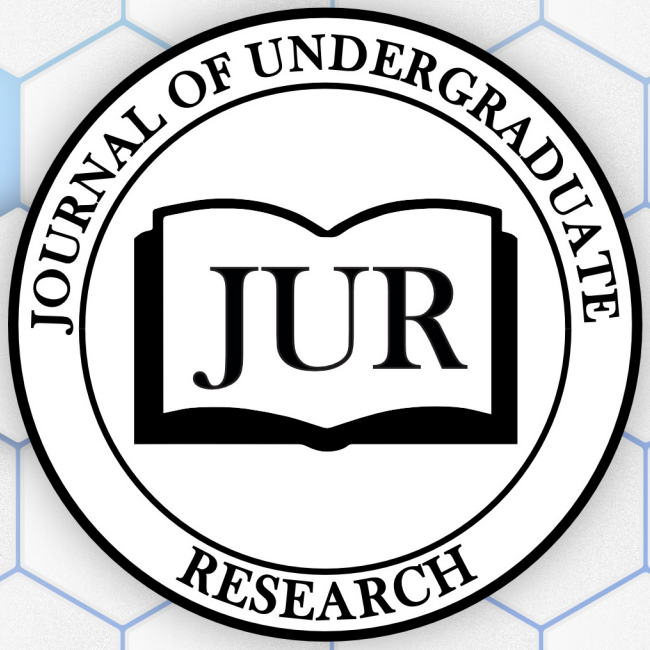

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Letter from the Editors

It has been a great honor to serve as the Editors-in-Chief of the University of Rochester's Journal for Undergraduate Research. In the past few months, we have endured challenges that ultimately changed many facets of our way of life, in particular our social and academic nature. As we go forward, we take with us the tremendous value of research and scholarship in advancing our knowledge for the benefit of society, which has been greatly emphasized by the scourge of COVID-19 and the dissemination of misinformation surrounding the pandemic. The incredible research done by our fellow undergraduate students has always been a subject of pride and marvel for us at JUR, but this is even truer this year as our world faces a difficult battle against a viral pandemic, as well as a reckoning to the plight that many among us face due to demonstrable societal inequities. In light of all of this, we are extremely appreciative of all the authors that have sent in the end-products of their remarkable scholarship, the professors that tirelessly and reliably reviewed the submissions, and our indefatigable and resilient editorial team for maintaining the standard of the journal. Now, more than ever, we are encouraged in our resolve to showcase the amazing research being done at the University of Rochester.

In this issue, we have selected five articles that represent a snapshot of the interdisciplinary research conducted at our institution. From Syed Ghani's statistics research into policing at the University of Rochester to Nisha Arya's anthropological examination of the dire consequences of redlining in the City of Rochester, the research showcased in this issue do not only serve as standalone scholarly discoveries, but also as the building blocks from which evidence-based approaches to tackling diverse problems might find inspiration.

To all our readers, we are pleased that you can join us on this exploration of subjects previously unstudied and unearthed. In doing so, we hope you may be inspired to chart out your own paths of learning and discovery.

Sincerely,

Arokoruba Cheetham-West and John Roy Lozada

Editors-in-Chief

Abstracts from Undergraduate Research Expo

University of Rochester, Rochester, NY

April 17-24, 2020

In-store and Online Advertising Messages for Tobacco Products in a Western New York Metropolitan Area

Authors: Astghik Baghinyan '22, *Public Health: Health, Behavior, & Society,* Manpreet Kaur '20, *Public Health: Health, Behavior, & Society,* Viktoriia Shevchenko '22, *Data Science*

Mentor: Scott McIntosh, *Public Health Sciences*

Smoking has been established by the CDC to be harmful to smokers and the people around them that inhale the second-hand smoke (CDC). However, smoke-shops still have the right to sell tobacco products to the public and we were interested in finding out what are some of the online and in-store advertising features they use to sell their products. For these reasons, a qualitative research method "windshield survey" collected words on-site from 6 smoke-shops' store-fronts to generate a word cloud where the size of the words correlates with the frequency of their usage. The second part of the research included gathering words from the 10 most recent Facebook posts of 15 smoke-shops to generate a world cloud. Using open coding qualitative methods, 15 themes were developed from these Facebook posts to generate a pie chart. For the in-store advertising, out of 50 unique words, the most frequently occurring words were "smoke" (n=5), "accessories" (n=3), and "vape" (n=3). For the Facebook advertising, out of 346 unique words, the most frequently occurring words were "stock" (n=28), "vape" (n=27), and "cigar" (n=26). The themes that emerged the most were the following: accessories (23.0%), novel (14.4%), and deals (9.2%). Overall, we observed that for both in-store advertising and online Facebook advertising the main focus of smoke-shops is on vapes and accessories. Additionally, other commonly used words such as "stock" and "in stock", which appeared 47 times in total, indicate the smoke-shops' tendency to advertise the variety of products they sell.

Regenerative capacity of ataxia-telangiectasia mutated deficent alveolar epithelial cells following injury in mice

Author: Molly Behan '21, *Biochemistry*

Mentor: Michael O'Reilly, *Department of Pediatrics, Lung Biology Program*

In the alveolar space, the alveolar epithelial type II (ATII) stem cell works as the progenitor cell for alveolar epithelial type I (ATI) cells, which together help to maintain lung function. In the airway, the critical progenitor cells are the club cells, they also are important for maintaining lung homeostasis. Unfortunately, the mechanisms involved in controlling the proliferation, expansion, and quiescent following injury for these cells are not fully understood. In previous studies, the cyclin dependent kinase ataxia-telangiectasia mutated (ATM) has been hypothesized to play an important role in the mechanisms involved in airway stem cell repair, as club cells were shown to lack the ability to sufficiently regenerate following injury when ATM deficiency was modeled in mice. Here, ATM's role in regulating the alveolar epithelial progenitor cells is studied using wildtype and ATM-null mice. The levels of genes expressed specifically by ATI and ATII cells were analyzed in ATM null and ATM WT mice using qRT-PCR and immunohistochemical staining before and after injury by infection or exposure to hyperoxia. Although, no changes in expression of ATII cells genes were detected, we observed lower levels of ATI specific genes in ATM-null mice prior to injury. This suggests that ATM may still be involved in development of the ATI cells but not in development or repair of ATII cells. Our finding suggest ATM is required in progenitor cells that regenerate the airway epithelium following injury and in alveolar cells required for postnatal lung development.

Exploring the relationship between overgeneralized autobiographical memory, impaired social problem solving, and stress generation

Author: Emma Cho '20, *Psychology, Brain and Cognitive Science*

Mentor: Lisa Starr, *Psychology*

Prior research suggests that depressed individuals are more likely to experience stress generation, or stressful life events that are dependent on their own characteristics or behavior (Hammen, 2006; Liu & Alloy, 2010). A possible unexplored contributor to stress generation is overgeneralized autobiographical memory (OGM), or the tendency for depressed individuals to give nonspecific memories in response to prompts for specific, personal memories (van Vreeswijk & de Wilde, 2004). Less specificity in memory recall is correlated with decreased effectiveness in social problem solving (Evans et al., 1992; Raes et al., 2005; Sidley et al., 1997). OGM may interfere with an individual's ability to access memories of previous social problem-solving attempts, leaving them less able to learn from their mistakes and more likely to experience the same interpersonal difficulties. Thus, in a sample of 173 undergraduate students (Mage = 20.2, 75.9% female, 41.5% Caucasian), this study explored a novel mechanism by which a deficit in social problem-solving skills mediates the relationship between OGM and stress generation at a one-month follow-up. OGM was not significantly correlated with the reported frequency of dependent or independent life events at follow-up, nor was it significantly correlated with social problem-solving ability. Both OGM and social problem-solving ability did not significantly predict stress generation at follow-up when controlling for depression ratings and reported frequency of dependent events at baseline. These results are inconsistent with both prior research and the proposed model, potentially because of the high level of functioning within the sample; future research in clinical samples is needed.

Experimentally Increasing the Thermotolerance of S. uvarum

Author: Haley Cohen '21, *Microbiology*

Mentor: Justin Fay, *Biology*

Many species have adaptations to temperatures in which they are found, but the genes and pathways by which such adaptations have evolved are widely unknown. Saccharomyces yeasts offer distinct advantages as a model system in which to study thermal adaptation. Saccharomyces yeasts are of particular importance to humans, as they are central to the production of beer, wine, bread, and even biofuels. These yeasts can help us understand general principles of microbial evolution. Here, we intend to determine: whether temperature-sensitive species can adapt to high temperatures, and if so by many small steps, few large steps, or something in between; and whether high temperature adaptation has a cost at low temperature. Eight strains of Saccharomyces yeasts, differing in baseline thermal growth profiles, were experimentally evolved under three different temperature conditions. After approximately 100 generations of evolution, lineages of S. uvarum appeared to have improved their thermal tolerance, most without a cost to growth at lower temperatures. Some areas that desire further investigation include the effects of repeated UV mutagenesis, heat shock, and a constant heat stress on experimental evolution.

The Interaction Between Maltreatment and Teacher Warmth and Effects on Peer Relationships and Emotion Regulation

Author: Erick DuShane '20, *Psychology*

Mentor: Melissa Sturge-Apple, *Psychology*

Maltreatment can have a number of deleterious effects on the social and emotional development of children. Because these experiences can result in a wide range of adverse outcomes in different domains of their lives, it is important to identify protective factors for children who experience maltreatment. The current study examined the impact of child maltreatment on peer relationships and emotion regulation as well as the role student-teacher relationships play. Participants included 115 high-risk urban children (ages 8-12) with histories of maltreatment. Results indicated that higher number of maltreatment subtypes was a predictor of increased peer victimization. Moreover, there was evidence of an interaction between extensive maltreatment and teacher warmth that affects emotion regulation such that low teacher warmth was associated with lower levels of emotion regulation for multiply maltreated children. Higher teacher warmth is also associated with more prosocial behaviors towards children with less extensive maltreatment histories, but not for children who were multiply maltreated. The role student-teacher relationships can play for maltreated populations are discussed in terms of intervention in the school environment.

Do Implicit Negative Appraisals of Anxiety Moderate the Relationship Between Anxiety and Depression?

Author: Hannah Duttweiler '20, *Psychology*

Mentor: Lisa Starr, *Psychology*

Decades of research consistently documents pronounced comorbidity between anxiety and depression (e.g., Lewinsohn, 1997; Mineka et al., 1998); however, more research is needed to better understand mechanisms underlying high rates of co-occurrence between the two disorders. A body of research suggests anxiety disorders develop prior to depression in the majority of comorbid cases (e.g., Wittchen, et al., 2000; Essau, 2003). However, little is known about specific conditions under which anxiety leads to later depression. The negative anxiety response style (NARS) model (Starr & Davila, 2012; Starr et al., 2016) suggests that the tendency to make hopeless inferences and ruminate about anxiety moderates co-occurrence between anxiety and later depressive symptoms. However, some may lack insight to their tendency to engage in NARS. Dual process models (Haeffel et al., 2007) theorize that many processes operate in both explicit (under conscious awareness) and implicit (instantaneous, unconscious processes) modes. The current study examined negative implicit judgements as a possible moderator in the relationship between anxiety and depression in a college sample.

A sample of 173 participants (Mage= 20.2, 75.9% female) were recruited through an undergraduate participant pool. Participants completed a novel version of the Implicit Associations Task (IAT; Greenwald et al., 1998), which paired associations between "anxiety" versus "calm" with "bad" versus "good" (drawing stimuli from existing IATs). Anxiety and depression were assessed with the Depression Anxiety Stress Scales (DASS; Lovibond & Lovibond, 1995), and explicit NARS was assessed with the Response to Anxiety Questionnaire (RAQ; Starr & Davila, 2012) and face valid questions. Participants re-completed questionnaire measures 1 month following baseline.

The novel IAT scoring algorithm by Greenwald et al. calculated a D score, which is the difference between response latencies for the two critical category pairing conditions, divided by the standard deviations across all blocks (2003). The final D score was used in analysis to represent implicit judgements such that more negative D scores imply more negative judgments of anxiety. Analysis revealed that, although 99.4% of participants endorsed negative associations with anxiety, there was substantial variation with a normal distribution (M= -0.945, SD= 0.303, skew= .852, kurtosis= 1.23). However, the D scores did not correlate with explicit measures of NARS (ps > .05). Further, preliminary cross-sectional analyses showed that the IAT did not significantly moderate the association between anxiety and depression (p>.05). The explicit measure for negative associations of anxiety was a marginally significant moderator of the relationship (b=.005, SE=.003; p= .076), in the predicted direction (i.e., higher explicit negative anxiety response style, stronger associations between anxiety and depression). Although these results failed to support the dual process model of the NARS theory of comorbidity, it is possible that adjustments to the novel anxiety IAT are needed to ensure the implicit associations are being accurately captured.

Toxicovigilance of Novel Psychoactive Substances using Social Media and Forum Data

Author: Cameron Fredriksen Isaacs '21, *Public Health: Health, Behavior, and Society*

Mentor: Vincent Ceretto, *Emergency Medicine*

Novel psychoactive substances (NPS) refer to classes of substances which have been either newly synthesized or involve pre-existing substances that are being abused in novel ways. NPS have become an increasingly abused class of drugs in the United States in part due to their ease of access, availability on the internet, higher potency, and sometimes a loophole bypassing DEA regulations. NPS are also commonly developed in clandestine labs and manufactured with variable concentrations. As a result, abusing these substances is associated with a high potential for morbidity and mortality. Due to the rapid development of new substances and the inability to screen for them, there is little epidemiological, pharmacological, and clinical information on these substances. In order to understand NPS trends, between 2016 and 2018, we reviewed over 4,000 posts on Reddit containing user's self-reported experiences after using a specific NPS. Of the 4,000 posts, there were 900 users included in the study. To be included, each user had to mention using at least one NPS and provide data about their experience. We found that the most commonly abused class of NPS were psychedelics followed by stimulants and that the most common substance was 4-AcO-DMT or Psilacetin. The most common route of administration was oral. Lastly, approximately 51% of all users reported that this was their first time using that substance. These results were similar to previous studies on NPS.

Analysis of North American Quitsites: Resources for Electronic Cigarettes and Vaping Cessation

Authors: Manpreet Kaur '20, *Public Health: Health, Behavior, and Society,* Astghik Baghinyan '22, *Public Health: Health, Behavior, and Society*

Mentor: Scott McIntosh, *Public Health Sciences*

Vaping is an epidemic and manufacturers of Electronic Nicotine Delivery Systems (ENDS) such as JUUL or PuffBarr are currently addicting a new generation of young people through their design, flavors, and marketing tactics (FDA). Youth engaging in vaping may be unaware of or misinformed about the harms of vaping and flavor toxicity. However, the North American Quitline Consortium (NAQC) includes a directory of quitsites for each state, province and territory within Canada and the USA. These quitsites provide information and resources for smoking cessation. The extent to which information on resources for vaping cessation are provided by each website has not been studied previously. Accordingly, this project has involved a thorough analysis of vaping-related information present on these quitsites and the type and amount of information and resources were compared across all sites. Only one third (21 of 66; 31.8%) of NAQC quitsites had specific sections or pages dedicated to vaping. Although one half (33 of 66; 50%) presented information on the harms of vaping, only 12 sites (18.2%) had messaging to indicate that flavors are harmful. Of the 22 sites with cessation resources, only two of them (New York State and the Province of Newfoundland) recommended speaking to a health care provider (although some websites included information and resources targeting healthcare providers and patient referral). In late 2019 and early 2020, there have been increased regulations on the vaping industry, including a partial ban on flavors (FDA). Information on the harms of vaping (particularly the harms of vaping flavors) remains lacking, andmessaging across these publicly available websites is not consistent in terms of facilitating and supporting vaping cessation.

The Impact of Interparental Conflict and Sensitive Parenting on Children's Cognitive Functioning

Author: Maya Koven '20, *Psychology*

Mentor: Melissa Sturge-Apple, *Department of Psychology*

Interparental conflict has been demonstrated to have substantial implications for the family system including parenting and children's development. This study examined the indirect relationship of interparental conflict and children's cognitive functioning through sensitive parenting. Participants included 235 families (mothers, fathers, and their child) who came for annual visits for three waves of data collection. Assessments of interparental conflict were derived from observational tasks coded for negativity and conflict and problem solving and cooperation. Assessments of sensitive parenting were derived from observational tasks coded for sensitivity. Children's warm problem solving was assessed during a puzzle box task. Children's working memory and cool problem solving were assessed during the administration of two subtests of the WPPSI-IV. Results show a direct significant relationship between interparental conflict and children's warm problem solving. Additionally, results suggested two indirect relationships between interparental conflict and children's cognitive functioning, such that there was an indirect relationship between interparental conflict and children's cool problem solving through paternal sensitive parenting, and an indirect relationship between interparental conflict and children's working memory through maternal sensitive parenting. These findings were significant over two waves of data collection. Results suggest that interparental conflict has direct and indirect effects on children's problem cognitive functioning.

Emotion Recognition Skills & Social Motivation Among ASD and Control Children

Author: Hanqiu Li '21, *Psychology*

Mentor: Jessica Keith, *Psychology*

Babies develop emotion recognition skills starting from 3-6 months (Camras & Allison, 1985). The social motivation theory of autism spectrum disorder (ASD) posits that individuals with ASD find social stimuli less rewarding than do people with neurotypical activity. The current research tested whether there exists a relationship between emotion recognition skill and social motivation among children with and without ASD.

Participants are 11 children (1 ASD, 10 typically developing) between 5-8 years old. Participants completed several computer tasks while completed questionnaires in another room. Questionnaires include the Stanford Social Motivation Scale—Brief Version (SSMS; Allerhand, 2017) and the Social-Emo-

tional Questionnaire for Children—Parent/Guardian Version (SEQ; Wall & Williams, 2011). The SEQ has three subscales: Emotion Recognition and Empathy, Social Conformity, and Antisocial Behavior.

Initial analyses examined the internal consistency of the SEQ and the SMSS. Both the SEQ (Cronbach's alpha = .96) and the SMSS (Cronbach's alpha = .97) demonstrated excellent internal consistency. Pearson correlation was then used to evaluate the relationships between the subscales of the SEQ and the SMSS.

For 11 participants in total, all the variables in SEQ including the subscale variables are positively correlated with higher levels of social motivation. The Emotion Recognition and Empathy subscale is significantly correlated with the SMSS (r=.99, p<.001).

The results show that higher levels of emotion recognition and empathy, as well as social conformity are correlated with higher levels of social motivation for children with and without ASD. Which means that the more accurate children identify human emotion, understand others' feelings, and change their own behavior or belief to fit in with a group, the more they interact with people and to be accepted by others. By the time of the Undergraduate Expo, we anticipate having collected data from several more children with and without ASD, which will allow us to examine these relationships within and across diagnostic groups.

Impact of Race and Socioeconomic Status on Diagnostic Age of Children with Autism Spectrum Disorder

Author: Andrea Lopez '21, *Brain and Cognitive Science, Psychology*

Mentor: Loisa Bennetto, *Department of Psychology*

This study looks at the impact of race and socioeconomic status (SES) on the age of diagnosis for children with autism spectrum disorder (ASD). As the prevalence of ASD has risen over the years, it has become increasingly important to understand different aspects of ASD including the health disparities and differences in age of diagnosis which impacts whether or not a child can access resources and treatment in the critical developmental time period. This pilot study analyzes archival data from the Developmental Neuropsychology Laboratory's research database within the University of Rochester's Department of Psychology to examine the relationship between SES, race, and age of ASD diagnoses. From this dataset, 56 of the participants were processes and analyzed. Data collected includes child's SES, race, severity of the child's symptoms, and the date and location of the child's diagnosis. A child's SES was calculated using the Hollingshead Four-Factor Index of Socioeconomic Status based on parental education, parental occupation and marital status (Hollingshead, 1975). ASD symptom severity was calculated using the Social Responsiveness Scale, 2nd edition (SRS-2). Information regarding the child's age of diagnosis was obtained via parent interview. Results from the sample indicated a mean age of diagnosis of 5.15 years. Pearson correlation results did not indicate a significant association between SES and diagnostic age. However, one-way ANOVA results indicated that the mean age of diagnosis for the children of color (n=13, 6.31 years) was notably higher than for white children (n=43, 4.85 years). While this effect was not statistically significant (F= 2.041.74, p=0.1) in this sample, the size of this effect is clinically meaningful. This difference in diagnostic age between groups means white children in our sample, on average, were diagnosed approximately 1.5 years earlier than children of color creating a health disparity in access to early treatment for children with ASD who are of a racial minority. Future research should continue evaluating disparities and barriers different populations face in accessing healthcare for children with ASD.

Fourier Processing of Partially Coherent Fields

Author: Benjamin Nussbaum '21, *Optics, Physics and Astronomy*

Mentor: Nick Vamivakas, *The Institute of Optics*

Techniques for the Fourier processing of entirely coherent or incoherent optical radiation are well known; we extend these techniques to spatially partially coherent light and verify the theoretical predictions of Opt. Lett. 42, 4600 (2017). We implement an optical system to generate a spatially partially coherent field by passing a coherent laser beam through a rotating ground glass diffuser. We examine the effect upon this beam of a spatial filter in a 4f system, the canonical optical processor, and quantify the degree of spatial coherence by measuring the interference fringe visibility resulting from a subsequent Young's experiment. We demonstrate control of the degree of spatial coherence with respect to the spatial filter pinhole diameter, in agreement with the theorized result. Future work could include the development of more intricate Fourier plane amplitude and phase filtering to generate arbitrary coherence profiles. This process of controlling coherence profiles could provide better imaging quality in such applications as astronomy, microscopy, lithography, medical imaging, and automotive sensing. Other extensions of this work could include examining the manipulation of polarization in partially coherent fields.

LinkedOut: Co-designing Technologies with Returning Citizens

Author: Rukimani PV '20, *Computer Science, Anthropology, Film and Media Studies*

Mentor: Rubez Chong, *MIT Media Lab: Center for Civic Media*

LinkedOut is a collaborative project between returning citizens (formerly incarcerated persons), researchers, city government, and an NGO. The project resulted in an online resource directory for returning citizens and 2 co-design workshops focusing on digital literacy and securing employment. In sum, the project lasted 10 months, and provided reflection on the inclusivity of technological design.

Role of Pore Structure on the Sintering Effect of Pt Diesel Oxidation Catalysts

Author: Natalie Ramesh '21, *Chemical Engineering*

Mentor: Abhaya Datye, *University of New Mexico, Department of Chemical and Biological Engineering*

The USDRIVE Low Temperature Oxidation Catalyst Test Pro-

tocol recommends an accelerated aging test for Pt diesel oxidation catalysts (DOCs) to be performed at 800 °C in flowing air. However, at such high temperatures, Pt sinters readily to form large particles due to significant vapor phase transport of PtO2. One approach we used to slow the rate of Pt sintering was by alloying Pt with Pd [1]. A second approach was to trap the mobile Pt species with an oxide such as PdO that reacts to form Pt-Pd bimetallic particles [2], or using CeO2, which traps Pt in atomically dispersed form [3]. Recently, we have explored the role of pore confinement to determine if it was possible to slow the vapor phase transport of PtO2, and therefore, the rate of Pt sintering. Since PtO2 vapor has negligible binding to silica [4], it provides the ideal support to study the role of pore structure. We studied MCM-41 and SBA-15 as silica supports and found that, although they slowed the rate of Pt sintering after aging at 800 °C, the resulting Pt DOCs was not very reactive due to blocking of the pores by the Pt particles, which in turn blocked accessibility of the smaller Pt particles retained inside the pores. This inaccessibility is due to high pore diameter to length ratios of MCM-41 and SBA-15. Here we explore other silica with a more open pore structure, such as silica spheres which have much lower aspect ratios. We found that we could slow the rate of Pt sintering and improve the reactivity using a model reaction, such as CO oxidation. The results are then compared to Pt on a commercial Davisil silica support, which we use as the control for this study.

Stroke prediction using Carotid Artery CFD simulations

Authors: Leonor Teles '21, *Biomedical Engineering,* Anna Weldy '20*, Chemical Engineering,* Hon Sum Alastair Lee '20, *Chemical Engineering,* Xiaoyan Wang '20, *Chemical Engineering,* Justin King '21, *Chemical Engineering*

Mentor: David Foster, *Chemical Engineering*

Stroke is a leading cause of death and is often prevented through carotid stenting, a surgery performed for patients with 70-90% artery blockage. However, when a patient's artery blockage is below this threshold, other predictive methods are necessary. Blood flow models can therefore aid these medical care decisions. This project is a collaboration between the Departments of Chemical Engineering and Neurosurgery with the goal of understanding whether computational fluid dynamics (CFD) can be used to predict strokes in patients with coronary artery disease. The project focuses on computationally simulating patient's specific blood flow patterns based on computerized tomography angiography for geometry and ultrasound for velocity and pressure data. CFD enables the analysis of each patient's blood flow patterns, focusing on their geometry, velocity profiles, streamlines, and pressure gradients. This is beneficial for quantifying the differences between velocity profiles given stroke outcomes. The purpose of this project is to ultimately create a model that predicts the onset of stroke in patients based on their carotid artery geometries coupled with ultrasound data.

Constructive Absorption and Reflection for Light Propagation Through a Cholesteric Liquid Crystal Film

Author: Baris Eser Ugur '21, *Chemical Engineering*

Mentor: Shaw Chen, *Chemical Engineering*

Circular Dichroism demonstrated by Cholesteric Liquid Crystals (CLC) is crucial for creating circular polarizers that can be used in the optics industry and the military. In this project the Good-Karali theory is extended to simulate composite CD through a cholesteric stack by incorporating chromophore's selective absorption and cholesteric stack's selective reflection. This allows the modeling of optical circular polarizers to maximize the polarization ratio and isolation ratio of incident light for optimized performance. The developed theory is capable of modeling the transmission, absorption, reflection and the polarization ratio which allows the optimization of various parameters for a given CLC film for device development. It has been shown in the theory that selective absorption of light plays a dominant role over selective reflection, providing a new area of circular polarizers with isolation ratio to be used for novel night-vision technology.

Accounting for New York State's Sports Participation Gap between Poor and Non-Poor Schools

Authors: Prajita Shrestha '22, *Business (Accounting) & Public Health (Epidemiology)*, Samiksha Vittalraj '20, *Public Health*

Mentor: Elaine Hill, *Department of Public Health*

Economic disadvantage is known to be associated with large reductions in the performance and participation of students in school. In this study, we investigate the extent to which the sports participation gap between rich and poor schools is explained by a reduction in sports available (extensive margin) versus a reduction in sports team sizes (intensive margin). We used data from the New York State Public High School Athletic Association (NYSPHSAA) to measure athletic participation, and data from New York State Education Department (NYSED) to measure school participation. We use the Blinder-Oaxaca decomposition method to explain the proportion of participation gap due to poorer schools providing fewer sports versus those schools having lower sports participation in the available sports. Our research suggests that the participation gap is not largely due to poor schools having smaller sports teams but offering the same sports choice set for students; what happens instead is that the poor schools have fewer sports available altogether. Overall importance of teams in our analysis is highly dependent on the definition of the sports offering; we have chosen to look at public schools that state that they offer certain team sports. Even though the overall importance of teams varies, depending on the definition used, there are a few sports, including lacrosse, field hockey and track, that consistently play sizable roles in contributing to the gap between rich and poor schools. Therefore suggesting that these teams are important.These findings shall be helpful to inform policies to boost athletic participation in poor schools.

Formation of Carbon Dioxide Adducts from Carboxamide Anions Generated During Gas-Phase Fragmentation of Anions Derived from Capsaicinoids

Author: Annie Wang '22, Physics, *Applied Mathematics*

Mentor: Athula Attygalle, *Chemistry and Chemical Biology, Stevens Institute of Technology*

Novel chemical reactions that consume CO2 as a reactant are

widely sought through research today because increasing levels of CO2 in the atmosphere is the cause to many environmental problems. One known reaction is the CO2 addition reaction, which can be used as a diagnostic structural probe for gaseous anions under mass spectrometric conditions. In our research, we experimented with capsaicinoids, the active ingredients in chili peppers that contribute to the pungency. Daughter scan experiments on all deprotonated capsaicinoids were conducted either in ion mobility mode with mobility cell filled with CO2 or ToF mode without CO2 in the mobility cell. We found that upon activation, all capsaicinoids lose a 136-Da 2-methoxy-p-quinone methide unit to generate a carboxamide anion. The presence of the hydroxyl group at the para position of the vanillamine moiety is crucial for this specific fragmentation to take place. Moreover, the carboxamide anions generated by this fragmentation undergo a nucleophilic addition reaction if they encounter carbon dioxide, and form respective alkanylcarbamate anions. To verify the role of the hydroxyl group attached to the para position in the fragmentation mechanism, we further experimented with N-4-hydroxybenzylbutyramide and N-benzylbutyramide. We found that upon activation, the anion of N-4-hydroxybenzylbutyramide lose a 106-Da fragment for p-quinone-methide to form a carboxamide (m/z 86) which readily react with CO2 to generate a carbamate ion (m/z 130). In stark contrast, the anion from N-benzylbutyramide did not form a CO2 adduct because for the initial p-quinone-methide elimination, the participation of the para hydroxy group is necessary. Thus, we report that for the CO2 adduct formation, a hydroxyl group must be at the para position of the benzene ring bearing the -CH2-NH-COR moiety.

Polynomial Generalizations of Knot Colorings

Authors: Matthew Zevenbergen '21, *Mathematics,* Jacob Miller '22, *Mathematics,* Dorian Kalir '21, *Mathematics, Chemistry,* Austin Ho '21, *Mathematics, Economics,* Rachael He '22, *Computer Science*

Mentor: Vitaly Lorman, *Mathematics, Swarthmore College*

In the mathematical field of knot theory, knot invariants are properties preserved across all embeddings and projections of the same knot. Fox's n-coloring is a classical knot invariant which associates to each knot projection a system of linear equations. Our research looks to generalize Fox's n-coloring by using two, not necessarily distinct, polynomials which we call a (g,f)_p labeling. We have found that the cubic 2x^3-y^3-z^3 forms a valid (g,f)_p labeling, when p is 2 modulo 3. Furthermore, we have confirmed a family of pairs of linear polynomials that together form a valid (g,f)_p labeling. Finally, we have proven that there are no possible pairs with a quadratic polynomial which form a valid (g,f)_p labeling.

Exogenous Attention at the Foveal Scale

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The effects of exogenous attention in the visual periphery have been studied extensively. Yet, it is not well-known if this type of attention can be fine-tuned in the foveola, the 1-degree foveal region where visual resolution is the highest. Here, we addressed this issue by investigating the temporal dynamics of foveal inhibition of return. This phenomenon is typically associated with exogenous attention, and involves the suppression of a stimulus that had been recently attended to.

A classic spatial cueing paradigm was used. The entire stimulus array was scaled in size to fit within the 1-degree foveola. Observers (n=9) fixated on a central marker throughout the trial. After a brief exogenous cue, high-acuity stimuli, tiny bars tilted 45 degrees, appeared at four locations 11' away from the central marker. Following a variable inter-stimulus interval, a response cue appeared pointing to one location. Subjects were instructed to determine the orientation of the stimulus previously presented there. Trials had 50% probability of being valid, i.e., when the exogenous and response cue matched. To eliminate the confounding factor of fixational eye movements, which would otherwise shift the stimulus array on the fovea, we used retinal stabilization; the stimuli remained immobile on the retina, and only trials without microsaccades were selected for analysis.

Our findings show that for shorter inter-stimulus intervals (~60 ms), subjects' ability to discriminate fine details was enhanced at the attended location and reduced at the unattended locations (d' difference between valid and invalid trials; 0.50, $p<0.01$). These results indicate that involuntary attention can be fine-tuned at the foveal scale, contributing to the enhancement of high-acuity vision.

About the Expo

The Undergraduate Research Exposition is a College-wide event in which University of Rochester students at all levels and in all areas of study are invited to present their investigative and creative work. The Expo reflects the passion for research that represents a significant part of the University of Rochester campus, in both professors and students alike. As shown by the work displayed here, which only represents a proportion of all the work presented at the Expo, research comes in varied forms, in every area of study. This year, due to the COVID-19 pandemic, the Expo was held virtually. All of the work presented at the Expo can be found at the link below. With JUR's commitment to serving as a platform for the amazing research done by undergraduate students at the University, we are pleased to display the abstracts from authors who chose to publish their work with us. As always, we hope that these works may inspire our readers on their paths of learning and discovery.

https://ugresearchuofr.padlet.org/ugresearchuofr/research-expo2020

A Self-Fulfilling Prophecy: How Redlining in Rochester Led to a Modern Housing Crisis

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Abstract

Historically, housing policies have been generated by experts with little to no input from the people affected by these policies. This has been especially true for the city of Rochester, in New York, which has been gripped by a housing crisis for almost a century. To contextualize the need for alternative approaches to inquiry, I begin by examining the history of housing policies through the lens of Rochester's minority communities and how they were systematically denied home mortgages through the practice of redlining. I then analyze the impact of redlining on contemporary housing policies and subsequent generations of housing programs. I provide a case study of a Rochester community that was devastated by these discriminatory policies. Finally, I present Participatory Action Research, which is an alternative approach that deeply engages with the communities targeted by policies and could serve as a possible solution to the modern housing crisis.

Keywords: redlining, Rochester, participatory research

Introduction

The Beechwood neighborhood of Rochester, New York lies within the so-called "Crescent of Poverty" that surrounds 75% of the city's downtown district. With dilapidated homes and shuttered storefronts that are in stark contrast to the upscale buildings and bustling restaurants across Main Street, Beechwood serves as physical evidence of the region's poverty, high crime rate, and failing schools.

The Crescent's large homeless population and low rates of home ownership are symptoms of the housing crisis that has gripped the area for almost a century. Of the more than 9,000 evictions processed in Rochester courts annually, the majority affect residents living in these neighborhoods (McDermott 2019). As the number of homeless persons in Rochester continues to increase – by 19% since 2010 – the Crescent has become the region where homelessness and its associated poverty are the most concentrated (Murphy 2016). That the Crescent, unlike the wealthier, predominantly white neighborhoods across Main Street, is largely inhabited by families of color, is no coincidence.

The outlines of Rochester's Crescent of Poverty area can be directly traced back to redlining, a racially-charged policy introduced during the New Deal era. In this paper, I explore the role that redlining, the practice of denying or limiting home mortgage loans to geographic areas with a large share of minorities, played in the origin of systematic housing discrimination in Rochester. I then analyze the impact of redlining on contemporary housing policies and subsequent generations of housing programs. Finally, I present participatory action research as a possible solution to the modern housing crisis that this complex history has engendered.

Residential Security Maps: The Origin of Redlining

In the 1930s, the Home Owner's Loan Corporation (HOLC) and the Federal Housing Authority (FHA) were created as part of the New Deal effort to bring the United States out of the depths of the Great Depression. Charged with the responsibility of refinancing the mortgages of Depression-era homeowners, HOLC refinanced home loans directly, while the FHA provided subsidized mortgage insurance. To steer government investment away from risky places, the HOLC created residential security maps to rate neighborhoods by their level of lending risk (Hillier 2003). The FHA only backed mortgages for residents in blue and green parts of the city, labelled as "best" or "still desirable." Areas outlined in red and yellow were labelled "definitely declining" or "hazardous," and thus did not receive the same level of federal investment (Figure 1).

In reality, neighborhood demarcations correlated strongly with race. Consequently, majority black or immigrant neighborhoods were systematically denied home mortgage insurance. They alsoreceived loans at worse terms than the white residents living in more desirable neighborhoods. The 1936 FHA mandate explicitly stated, "If a neighborhood is to retain stability, it is necessary that properties shall continue to be occupied by the same social and racial classes." In the first 40 years of operation, the FHA distributed over $119 billion in mortgage insurance, and homeownership increased from 44% in 1934 to 63% in 1972 (Jackson 1987, 215-216). Of the 35 million families who benefited from FHA-backed loans, 98% were white (Loewen 2005, chap. 5). This practice of discriminatory lending, based on geographic region and race, became known as redlining.

The HOLC map of Rochester was created in 1935, a seminal event in the city's history of discriminatory housing policies. For three decades, minority and low-income populations in Rochester's redlined neighborhoods systematically received less government sponsorship to become homeowners or refinance mortgages, while white residents purchased homes and moved to suburban neighborhoods. The HOLC's redlined neighborhoods became a self-fulfilling prophecy as the demarcations informed contemporary public and private housing policies, firmly establishing the borders of Rochester's Crescent of Poverty.

The Impact of Redlining on Contemporary Policies

The impact of redlining was compounded by additional New Deal housing policies that similarly discriminated against minority populations. Public housing projects, created to provide subsidized homes for millions rendered homeless by the Great Depression, were racially segregated in Rochester. With worse infrastructure and facilities for blacks than those for whites, public housing exacerbated the social marginalization of minority families (Thurber 2018).

Private lenders and employers also followed the lending practices legitimized by the HOLC maps. From 1924 to 1950, The Code of Ethics of the National Association of Real Estate Boards that served to guide real estate professionals stated: "A realtor should never be instrumental in introducing into a neighborhood a character of property or occupancy, members of any race or nationality, or any individuals whose presence will clearly be detrimental to property values in that neighborhood." Similarly, Rochester's major employers wrote covenants limiting home ownerships in affluent neighborhoods to whites. Kodak, which employed 60% of the city's workforce in the 1950s (Jacoby 1999, 234), released an official covenant for the Meadowbrook neighborhood of Brighton, a wealthy Rochester suburb, that "no lot or dwelling shall be sold to or occupied by a colored person." As discriminatory policies became more widespread, Rochester neighborhoods became increasingly segregated.

The Fair Housing Act of 1968 brought an official end to the practice of redlining by prohibiting discrimination in housing due to "race, color, national origin, sex, religion, familial status, or disability" (Hillier 2003). However, by this time, discriminatory practices had become deeply entrenched in governmental policies and among private lenders. Minority families continued to struggle to find home mortgages or even affordable rental units due to rising rates imposed by landlords that were unchecked by legislation (McKelvey 1965, Crowley 2003). As families moved into "degrading housing in dangerous neighborhoods" (Desmond 2016, 5), depression and loss of jobs followed. Redlined areas, largely occupied by minority families, deteriorated into impoverished neighborhoods of blighted properties, unemployment, and crime.

The Enduring Effects of Redlining: Urban Renewal Programs and Rochester Today

Following World War II, intolerable housing conditions in old broken-down buildings, coupled with the desire to drive poverty out of sight and make better use of urban land, led to the physical destruction of impoverished neighborhoods across the country (Carmon 1999). Under the guise of urban renewal programs, impoverished neighborhoods in several U.S. cities, including Rochester, were demolished and replaced with shopping centers and office buildings (Carmon 1999). The Rochester demolitions were part of the nationwide practice by which 269 neighborhoods in 49 American Rust Belt cities lost more than 50% of their housing (Hackworth 2016). Previously redlined neighborhoods of Rochester, which had continued to deteriorate in the years following the policy's introduction, were specifically targeted.

This policy of ad hoc demolition physically tore down existing black communities. This, coupled with discriminatory hiring practices, culminated in the Rochester Race Riots of 1964. Sparked by an incident of alleged police brutality in Corn Hill, one of the poorest neighborhoods in the Crescent, the rioting spread rapidly to black majority neighborhoods in the west. If poor housing was not the direct cause of the riots, it was certainly a major contributing factor (McKelvey 1965). The Philander Street Case Study (below) is additional evidence of the impact of redlining and subsequent urban renewal programs on Rochester.

Today, the outline of Rochester's Crescent of Poverty almost exactly matches the neighborhoods redlined by HOLC in 1935 (Figure 2). Explicit evidence of the city's chronic housing crisis remains, where even in 2015, black people are more still likely to be denied a housing loan than whites (Empire Justice Center 2015). In the same year, allegations of redlining were settled by Five Star Bank for excluding minority neighborhoods in Rochester from its "lending area" (Murphy 2016). Ultimately, the combination of public and private housing policies and lending practices introduced almost a century ago served to worsen economic and racial segregation such that Rochester remains one of the most segregated cities in the United States today (ACT Rochester 2017).

Case Study: The Erasure of Philander Street

In the 1930s, near the present-day neighborhood of Beechwood, existed the vibrant and family-oriented Philander Street. Old-time residents today still remember Philander Street as the epitome of diversity and community. Initially settled by German and Italian immigrants, black families began moving into the neighborhood, migrating from the South in search of jobs in Rochester's factories. The lively and integrated Philander Street came to be known for its frequent block parties and strong sense of community. Despite its thriving community, the growing black population led to Philander Street's inclusion in the redlined regions of the HOLC map. The resulting loan restrictions made it nearly impossible for black residents to buy homes and build equity while German and Italian families obtained loans and moved to suburban homes.

The neighborhood steadily deteriorated until the 1970s, when under the claims of urban renewal, the city began demolishing houses on Philander Street. The last remaining house was torn down in 1985 and the athletic field of Dr. Freddie Thomas High School was built on its site. Today, no physical evidence of the once thriving community remains. Without the memories of the neighborhood's oldest residents and its documented presence on the 1935 HOLC map of

Rochester, the very existence of Philander Street would be in doubt.

Present-day Beechwood is a living example of how redlining and urban renewal policies result in social marginalization and the destruction of the fabric of communities. The neighborhood suffers from low-median household incomes, a severe shortage of affordable housing units, and failing local schools. Of the 10 least desirable neighborhoods to live in Rochester in 2018 (RoadSnacks 2018), all, including Beechwood, were redlined by the HOLC in 1935.

The Way Forward: Collaborative Community Transformation

The Philander Street Case Study demonstrates how housing policies exploited low-income and minority residents who were not represented in policies that displaced their families and demolished their communities. Historically, housing policies have been generated by experts with little to no input from the people affected. These models not only ignored the lived experience of people in poverty, but also systematically excluded them from framing research questions, analyzing findings, and influencing the design and implementation of intervention (Thurber 2018). When advocating for change, sociologists and urban planners have called for housing policies grounded in credible data generated by community members, who know firsthand the issues they face and thus can break down oppressive systems through research and advocacy.

Such Participatory Action Research (PAR) has already seen success in Rochester. For example, the North East Area Development (NEAD), a community-based development organization in Beechwood, used PAR methods to identify a solution to the neighborhood's "food desert" problem in 2011. Rather than relying on government policies enacted without evidence of positive change in the neighborhood, NEAD purchased its own urban corner store and partnered with the University of Rochester to conduct research. The ongoing participatory ethnographic project in Beechwood is documenting the process of transformation of a typical corner store into the cornerstone of its community – the Freedom Market (Larson 2018). The PAR method has resulted in grassroots efforts to support access to nutritious alternatives through dialogue and food recipes. As the project increased opportunities for community interactions, the process evolved into an interdependence model that built relationships between various groups: NEAD, the Beechwood community, the University of Rochester, and local government. With the corner store serving as a community hub, where generative frictions experienced within the store setting played a key role in animating change, the Freedom Market project has become the seed for a growing grassroots network of justice initiatives throughout the community.

Innovative research methods alone are not enough to produce social, cultural, economic, and political transformation. Housing is a complex issue involving many stakeholders; Whitzman (2017) has proposed that PAR methods should be complemented by the involvement of industry partners with the ability to generate resources. However, by deeply engaging with the targeted communities, PAR is equipped to advance social justice, both in process and outcome. The Freedom Market example demonstrates how by designing their own research agenda and analyzing their own findings, research participants become agents of change and architects of the systems that enable their work (McTaggart 2017). Only direct, meaningful participation of residents can end forced displacement and demolition of minority communities and rebuild community networks.

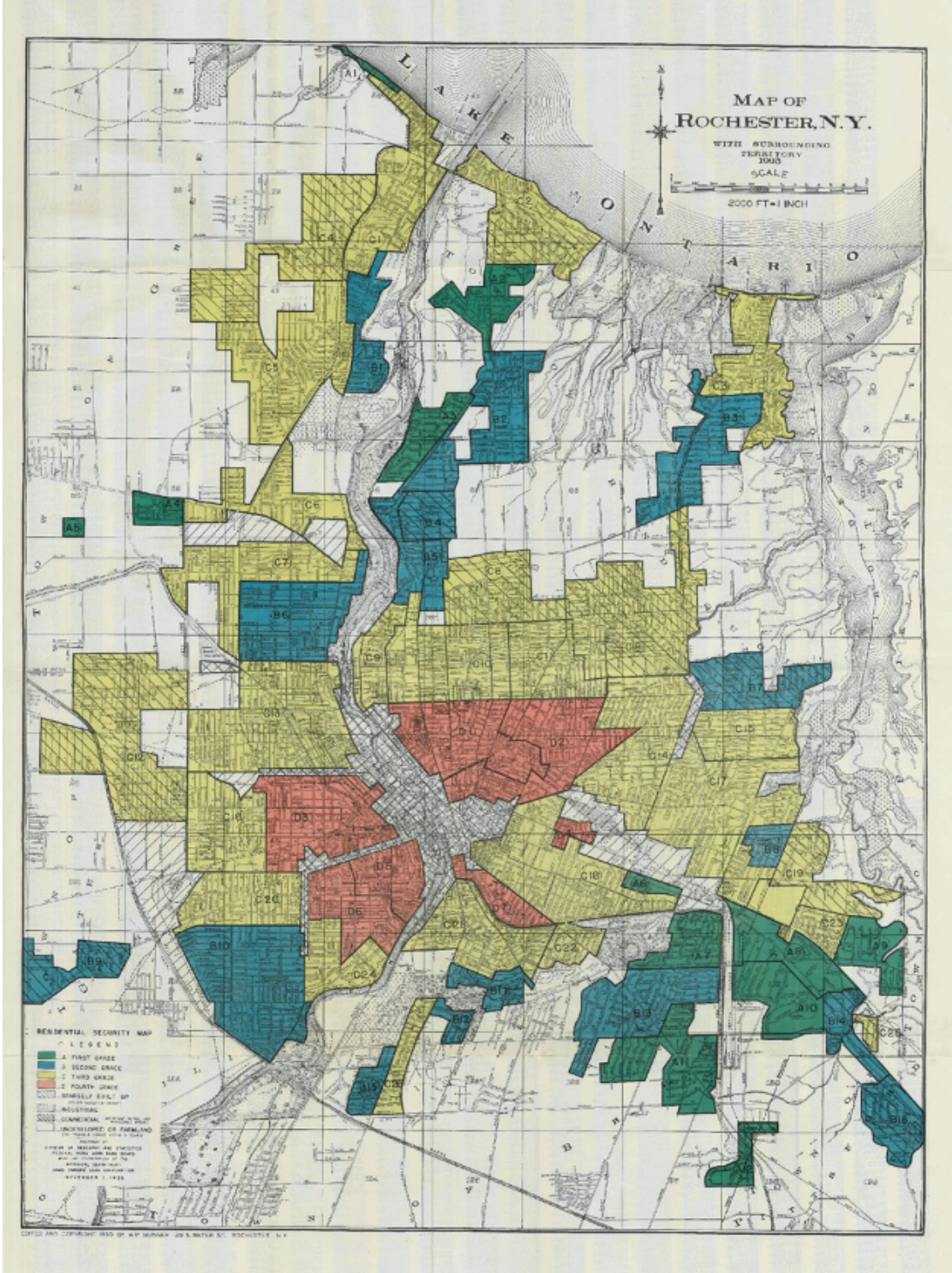

Fig 1. 1935 HOLC Areas by Grade Map, Rochester, NY. Robert K. Nelson, LaDale Winling, Richard Marciano, Nathan Connolly, et al., "Mapping Inequality," American Panorama, ed. Robert K. Nelson and Edward L. Ayers, accessed August 25, 2019, https://dsl.richmond.edu/panorama/redlining/#loc=11/43.188/-77.635&city=rochester-ny

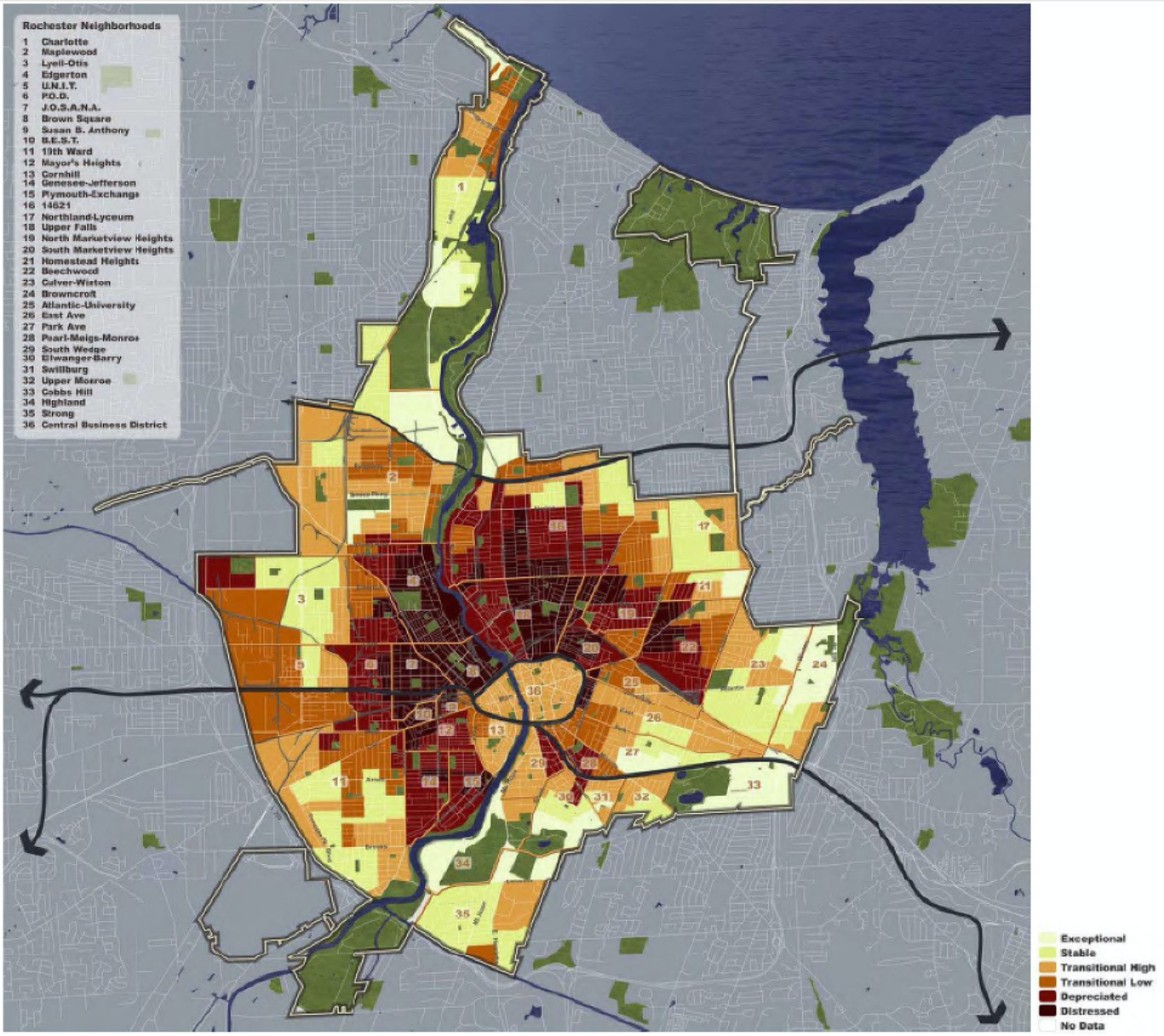

Fig 2. 2006 Neighborhoods Classification, Rochester, NY. The map shows six neighborhood classifications ranging from "exceptional" to "distressed". "Distressed" areas closely follow the distribution redlined on the HOLC map in Figure 1.

https://www.cityofrochester.gov › WorkArea › DownloadAsset

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The Search for Happiness in Meditation Technology

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The practice of mindfulness meditation, which originated in Buddhist India and Taoist China, trains people to pay attention to what is happening in the moment. Today, it is estimated that between 200 and 500 million people meditate regularly around the globe. A research study conducted by the Good Body shows that over 14% of US adults have tried meditation at least once. The benefits of practicing meditation individually or in a group have also been supported by Harvard scientists. This indicates that Americans do not see meditation as a mysterious ancient eastern practice, but rather a powerful tool to improve one's physical and mental well-being.

Since the introduction of the Mindful University Project, more University of Rochester students have joined the program to learn how to meditate and practice mindfulness in their everyday lives. This research study has compiled and analyzed results from a survey with 23 participants and 3 in-person qualitative interviews. After analyzing the risks and the benefits of meditation technologies used by students, this paper aims to list recommendations to improve the meditation program at the University of Rochester using technology.

Burgeoning Meditation Technology

Social media, YouTube videos, advertisements, phones, and laptops are constantly calling for students' attention. A published survey conducted by the University of Waterloo shows that 49% of students said the use of technology for reasons unrelated to classes was distracting to them. The Dominguez Hills researchers observed hundreds of middle school, high school, and university students. They found that students stayed focused on a single task on average for less than six minutes before switching to something else. Thus, the Dominguez Hills school banned the use of smartphones and laptops to minimize digital distractions. Students were punished by grade deduction for sending texts, snap stories, and emails. Nevertheless in the world of prevalent digital distraction, many people have turned to technology for help to find focus, to relax, and to meditate.

One of the most prominent trends is the emergence of technology to help people find peace in a chaotic and overstimulating world. Meditation apps and wearable devices have quickly populated the market to aid in meditation, relaxation, and finding moments of calmness. According to Marketdata Enterprises, meditation is a $1.2 billion industry that could double to $2 billion by 2022. Meditation apps generated more than $100 million last year. The Calm app, a meditation and relaxation app, was valued at roughly $250 million in March 2018. It was founded in 2012 and it currently has 60 million active users. Apple awarded the Calm app as the "App of the Year" in 2017, promising to help users boost their confidence, get better sleep and reduce stress and anxiety. Calm's closest competitor, Headspace, was valued at $250 million in January 2018. Apps like Calm and Headspace guide users through a series of meditations that last 10 to 15 minutes. They usually start with a general introduction of what mindfulness and meditation are and then dive into tailored topics such as managing stress, calming anxiety, boosting confidence, and achieving better focus and sleep.

Interaxon, a meditation hardware company, raised $11.6 million last year. Interaxon produces Muse, a wearable headband with sensors to detect users' brain activity and help people meditate. Muse uses EEG sensors embedded in a headband to monitor brain activity statistics, including how many minutes users spend in a calm state of mind. As apps and wearable device companies continue to capitalize on meditation and mindfulness, many scholars wonder about the effectiveness of these products and the risks and benefits associated with using meditation technology to meditate. People have been meditating for thousands of years without the assistance of meditation technology. How will technology affect our capability to meditate?

Benefits of Using Meditation Technology

Meditation technologies have helped numerous people start their meditation practices and have spread awareness among both busy professionals and university students. Trungram Gyalwa Rinpoche, a Tibetan meditation teacher, felt that the "biggest benefit of technology-assisted meditation is that it can help more people to meditate" and thus has "great potential" to help many individuals. Meditation apps give students the privacy and comfort they need to start their practice. In one of my in-person interviews, a student named Kayla said: "I prefer using the Headspace app because meditation is a personal experience for me and I want to be the only one involved." The use of meditation apps relieves social anxiety that students may face in a group meditation setting or in a public meditation class. Students do not have to interact with an instructor, which may reduce feelings of judgment or punishment. With the help of meditation apps such as Headspace, students can not only find the privacy they need, but also meditate anywhere and at any time. This has made meditation easy for students who live off-campus.

With meditation technologies, students find it easy to fit meditation sessions into their schedules and gamify their progress through reinforced learning. During my interviews,

a student named Bryce revealed that she stopped attending in-person meditation workshops because she lives 20 minutes away from campus and it is inconvenient for her to commute to campus just for the meditation workshops. She downloaded the Headspace app after realizing that committing to a meditation workshop on-campus was not realistic for her. Headspace has many tailored sessions for students such as life changes, self-esteem meditation, and sleep cast. She found a large variety of meditation sessions to choose from. Bryce is currently doing a series about labeling thoughts and feelings. Each session of the series is merely 10 minutes so it is easy to fit into her schedule. Each time she completes a session, Headspace denotes meditation milestones and awards colorful badges based on her progress. The app tracks her statistics under "My journey," which includes her total meditation time and how many sessions she has completed. Each session starts with a "Welcome back" and ends with "See you tomorrow." It has a positive reinforcement effect on her and has held her accountable. Bryce is not alone; in my survey results, 36% of students who meditate have indicated that using a meditation app has increased the consistency of their practice.

Headspace appears to be the most popular meditation technology students use on campus, followed by YouTube videos, Spotify, and the Calm app. None of the students interviewed have used meditation hardware such as the Muse headband. This indicates a lack of awareness around the use of hardware technology to meditate. Regarding Headspace, Bryce and Kayla both think that its yearly subscription fee is fairly priced. Bryce saw an advertisement on Instagram about the $10 yearly subscription fee for Headspace and she decided she would invest $10 in her mental health. A student named Marcus uses the built-in clock app on his iPhone to track how much time he spends on meditation each session. He mentioned that it helps him to meditate more frequently by keeping track of the time. However, Marcus is often too focused on waiting for the bell to ring instead of tuning into his practice. Despite the numerous benefits, meditation technologies also have their limitations.

Risks of Using Meditation Technology

Meditation technologies have three main risks: a lack of monitoring intrinsic motivation, distractions from emails and alerts when meditating, and the potential to trigger adverse reactions to meditation. Bryce has been using Headspace to meditate for more than a year. She stated that she cannot meditate without the Headspace app because she does not have the motivation to meditate on her own. She argues that the app does not support her to develop intrinsic motivation. This could result in an overdependence on technology-assisted meditation.

A group of human-computer interaction researchers from Lancaster University investigated how 280 mindfulness-based meditation applications train mindfulness meditation. According to their findings, most mindfulness apps focus primarily on guided meditations, but offer only limited support for monitoring intrinsic meditation processes or measuring the effectiveness of the training. It is difficult for mobile apps that only have audio and visual outputs to design intrinsic processes or measure the outcomes of meditation practice. Notably, Headspace is the only evidence-based app that has been experimentally studied. The app showed decreased rates of depression and increased positive emotions after use for 10 days. Unlike other apps, Headspace also provides video infographics to explain meditation concepts in simple terms.

Kayla stated that using meditation technology can be a distraction from meditation because she receives email alerts and notifications when meditating. Initially, she planned on listening to relaxing music for meditation. Then, she was reminded by her phone to send out an email, so she shifted her focus from meditation to finding other things to do. This struggle could be resolved by turning off notifications on other applications or designing a feature in the meditation app to turn off notifications from emails or Google calendar.

Meditation technologies could trigger adverse reactions when there is not a real teacher to offer proper guidance to aid a struggling student. In an article for Psychology Today, Willoughby Britton, Ph.D., Director of the Clinical and Affective Neuroscience Laboratory and Assistant Professor of Psychiatry at Brown University Medical School, researched the adverse reactions to meditation. Her research revealed that these reactions can take the paradoxical form of depression, anxiety, and traumatic re-experiencing. If a student experiences any of those adverse reactions when meditating with an app, there is a safety risk if no one is present to intervene or help. Despite these adverse reactions, a student could develop an addiction to the continued use of technology. Will meditation apps be liable for any adverse reactions that they cause? The question of liability is undetermined.

The Future of Meditation Technology: Sensors and AR/VR

Researchers in the field of Human-Computer Interaction have proposed concepts using hardware devices and AR/VR technology to address the challenge of monitoring intrinsic meditation processes. IBM research partnered with the University of Michigan to present MindfulWatch, a smartwatch-based sensing system that monitors respiration in real-time during meditation. It collects essential biosignal data that can be used to build applications to track changes in breathing patterns, offer real-time guidance, and provide accurate biomarkers for meditation research.

Breathing is used as an anchor of present-moment awareness in meditation. Measuring changes in respiration timing during meditation could become an effective method to monitor the outcome of meditation practice, with the aim of helping users sustain their practice long-term. The MindfulWatch senses subtle motions of the wrist caused by respiration to capture the duration of each inhalation and exhalation. The scientists developed a self-adaptive model to keep track of

the user's breathing cycles and train the watch to adapt to the user's respiration patterns and postures over time. The researchers also designed a preliminary feedback scheme to visualize the respiration data that the MindfulWatch collected from 11 meditators and 36 real-life meditation sessions. This data visualization allows meditators to view changes in their breathing patterns. The challenge for future designs is to implement an effective biofeedback mechanism without interfering with the participant's meditation.

Inspired by the concept of Zen Gardening, a group of international researchers developed an initial prototype called ZenG to pave the road for the next generation of AR meditation technology. Combining physiological sensing through electroencephalography (EEG) with AR visualization, ZenG provides an immersive, interactive environment for kinetic meditation practices on the AR headset Magic Leap Display. ZenG uses a number of mindfulness virtual tools derived from kinetic meditation activities, such as a watering can, rake, and seeds in the context of gardening. While the user is meditating, an EEG collects neurofeedback to analyze their brain activity and measure engagement with meditation tools. ZenG, as a neurofeedback technology, has the potential to make user's internal processes more tangible. The preliminary user test with 12 adults indicates that the application was enjoyable and created a relaxing environment for the user. The limitation of this research is that the bio-feedback system requires more rigorous research.

Recommendations for Meditation Students

Intention matters in the practice of mindfulness and meditation. A student must know what they want to gain from a meditation app before using it. Meditation technologies are tools to assist practices. Students need to find their own intrinsic motivation in their practice. Setting an intention could be "I want to reduce stress and manage my anxiety,"or "I want to sleep better," or "I want to find peace in my mind." The intentions need to come from within. Overdependence on technology will not help students find the root problems of their suffering in the long term.

Whether a student wants to try meditation for the first time or build a routine of practices, I recommend taking advantage of the free trials of these meditation apps and exploring some of the free sessions before committing to and subscribing to their full libraries and services. A student should select an app that fits their personality and needs. If they are drawn to colors and design, Headspace has quirky visualizations and vivid animations to explain meditation concepts. Alternatively, meditating with the Calm app will give users a wide range of high-quality narrated meditations, daily mood checks, sleep stories, and relaxing music. If they are interested in trying out a wearable meditation hardware device, Muse is available for rental from the Mindful University Project.

Meditation technology makes meditation lessons more accessible and more convenient for students. However, there is still tremendous value in attending a meditation workshop and learning with a supportive community. A meditation teacher can listen and respond to students' questions and concerns in real-time. Going to a series of meditation classes allows students to learn from their peers and become exposed to different meditation techniques. The aim of meditation practice goes deeper than feeling relaxed and calm. Meditation teachers encourage students to notice the root of their suffering and develop intrinsic motivation to sustain their practice. If a meditation teacher notices any signs of an adverse reaction to meditation, they can help guide students in a more positive direction.

Recommendations for the Mindful University Project

My recommendation for the University of Rochester is to integrate technology-assisted meditation into the Mindful University Project. The University could invest in a meditation application, especially for students who live off-campus and cannot easily access the on-campus workshops. Calm has partnered with seven universities to provide their subscription services to students for free through their Calm College program. They are not currently receiving new applications, but this could be a great partnership to pursue in the future.

On the Mindful University website, meditation apps are listed as part of the resources on campus. However, cost is a barrier for students who want quality content to help them meditate, and it would be helpful if the resource website provided student discount links from meditation companies. For example, when clicking on the Headspace link on the resource page on the website, it currently leads to the main company page for Headspace. Instead, the University could link it to the student discount page for students to easily access the $9.99 per year student discount. Since my research has found Headspace to be the most popular meditation app on campus, the University could negotiate with Headspace to offer students a less expensive subscription fee. In addition, the Mindful University resource page should provide more information on the features of each app or wearable device. Most students sign up for an app without being aware of how to use the app, or the adverse reactions that it could cause.

The University should be cautious about addressing the risks of promoting meditation technologies among students. Meditation technology can have an adverse impact on students such as triggering depression, anxiety, and traumatic re-experiencing. The University can implement an introduction workshop to present students with information about the benefits and risks of a variety of mindfulness technologies. For students who live off campus, it is more likely for them to subscribe to a meditation app or use a device. The University could offer virtual sessions for students to ask questions about the meditation practice and offer guidance if they notice any signs of adverse student reactions to technology-assisted meditation. If there are not enough teachers available

to host virtual sessions, an experienced student could lead virtual meditation sessions to mentor the less experienced.

Links for university program partnerships:

https://www.headspace.com/studentplan

https://blog.calm.com/blog/calm-college

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Calling The Cops: How Race/Ethnicity and Gender Contribute to the Perception of the Police at the University of Rochester

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Abstract

Nationally, people of color report lower levels of trust in the law enforcement compared to their White counterparts. This paper examines this sentiment at the University of Rochester in New York, in relation to the campus police called Public Safety. A survey regarding race/ethnicity, gender, and number of emergency calls to Public Safety was administered to 391 undergraduates. Trust in Public Safety was operationalized by the amount of calls made to them by students, wherein more calls suggest higher amounts of trust. A two-way ANOVA, logistic regression, and Poisson-Hurdle regression all showed only gender to be a significant predictor of calling Public Safety, with males calling more often than females. Neither race/ethnicity nor the interaction of race/ethnicity and gender were significant predictors. Implications of these results will be discussed.

Background

The prevalent social climate in the United States of America is one where law enforcement is feared by people of color (POC). This is mostly because POC are disproportionately targeted and profiled by law enforcement agents. In 2017, police killed 1,147 people with Black people being 25% of those killed despite making up 13% of the population. The same study found that Black people were three times more likely to be killed by the police than White people even though 30% of those Black people were unarmed compared to 21% of the White people. It is also pertinent to mention that 13 out of the 100 largest U.S. city police departments kill Black men at higher rates than the United States' average murder rate. The Black Youth Project found that less than half of Black youth (44.2%) trust the police compared to young people from other racial and ethnic groups.

Research also suggests that the gender of an individual affects one's experience when interacting with the police. Due to the gendered policies of many U.S. police departments (such as the policy that only male policemen can search males and vice versa) and the male-dominated police force, there exists a dynamic of procedural injustice that is based upon the gender of an individual.[1] This results in men and women having vastly different interactions with the police. Moreover, it is very important to consider the intersection of one's identities because those identities introduce a new dimension into one's experience with the police. Novich, Kringen, and Hunt (2018) found that the police unfairly enforced the law on disadvantaged male suspects when compared to female suspects. Such research is crucial to ensuring that all people feel safe and equal when interacting with the police and to guaranteeing harmony.

The goal of this study is to see whether or not race/ethnicity, gender, and the interaction of the two (such as Black females or White males) will have different expectations of interactions with a campus police force (Public Safety) at the University of Rochester. This was quantified by administering the student body a survey which asked the number of times they had called Public Safety in emergencies during the last academic year. An emergency was described as *"a medical or non-medical emergency that requires immediate Public Safety's attention"* to control for the plethora of other reasons Public Safety is called for such as lost belongings, lock-outs, and "safe" rides. Higher amounts of calls indicate higher levels of trust and vice versa. The rationale is that if a student trusts Public Safety then they would not hesitate to call them, while students with lower levels of trust would generally try other approaches in tackling the emergency. Thus, this study has two guiding hypotheses:

1. POC will be less likely to call Public Safety due to high levels of distrust and disproportionate targeting nationally.

2. Male POC will call Public Safety the least due to the disproportionate targeting towards them evidenced at a national level.

Methods

The data was collected through convenience sampling and the participants were given a short survey which asked for their demographic data (i.e., age, gender, race/ethnicity, and class year). Lastly, the survey asked for the number of times they have called Public Safety in the past academic year for an emergency. Responses were collected from 391 participants , representing 10% of the total undergraduate population of the college. These 391 participants represented the four major races/ethnicities in the school: Asian (including the Indian subcontinent), Black or African-American, Latinx, and White/Caucasian. Since very few non-binary people took part in the study, the data was categorised as males and non-males (including females and non-binary students). Three inferential statistical tests were run to test the reliability and the validity of the data:

1. Two-way ANOVA was chosen to test the differences in mean between the groups of races and genders. Interaction between gender and race/ethnicity was also tested. ANOVA was chosen because it is a versatile test and is robust when

the sample size is big enough. The data was not normal in this dataset (there were many zeros signifying no calls to Public Safety), but, since the sample size was 391 participants, we were able to assume that ANOVA conditions would hold.

2. Binary Logistic Regression was chosen since the data could easily be converted into binary by designating no calls to Public Safety as "0" and one or more call(s) as "1." This allowed for the calculations of the odds of calling Public Safety based on one's race/ethnicity and gender.

3. Poisson Hurdle Regression was chosen because the data had many zeros which made the data non-normal. This model is for count data and helps handle excess zeros and over-dispersion. When performing Poisson regression, it is assumed that our count data follows a Poisson distribution with a mean conditional on the predictors.

The data was analyzed with the statistical program Minitab. The chosen significance level was α=0.05.

Results

Of the 391 participants, 77.4% never called Public Safety in the academic year, while 22.6% called at least once. With regard to gender, 41.2% of the participants identified as males, 56.9% as females, and 1.9% as non-binary. When asked for racial and ethnic backgrounds, 54% of the participants identified as White, 10.7% as Black, 24.5% as Asian (including the Indian subcontinent), 9.1% as Latinx, and 1.7% as other. This gender and racial breakdown closely mirrors the college's overall population.

Two-way ANOVA

This analysis showed that gender was very significant in predicting the calls made to Public Safety (p=0.005). This suggests that there is a difference in the means of calls made to Public Safety between males and non-males in this sample. Moreover, race/ethnicity also approached significance (p=0.082). However, the interaction between race and gender remained non-significant. A closer look into the ANOVA results shows a very clear pattern that is consistent with our hypotheses. Specifically, for race/ethnicity, the number of calls made by White/Caucasian individuals was significant and implied that the means of Whites/Caucasians were different from the rest (p=0.026). The Means Table from Minitab showed that the mean for Whites/Caucasians was much higher than the rest while the mean for all the non-male participants was lower than for males.

Binary Logistic Regression

The binary logistic regression analysis also showed results consistent with the ANOVA. The results suggest that gender has a statistically significant association with the number of calls to Public Safety (p=0.007). The odds ratio for the significant term was also calculated to be 4.3. This implies that males are 4.3 times more likely to call Public Safety than non-males. No other predictor variables (such as race/ethnicity) were significant.

Poisson Hurdle Regression

As mentioned above, there was a huge number of zeros in the dataset, indicating individuals made no calls to Public Safety as apparent from Figure 1.

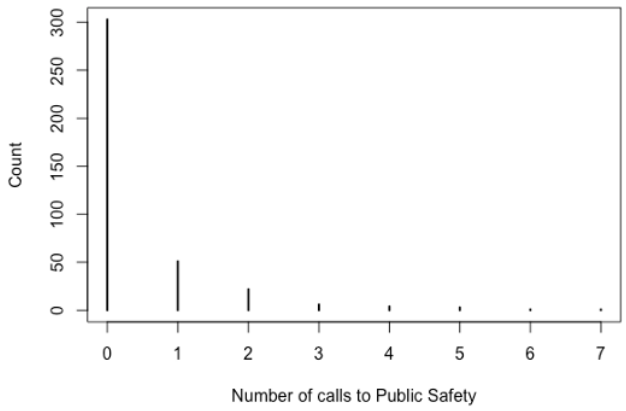

Fig 1. The over-dispersion and skewness of data

Illustration of Skewness

After correcting for the over-inflation of the excess zeros (266 expected while 303 observed), the Poisson Hurdle regression showed that gender had a significant effect on Public Safety calls (p= 0.00562). No other factors were significant, including race. This implies that our previous models, which were poor fits, could not correct the over-inflation of the zeros in the data. Figure 2 shows the counts after correcting for over-inflation of the zeros.

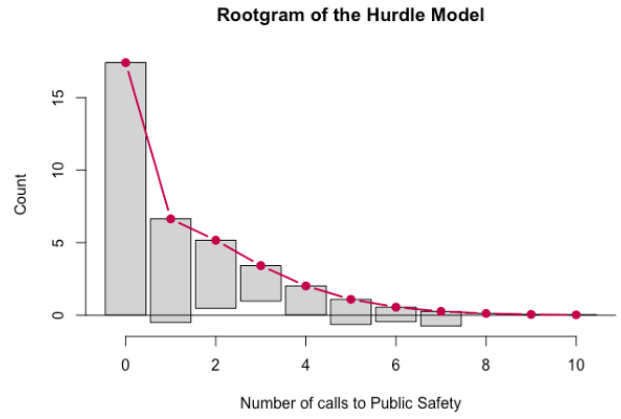

Fig 2. The hurdle model after correcting for the over-inflation of number of zeros in the data.

Conclusion & Discussion

This study aimed to analyze discrepancies that may exist in seeking Public Safety's help as a function of race/ethnicity, gender, and the interaction of the two at the University of Rochester. The results suggest that a racial/ethnic bias towards calling Public Safety does not exist on the campus,

effectively refuting both hypotheses. However, there is a gender bias, wherein males are 4.3 times more likely to call Public Safety for help compared to non-male students, regardless of race/ethnicity. Lastly, there was no evidence of significant interaction between gender and race/ethnicity.

A major reason that this data could have deviated from previous research is that students may have a very different outlook on the role of Public Safety on campus, compared to police in the city. This could be due to the fact that Public Safety officers are currently unarmed, thus reducing the student body's fear. They are also seen around the school often, which in a way normalises their presence. This could lead to students seeing them as trustworthy and helpful, and not as a threat. Moreover, previous research on police brutality has been done in areas with relatively little economic growth and low education rates, which increases the chances of the police getting away with misdemeanors. However, this is not necessarily the case in a large upstate New York college, where students are well aware of their rights and Public Safety is kept in strict check by the college.

However, it was surprising to see a gender deviation in the sentiments towards Public Safety, which could potentially be explained by the disproportionately low number of female officers on-campus. Positive, same-gender role models are excellent in fostering a sense of trust towards an organisation, and Public Safety fails to possess them. This is in line with previous research which shows that males and females have a very different experience with law enforcement, mostly because of the bureaucratic problems that exist in police stations. Non-male students may not expect cis-male Public Safety officers to understand some of their problems; thus they may opt to consult other resources, such as *RESTORE Rape Crisis*, significantly reducing calls made to Public Safety.

There are several limitations in the study. The dataset, though representative, captured only approximately 10% of the college's population. A bigger and randomly-sampled dataset would be excellent in elucidating this phenomenon. Since participants were self-reporting, they could also have been exaggerating the amount of times they called Public Safety to appear more responsible. Another problem in this dataset was the over-inflation of zeros, making it non-normal, thus requiring several tests to check and balance the robustness of two-way ANOVA. A future direction could be to develop a novel method to test such data. Lastly, for a future study, participants could be asked for the specific reason they called Public Safety; responses could then be coded to provide a greater depth in the data.

These are incredibly optimistic results and show a general trend of trust towards law enforcement on racial and ethnic lines. Although the police force has a long way to go to cultivate trust among American minorities (non-males and non-Whites), this study suggests that it is possible on smaller scales, which can eventually build up.

Footnotes

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Expression analysis of *Drosophila melanogaster* Immunoglobulin proteins across follicular epithelium and embryo tissues with RNA-seq

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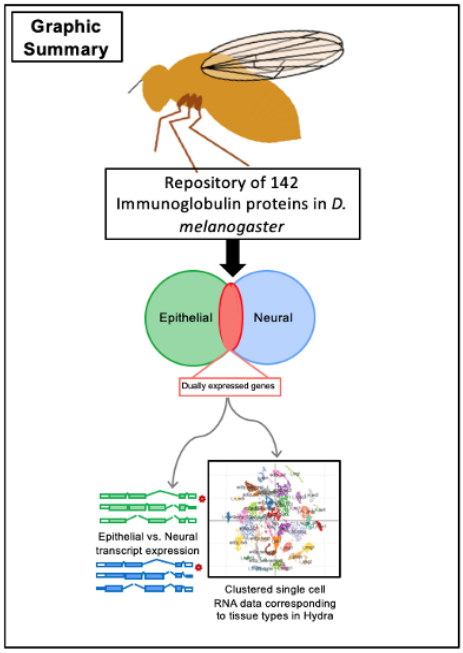
Advised by Amanda Larracuente, *Department of Biology*



Abstract

The immunoglobulin (Ig) superfamily is comprised of proteins with conserved structures of Ig domains. Many of these proteins have defined roles in neural and epithelial tissue development. These roles include mediating cell adhesion, specifically within neural tract development and axon guidance. In this study, we conducted an analysis of the Ig proteins in *Drosophila melanogaster* and their expression in epithelial and embryo tissues. By comparing expression levels across two RNA-Seq datasets, we found six Igs to be dually expressed in both the follicular epithelium and the embryo: fasciclin 2, fasciclin 3, lambik, sidekick, neuroglian, and basigin. We analyzed the transcripts of these six Igs but were not able to draw strong conclusions on tissue-specific isoforms or transcript expression. Finally, we were interested in the evolutionary origin of Igs in neural and epithelial development by studying Ig expression in *Hydra vulgaris*. Of the six dually expressed Igs found in *D. melanogaster*, homologous proteins for neuroglian and sidekick were identified in *H. vulgaris*. Expression patterns held true for these homologs in *H. vulgaris* based on single cell transcriptome data. Our study provides a basis for a comprehensive analysis of Ig expression across neural and epithelial tissues using modern computational methods.

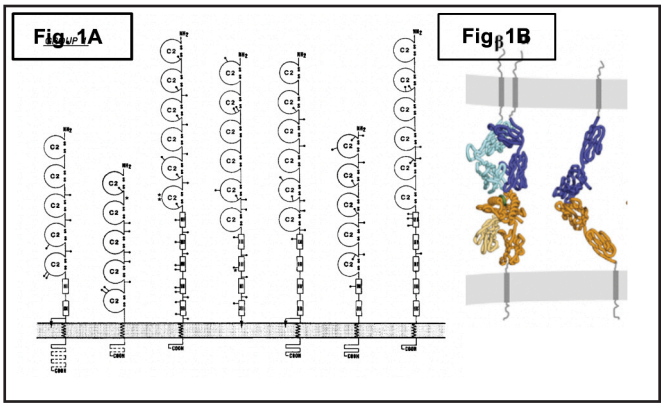


Figure 1) Structure and tent located in encampment, 2019. An image shows living environment for residents of the encampment.

Introduction & Background

Immunoglobulin cellular adhesion molecules (IgCAMs) are members of the immunoglobulin (Ig) superfamily, characterized for their role in cell surface connections and communication (Aricescu & Jones, 2007). The structure of Ig proteins is highly conserved as each Ig protein contains a transmembrane domain, a cytoplasmic domain, and an extracellular domain with arrangements homologous to those of immunoglobulin domains (Fig. 1A) (Shimono, Rikitake, Mandai, Mori, & Takai, 2012). The structure of these proteins lends to participating in homophilic and heterophilic adhesive interactions at cell contacts (Fig. 1B) (Aricescu & Jones, 2007). The role of IgCAMs is well characterized in neural tissues, defining their function as critical for laying the molecular architecture needed for axon guidance and neuron development (Grenningloh et al., 1990; Siegenthaler, Enneking, Moreno, & Pielage, 2015, p. 1; Spindler & Hartenstein, 2010). Curiously, some of these Ig proteins have also been identified in epithelial tissues with significant functional roles in cellular adhesion and maintaining tissue integrity (Aricescu & Jones, 2007; Bergstralh, Lovegrove, & St Johnston, 2015; Wu, Tanwar, & Raftery, 2008). The functions of Igs in epithelium are not well studied compared to neural immunoglobulins. Nonetheless, expression and functional implications of Igs in both neural and epithelial tissues is striking and presents an interesting question: in what tissues did IgCAMs originate and how have they developed through evolution? Of particular interest is how expression patterns

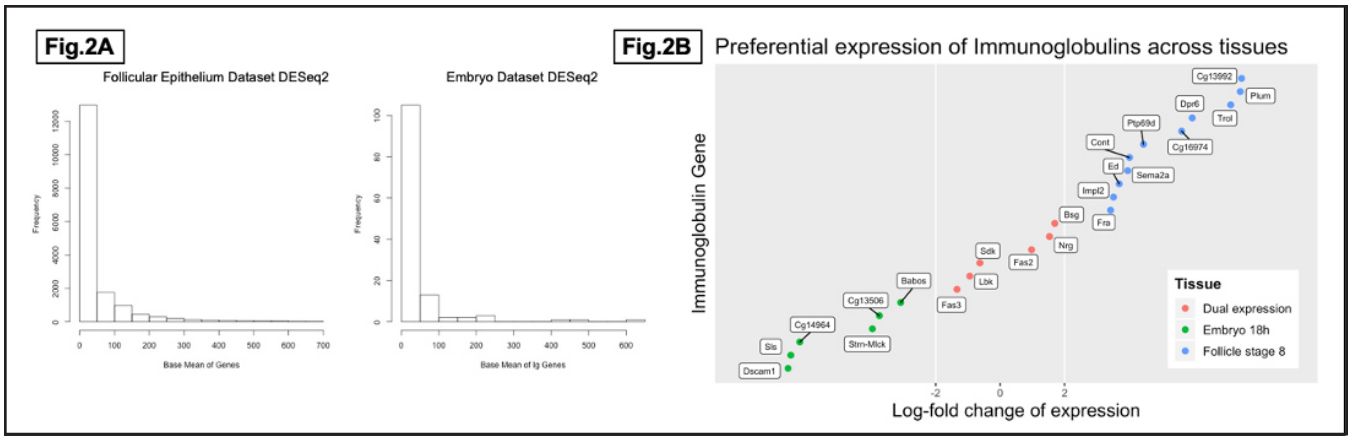


Fig. 2A) Base mean values for scaled mapped read counts of each dataset.

Fig. 2B) Log2fold values from HTSeq counts characterized by significant expression according to dataset.

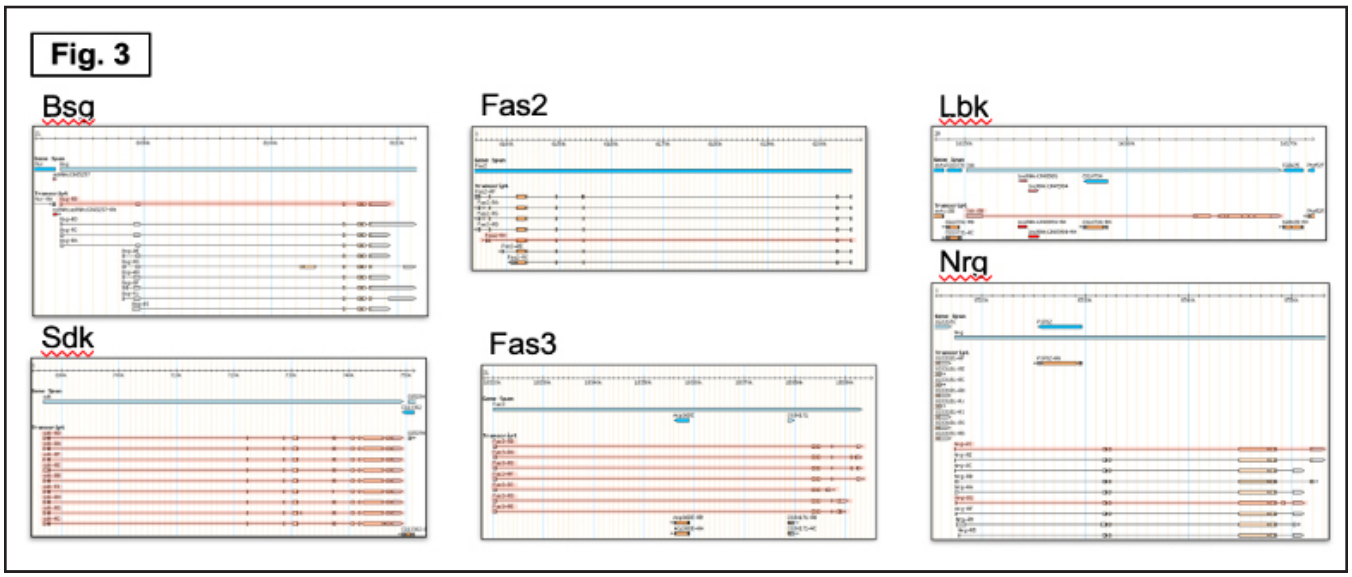


Fig. 3) Unique transcripts of Bsg, Fas2, and Lbk were found to be expressed in neural and epithelial tissues (1 transcript identified as expressed). However, for Nrg, Fas2, and Bsg, multiple transcripts were found to have reads mapped in both datasets.

reflect this evolutionary development in neural and epithelial tissues.

The evolutionary relationship of Igs between *C. elegans* and *D. melanogaster* may be elucidated by identifying the repertoire of all Igs in *D. melanogaster* and in *C. elegans*. Examining all Igs between organisms, this comprehensive analysis still fails to provide conclusions on any tissue-specific roles of these proteins through evolution (Vogel, 2003). To the best of our knowledge, there is currently no comprehensive analysis regarding IgCAMs and their roles in both neural and epithelial tissues. Interestingly, neuroglian and fasciclin 2 are two Ig proteins that have been functionally characterized independently for their role in axon guidance and epithelial adhesion through development, making these proteins a built-in control for our study (Halberg et al., 2016; Siegenthaler et al., 2015). Although functional assays have revealed a great deal of what we know about immunoglobulin proteins, large amounts of genomic data in conjunction with powerful computational tools provides a method to study questions related to IgCAM function and evolution.

In addition to genomic data available on expression patterns in *D. melanogaster*, *H. vulgaris* single-cell sequencing efforts provide a system for comparing Igs between *D. melanogaster* and an organism more basal than *C. elegans*. *H. vulgaris* is a unique species, as it is one of the most basal organisms to *D. melanogaster* that has both neural and epithelial tissues (Siebert et al., 2019). This model allowed us to compare expression through evolution and presents a niche system to study early epithelial and neural tissues. Our investigation provides exciting tissue-specific information on the role of

Fig. 4A

D. Melanogaster protein	Neuroglian Nrg	Fasciclin 2 Fas2	Fasciclin 3 Fas3	Sidekick Sdk	Lambik Lbk	Basigin Bsg
Hydra vulgaris homolog	Contactin-2-like			Sidekick-1-like		

Fig. 4B

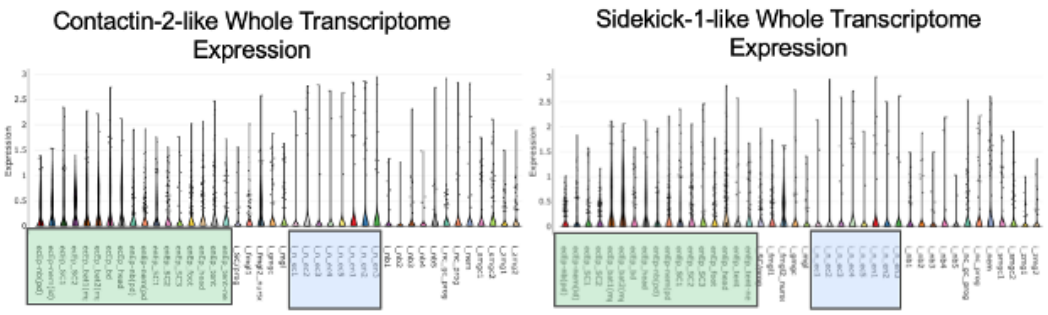


Fig. 4A) BLAST searches identify reciprocal, 1-to-1 homologs for two of six dually expressed immunoglobulin proteins. **Fig. 4B)** Expression data from single cell transcriptome analysis is clustered based on tissue type of Hydra vulgaris.[3] Blue highlighted labels correspond to neural tissues and green highlighted labels represent epithelial tissues.

Igs as well as demonstrates overlapping patterns dating all the way back through *H. vulgaris*.

Results

Differential expression of Ig genes

The repository of Ig proteins identified in *D. melanogaster* was the starting point for our comprehensive expression analysis (Vogel, 2003). Starting with these 142 predicted Ig proteins, we identified 132 unique and annotated Igs in a gene transfer file for *D. melanogaster*. We mapped RNA-Seq reads from two distinct datasets to the most recently available *D. melanogaster* genome assembly (dos Santos et al., 2015). In our study, we used a stage 8-10 follicular epithelium RNAseq dataset as a system to study epithelial tissues and an 18-hour embryo dataset that allows us to investigate neural tissue development (Becker et al., 2018; Sieber & Spradling, 2015).

With differential expression analysis, a base mean threshold (>50) was used to determine 23 genes that are significantly expressed in stage 8-10 follicular epithelium, 18-hour embryos, or both (Fig. 2A). From this subset of Ig proteins, log2fold values classified proteins to be significantly expressed in embryo tissues, follicular epithelium, or both tissues ("dual expression"). Six genes were characterized with embryo expression and eleven genes were expressed in follicular epithelium. Of particular interest are the six Ig genes identified as dually expressed with significant expression in both datasets:

fasciclin 3 (Fas3), labkin (Lbk), sidekick (Sdk), fasciclin 2 (Fas2), neuroglian (Nrg), and basigin (Bsg) (Fig. 2B).

Transcript analysis of dually expressed proteins

We proceeded to analyze the transcripts for genes identified as dually expressed to study tissue specific expression patterns at the isoform level. RNA-Seq reads were mapped to transcripts in the *D. melanogaster* genome and mapped read counts for each transcript were calculated. Lbk had one isoform and showed significant mapped read counts in both datasets. Bsg and Fas2 each had read counts mapped to the same unique transcript in both datasets. Nrg had reads mapped to two distinct transcripts in both datasets. Fas3 and Sdk had read counts mapped to all transcripts in both datasets (Fig. 3).

Comparative Expression Patterns in Hydra vulgaris

To gain insight on the functional roles of Ig proteins in neural and epithelial tissues throughout evolution, *H. vulgaris* provides a unique model system with significant data available from single-cell transcriptome analysis. Homology searches found two of six dually expressed *D. melanogaster* proteins to have clear one-to-one homology with proteins in *H. vulgaris*; contactin-like-4 is homologous to Nrg, and sidekick-1 is homologous to Sdk (Fig. 4A).

Expression data for these homologs was obtained by querying available data from single-cell transcriptome efforts in *H. vulgaris* (Siebert et al., 2019). While quantitative analysis was not possible, these two homologs both demonstrate dual expression in both epithelial and neural tissue clusters (Fig. 4B).

Discussion

Central to our study are the RNAseq datasets used for expression analysis. A stage 8-10-hour follicular epithelium dataset was selected because, through these stages of egg chamber development, cell adhesion is critical for successful epithelial tissue development (Sieber & Spradling, 2015). Thus, Ig proteins critical for epithelial tissue development are expected to be expressed in the follicular epithelium dataset. An 18-hour embryo dataset was selected on the basis that neural development – specifically axon guidance – occurs at this point in development (Becker et al., 2018). Ig proteins involved in neural development are expected to be expressed and enriched in representation within our embryo dataset. However, 18-hour embryos have various tissue types aside from neural tissues represented in our embryo dataset. At this late stage, an embryo will also include epithelial tissue. This adds complexity to our results, restricting our ability to define a relationship directly between neural Ig proteins and expression in our embryo dataset.

In terms of our differential gene expression data, the limitations of our dataset cloud the implications of the set of six dually expressed genes. We can confidently conclude that Ig proteins demonstrating significant expression in the follicular epithelium dataset are important for epithelial tissue development. On the other hand, it cannot be determined if Ig proteins expressed in the embryo dataset are expressed strictly in neural tissue, strictly in epithelial tissues, or if expression is a sum of various tissue types of the embryo. We assume that, because axon guidance and neuron development typically occurs at 18 hours, the proteins involved in this process of neural tissue development are upregulated at this stage. Thus, we infer that embryo dataset protein expression reflects proteins involved in neural tissue development. The proteins we find to be dually expressed in datasets likely have some role in both epithelial and neural tissue development.

The characterization of Nrg and Fas2 as dually expressed across datasets is not surprising, as multiple functional analyses have shown that these proteins have roles in both tissue types, and we considered these proteins as controls throughout our experiments (Bergstralh et al., 2015; Halberg et al., 2016, p. 2; Siegenthaler et al., 2015). Although not a control in our experiment, finding Sdk to be significantly expressed in both datasets is not shocking. Sdk has documented functions for homophilic cell-cell interactions in membranes and growth of cones in the eye, a common process in developing neural systems (Nguyen, Liu, Litsky, & Reinke, 1997). Expression data characterizes Fas3 as a dually expressed protein, which is also not surprising because of this protein's described roles in axonal fasciculation and axon guidance in embryos, as well as distinct roles for cell adhesion in follicle cell development (Halberg et al., 2016; Snow, Bieber, & Goodman, 1989). Lbk and Bsg are exciting findings as dually expressed proteins, as Bsg is only annotated for cell-cell adhesion functions and Lbk lacks any related GO terms (Besse et al., 2007). In the future, phenotypic assays aimed at comparative tissue specific investigation, particularly for Bsg and Lbk, have potential to provide novel information on the functional similarities between these Ig proteins in neural and epithelial tissues.

While most proteins characterized with significant expression strictly in one dataset appeared reasonable, we expected opposite expression patterns for semaforin2 (Sema2). Although our analysis indicated that Sema2 is strictly expressed in follicle cells, we anticipated expression in the embryo as this protein was originally characterized for its role in axon guidance (Nguyen, Liu, Litsky, & Reinke, 1997). This 'misclassification' indicates that there are holes in our pipeline and suggest more tissue-specific, alternative datasets may be better equipped for the analyses we conducted.

While we were able to identify the unique, uniformly expressed transcripts in follicle and embryo datasets for proteins Bsg, Lbk, and Fas2, the results for Fas3, Nrg, and Sdk were essentially ambiguous. Our mapping of reads to transcripts was likely not sensitive enough to distinguish which transcript was expressed in each dataset. Further, the transcripts for these proteins are so highly conserved that there is likely little functional insight to be gained from differential transcript analysis. In retrospect, an isoform analysis should be conducted with mapping to exons and exons mapped back to transcripts or genes to investigate alternative splicing across datasets.

Because of the large evolutionary distance and difference in complexity between *H. vulgaris* and *D. melanogaster*, identifying direct homology with confidence is difficult. For the proteins we did identify homologs for, the conserved expression pattern across tissues suggests the functional role of Ig proteins has been essential in each tissue type development from a very early origin. *H. vulgaris* is one of the most basal organisms to have neurons, although it still lacks a central nervous system. Our comparative analysis results suggest that Igs are essential to neural tissue development and challenge the hypothesis that neural Ig proteins evolved from epithelial Igs as a result of the development of central nervous systems.

The classification of dually expressed proteins presents a subset of Ig proteins that experimental investigators may be interested in characterizing across neural and epithelial tissues. Our study also emphasizes that, while large amounts of genomic data are available, relevant analysis is dependent on particular conditions and datasets available. Repeating our study with neural-specific datasets would likely provide more significant findings.

Methods

Curating Ig protein transcript lookup table

The initial list of proteins of interest and associated transcripts was created by extracting FBgn IDs for genes from FlyBase Batch Download using CG IDs 142 Ig protein repos-

itory and was taken from a previous study. FBtr IDs were extracted for corresponding transcripts from the GTF file on Bluehive and further processing of this lookup table was done via Python scripts.

Genome:

The reference genome available on Bluehive was used for mapping: dmel-all-r6.13.gtf .

RNA-Seq Datasets

Datasets for both follicle and embryo were obtained from SSR, controlled for Oregon R genotype with three and four replicates respectively. (Follicle SSR IDs: SRR1792881, SRR1792882, SRR1792883; Embryo SSR IDs: SRR8040230, SRR8040231, SRR8040232, SRR8040233)

Mapping reads

RNA-Seq reads were mapped to the *D. melanogaster* genome using Bowtie2. Outputs were indexed and sorted using Samtools. HTSeq was then used to analyze mapped read counts.

Differential expression analysis

DESeq2 software was used to analyze expression across two datasets. BaseMean values were used to determine an arbitrary cutoff of significant expression for proteins of interest. Log2fold values were used to determine a threshold for significant expression of expressed proteins in one or both datasets.

Comparative analysis with H. vulgaris

NCBI protein accession codes were obtained for the six dually expressed Ig proteins (Nrg NP_001259336.1, Fas2: NP_001284855.1, Fas3: NP_001286039.1, Bsg: NP_723346.2, Sdk: NP_001284758.1, Lbk: NP_611091.2). BLAST searches were conducted in *H. vulgaris* and reciprocal BLAST searches were conducted to ensure the top hits were one-to-one homologs. For the two one-to-one homologs identified (Nrg homolog: XP_004210093.2, Sdk homolog: XP_012557393.1), the associated nucleotide sequences were obtained from NCBI . BLAST searches for these nucleotide sequences (Nrg homolog: XM_004210045.2, Sdk homolog: XM_012701939.1) were then conducted using the Single Cell Server and were queried against Juliano2aepvl to obtain the transcripts for *H. vulgaris*. These accessions (Nrg homolog: t6717aep|CNTN4_HUMAN, Sdk homolog: t8498aep|SDK1_CHICK) were then searched in the Single Cell Portal Whole Transcriptome Database of *H. vulgaris* for qualitative expression levels.

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Implementing Chemical Reaction Networks in AR

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Introduction

Project Outline

A chemical reaction network refers to the subject area of real-world calculations involved in determining how a chemical system proceeds. In this project, the chemical system is a collection of chemical reactors in which users are able to configure reactors to set up the reaction network. An augmented reality (AR) program calculates the variables of interest in real time as the user moves and adjusts reactors or parameters within the reaction network; these variables of interest are then simultaneously projected onto the user's work area. Within the AR program, critical assumptions are made regarding the reaction conditions such as temperature, volume, etc. This paper aims to elucidate the assumptions made within the reaction model to determine the impact on accuracy and meaningful physics of the chemistry involved.

This introductory section aims to describe the overall system, the general system and specific reactor assumptions, and consequences of these simplifications. The following section describes how reactors may be configured differently and how this affects conversion. (Conversion, X, is a measure of how much reactants are converted into desired products within a reaction.) The third section focuses on temperature and volume changes the user may implement and how to determine the optimal conditions for favoring increased desired product yield.

AR System Description

An AR system was constructed in Dr. Andrew White's research group to simulate systems of chemical reactors in real time. Students interact with the table by placing miniature reactor figures on the tabletop and connecting the reactors with sticks which act as pipes. A camera tracks all the reactors and connections as the user makes adjustments, while a projector overlays relevant chemical information onto the glass tabletop.

This learning experience aims to provide undergraduate STEM students a hands-on environment for exploratory learning. The system fosters exploratory learning through its inherently open-ended format: students have millions of configurations available to them, if only they can think of them. In the Spring 2018 and Spring 2019 semesters, students from the ChE231: Chemical Reactor Design course used this AR system for a learning activity. Research has been conducted for Spring 2018 regarding how students learn with this experience. [1]

Within this particular AR system, there are three chemical reactor types: plug flow reactor (PFR), packed bed reactor (PBR), and continuous stirred tank reactor (CSTR). As long as the reactors and pipes are placed on the tabletop, the augmented reality system takes care of the calculations of chemical species conversion based on the configuration and its conditions.

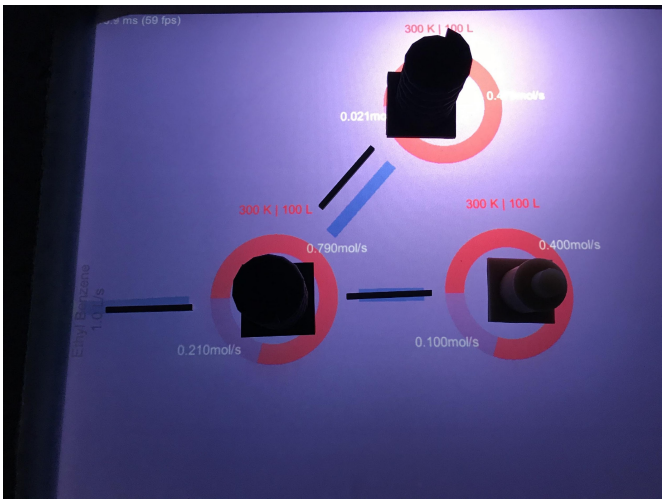


Figure 1. Sample AR Table configuration: several reactor figures connected via pipes with chemical species molar flow rate represented in the surrounding glowing ring.

System Assumptions

During the operation of the chemical reaction network, several assumptions are critical to the calculations and results.

(a) Steady state is maintained (i.e. Constant volumetric flow rate, $v_0 = v$. No accumulation, $\frac{dN_j}{\mathrm{dt}} = 0$.);

(b) Steady state is maintained (i.e. Constant volumetric flow rate,

(c) No reaction occurs within the pipes between the reactors;

(d) Unless otherwise stated, $aA + bB \rightleftharpoons cC + dD$ is the general chemical reaction used where $a + b = c + d$.

(e) All reactions are first order (i.e. only one limiting reactant, assumed to be species A for forward reaction and species C for reverse reaction) such that the general rate law expression is:

$$-r_A = k_1 \, c_A$$

or

$$-r_{A_{\mathrm{net}}} = k_1 (c_A - \frac{c_c}{k_{\mathrm{eq}}})$$

where k is a rate constant.

(f) All reactions are reversible;

(g) No phase change of any chemical species;

(h) Source feed contains only reactant species (i.e. There is no recycled feed nor any contamination present.);

Assumptions (a) - (b) we know to be untrue. For example, steady state will occasionally be compromised through channeling of flow or even during reactor startup as the system is initially filling up with

In contrast, assumptions (c) - (g) are true because we have selected reactions or conditions which make it so. With additional effort, the system capabilities could theoretically be extended to allow non-first order, irreversible, inconstant molar, and/or phase-change reactions in a recycled feed system; however, the simplifications serve to have students focus their attention on what variables are most important toward the learning activity, which in this case are reversibility, temperature, volume, and selected configuration of chemical reactors.

Chemical Reactor Assumptions

Generally, regardless of reactor used, the mole balance equation can be expressed as:

$$\text{In} - \text{Out} + \text{Gen} = \text{Accumulation}$$

$$F_{j0} - F_j + r_j dV = \frac{dN_j}{\text{dt}}$$

Where generally F is flow rate, N is moles, t is time, r is reaction rate, V is volume, and j is the chemical species to which some of those variables refer. Because species A is assumed as the limiting reagent for the forward reaction, species A is rate-determining and thus how we most often will consider conversion, rate, and other variables. Accordingly, F_{A0} is initial flow rate for species A, F_A is final flow rate for species A, r_A is reaction rate for species A, etc.

Oftentimes, we want to maximize the amount, or conversion, of a particular species in a reaction. X represents conversion in the following general relationship: $F_A = F_{A0}(1-X)$. That is, the outflow of species A is equal to the inflow of species A minus the amount of species A which is converted into a different species.

In the following, the specific assumptions which lead to derivations for each reactor are discussed. See Appendix A for complete derivations.

First, specific assumptions for Continuous Stirred Tank Reactors (CSTRs) are that they are well-mixed such that the conditions of the exit stream are identical to those throughout the reactor. This means that $r_A dV = r_A$ V, i.e. the reaction rate behaves identically throughout the entire volume. Additionally, CSTRs are intended for liquid-phase reactions only, where gaseous species will not react within the reactor.

After simplification from the general mole balance equation, conversion within a CSTR can be expressed as the following: $X = \frac{-r_A \text{V}}{F_{A0}}$.

Next, specific assumptions for Plug Flow Reactors (PFRs) are that there is no radial variation of properties, i.e. perfect radial mixing. Additionally, they are only applicable to gas-phase reactions. After simplification from the general mole balance equation, conversion within a PFR can be expressed as the following, where v_0 is volumetric flow rate:

$$\frac{\text{dX}}{-r_A} = \frac{v_0}{F_{A0}}\text{dt}$$

Lastly, specific assumptions for Packed Bed Reactors (PBRs) are the following: no radial variation of properties, reaction rate is a function of W, the catalyst weight (not reactants' volume as with CSTR and PFR), and lastly, W is constant throughout the reaction. Additionally, PBRs are applicable to both liquid- and gas-phase reactions, however they are most often used for gaseous reactions. After simplification from the general mole balance equation, conversion within a PBR can be expressed as the following:

$$\frac{\text{dX}}{-r_A} = \frac{V_0}{F_{A0}}$$

Consequences of Assumptions & Simplifi- cations

Chemical & Catalyst Properties

Firstly, there are chemical and physical properties which can cause radial variations in flow in PFRs and PBRs. For instance, the species could be poorly-mixed, resulting in separation, meaning the species have less opportunity for collision to create products. This causes less conversion of reactants resulting in lower product yield.

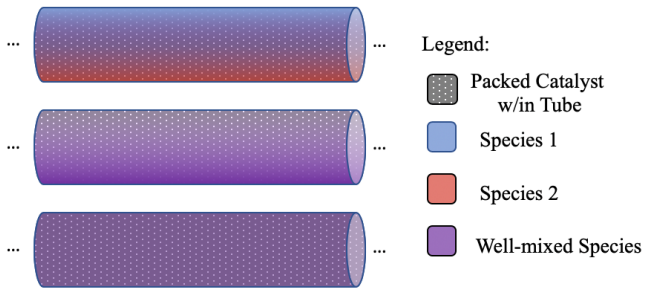


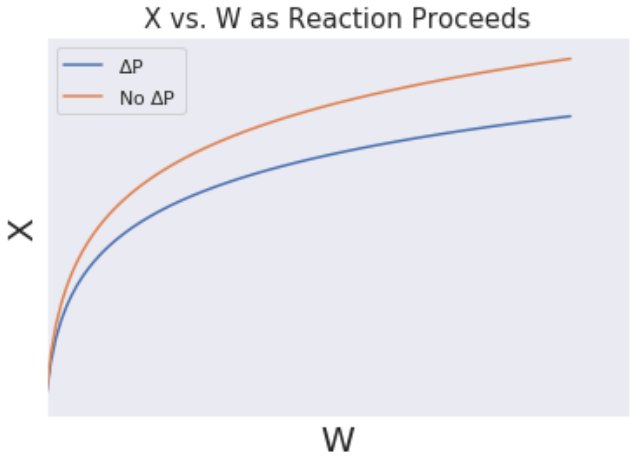
Figure 2. Section of PBR tube where chemical species 1 and 2 pass through a catalyst-packed tube. Comparatively represents radial variation in properties.

For example, two chemical species with a high density gap or high immiscibility could cause one species to naturally elevate above the other. Or that even if the two chemical species are well-mixed, the flow might be unevenly distributed throughout the tube radially. Ideally both species should be well-mixed while also being evenly distributed radially. See Figure 2 for each of these conditions, respectively, from top to bottom.

Alternatively, the chemical species could react in a way that causes a phase change (e.g. liquid to gas). Thus, the selected reactions always have species which are either all gases or all liquids to begin with, and it must also be assumed that the phase does not change for any species throughout the reaction in order to preserve our simplification. While the former assumption is a matter of finding the appropriate reaction, the latter assumption is complex.

When temperature or volume changes are applied to the system by the user, this could naturally cause one or more species to begin or reach a different phase. In acknowledgement of this possibility, there are set boundaries for volume and temperature in order to limit this occurrence. Nonetheless, certain configurations and conditions could experimentally demonstrate our predicted model to be incorrect, as described in the final section.

Lastly, the catalyst which is packed into PBRs can cause abnormal flow if there is irregular packing. In a gaseous reaction, an unsteady state flow could mean that there is a pressure drop, which may be represented through Ergun's equation, where the relationship of conversion (X) as function of catalyst weight (W) for a PBR is shown below:



Graph 1. Demonstrates how pressure drop in a PBR inhibits conversion. The relationship $\frac{dX}{dW} = \frac{k C_{A0}^2}{F_{A0}} \frac{(1-X)^2}{(1+\varepsilon X)^2} \left(\frac{P}{P_0}\right)^2$ is modeled after the Ergun Equation.

Notably, pressure drop is not very significant in liquid reactions as liquids are simply less affected by pressure changes than gases. Yet varying temperature or volume can result in a pressure drop across all reactor types here, discussed further in the final section.

Reactor Network & Configuration

In order to save money and reduce waste, many real-world chemical reaction networks will separate unconverted reactant species which are still present in an intermediate or final output, and then circulate those reactants back to an earlier location within the chemical reaction network. Sometimes, however, by-products of the chemical reaction or even products are recycled to remove trace amounts of reactant species or contamination; the recycling process can purify what ultimately becomes the final product.

Within a chemical reaction network, recycling increases conversion: there are more reactants converted to products as a result. See Figure 3 for a recycled feed system. In comparison, a non-recycled system (as we implemented) will simply go directly from source feed into the chemical reactor network which directly yields the final output.

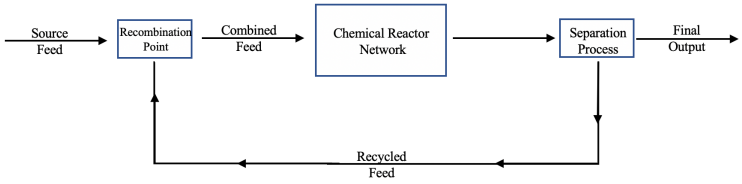


Figure 3. Recycled feed system

Given that the separation process does not perfectly isolate reactant species, if a recycled feed were re-added to the source feed, then there would be some level of product species also present. The product concentration present in the recycling would be highly dependent on the particular reaction and separation process, which can vary considerably. For example, liquid mixture separation can occur through flash separation, stripping, distillation, liquid-liquid extraction, and crystallization to name a few. Vapor separation can occur through cryogenic distillation, dialysis, membrane separators, partial condensers, adsorption, and so on. Some separation processes work better or worse for certain reactions, and thus the recycled feed reactants-products concentrations are too subject to variation to attempt any generalizations here.

In a separate consideration within the chemical reaction network, if pipes are connected from one reactor toward another two or more reactors, then the output is automatically divided equally among each of the outgoing pipes in the AR system. However, it is possible to unequally subdivide the outflow among subsequent reactor connections. For example, a company may wish to use a product in the outflow of a reactor as one or more of the reactants for other chemical reactions in which they may accordingly draw only the necessary amount of outflow from the previous chemical reactor.

Other Considerations

Proper reactor maintenance is an unstated assumption previously, though there are two important pieces of maintenance worth discussing. The first is that for a PBR, we assume no catalyst weight loss occurs when in actuality it continuously diminishes as the reaction proceeds. When weight loss occurs, it slows the reaction rate over time. However, if the PBR is being properly maintained, weight loss should be generally negligible as it occurs relatively slowly anyway.

Secondly, buildup on the walls of reactors occurs. Depending on the reactor's internal construction, it may require a manual cleaning every few years which can cost hundreds of thousands of dollars. Over time, the buildup slowly works to inhibit the reaction and reduce yield.

Unsurprisingly, there's still complexity from other variables to consider. Here are some not yet discussed: different catalysts for PBRs which affect reaction rate; propeller size and type within reactors which affect how "well-mixed" the chemical species are; interface between chemical species and reactor or pipes which have friction and affect flow via shear stress; and poor temperature control within PBRs and PFRs as compared to CSTRs, meaning additional heat is necessary to apply to system to account for heat loss. While there will always be more factors to discuss, laying the foundations and parameters here help users model the system later on.

Setting Up A Model

To start the flow of chemical species, at least one reactor should be connected to the source feed which contains the reagents. Multiple reactors may be connected to the source or to any other reactor. If multiple connections stem from a single reactor or the source, the outflow will be equally divided among all the outgoing pipes.

The configuration of those pipes can manifest in two primary categories: in "series" or in "parallel". Reactors in series are consecutively configured such that each reactor is receiving the input from or output to one other reactor. Reactors in parallel receive input from or output to multiple reactors, often just two.

Reactors in Series: $\textit{Source feed} \longrightarrow R_1 \rightleftharpoons R_2 \rightleftharpoons R_3 \longrightarrow \textit{final output}$

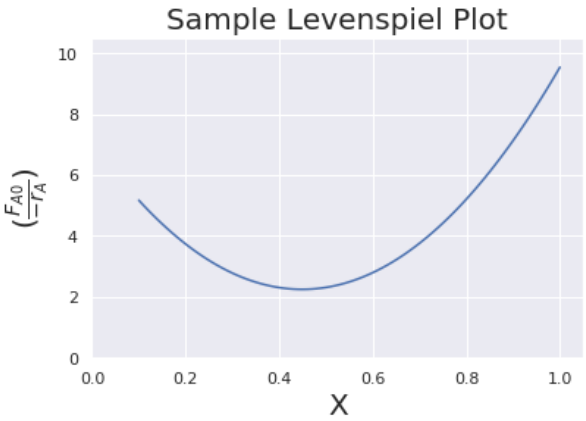
Reactors in Parallel: $\textit{Source feed} \longrightarrow R_1 \rightleftharpoons \begin{matrix} R_2 \longrightarrow \textit{final output \#1} \\ R_3 \longrightarrow \textit{final output \#2} \end{matrix}$

Figure 4. Schematic of series and parallel reactor configurations.

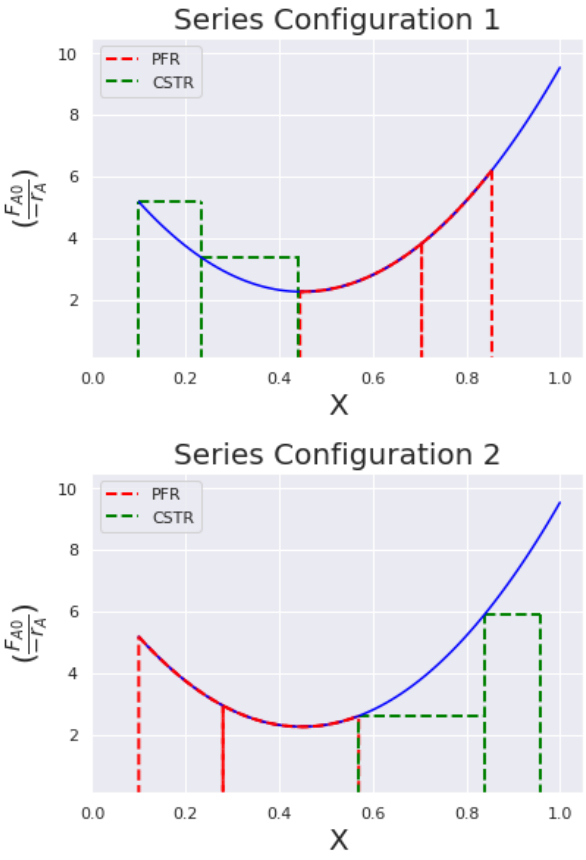
Series and parallel configurations are the two foundational ways to connect reactors and consider how chemical reactions occur. Even in larger reactor networks, called complex reactions, you can identify subsets of the network where reactors are in series or parallel with one another.

The conversion of species based on the configured chemical reaction network inevitably depends upon the reaction. Some configurations will favor better yields for some reactions and worse yields for others. Determining this optimal configuration for series and also for parallel and complex reactions is possible by using a Levenspiel plot, shown in Graph 2.

For example, let's consider the series configuration of a reactor network of two CSTRs and two PFRs, each 0.70 m^3. From rearranging the conversion equations previously found, the volume for each reactor type is: $V_{\text{PFR}} = \frac{F_{A0}}{-r_A} \text{dX}$ and $V_{\text{CSTR}} = \frac{F_{A0}}{-r_A} X$. Thus, we can find PFR's volume as the area under the curve of the Levenspiel plot, and CSTR's volume is essentially equal to a left Riemann sum since the reactor is based on the initial reaction rate only.



Graph 2. Sample Levenspiel plot. Total area underneath the plot is 3.70



Graphs 3 & 4. Comparison of each configuration. Graph 3 is two CSTRs followed by two PFRs, Graph 4 is the opposite.

Relationship to Other Variables

Notably, pressure is not considered in our rate law expressions, yet it's inextricably correlated with the volume and temperature variables within our rate expressions.

If we consider a gaseous reaction, the ideal gas law which governs pressure, temperature, and volume is $PV = nRT$ (where n is the number of moles and R is the universal gas constant). When temperature and volume are altered by the user, one would think that pressure will change based on the relationship $P = \frac{nRT}{V}$. However this is not the case: the moles, n, accordingly change as well e.g. it takes more moles to initially fill a larger reactor after which the concentrations are the same. However, one might think that specific volume (volume per mole) of the gaseous chemical species would change as reactants are converted to products, but again, this is not the case. One of our initial assumptions states that the molar ratio of reactants to products is equivalent. Thus, temperature changes are more significant within our system.

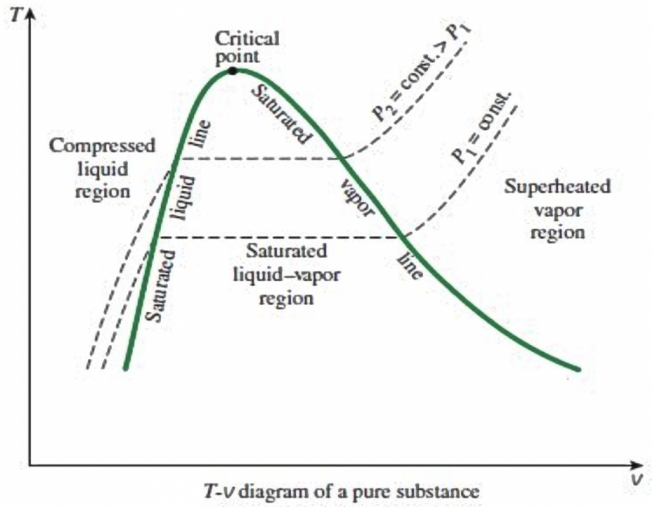
See Graph 5 for a general phase change diagram where pressure is kept constant (isobaric conditions). [2] Because we have no entirely pure species within the system, the diagram serves a more qualitative purpose to see the general relationship present.

Because volume changes will be offset by more moles, and temperature has specified boundaries based on the particular chemical reaction, it would be difficult for the user to find a set of volume and temperature conditions where a phase change is approached. Instead, what's more likely a cause of pressure change are intermolecular forces.

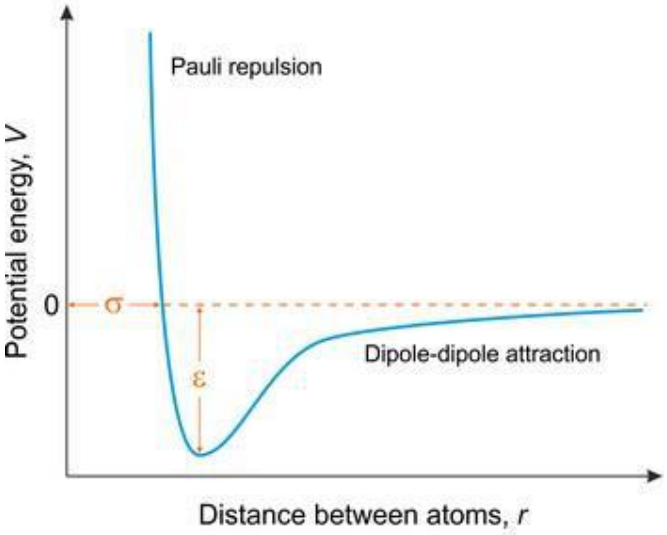
The ideal gas law considered above assumes all gas molecules have no intermolecular forces; that is, no attractive or repulsive forces between one another where $E_{\text{potential}} = 0$ and $E_{\text{total}} = E_{\text{kinetic}}$. Yet real gases *do* have potential energy from intermolecular forces which can be represented via the Lennard-Jones Potential found in Graph 6. [3]

So if we consider real-world conditions, pressure *must* change despite our best efforts otherwise. For example, consider gaseous reactants A and B converting into products C and D where the products have an attractive intermolecular force which allows more moles n to be present within a chemical reactor. Even if we are not using the ideal gas law, its correlation still holds: $P \propto \frac{nRT}{V}$. Thus an increase in moles will result in greater pressure. Likewise, a decrease in moles will directly relate to a decrease in pressure.

Therefore, the isobaric simplification cannot hold under present operations, and Graph 5 shows that if pressure increases, there is a smaller intermediate liquid-vapor saturated phase before a full phase change. In this regard, a user could approach a new phase of a chemical species present in the chemical reaction network.



Graph 5. Temperature-Volume Phase Change Diagram. Dashed lines are isobaric. However, even if pressure is kept constant, it is possible to approach or reach a new phase if boundaries are not set.



Graph 6. Lennard-Jones potential as a function of the distance between atoms.

Appendix A: Theoretical Derivations of Conversion

General Notes:

- $\frac{dN_j}{\mathrm{dt}} = 0$ because steady state assumption, so there is no change in moles per time of any species j.
- $F_A = F_{A0}\,(1 - X)$

CSTR:

$$F_{A0} - F_A + r_A\,dV = \frac{dN_A}{\mathrm{dt}}$$

For CSTRs, $r_A\,dV = r_A\,\mathrm{V}$, meaning there is negligible change in reaction rate across volume. (The CSTR *must* be well-mixed for this to occur.) Unlike tubular reactors such as PFRs or PBRs, the CSTR's entire volume of chemical species all react within one chamber, as opposed to reacting throughout the length of the tube for PFR and PBR. See below:

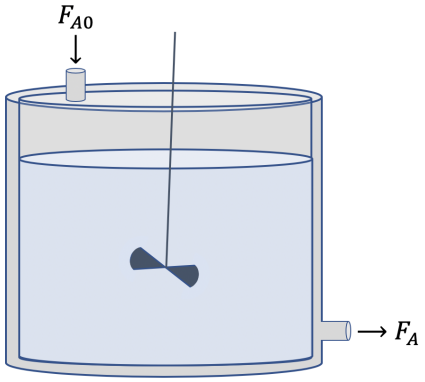


Figure 5. CSTR diagram with propeller, inlet and outlet pipes.

$$F_{A0} - F_A + r_A\,V = 0$$

$$V = \frac{F_A - F_{A0}}{r_A} = \frac{F_{A0}\,(1-X) - F_{A0}}{r_A} = \frac{-F_{A0}\,\mathrm{X}}{r_A}$$

$$\Longrightarrow X = \frac{-r_A\,\mathrm{V}}{F_{A0}}$$

PFR:

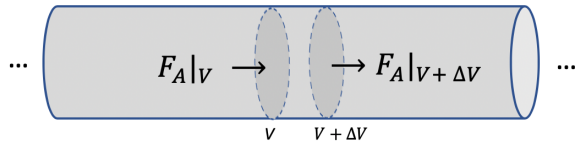


Figure 6. Section of tube from overall PFR. Note $F_A|_V$ notation is molar flow rate of species A at volume V.

$$F_A|_V - F_A|_{V+\Delta V} + r_A dV = \frac{dN_A}{\mathrm{dt}}$$

$$F_A|_V - F_A|_{V+\Delta V} + r_A\,\Delta V = 0$$

$$r_A = \frac{F_A|_V - F_A|_{V+\Delta V}}{\Delta V}$$

$$\Longrightarrow As\ \Delta V \longrightarrow 0,\ r_A \approx \frac{dF_A}{\mathrm{dV}}$$

$$r_A = \frac{dF_A}{\mathrm{dV}} = \frac{d(F_{A0}(1-X))}{d(V_0+v_0t)} = \frac{-F_{A0}\,\mathrm{dX}}{d(0+v_0t)} = \frac{-F_{A0}\,\mathrm{dX}}{v_0\,\mathrm{dt}}$$

$$\Longrightarrow \frac{\mathrm{dX}}{-r_A} = \frac{v_0}{F_{A0}} 1dt$$

PBR:

$-r_A^{'} = \frac{dF_A}{\mathrm{dW}}$ Note: PBR rate expression is in terms of catalyst weight, not reactor volume.

$$F_A|_W - F_A|_{W+\Delta W} + r_A^{'} dW = \frac{dN_A}{\mathrm{dt}}$$

Same process as PFR from here. However, if you only have the rate expression in terms of volume and not catalyst weight, then you could use the $-r_A^{'} = r_A \frac{V_0}{W_0}$ relationship to also derive…

$$-r_A^{'}\,W = r_A\,V \Longrightarrow -r_A^{'} = r_A\,\frac{V}{W} = r_A \frac{V_0}{W_0}$$

$$\frac{dF_A}{\mathrm{dW}} = -r_A^{'}$$

$$\frac{d(F_{A0}(1-X))}{\mathrm{dW}} = r_A \frac{V_0}{W_0}$$

$$\frac{-F_{A0}\,\mathrm{dX}}{\mathrm{dW}} = r_A \frac{V_0}{W_0}$$

$$\frac{\mathrm{dX}}{-r_A} = \frac{V_0}{W_0\,F_{A0}} 1dW$$

Since $W_0 \approx W$, $\frac{\mathrm{dX}}{-r_A} = \frac{V_0}{F_{A0}}$

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Featured in This Issue

A Self-Fulfilling Prophecy: How Redlining in Rochester Led to a Modern Housing Crisis by Nisha Arya '21, *Anthropology*

Housing policies have been historically put in place with little to no input from the affected populations. Here, the author examines the history of housing policies in Rochester through the perspective of minority communities, which the policies often discriminate against, and puts forth suggestions to better serve such communities.

The Search for Happiness in Meditation Technology by Xueying Chen '20, *Public Health*

Mindful meditation currently serves as a widely used tool to improve physical and mental well-being. This paper looks at the University of Rochester's Mindful University Project which aims to teach students how to meditate and practice mindfulness in everyday life. After reviewing the risks and benefits of the meditation technologies used by students, the author provides recommendations to improve the meditation program through the use of technology.

Calling the Cops: How Race/Ethnicity and Gender Contribute to the Perception of the Police at the University of Rochester by Syed Arsalan Ghani '21, *Statistics*

Nationally, people of color report lower levels of trust in law enforcement. This timely paper examines this phenomenon at the University of Rochester campus in relation to the campus Public Safety. Through the use of various statistical methods, the author shows the inability of race/ethnicity to be used as a predictor of trust in this context and discusses the possible implications of these results.

Expression analysis of Drosophila melanogaster immunoglobulin proteins across follicular epithelium and embryo tissues with RNA-seq by Colleen Mallie '20, Jacob Rozowsky '20, Himi Begum '20, and Nadim Quazi '20, *Biology*

Immunoglobulin proteins have important roles in neural and epithelial tissue development. Here, the authors study the expression of immunoglobulin proteins in epithelial and embryonic tissues of the common fruit fly. They further evaluate the evolutionary conservation of immunoglobulin proteins by studying their expression in fresh-water polyps.

Implementing Chemical Reaction Networks in AR by Tayfun Sahin '20, *Chemical Engineering*

Chemical reaction networks help determine how chemical systems proceed. The author looks at the application of an augmented reality program in calculating reaction variables in real time as parameters within the reaction network are adjusted. Given the critical assumptions made in the augmented reality program, the author defines the impact of each assumption on the accuracy and meaningful physics of the chemistry involved.

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