Duclos

In Vitro Model of How Advective Flows Impact Protein Spatiotemporal Organization on Membranes

Spontaneous formation of spatiotemporal patterns is ubiquitous throughout living organisms, from the spots and stripes on animal skin to traveling waves of proteins on cell membranes. The formation of these patterns – called Turing patterns - has been associated with reaction-diffusion equations. Pattern-forming proteins can also be found in cells whose cytoplasm gets spontaneously mixed by flows resulting from molecular motors pushing and pulling the cell cytoskeleton. However, little is understood about how such cytoplasmic flows affect protein self-organization. The reconstitution of these reaction-diffusion patterns in an active fluid – a liquid composed of spontaneously moving molecules - can provide insights into how patterns are robustly maintained despite cytoplasmic flows observed in living cells. We developed a novel in vitro assay combining reconstituted proteins that self-organize into a variety of dynamic Turing patterns on a lipid membrane combined with cytoskeletal proteins that spontaneously churn the solution. Our assay combines the self-organizing Min proteins, which regulate cell division in Escherichia coli, with a continuously moving network of kinesin and microtubule bundles to generate chaotic flows. The Min proteins self-assemble into spirals and waves irrespectively of the presence of microtubule-driven flows. Preliminary observations suggest that flows delay the establishment of the pattern on the membrane. Overall, our results suggest that cellular components can remain robustly organized even in a chaotic, but minimal, reconstituted system.

Sarah Karan ‘21

Faculty Mentor: Angela Gutchess

Values and Well-Being During COVID-19

The present study investigated the relationship between personal values and well-being and how these factors might impact individuals’ outcomes during the COVID-19 pandemic. American and East Asian college students and recent graduates completed measures on depression symptoms, loneliness, and perceived stress due to COVID-19. This study focused on the higher order values of self-enhancement and self-transcendence. Self-enhancement values reflect the prioritization of personal desires, whereas self-transcendence values reflect the prioritization of others’ desires. We hypothesized that higher scores for self-enhancement values would predict poorer responses to COVID-19, as indicated by more depression symptoms, higher levels of loneliness, and higher levels of perceived stress

related to COVID-19. Conversely, we hypothesized that higher scores for self-transcendence values would predict better outcomes during COVID-19, as indicated by fewer depression symptoms, lower levels of loneliness, and lower levels of perceived stress related to COVID-19. This sample's baseline data on personal values, depression symptoms, and loneliness had been collected for a previous study conducted prior to COVID-19. Analysis of how participants' baseline values might predict different outcomes during COVID-19 indicated no significant relationship between values and depression symptoms, loneliness, or perceived stress. However, the data revealed a significant increase in depression symptoms and loneliness levels from before to during COVID-19. This finding suggests the need for further research on the impacts of this pandemic on mental well-being, and specifically, which factors might influence individuals' ability to cope amidst such unprecedented stress. Understanding such relationships would assist in developing effective interventions to foster coping and recovery.

Madison Chacon

Faculty Mentor: Sebastian Kadener

Characterizing Thermosensitive Isoforms of the Circadian Gene Timeless

Many organisms face daily adaptive challenges. They must cope with large changes in their environment such as temperature and light fluctuations. The circadian rhythm evolved in response to these daily stresses (Somers et al., 2018). To enhance environmental fitness of an organism, circadian rhythms predict diel changes in the environment and carefully synchronize biochemical processes (Patke et al., 2020). A dynamic network of core oscillatory machinery serves as a buffer giving the circadian rhythm remarkable robustness under a variety of conditions. Simultaneously, the circadian rhythm is also able to quickly adjust to different conditions (Martin Anduaga et al., 2019). This property of robustness and plasticity is uniquely illustrated with temperature. In response to temperature, the circadian rhythm can take two paths. It can adapt to the new temperature regime or compensate for the temperature and maintain its original rhythm (Majercak et al., 1999; Pittendrigh, 1954). The mechanisms that underlie both temperature adaptation and compensation are not fully known. However, alternative splicing of circadian genes in Drosophila, including period and timeless, have been implicated in temperature sensing, providing an avenue for further study of the interaction between temperature and the circadian rhythm (Majercak et al., 1999; Martin Anduaga et al., 2019; Shakhmantsir et al., 2018).

Quinn Weiner ‘21

Faculty Mentor: Tom King

The Polysemy of “Gender Identity” in Recent Sociological, Psychological, and Feminist Theory Journals

This study seeks to understand the multiple meanings of the phrase “gender identity,” as it appears within sociology, psychology, and feminist theory journal articles, in an attempt to address the phenomenon within which scholar-activists concerned with gender utilize critical terms in inconsistent ways. Illustratively, one sociologist uses “gender identity” to mean “one’s state of being a man or a woman,” while a psychologist employs the term to refer to the accumulation of multiple quantifiable aspects of gender, including one’s conformity to and comfort with their gender, without acknowledgement of this difference. Through the application of an original literary analysis methodology to 23 paradigmatic articles, this study aims to provide a minimal platform for these discussions of meaning so absent from current academic conversations. Rather than advancing any particular meaning of gender or the phrase “gender identity,” this thesis-length written project recognizes the variety of meanings already established but unacknowledged by scholars, outlining and analyzing five definition categories which collectively account for all 23 definitions. With consideration for the multidisciplinary nature of gender studies discourses and the real consequences of these discourses for gender minority communities, this project aims to create an accessible platform for outlining the competing ways that “gender identity” is defined and claimed across disciplines and locations, and among the academy, the blogosphere, and activists. Ideally, this platform would serve to uncomplicate future discourses around “gender identity” and lower one communicational barrier to greater gender justice.

Andre Kish ‘22

Faculty Mentor: Jytte Klausen

U.S. Policy on U.S. Foreign Fighters for the Islamic State of Iraq and the Levant

This project identifies those United States (U.S.) residents that have traveled to fight for Jihadist-Salafist groups in Iraq and Syria from 2011 to the end of 2020 and how the U.S. government has chosen to handle their crimes and possible return to the U.S. after the fall of the last ISIL territory in 2019. The goal of this work is to determine what choices the U.S. has in treatment of citizen foreign fighters and what the U.S. has chosen to do to those who have been captured or returned. The data was compiled from a number of open source documents. Most of the underlying data comes from the Western Jihadism Project. It was updated and modified based on the Intercept’s *Trial and Terror* database. The project employs a largely qualitative case study method, involving the close examination of every known U.S. citizen foreign fighter who has been repatriated to the U.S. to be prosecuted or is known to be in U.S.

custody. Cases were selected for greater analysis based on the degree of variance their outcome demonstrated. This work demonstrated that the U.S. has few other options besides prosecution which is the most commonly used tool to deal with those who have traveled to fight.

ASYNCHRONOUS PRESENTATIONS

Paul Jiang ‘21

Faculty Mentor: Maria-Eirini Pandelia

Redefining the Functional Repertoire and Metal Dependence of Type I Cas3 HD Domain Nucleases

Targeted DNA degradation by the Type I CRISPR-Cas system is performed by Cas3, typically a two-component protein with a nuclease and a helicase domain. The nuclease belongs to the HD-domain metalloprotein superfamily, that harbors functionally diverse representatives including phosphodiesterases, phosphatases and oxygenases. The range of metal ions reported to support Cas3 catalytic activity is diverse, including Mg, Mn, and Ni, demonstrating variability in cofactor requirements. Type IE Cas3 nucleases are dinuclear, whereas for Type IA Cas3s (containing only the nuclease domain) assembly of a binuclear site has not been demonstrated. In the present study, we redefine the metal ions that confer hydrolytic activity and show that the diferrous cofactor in Thermobifida fusca Cas3 degrades ssDNA with the highest observed rates. We also demonstrate assembly of diiron cofactors in two Type IA Cas3s and show that these have phosphodiesterase activity. In addition, Cas3 efficiently hydrolyzes 2’3’-cAMP, in agreement with previous notions that it may act as a nucleotidase at the 2’3’-cyclic phosphate crRNA termini. 2’3’-cAMP hydrolysis is specific to Cas3, and not a general property of the HD-domain scaffold. ssDNA and 2’3’-cAMP cleavage exhibit the same metal-dependence, suggesting that cofactor chemical nature is not a substrate specificity element. HD-domain PDEs harbor a seventh conserved histidine ligand, for which the role remains unclear. We show that this histidine is not essential for activity, but is crucial for substrate (re)positioning, in particular for the larger ssDNA substrate compared to the smaller 2’3’-cAMP.

Matthew Knotts ‘22

Faculty Mentor: Daniel Oprian

Elucidating the Stabilizing Mechanism of High Energy Carbenium Ions in Terpene Synthases

Terpenes are a large and diverse class of natural products that produce products from essential oils to precursors to chemotherapeutic agents. Despite being a widely studied class of molecules, many of their biosynthetic pathways are uncharacterized. In an effort to better understand these reactions, the activities of two sesquiterpene synthases, pentalenene synthase and caryolanol synthase, were examined. Both of these terpene synthases use farnesyl diphosphate, undergoing an initial anti-Markovnikov addition reaction that results in a carbenium intermediate. While it has been found that pentalenene synthase participates in a concerted 1,2 hydride shift immediately after the initial anti-Markovnikov attack, the second step in caryolanol synthase’s mechanism is unknown. In an attempt to elucidate the mechanism in caryolanol synthase, both terpene synthases were assayed with two deactivating substrate

analogues, 2-fluorofarnesyl diphosphate and 12,13-difluorofarnesyl diphosphate. GC/MS analysis showed that 2-fluorofarnesyl diphosphate is a deactivating substrate for caryolanol synthase, but not pentalenene synthase, while 12,13-difluorofarnesyl diphosphate is a deactivating substrate for pentalenene synthase, but not caryolanol synthase. This suggests that caryolanol synthase does not participate in a concerted hydride shift like pentalenene synthase. This result sparks interest in investigating other terpene synthases closely related to pentalenene synthase and caryolanol synthase. By testing related terpene synthases with these inactivating substrates determined through ancestral sequence reconstruction, it can be found where these two enzymes diverged in their mechanistic pathways along their evolutionary paths.

Zoë Fort '21

Faculty Mentor: Wangui Muigai

"Not Your Superwoman": The Implications of the Superwoman Trope on Black Women's Birth Outcomes in the U.S.

The United States is experiencing an infant and maternal mortality crisis across racial stratifications at more alarming rates than in the antebellum era and Jim Crow. Over the past fifteen years, these disparities have accrued significant media, scholarly, and medical attention. Scientific evidence has proven that racism and the physiological stress it causes are contributing factors to these birth outcome disparities. Even so, there has been a dearth of information on how harmful tropes have amplified the adverse birth outcomes for Black mothers and infants in the U.S. For this thesis, I have conducted extensive research on how the Superwoman trope impacts U.S. Black women's health generally and gestational health specifically. This research is grounded in evidence-based findings and Black feminist scholarship and thinking including lived experience and privileging the truths of Black American women. Labor, childbirth, and the prenatal and postpartum periods are critical temporal sites which I consider using the Superwoman lens to better understand Superwoman's function. Importantly, I revisit history regarding the genealogy of the term Superwoman, other harmful tropes assigned to Black women, the inherently racist nature of American gynecology, and how healthcare providers have interacted with expecting and birthing Black women historically and contemporarily. Lastly, I explore imaginings for eradicating these birth outcome disparities and underscore how much Black women have done for themselves in harmony with today's birthing justice movement.

ACKNOWLEDGMENTS

The following programs and donors funded undergraduates' research, enabling them to design and implement their projects throughout the past year:

Dr. Frederick W. Alt '71 Summer Biology Research Fellowship
Madison Chacon
Lillian Xue

Blavatnik Summer Science Research Fellowship
Sadie Antine
Chase Chen
Katie Ferguson
Miranda Gavitt
Elise Hallstead-Williams
Matthew Knotts
Isaac Paddy
Sonia Presti
Shinji Rho
Yuran Shi

Brandeis Department of Theater Arts
Renata Leighton
Amy Ollove

Dan Getz Endowment for Cardiovascular Research Fellowship
Aaron Kalpakian

Division of Science Summer Research Fellowship
Sadie Antine
Ilana Blumen
Michelle Cho
Tess Kowalski
Ziyao Li
Luana Lima
Karen Phuong
Shinji Rho
Alden Sanford
Wanchen Zhao

Greenberg Scholar Award
Anna Greenberg

Jane Kahn '77 Undergraduate Research Fellowship
Leah Fernandez
Caroline O

Jerome A. Schiff Undergraduate Fellowship
Eric Blum
Haley Brown
Madison Chacon
Hunter Kessous
Luochen Liu
Isaac Rose-Berman
Angela Self
Yoo Ra Sung
Leah Trachtenberg
Amy Wang
Iria Wang
Quinn Weiner

Jordan-Dreyer Summer Undergraduate Research Fellowships in Chemistry
Patrick Li

Louis D. Brandeis Legacy Fund for Social Justice
Jason Frank
Andre Kish
Ellie Tang Kleiman
Jason Walter
Chelsea (Chengrui) Wu

M.R. Bauer Foundation Summer Undergraduate Research Fellowships

Ethan Crouse
Laura Grunenkovaite
Ziyi Guo
Paul Jiang
Luochen Liu
Jessica Lu
Leah Naraine
Alex Rich
Christina Xing

MRSEC SMURF (Summer Materials Undergraduate Research Fellowship, NSF Grant DMR-1420382)

Daniel Hariyanto
Julia Apiki
Lance Babcock
Miranda Gavitt
Stephanie Brody

National Institute of Health (Grant R01GM096053)

Karen Phuong

National Science Foundation (Grant 1651083, REU supplement)

Ruth Rosenblum

National Science Foundation (NSF Linguistics GR404043: Parsed and Audio-Aligned Corpus of Bilingual Russian Child Speech [BIRCh] REU Supplement)

Erin Magill
Ruth Rosenblum
Keren Ruditsky

Tema Nemtzow '79 and Professor Kraig Steffen Student Research Endowment Fellowships

Yuran Shi
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Provost's Undergraduate Research Fund

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Quantitative Biology Research Community (QBReC) Fellowship

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School of Arts and Sciences Undergraduate Research and Creative Collaborations Fellowship
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Tauber Grant
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Teaching Innovation Grant
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Theatre Arts Fellowship
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Traineeships for Undergraduates in Computational Neuroscience (NIH R90 DA033463)
Alexandra Cao
Danni Cao
Isabel Cepeda
Ziyi Guo
Janis Li
Samuel Smith
Rachel Sussman

Women's Studies Research Center's Student-Scholar Partnership
Allison Sukay

***

The 2021 Brandeis Spring Undergraduate Research and Creative Collaborations Symposium is the result of collaborative efforts of many individuals, groups, and units within the university. Below is a list of some of our major contributors. We thank everyone in the Brandeis community for their efforts.

Undergraduate Research and Creative Collaborations and Dean of the School of Arts and Sciences Offices
Alexandra Burkot
Doug Bafford
Wendy Cadge
Natasha Chaiyarat ‘22
Simon Goodacre
Dorothy Hodgson
Shannon Livingstone ‘21
Margaret Lynch
Kathleen McMahan

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Bulbul Chakraborty
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