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ABOUT THE PAPER

“Our vision as the founders of The Research Paper is to create a magazine that humanizes research on all levels. We believe that research is as much about self-discovery as it is about achievement. In addition to showcasing the outstanding research that is conducted here at Cornell, we also aim to highlight the uniqueness, creativity, and personality of each researcher to all of our readers. We do this by focusing our articles on who the researcher is, what they are involved in both at Cornell and in their local communities, and what their future visions and aspirations are.”

Letter from the Editor

Dear reader,

I am extremely pleased to present the Fall 2017 issue of The Research Paper. As a first semester Editor-in-Chief I wanted to ensure that I continued the great work of my predecessors and I could not have done this without this year’s team. I am so proud of everyone’s hard work and dedication to TRP. I would like to especially thank the Design Team for their hard work in redesigning the magazine as we tested new things this semester.

If you have any comments or concerns, please feel free to email me at amj58@cornell.edu. I hope you enjoy the issue!

Anita Jegarl ‘18
Editor-in-Chief

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Spring 2018 Preview

*College Feature
College students have a reputation for eating ramen, drinking an unhealthy amount of coffee, and spending late nights studying in the library. But is this stereotype actually true? As team and subteam leaders of a group of 11 people, seniors Ninad Thanawala, Dave Rubinow, and Zachary Roga set out to determine if this stereotype was justified. Using publicly available information from the Centers for Disease Control and Prevention (CDC), Thanawala, Rubinow, and Roga—students in the College of Arts and Sciences, Human Ecology, and Agriculture and Life Sciences, respectively—conducted a retrospective observational study on the health and diet quality of college students.

Using complex survey methodology and various statistical tools, they analyzed a large, publicly available data set from the CDC called the National Health and Nutrition Examination Survey. By analyzing physical activity, food security, and diet quality scores, they determined that only 70.56% of college students achieve full food security, compared to 77.6% of the general adult population. In addition, only 10.8% of college students have a healthy diet, compared to 17.2% of the general adult population. However, the survey also concluded that although college students are more food insecure and have a lower diet quality than the general adult population, they also exercise more frequently. 57.9% of college students have adequate physical activity, compared to 35.4% of the general adult population.

Currently, the group is looking to share their research through publications in hopes of reaching professors and the broader community. They believe their research is a “jumping off point” for future research, as college students are a lesser-studied population. “We found certain regions where they’re much healthier than the general population, and certain regions where they aren’t. All those regions can be further looked into further down the line by anyone,” Thanawala says.

The research project first began when Thanawala, Rubinow, and Roga met in a professional health sciences organization. From there, they realized that they all shared common interests in the questions they wanted to answer. “From the inception of the idea, this wasn’t an idea from a professor or a lab director. We asked ourselves the question. Here are the tools we have, here are the resources we have, and here are the skills,” Thanawala says. “Then we asked, where in that intersection are interesting questions that we can feasibly answer? So it’s all very organic.”

“It was really empowering to choose our own project and have a very big say in the design,” Roga adds.

There were particular obstacles that the group, as a student-led organization, had to overcome. Without a proper research office, they worked anywhere they could find—from random rooms in campus buildings to Skyping each other when they chose to work remotely. Another issue was learning how to take the role that a principal investigator or professor would normally fill to drive the project forward. “Since we all are incredibly busy students, one challenge of being an informal project team was getting motivation,” Rubinow says. “It worked out for us at the end because it was a lot of intrinsic motivation.”

Thanawala also stressed the importance of good leadership. “Beforehand, I thought science just kind of happened from being a good or bad scientist, doing the research, and reading the literature, but I realized leadership and management can really bring out the best in researchers we have on our team,” he says.

Inspired themselves by the student-created store Anabel’s Grocery, the team hopes to be a model for other undergraduates to start their own research teams. “It’s kind of like a startup company,” Rubinow says. “Undergraduates have a lot of talent. I feel like if they had the opportunity to take these leadership positions, they would really learn a lot more than just working in a lab.”

— Stacey Li
Many would use the term “personalized medicine” synonymously with “precision medicine.” However, in China, according to Elisabeth (Liz) Abeles, many medical practitioners believe that it means “combining advanced biomedical techniques with traditional therapeutics in each doctor’s unique way.” Acknowledging both views and being aware of the cultural impact of personalized medicine is a part of Abeles’s College Scholar honors thesis.

Incorporating a combination of biomedical engineering, sociology, Asian studies, and anthropology, Abeles’ research is centered around personalized medicine. She approaches the topic in two very different ways: through immunotherapy and immune engineering and through Chinese medical sociology.

A Hunter R. Rawlings III Presidential Research Scholar (RCPRS), Abeles has been conducting cancer research since she was 16 at the National Institutes of Health (NIH) with a focus on oral cancer. During her freshman and sophomore years, she was part of The Baker Institute at Cornell, where she studied breast and skin cancer before joining the Singh lab in her junior year to study personalized medicine in cancer.

Abeles currently conducts research in the Singh Immunotherapy and Cell Engineering Lab (ICEL) in the Sibley School of Mechanical and Aerospace Engineering. She uses the 3D ex vivo model “organoid” to study B-cell development and dysfunction, potential developments of lymphoma cancer. The organoid system uses conditions that reflect the way cells grow in the body and mimics what might happen in patients treated with medication. With samples from the patient’s tumors, the organoid model could “bridge the gap in our understanding of in vitro and in vivo models”. Information acquired from this system will ultimately be used in developing personalized treatment targeting the specific illness in each patient. In the lab, Abeles constructs organoids, culture cells, and tests the effects of different drugs on organoids.

Although the Singh lab provides Abeles with a microscopic, biomedical level understanding of personalized medicine, it is her experience in China that takes her questions to a larger, socio-cultural level. Abeles has been studying Chinese for over nine years and her interest in the Chinese language and medicine culminated as a project that looks into understanding the way traditional Chinese medical practitioners approach healing.

In June 2017, Abeles traveled to China with funding from the RCPRS program. She interviewed Chinese doctors at the China-Japan Friendship Hospital in Beijing, China as case studies for her thesis. Conducting the interviews completely in Mandarin, Abeles asked the doctors questions such as how they would define diseases, diagnose patients, and draw from traditional healing and more advanced biomedical technology. Abeles hypothesized that the doctors’ medical training backgrounds and their understanding of the human body inspired them to draw on new biomedical technology while preserving traditional therapeutics. For example, she discovered that practitioners at the department of integrative oncology combine the use of chemotherapy and radiation with traditional therapies like acupuncture and herbal remedies. Many doctors Abeles interviewed “strongly believe that their practice is unique and of best serving to patients because it offers both angles.”

Talking about the goals of her research, Abeles, who aspires to become a surgical oncologist after medical school, said, “I would like to understand the different healing modalities that exist around the world and use them to guide me as I practice western biomedicine – how might I best interact with my future patients, considering various cultural implications of a particular pharmaceutical therapy or surgical procedure?” Abeles hopes to use the knowledge she gains from research in her own surgical practice to help inform clinical decisions.

In her spare time, Abeles enjoys running and mentoring. She is part of the Cornell Running Club and finished her first marathon last fall. She is a peer advisor, a BEARS mentor, and an RCPRS mentor. She is also a student assistant in the Flora Rose house on West Campus.

— Freya Zhang
You never know what to expect when looking through a window into an unknown place. Dennis Nyanyo, a senior in the College of Arts and Sciences, knows this from experience. Nyanyo, who is from Ghana, is a biological sciences major conducting research in the Schaffer-Nishimura Lab in the Department of Biomedical Engineering. Guided by his mentor, Professor Nozomi Nishimura, Nyanyo studies disease initiation and progression, using an abdominal window—an opening into the small intestine—to observe stem cell division in mice. He is involved in two projects that make use of this technique: the first is studying the maintenance of tissue homeostasis in the small intestine and the second studying the development of colorectal cancer.

In the first project, Nyanyo’s graduate student mentor uses a laser to kill a stem cell in a region of the small intestines of mice called a crypt. He observes the response of the remaining cells through the abdominal window. Afterward, Nyanyo removes the desired tissue from the mouse and performs a technique called CLARITY on it, which turns the sample transparent so he can observe the entire tissue section after staining it.

Nyanyo uses the abdominal window technique in his cancer project as well. In this project, he injects cancer cells into the caecum of a mouse and observes their development through the window. After about three days, he images the caecum using multi-photon microscopy. This type of imaging is said to be in vivo, because it is done within the live mouse itself. Afterwards, he removes the required tissue and carries out CLARITY. This tissue is then imaged for the second time and the two images, one from in vivo imaging and the other after staining, can be compared.

In addition, Nyanyo has been able to develop a method by which blood vessels can be stained with a chemical known as agarose, which might allow him to locate crypts ex vivo.

Nyanyo has been interested in stem cell division since high school. In the second semester of freshman year, he took BME 1110: Seeing Science in Action, in which he shadowed four laboratories, one of which was the Schaffer-Nishimura Lab. He found the research conducted there particularly interesting and decided to join the summer after his freshman year.

Nyanyo appreciates that his research is hands on and allows him to observe real-time biological events. Additionally, he enjoys the experience of working with a multi-disciplinary team, which includes physiologists, computer scientists, engineers, and physicists. He has also been able to apply the skills he gained in lab to various aspects of his life. He has learned how to break down tasks into their simplest form, identify patterns, critically analyze results, and, of course, manage time when balancing his classwork with his research.

He gains satisfaction from “…knowing that the tools I will be able to develop will be able to help other scientists in the future [in this field],” he says. He plans to pursue a career that combines cancer research and clinical practices, and is a founder of a healthcare technology start-up at Cornell.

— Gayathrini Premawardhana
If you’ve ever followed a path just to see where it could take you, then you know how John Kelland, a senior from Hartland, Michigan, felt when he began his research in planetary science. Little did he know the scientific impact he would have.

Kelland, a mechanical and aerospace engineering major, has always been passionate about astronomy, but he had more of a knack for engineering. Because of his interest in the extraterrestrial bodies of the solar system, he began working with Professor Alexander Hayes in the astronomy department in his sophomore year. His research since then has focused on improving our understanding of the intermediate weather systems and atmospheric dynamics of Titan, Saturn’s largest moon.

Kelland works with a data set that characterizes Titan’s clouds, providing data for models of the moon’s atmosphere. In the case of Titan, further population of these data sets helps researchers understand the global distribution of methane and yearly precipitation patterns. “This will give a comprehensive understanding of Titan’s atmosphere that couldn’t have been achieved before this data set was created,” Kelland says.

The cloud data set that he works on also helped Hayes’s team better understand the dynamics of Titan’s atmosphere. Combining the data set with a model for clouds and precipitation can indicate where precipitation might occur on the planet, based on altitude and optical depth.

So how exactly did Kelland construct this cloud data set? It all began with the Visible and Infrared Mapping Spectrometer (VIMS) aboard the Cassini orbiter, a spacecraft that orbited Saturn for thirteen years. VIMS is a color camera that measures and analyzes the visible and infrared wavelengths to provide information about Titan’s atmosphere. VIMS took hundreds of thousands of raw spectroscopic images of Titan’s clouds—images that weren’t useful until Kelland went through each one individually.

By clicking on each pixel in every cloud where any spectral variation occurred, Kelland could manually identify the clouds belonging to the troposphere, the lowest layer of Titan’s atmosphere. In doing so, he found more than 300 unique cloud sequences over thirteen years of Cassini observations and resolved cloud speeds in over 50 of them. This is what ultimately allowed Hayes’s group to investigate the dynamics of cloud sequences on Titan so comprehensively.

Interestingly enough, constructing the cloud data set wasn’t always Kelland’s job. “I was initially brought on to create input data for a graduate student’s project. But once we saw the unique opportunity to explore clouds on Titan with the whole VIMS data set, my work kind of grew into its own project,” he says. Kelland’s next steps will be to analyze the local formation and propagation of cloud sequences on Titan on smaller scales.

Kelland says the most interesting part of his research is the unique position he holds in the scientific community: “I’m the one person who has gotten to look at every single VIMS image of Titan. Human eyes have never seen what I see on a day to day basis.” He has also had the opportunity to present his research at numerous conferences. Most recently, he presented at the Titan Surface Meeting at MIT, as well as at the 49th Division for Planetary Sciences meeting.

Through his research, Kelland has learned the appeal and complexity of atmospheric dynamics and increased his interest in the analysis and exploration of bodies in the solar system. He has also enjoyed learning the computer languages and algorithm development he needs for his research. Kelland plans to pursue a Masters of Engineering next year, hoping for an eventual career in aerospace engineering or astronautics. He is particularly interested in propulsion research, which focuses on fluid analysis of spacecraft entering extraterrestrial bodies with atmospheres. “Titan has an extremely dense atmosphere, so putting a spaceship down there is very different than putting one down on Pluto,” he says. “Further exploration of Titan is going to require people who can analyze all that.”

— Keri Heuer
Every day, around the world, people use language to tell their stories, but perhaps the most interesting stories can be found in language itself. Language is not just a method of communicating human history—it is a living record of cultural identity. And to let a language die is to let a culture disappear from the world.

José Armando Fernández Guerrero, a senior triple majoring in linguistics, anthropology, and the College Scholar program, aims to preserve cultural identities through his research into Ch’ol and the revitalization programs of Amerindian languages. Ch’ol is a Mayan language that developed several centuries ago; today it is the language of a small population living in Chiapas, Mexico. Fernández Guerrero’s ongoing research examines Ch’ol through what he describes as “the interfaces between phonology, syntax, and morphology.” In other words, he studies how the interactions between Ch’ol’s syllable structure, word construction, and word order affect the application of clitics, which are grammatical particles attached to words. In English, the closest thing we have to clitics are suffixes, but instead of simply identifying a tense, clitics in Ch’ol can reveal important pieces of information, like an expression of doubt or certainty.

Fernández Guerrero plans to travel with graduate students Mia Wiegand and Carol-Rose Little to southern Mexico to record Ch’ol in its native environment, a hands-on experience that will place the language into a less theoretical setting. While his research into Ch’ol will have a smaller impact, he hopes that it will contribute to “theories about language that are still relatively new.”

Fernández Guerrero’s linguistic anthropology project on Amerindian languages, or indigenous languages of the Americas, looks broadly at language and social identity. He started his research by first examining how laws dealt with indigenous language maintenance, or, as Fernández Guerrero puts it, “the different ways [North American governments] institutionally started killing off indigenous languages.” On this institutional level, Fernández Guerrero found several factors that lead to language death, including the displacement of people and the educational structure of boarding schools. Eventually, his research focused on studying a combination of education, anthropology, linguistics, and indigenous studies.

Sometimes, Fernández Guerrero says, in bringing dead languages back to life their dynamic nature with the present is stunted because they are handled like old relics: gingerly and with interest limited to academic circles. Revitalization programs in classrooms are efforts by communities to encourage that dynamic, reintroducing a piece of the cultural past into modern households, schools, and religions as more than just a relic, but as a language of utility. Fernández Guerrero hopes that his research into these programs will help communities use language to reconcile their present social identities with that of their past culture.

Linguistics data predicts that of the world’s 7,000 languages, half of them will disappear in the next 150 years. So, why bother researching and preserving dying languages like Ch’ol? “There are two main reasons,” Fernández Guerrero says. “The first one is the cultural argument. Language is a big part of culture, and keeping culture is important because it adds to the diversity of daily life, it adds to the idea that there’s not just one way to live.” If the cultural argument remains unconvincing, then the second reason is one that all life-long learners can appreciate. Studying other languages, he explains, “tell[s] us about our limitations as human beings and our codification of knowledge and thoughts.” In short, language is a part of our identity, culturally and cognitively. Beyond his research, Fernández Guerrero plans to pursue a career as a professor, becoming a “safekeeper of knowledge and of a person’s identity to that knowledge,” spreading intellectual curiosity and the importance of language to future generations.

— Earl Daniel de los Santos
While many students on campus might know Shoals Marine Laboratory as a hub for biology research, they may not be aware that it is situated on Appledore Island, an island with historical significance since it used to be the home of a hotel in the 1800s to the early 1900s. Junior Garrett Hastings started a project with Dr. Robin Hadlock Seeley in Summer 2017 to correct a list of GPS coordinates for historic sites on Appledore Island.

In the College of Arts and Sciences, Hastings is double majoring in archaeology and performing and media arts with a concentration in film. Alongside academics, he writes film reviews for the Cornell Daily Sun and is a member of the Quill Guild, Anthropology Club, and Film Club. He is also the president of Scare Me at Cornell, an organization where people recite or invent scary stories.

Hastings’ foray into research began while he was still in high school. Originally from Chittenden, VT, he participated in The Established Program to Stimulate Competitive Research (EPSCoR) through the University of Vermont. His project entailed analyzing stream water quality in relation to macroinvertebrate species. The organisms present in the water were indicative of factors such as pH, so identifying them could determine the quality of the stream. Once he arrived at Cornell, Hastings turned toward research in ornithology, in which he analyzed videos from the field location in Australia of the Red Backed Fairy Wren. He recorded bird behavior and tried to see differences in the relationships between dull males and females and bright males and females.

Following the conclusion of his ornithology research, Hastings spoke to Dr. Seeley about a non-credit archaeological dig. He became interested in focusing on archaeological research after switching his major. Dr. Seeley knew Arthur Speiss, the senior archaeologist for the Maine Historic Preservation Commission who identified that the GPS coordinates of historic sites on the 95-acre Appledore Island were incorrect and needed to be fixed. The challenge to correct the GPS coordinates became Hastings’s project, and he spent three weeks of his summer doing on-site research on Appledore Island.

Hastings’ responsibilities over the summer were multi-fold. He started with the original coordinates from the 1990s and cross-referenced them with pre-existing maps to find the sites’ general location. This journey to the sites ranged from easy to treacherous depending on the amount of brush and poison ivy, so Hastings was often equipped with protective gear and a machete to blaze through the shrubbery. Then, he used landmarks to create a polygon encompassing the entirety of the site. In the laboratory, he input the site location, coordinates of the site center, and any artifacts or additional annotations he recorded into the ArcGIS mapping program. Additionally, Hastings journaled his experiences every night and made two presentations on his progress. Once he returned to campus, Hastings continued working on aspects of this project. Currently he is looking into who the island inhabitants were, including some of the famous figures who frequented the hotel. He also plans to transcribe some available first-hand accounts.

Regarding the implications of his summer research, Hastings said, “The GPS points were taken in the 1990s, so the most accurate technology was not available. By knowing where these historic places are, we can protect them if possible and use them as an outdoor learning experience. The past is the gateway to the future, and we can really learn from our past and learn how to utilize lessons from the past to be sustainable in the future.”

Over the course of his research experience, Hastings values the opportunity he had to gain new skills and make a project truly his own. Though he has participated in some archaeological digs before, he had not used GPS data as much as he did over the summer nor ever worked with ArcGIS before. He also learned how to explain archaeology to a different audience; Shoals Marine Laboratory is primarily focused on biology, and he used his presentations to familiarize the scientists and people of Appledore with archaeology and preservation initiatives.

Post-graduation, Hastings is interested in pursuing graduate school and finding opportunities to integrate his interests in film and archaeology to create appealing documentaries for the general public.

— Akila Venkataramany
2017 marks the hundredth year since the dawn of jazz — but the original sounds of the genre have almost been forgotten. Early jazz is rarely heard, and instrumental pieces that shaped the foundation of jazz have nearly been erased.

Fortunately, Colin Hancock, a junior in the School of Architecture, Art, and Planning majoring in Urban and Regional Studies, is trying to maintain the earliest sounds of the genre and bring it to the modern generation. “There aren’t enough people trying to preserve it in the right way when it is an integral part of culture,” he explains. Currently, Hancock’s research is focused on recomposing and sharing the original sounds of jazz in order to preserve its culture.

Born and raised just outside of Austin, Texas, Hancock has been developing his love for music since the age of eight. Exposed to music by his parents and his father’s seemingly endless vinyl collection, Hancock was inspired by what he heard and soon learned to play the trumpet. His love for music was so intense that in his sophomore year of high school, he headed a recording session while wearing a cast and on painkillers.

For Hancock, playing with the same soul, rhythm, and precision of each jazz piece was so enriching that it inspired him to compose and reconstruct the music that never fails to make him happy. In his freshman year of college, he founded the Orginal Cornell Syncopaters under the guidance of Professor Paul Merrill, who heads the jazz department at Cornell. The group’s goal is to reconstruct and preserve the original sounds of jazz, because “there are not many programs focused on early jazz, leading to the misinterpretation and misrepresentation of it.”

The Orginal Cornell Syncopaters officially began to rehearse in earnest in the fall of Hancock’s sophomore year. Hancock compares the experience to “learning a new genre of music,” stressing how difficult it was to adjust to the style of the music they were playing. To help them in their efforts, the group would listen to recordings of jazz produced during and around 1917 in addition to rehearsing for many hours.

The Original Cornell Syncopaters have grown to twelve members, and they are currently performing at venues in various parts of the country, including the next San Diego Smooth Jazz Festival. Hancock plans to use the experience he has acquired through composing and performing with them to start his own recording company and write a book on early jazz to further preserve its culture.

— Jeremiah LaCon
For many music aficionados, the works of Beethoven, Bach, and Mozart are masterpieces and the epitome of classical music. It’s almost forbidden to think of putting a twist on anything they have done. One student researcher at Cornell, however, has decided to push back against this musical taboo.

Hannah Krall, a senior music major in the College of Arts and Sciences, believes that musicians can learn to improvise in any genre, even within the pages of classical sheet music. For her honors senior research project, Krall is stepping up to the task of analyzing historical music and comparing it to the music we know today. More specifically, she seeks to understand violin improvisation in the Renaissance by comparing it to modern jazz improvisation.

Since she picked up the saxophone in the third grade, music and jazz have always been part of Krall’s life. After completing a research project for MUSIC 2207 (Intro to Early Western Music History), she became determined to pursue a career in music academia. The class inspired her to focus on pre-classical (Renaissance) music, which was for the most part very much improvised. With the guidance of her professors, Krall realized that the improvisation techniques of jazz may have similarities to those of the Renaissance. This was the inspiration for her senior honors project.

Krall explains that none of the classical geniuses we know of today could have created their masterpieces without the skill of improvisation. “Scholars had some idea of improvisation back then. Now classical music is stripped of it,” she says. Krall sees jazz as the gateway to bringing back this creative quality of music to musicians of any genre.

So how exactly does one understand a skill that is supposed to come naturally? Krall explains that there are techniques used within improvisation to help the musician improvise better. In the Renaissance, diminution was a technique that took ornaments and patterns and added them intermittently into a piece, building them up as a piece progresses and taking them away as it nears the end, and finishing on the same note the piece started with. Jazz improvisation frequently uses licks: musical phrases that are played in different keys to fit the piece. In using and practicing techniques like these, musicians can become very capable improvisers.

Understanding how these techniques worked in the Renaissance is no small task. Instead of conducting research in labs, Krall’s research involves reading literature from various sources and thinking and reflecting on the information she learns. To help her research, Krall had to learn to read German, French, and Italian, as personal translation allows her to understand primary sources better. Her primary text for this project is a treatise by Diego Ortiz, which is an even more daunting challenge because it is written in Spanish. In addition, although Ortiz’s treatise is comprehensive, it assumes the reader already understands improvisation and the natural flow of music. To fill in some of the blanks, Krall draws on ideas from the journal entries of musicians and scholars at the time, and from articles written by modern-day researchers.

As with all research, obstacles are inevitable, but the battle isn’t fought alone. Krall sought help from professors, who always responded quickly to her questions; mentors, who invited her to graduate seminars; and many others who went out of their way to give her the support she needed to pursue her project.

The importance of Krall’s work lies in its relevance to genres aside from jazz. In music analysis and comparison, we tend to take western music and compare it to genres from other cultures. Krall’s research, however, has the power to do the opposite: jazz is a musical genre that finds its origins outside of the western world, and she is using this outside genre to understand western music.

When asked if the concepts used in jazz could work in other genres, Krall simply says, “Improvisation is improvisation.” The ability to improvise is something that can become second nature for any musician, regardless of who they are or what type of music they play.

— Tilka Persaud
In 2016, Chicago reported the highest count of homicides in the United States, with over 750 cases. While the government discussed measures to increase the number of arrests and introduce harsher penalties for criminals, one English student at Cornell decided to go to the root of this issue: inequality and gang formation.

Salvador Herrera is a senior English major with a Latino Studies minor in the College of Arts and Sciences. A Mellon Mays Undergraduate fellow, Herrera spent the summer analyzing autobiographies of former gang members. His project looked at how these narratives can be used to understand gangs as "corporate institutions built into the country's socioeconomic structure." One autobiography Herrera focused on is *My Bloody Life: The Making of a Latin King* by Reymundo Sanchez, which he had first encountered in elementary school. "The topics in it are very mature — a lot of violence and harsh realities," Herrera says, "but the principal believed that we were mature enough to handle the content and put it in the context of our own lives." Over the summer, Herrera wanted to revisit the book with a historical, anthropological, and social frame of reference, in order to understand how the narrative speaks not just to personal experiences, but at a regional, national, and global scale as well.

The Latin Kings, a historically Puerto Rican gang from Chicago, initially formed for political recognition. Herrera explains that between the late nineteenth and mid-twentieth centuries, first-generation immigrant groups in the U.S. tended to form "subgroups within their ethnic enclaves" to protect themselves against a corrupt and racist authority that held anti-immigration sentiments. These gangs eventually evolved from small neighborhood groups to full-scale organizations. The gangs also protected themselves from other ethnic groups that attempted to encroach on their land, resulting in increased violent encounters on the perimeters of gang territories where two groups were more likely to interact. These dynamics still play out in contemporary violent encounters.

In addition to studying why and how conflict arises in gangs, Herrera also attempted to clear false perceptions surrounding gang violence. "[The] majority of gangs only commit slightly more crimes than the average citizen… Who is doing the deed has a lot more to do with how the individual is perceived," he says, referring to the discriminatory nature of the criminal justice system. With this information, Herrera hopes to change the way people perceive and empathize with others by allowing them to understand the circumstances and social factors that shape an individual.

Ordinarily, the field of English employs a broad range of unorthodox research methods. Researchers can do distant reading, looking at trends in literature over time to put it into the perspective of changing historical conditions. On the other hand, they can look closely at a single text and its language, neglecting the social aspects of literature. Herrera's research method takes the middle ground between these two, studying individual texts from multiple perspectives.

Despite the interdisciplinary and flexible nature of English research, there are several challenges Herrera has had to overcome. Herrera explains that because English is so vast, he has had to choose a field to specialize in, familiarize himself with the literature that everyone in the field has read, keep up to date with the latest trends in academia, and catch up on the centuries of history he has missed. Despite these hurdles, he says that doing research has allowed him to filter information better, and to develop the technical language needed to communicate and build personal relationships with English faculty.

Before coming to Cornell, Herrera had no research experience; in fact, he was not even sure what research meant, especially in a field like English where nothing is tangible. After graduating, Herrera plans to pursue a graduate degree, and eventually a career in research.

— Meera Shah
How can we advance the building blocks of our civilization? For years, our world has been built on brick and mortar, but with access to fabrication technology like 3D printing and robotics, we now have the capacity to modernize our built environment.

Working with the Sabin Design lab, David Rosenwasser, a fifth-year Architecture student in the College of Architecture, Art, and Planning (AAP), strives to make cutting-edge contributions to modern architecture. His passion for making and designing things like woodwork and pottery translates naturally into his research as he explores innovative ways of implementing modern fabrication technologies in order to transform masonry from old-fashioned to modern and technologically advanced.

One of Rosenwasser's main projects is Polybrick, a collaboration between the Sabin Design Lab (Architecture) and Luo Labs (Bioengineering) to create a 3D-printed ceramic brick that encodes information in both its structure and a unique DNA signature. Drawing from historical inspiration, the most recent prototype of Polybrick references and modernizes the early practice of stamping bricks for the purpose of recording their place, date of construction, and type. Polybrick utilizes 3D-printed clay and synthetic DNA to make “intelligent” bricks. 3D-printing makes the structure of the bricks intelligent because they can be made in nonstandard shapes that fit together to make complex and mass-customizable forms. Utilizing DNA’s natural capacity for storing information, researchers add an additional layer of intelligence to the bricks by encoding them with synthetic DNA “stamps” that can store complex data. Polybrick will soon be featured in the International Journal of Rapid Manufacturing. Rosenwasser said he enjoys seeing how his research “can create a dialogue with the architectural community” and allows others to “apply [his] experimentation to a larger-scale and more practical application within the field of architecture.”

When asked about his main takeaways from his research experience, Rosenwasser expressed that he has benefited from finding a “productive way of translating [his] personal interests and experiences into productive and tangible advanced research.” In addition to his work on Polybrick, Rosenwasser has applied his knowledge of robotics and ceramics to a project titled Clay Non-Wovens, for which he customizes and programs the Sabin Design Lab’s six-axis robotic arm to extrude clay into intricately patterned tiles. He hopes that Clay Non-Wovens can provide a compelling alternative to more typical facade paneling systems by providing a method of mass-producing unique and beautiful tiles that can be used to add material complexity and richness to our built environment. Through projects like this, he is able to create architectural components and construction systems by expanding upon his existing knowledge. He noted, “I used to know how to use clay on a potter’s wheel, and now I have a repertoire where I can apply my knowledge of a material to more cutting-edge tools.” His paper for Clay Non-Wovens, written in collaboration with Sonya Mantell and Jenny Sabin, was accepted for ACADIA 2017’s conference and proceedings. He will be presenting this research at MIT later this year.

A common theme running through Rosenwasser’s research experience is the enhancement and reinvention of existing knowledge and technology through collaboration and experimentation. Because many members of the Sabin Design Lab are undergraduates, spanning majors from architecture to computer science to materials science, they can combine their areas of expertise to create unique and innovative multidisciplinary projects. Rosenwasser is keen on encouraging anyone who is interested in multi-disciplinary research and design to look into the Sabin Design Lab.

For the future, Rosenwasser plans on continuing research in either an academic or industry setting, since architecture is a field that is constantly looking to be more cutting edge. When he is not in the design lab, Rosenwasser runs a design restoration business and gallery called D ROSE MOD, which specializes in some of the most prolific objects in design history. His work can be seen at either: www.drosedesign.com and www.drosemod.com.

— Kathie Lin
Fall is a popular time of year: people prepare for Halloween, pumpkin spice re-appears, and leaves change color and fall. Some view these leaves as a nuisance, while others find them beautiful. But did you know they can help further our understanding of the effects of climate change?

Alexis Wilson, a junior who studies Environmental and Sustainability Sciences in the College of Agriculture and Life Sciences, is currently analyzing various aspects of fallen leaves as part of her senior thesis, which examines the effects of drought and changing climates on forest systems. Wilson conducts her research under Prof. Joseph Yavitt of the Fahey-Yavitt Lab in the department of Natural Resources.

Wilson began her research at Cornell as a freshman in the Rawling’s Research Scholar Program. Then, during the start of her sophomore year, Ithaca underwent a drought, and Wilson was inspired to study the effects of drought on the environment. She started an independent research project examining the effects of drought on the timing of leaf fall. She began by choosing a woodland plot and three field plots. Then she randomly placed laundry baskets throughout these plots to catch falling leaves. Each week she collected the leaves and organized them by tree species. She then analyzed her data to determine the rate of leaf fall for each species in the woodland plot and found that different species had different tolerances to drought. Oak was relatively drought tolerant: its leaf fall began later than those of other species. Maple, on the other hand, was not drought tolerant: its leaf fall began early and continued throughout the study.

Wilson continued her research by examining the effects of drought on the decomposition of leaves. She chose to examine leaf decomposition because decomposition affects soil chemistry and releases various gases into the atmosphere, which can have effects on climate. Wilson plans to compare the rates of decomposition of leaves that fell from trees affected by drought with the rates of decomposition of leaves from trees not affected by drought. Since she carefully stored leaves from her previous research last year so that they would not decompose, Wilson can now use those leaves as the sample affected by drought, and can collect new leaves this fall for her non-affected sample.

Wilson plans on collecting the new leaves using the same method from her sophomore year, and after weighing the leaves and examining their chemical composition, intends to place all of the leaves in decomposition bags and leave them out in the woodland plot they came from for one year. While waiting for the leaves to decompose, she hopes to study abroad. After a year, Wilson will calculate changes in mass and chemical composition of the drought and non-drought leaves. She expects that drought leaves will decompose faster due to differences in chemical composition since droughts put plants under stress, which would cause the leaves to fall earlier and be weaker. Wilson hopes her work will help us better understand the effects of drought on our environment and climate.

Through research, Wilson has learned many important skills. She has learned that she enjoys the freedom of exploring and conducting her own research. She is glad that her PI gives her freedom and control over her work while still being there to guide her when she needs help. Although Wilson regrets not being able to change the experimental design of her fall semester sophomore year research, she is glad she had the chance to learn about the importance of planning an experiment and has since improved how she plans and conducts research.

In the future Wilson hopes to get a PhD in environmental sciences and continue to conduct research in this field in order to “better our understanding of the environment.” She hopes that through her work, she can “raise awareness about the importance of environmental science and climate change.”

— Manavii Kumar
Most students have experienced reward-based learning first hand over the years. After all, earning a sticker or a piece of candy can inspire an impressive amount of action. Meanwhile, the neural circuitry in our brains is conducting a similar reward-based process, driving learning internally.

Kamal Maher is a senior from Phoenix, Arizona majoring in Interdisciplinary Studies, a mix of cognitive science and neurobiology, in the College of Agriculture and Life Sciences. Maher works with zebra finches to study how reinforcement circuits drive learning by mapping these pathways within the brain.

Previous studies have shown that the neurotransmitter dopamine is linked to reward-based learning. For example, a mouse can be trained to press a lever if given an external reward, such as juice. Now the question remains – can the process work internally? When courting, male zebra finches sing unique songs that have been passed down from their fathers. As babies, they “babble,” testing out different syllables, until they hear themselves hit the correct note. This study proposed that when these birds heard themselves singing poorly there was a decrease in the firing rate of dopaminergic neurons. Likewise, when the faulty note was corrected, the birds would be rewarded with an increase in the firing rate. To determine this behavior, software was used to distort the sound that a bird heard while it sang, creating a “bad” note, and then removed the disruption from the picture, creating “good” notes, while recording traces from neurons. When the song was worse than expected, the firing rate decreased and when the song was better than expected, the firing rate increased. Thus, internally, dopamine does indeed encode reward through these reinforcement circuits, outlining the source of the internal motivation to learn.

Maher works specifically on determining how this computation happens, asking, “how do these dopamine neurons know what’s good and what’s bad?” As the birds sing, they are receiving auditory input in addition to timing-based input, because the song requires a certain order for each syllable, and their brains are sorting out good notes from bad notes. By injecting a retrograde tracer into the nuclei, the areas that give these neurons information on when to fire can be fluorescently labeled. Thus the source of the process can be narrowed down to a few areas.

These results can have interesting applications. For example, Maher said, “Machine learning is a lot like this… there’s reinforcement learning, which is based on this.” In fact, Maher is working on another project about deep brain stimulation that has similar ties to machine learning. In Parkinson’s Disease, neuron firing becomes synchronized and triggers tremoring. To disrupt the oscillating patterns and thus stop the symptoms, a neurosurgeon will move an electrode up and down within the brain, testing different depths, while watching the patient to determine when the tremors stop. One of the unattractive parts of the procedure is that the patient must remain awake throughout. Additionally, only one dimension, depth, can be tested. Thus, Maher is attempting to find a way to explore a three-dimensional space, via the insertion of a column. According to Maher, “If we could explore the space, then we could hypothetically use machine learning” to trace the oscillations and disrupt the symptoms. It’s a trial and error process, but the possibilities are enticing.

Maher genuinely enjoys the time he spends working in his lab, and he also counts himself lucky to be part of a group of such fantastic people. In the future, he plans to earn a PhD and continue research in neuroscience. He is especially interested in a combination of computational and translational research.

— Emily Woodward
The secret to curing Alzheimer’s may lie in your brain itself. Alzheimer’s disease is a complicated neurodegenerative disease and the sixth leading cause of death in the United States alone. Research on its cause and treatment is a cutting-edge branch of dementia research where momentum and discoveries are continuing to build.

Stephanie Becker, a junior biology major in CALS, dedicated her summer to Alzheimer’s research at the University of Massachusetts Medical School and is continuing to conduct dementia research at Cornell. Becker is an active member of the Cornell community, dedicating her time to the Cornell Undergraduate Research Board and Scientista, an organization dedicated to promoting women in STEM. Equipped with a background in research from high school, she was able to secure a research opportunity in the department of infectious disease and immunology at the University of Massachusetts Medical School last summer.

At UMass Medical, Becker and the innate immunology research team set out to explore the function of astrocytes, a specific kind of brain cell, and their ability to produce cytokines, which are inflammatory proteins that may play a direct role in Alzheimer’s disease. Their goal was to determine whether astrocytes produced both forms of a specific cytokine known as interleukin-18 (IL-18), which may play a protective role in the early stages of Alzheimer’s. Using molecular biology techniques, Becker was able to show that astrocytes only produce a preliminary, non-activated form of IL-18.

At this point, Becker says it is unclear exactly what her findings will mean in the context of understanding Alzheimer’s. However, her results demonstrate the importance of IL-18 for future avenues of research. She adds that perhaps in the future, research will move towards directly targeting IL-18 production in astrocytes, which may play an important role in the race to treat Alzheimer’s disease.

Through her research, Becker has been able to learn new skills and face challenges head-on in a lab setting. She says her experience at UMass Medical forced her to become a more independent researcher and thinker, and taught her that science often requires thinking on your feet and problem solving. Over the summer, she had to utilize this kind of problem solving when figuring out how to obtain pure samples of cells to work with. “Getting a pure fraction of the brain cells with no contamination from other types of brain cells required a lot of thinking outside the box,” she says. “We basically came up with this system where we used magnetic beads to create different fractions to obtain pure samples of astrocytes.”

At Cornell, Becker is working in the lab of Professor Fenghua Hu, in the Department of Molecular Biology and Genetics. Her current research focuses on exploring lysosomal dysfunction and its role in dementia. In the future, Becker says she hopes to combine her passion for immunology and neurobiology and return to her study of Alzheimer’s.

—Marisa Gerard
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Helping Hawking: The Cure to ALS

What do Stephen Hawking and Biology & Society major Alyssa Holman have in common? They are both battling amyotrophic lateral sclerosis (ALS): Hawking by living and Holman by researching.

For her honors thesis, Holman is searching literature, running experiments, and analyzing data to determine which genes and proteins could be modifying the repeat expansion in the gene C9orf72, which causes “the most common form of ALS for both familial and sporadic cases,” says Holman. She is conducting this research with Principal Investigator Dr. Andrew Clark in the Department of Molecular Biology and Genetics.

ALS is a neurodegenerative disease that affects more than 20,000 Americans at any given time. It has many different forms, causing muscular atrophy and even dementia, but is always fatal. Therefore, “[i]t is incredibly important that research is done on such a devastating and, as of now, an incurable disease,” Holman says.

Holman explains that she and Dr. Clark are sequencing RNA and performing a genome-wide association study to explore the “many unsolved molecular pathways for C9orf72.” While she hopes to publish her research, Holman aspires to “find natural modifiers of the repeat expansion, so [a] drug or CRISPR targets can be made in humans which could have the potential to cure some forms of ALS.”

— Helen Hu