New York University
College of Arts and Science

Student Research Abstracts

A JOURNAL OF UNDERGRADUATE RESEARCH VOLUME XVII, 2013

INQUIRY

in Humanities, Social Sciences, and Natural Sciences

INQUIRY:

A Journal of Undergraduate Research

Volume XVII, 2013 College of Arts and Science, New York University

ACKNOWLEDGMENTS

*The College of Arts and Science wishes to thank the contributors to the **Dean's Undergraduate Research Fund** for their generosity in establishing the following scholarships to support undergraduate research projects:*

Ronald Abramson Research Scholarship
Harold Akselrad Research Scholarship
Angelica Foundation Research Scholarship
Samuel E. Q. Ashley Research Scholarship
Giuseppe Astorina Research Scholarship
Count Lorenzo Attolico di Adelfia Research Scholarship
William B. Baer Research Scholarship
Bailey Family Research Scholarship
Dr. Charles Barbiere Research Scholarship
Mary Rudie Barneby Research Scholarship
Joel and Shari Beckman Research Scholarship
Frances and Benjamin Benenson Research Scholarship
Peter Bergmann Research Scholarship
Herman Berkman Undergraduate Research Scholarship
Steffi Berne Research Scholarship
Max Bronner Research Scholarship
Roger and Beth Carlton Research Scholarship
College of Arts and Science Parents Research Scholarship
Tory Dent Research Scholarship in Creative Writing
Nathan Ende Research Scholarship
Benjamin P. B. and Fannie L. G. Feldman Research Scholarship
Norman M. and Ann C. Feldman Research Scholarship
Sidney Feldshuh and Lillian Kaplan Feldshuh Research Scholarship
Nicholas and Andrea Ferrara Research Scholarship
John G. Fleming Research Scholarship
Robert A. Fowkes Research Scholarship
Sylvia Engel Friedman Research Scholarship
Samuel and Lilyan Frome Research Scholarship
Arthur Frommer Research Scholarship for Travel and Global Studies
Hugh and Geraldine Fryer Research Scholarship in Classics
Dr. Molly S. Geller Research Scholarship
Daniel Getman and Leonard Marker Memorial Research Scholarship
Joseph Gilbride Research Scholarship
Jeffrey Gould Research Scholarship in American Politics
Marion Cohen Griffel Research Scholarship
Susan and Robert Grossman Research Scholarship
Eileen Guggenheim Research Scholarship
Russell and Diana Hawkins Research Scholarship
Hirschfeld Family Research Scholarship
Heights Alumni Association Research Scholarship
Holten Family Research Scholarship
Joseph Jerome Research Scholarship
Thomas Kane Research Scholarship in English
June Schlesinger Katz International Research Scholarship
Dr. Evan and Brooke Kaye Research Scholarship
Jurate Kazikas Research Scholarship
James Koch Research Scholarship
Myron Kove Research Scholarship
Kringstein Family Research Scholarship
Joan Kupersmith Larkin Research Scholarship
Howard Levene (WSC '41) Research Scholarship
Barnet and Phyllis Liberman Research Scholarship
Liebman Family Research Scholarship
John and Julia Lindsey Research Scholarship
Linn-Cohen Family Research Scholarship
Walter and Phyllis Loeb Research Scholarship
Philip Alfred Lotz Research Scholarship
George Maker Research Scholarship
Rose and Barry McInerney Research Scholarship
William J. McKeon Research Scholarship
Dr. Aston McLaughlin Research Scholarship
Nicole and Joseph Meyer Research Scholarship
Kurt M. Mislow Research Encouragement Scholarship
Mortimer J. Natkins Memorial Research Scholarship
The New York Community Trust Murray Hidary Research Scholarship
Arthur Noulas Research Scholarship
S. Okamura Research Scholarship
Ariel and Alaleh Ostad Research Scholarship
Drs. Mayank and Amita Patel Research Scholarship
Wilfred L. and Ruth S. F. Peltz Research Scholarship
Sidney Probst Research Scholarship
Pudding Hill Research Scholarship
Marie and Anthony Rao Research Scholarship
Lydia R. Reeve Research Scholarship
Joseph A. Rice Research Scholarship
Richard Robins Entrepreneurial Research Scholarship
Daniel A. and Amy L. Rock Research Scholarship
Peggy and Bernard Sakin Research Scholarship
Salant Family Research Initiative in Pre-Health Studies
Ravi and Nalni Saligram Research Scholarship
Schachter Family Research Scholarship
Julie C. Schiefflin Research Scholarship
Robert Selander Research Scholarship
James A. Shea Research Scholarship
Sigal Family Research Scholarship
Seena and George Silbert Research Scholarship
Larry and Klara Silverstein Research Scholarship
J. S. Sinclair Research Scholarship
Jack Sitt Research Scholarship
Dr. Dorothy A. Starr Research Scholarship
Drs. Aaron A. and Francine M. Stein Family Research Scholarship
Joan C. Suttles Research Scholarship
Swartz Family Research Scholarship
Daniel A. Swick Research Scholarship
Varet Family Research Scholarship
Shirley Schmones Wallach Research Scholarship
Washington Square College Class of '42 Research Scholarship in Humanities
Herman J. Wechsler Research Scholarship in Fine Arts
Howard M. Weisberg Family Research Scholarship
William F. Weld Research Scholarship in Ancient Studies
Horace Wendorf Research Scholarship
Ellie and David Werber Research Scholarship in Social Science
Arthur L. Wolf Research Scholarship

Anonymous Donors
Sidney and Judith Kranes Charitable Trust
Beta Chapter of New York, Phi Beta Kappa

CONTENTS

[*] supported by Dean's Undergraduate Research Fund [†] winner of Phi Beta Kappa Albert Borgman Prize for Best Honors Thesis

NATURAL SCIENCES

* supported by Dean's Undergraduate Research Fund † winner of Phi Beta Kappa Albert Borgman Prize for Best Honors Thesis


LEICA M50
serotec

INTRODUCTION:

Research as Educational Paradigm

The annual journal *Inquiry* showcases abstracts of selected student research undertaken in the academic year 2012–2013 in the College of Arts and Science at New York University. It is a celebration of the achievements of our most curious, driven students, and those who have availed themselves of the opportunities for research that we afford. As part of a premier institution of research, the College of Arts and Science has the responsibility to involve undergraduates in the production and expansion of knowledge, under the aegis of world-class faculty researchers who routinely teach our undergraduate students.

Research can take many shapes, as this publication attests. Students featured here spent time working in a lab with a team of scientists in order to understand how a specific hormone affects brain development; picking through boxes in an archive, finding textual evidence to support a literary analysis; or interviewing a living eyewitness to a major historical event in a foreign country. The benefits are many. Educationally, students learn to work closely with a mentor, sharpen their problem-solving skills, and learn about "the big ideas" of their chosen field. Professionally, students explore possible future careers, learn how to work independently, and hone marketable skills, such as effective written and oral communication. Personally, there is no greater achievement then meeting the challenges of a long-term project, following a passion to a wonderful conclusion, and having a completed work to show for it, whether it be a poster, thesis, or data set. The internal standard of excellence that our students discover within themselves is perhaps the most salient personal outcome of undergraduate research, and a reward that keeps on giving no matter what one pursues after college.

This publication represents only a fraction of the research undertaken by College students, as individuals and in groups, under the close mentorship of faculty; for the most part, the projects featured here were supported by the Dean's Undergraduate Research Fund, created through the generosity of alumni parents, and friends, which provides material support necessary to carry out their inquiries. (A list of the research scholarships that have been endowed in the Fund appears on page 2 of this journal.) These abstracts were also presented at the annual Undergraduate Research Conference, which was established over thirty years ago and encompasses the sciences, humanities, and social sciences, as well as creative writing.

At the start of this issue is the "Faculty Perspective," in which we publish the remarks delivered by an NYU faculty member at the closing award ceremony of the previous Undergraduate Research Conference. The content of this issue underscores the crucial importance of independent inquiry as a paradigm for a liberal arts education for the twenty-first century. We are very grateful to the students, their faculty mentors, and the generous funders who have made this sort of educational experience, and this journal, possible.

G. Gabrielle Starr
Seryl Kushner Dean, College of Arts and Science
Associate Profesor of English

FACULTY PERSPECTIVE:

Stochastic or deterministic? . . . That is the question . . .

by Professor Claude Desplan

"I, at any rate, am convinced that He does not play dice," claims Albert Einstein, meaning that life on earth is highly constrained and that little in Nature is left to chance. This is clearly illustrated when we look at identical twins who, for the most part, are indistinguishable. Another example is the astonishingl symmetry between the left and right parts of our face, which reflects the fact that Nature is highly reproducible (and therefore deterministic). In fact, the world of biology is full of such examples and, in agreement with Einstein's statement, everything appears to be written in the blue print of our genes: Life is deterministic.

Yet, Einstein, who usually got things right (!) missed something here. He certainly was not aware of an old reference in the Talmud, written in 120 AD by Rabi Akiva Mishn that says: "All is foreseen, but freedom of choice is given." This means that there might be a degree freedom that is left to interpret the precise information contained in our genes, leading to variable outcomes. This is not to say that life is random, but Nature might give us some limited choices between alternatives. We could then say that this is "deterministic chance," even though these two words are highly contradictory.

Why would Nature leave some freedom of choice to biological systems when evolution requires that each character, almost each base pair of our DNA be under intense selection in order to allow us to adjust to our environment? Evolution takes the precise information written in our genes and tries to adapt it to a changing world. But how can Nature achieve this if the information is variable, making it impossible for selection to act? There must be some practical reasons why Nature would choose to let (some) freedom of choice occur in its biological systems.

One reason is the limitation of information that can be stored in our genes. It has recently appeared that Nature has not chosen to increase the total number of genes between the simplest animal life and the most complex, humans. Indeed, we share the same number of genes, around 25,000, with most other animals, the simple round worm *C. elegans*, the fruit fly *Drosophila* or the mouse. This means that complexity has to come from a limited amount of information.

There are situations where the number of parameters to which our body has to respond far exceeds the capacity of the genome to encode this information. The best illustration of this idea is our ability to recognize millions of different foreign agents with our immune system, be it bacteria, viruses or molecules, most of them having never been in contact with our body before. Nature has therefore devised a very clever way of building a huge variety of antibodies based on chance arrangement of gene segments. This creates millions of random antibodies: If one of these antibodies is able to recognize the foreign object, it will be selected (and amplified) to fight the disease. Each individual will generate different antibodies, and one will be selected, thus explaining why we all fight diseases differently.

Another illustration is our olfactory system, which is able to recognize thousands of odors, often with an amazing precision: think of tastevins, people able to recognize wines, Chateaux and years, with amazing precision. This is because we have about 1,000 different genes that encode 1,000 odorant receptors that each specifically binds to one of 1,000 chemicals. In each of the odorant receptor cells in our nose, only one of these 1,000 genes is turned on to confer specific odor recognition to this cell. As we have only 25,000 genes in our genome, this means that 4% of our genes are dedicated to detecting odors; some animals that rely more on odors than we do have even more of these genes. This leaves our body with the huge task of placing each of these proteins on the right cell and there is not enough information in the genome to do so. Therefore, Nature lets chance play its role: Each cell decides randomly to express one of the 1,000 genes, and, by chance, each of the 1,000 genes will be expressed in a number of odorant receptor cells. By using this system, Nature can hugely diversify its repertoire of odor recognition; the unique constraint is that only one gene must be expressed in each cell, and there is indeed a built-in system of exclusion that is in place.

In these two cases, chance provides the opportunity to increase the repertoire of antibodies or olfactory receptors at a low regulatory cost. The same thing happens in our color vision system. Humans are trichromats in the sense that we have three types of 'cone' photoreceptors that each better respond to blue, green or red. By comparing the light received by these three cones, we can discriminate between lights of different wavelengths (colors) with high precision. As for olfactory receptors, the two red and green cones are distributed randomly in our retina (see Figure 1B). In this case, however, the regulatory task of precisely expressing the gene that encodes the green photopigment in green cones, and the gene that encodes the red photopigment in red cones should be fairly simple. Yet, Nature has chosen to distribute them randomly. There might be some advantage to this distribution or a simpler explanation might exist.

Professor Desplan was trained at the Ecole Normale Superieure of St. Cloud, France. He completed his Ph.D. in Paris at the INSERM on calcium regulation before moving to the University of California at San Francisco. At UCSF he initiated his studies of the homeodomain and demonstrated that this conserved signature of many developmental genes was a DNA binding motif. In 1987, he joined the Faculty of Rockefeller University and was a Howard Hughes investigator. He pursued structural studies of the homeodomain and initiated his work on the evolution of axis formation in insects. In 1997, he began his investigation of color vision in *Drosophila* that occupies most of his current laboratory. He moved to New York University as a professor in 1999. His team has described the molecular mechanisms of patterning of the fly retina that underlie color vision. He is now studying the processing of color vision and the functional anatomy of the medulla part of the optic lobe. In parallel, his lab developed the wasp *Nasonia* as a model system to compare early developmental events in the embryo (Evo-Devo). He contributed extensively to the understanding of how insect embryos pattern their antero-posterior axis through the utilization of many of the same genes that are used in *Drosophila*.

Indeed, most other vertebrates such as fish or birds have excellent color vision with 4 types of cones that are distributed in a precise and deterministic manner, with for instance alternate stripes of blue and UltraViolet (UV)-sensitive cones in the fish retina (see Figure 1A). In contrast, most mammals, such as rats, mice or cats only have few blue and green cones and are basically color blind. This is because they live at night, when there is not enough light to see colors: they are nocturnal, having spent the last 100 million years in the dark, maybe trying to escape dinosaurs! But when our closer ancestors, the "old world monkeys" became diurnal and fruits gatherers, color became

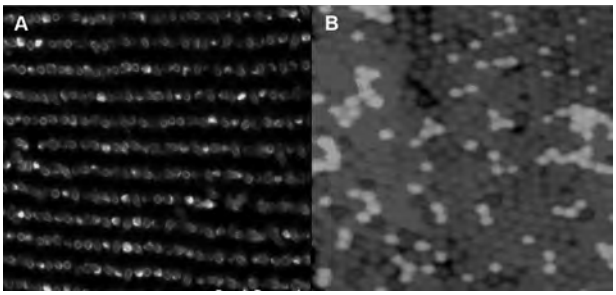


Figure 1: Deterministic vs. stochastic retina: The fish retina (A) has rows of blue- and UV-sensitive cone photoreceptors, while blue, green and red cones are distributed randomly in the human retina (B)

important for their lifestyle. As adding a red photopigment to their blue and green cones would be advantageous, a duplication of the green gene occurred and the new gene evolved to become red-sensitive, thus recreating trichromacy in mammals. It happens that the molecular process to express the new red pigment to the exclusion of the green (and blue) pigments is stochastic, allowing diversification of cones. Although stochasticity might not be the simplest way to tell apart different colors, it works well, so we kept it, at least for the last 8 millions years since the duplication of the green gene allowed trichromacy.

Interestingly, stochastic distribution of color photoreceptors is not unique to old world monkeys. In fact, the lowly fruitfly, *Drosophila*, has a very similar stochastic distribution of green and blue photoreceptors (Figure 2A), albeit through a very different mechanism: This is not surprising since the common ancestor to flies and humans lived . . . 800 million years ago! The two stochastic distributions of color photoreceptors in humans and in flies are independent; this is called 'convergent evolution' when Nature evolves a similar process twice in very different organisms. The retina of the fruitfly has a random distribution of blue and green photoreceptors, with a biases distribution with 70% green and 30% blue (Figure 2A). We understand how the stochastic mechanism works: it is controlled by a specific gene called *spineless*. But one question lingers: Why did flies choose to distribute their photoreceptors randomly rather than in a deterministic way? This is an even more serious question when we know that the fly brain is "hard-wired," *i.e.* it does not change much with experience. Could it be that, like mammals, the flies' ancestors were color-blind and flies have recently recreated color discrimination? Not so, as most insects are diurnal and most feed on colorful flowers. Bees, for instance, can beautifully recognize colors to choose the flowers that will give them the most pollen. In fact, most insects have a stochastic distribution of photoreceptors, which dates back to several hundreds of millions of years. Nature would have had plenty of time to evolve a deterministic system if it were advantageous, but She did not. The reasons for keeping the stochastic mechanism are not clear: It might be a way to have a system that is very fluid and that can quickly adapt (evolve) to changing environments by adjusting the ratio of blue and green. Therefore, rather than a makeshift solution as in the human retina, stochastic choices might be a sophisticated mechanism that has evolved over hundreds of millions of years to accommodate changes.

One important question is whether insects are able to develop a deterministic system where color photoreceptors are organized, for instance, in fixed rows. This is indeed the case and we have identified

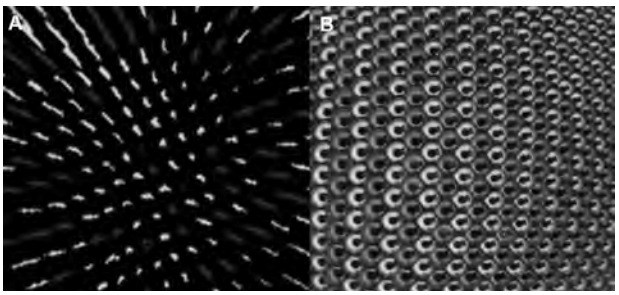


Figure 2: Stochastic vs. deterministic retina: The fruit fly retina (A) has blue and green photoreceptors distributed randomly while the Dolichopodidae retina (B) has rows of differently pigmented unit eyes.

a group of *Dolichopodidae* flies (*Dolis*), also called long-legged flies that exhibit this feature. These are very common flies in grassy humid places; they are related to *Drosophila* since they are both Diptera, although their common ancestor dates back to 160 Millions years. In *Dolis*, the eyes have stripes of different photoreceptors. In the picture (Figure 2B), they should be green and red, due to pigments on the cornea of the eyes. Why did these flies evolve such a deterministic system and escape from stochastic choices? The 'why' questions are always very difficult to answer, but one can speculate that these flies have a higher need to have equal distribution of two types of photoreceptors; we believe that one row serves for the detection of colors while the next row serves to detect polarized light: This is important when insects live next to water surfaces as landing on water is lethal for an insect that is not specialized for water life. Since water surfaces reflect polarized light, Dolis must be able to detect them and avoid them. What is exciting is that the same molecular principles that serve to make stochastic choices in *Drosophila* are re-utilized for *Dolis* to distribute their photoreceptors. For instance, the gene *spineless* that controls stochastic choices in the *Drosophila* retina, appears to also be involved in the deterministic choice in *Dolis*. The genetic system, rather than responding to random cues, instead uses a template to pattern its photoreceptors one row at a time.

This shows that Nature takes advantage of existing systems and is able to tinker with them to adjust to the requirements of the external world. In most cases, Nature likes to have the biological processes under full control. The genetic information programs every part of our body, and this is why twins look identical, or how the right and left sides of our faces are almost perfect mirrors of each other. However, if stochasticity provides an advantage, or if it is the only way to proceed, then Nature can design systems that allow some "freedom of choice." But even in this case, the genome controls this freedom: it is programed randomness!

There is today a good deal of confusion about the status of knowledge in the humanities. To some, the admission that we seek only an interpretation seems to allow all kinds of subjective opinion to count as knowledge. Or worse, it seems to endorse the principle that those with the power to impose "their" opinion define knowledge. Nothing could be further from the truth. Interpretation is a form of knowledge, not mere opinion. What distinguishes knowledge, even knowledge that makes no claim to absolute certainty, is evidence and rigorous analysis. That is the meaning of disciplined inquiry in any field.

—Thomas Bender, University Professor and Professor of History

HUMANITIES

Representation, Signification, Interpretation in the Photography of Graciela Iturbide

Olaya Barr, Spanish

Sponsor: Professor Lourdes Dávila, Spanish and Portuguese

In the photography of Graciela Iturbide, images do not have fixed narratives. In fact, their meanings are unstable and often collide with our expectations of gender, ethnicity, space and culture. Often, photographic readings rely on codification that potentially silences images and denies the subjects their own narratives independent of codes or categorization imposed by the viewer. My work aims to deconstruct these visual codes that bind images to a pre-determined and simplified reading. Because there are so many conventions regarding who is nude, how we view the nude, and consequently the relationship between object, subject, and artist, I have chosen the genre of the female nude to demonstrate how Iturbide's photography ought to be read against the grain. Close photographic analyses as well as an interview with Iturbide herself have led me to deconstruct such binary conventions as the natural and the man-made, high culture and low culture, the insider and outsider, and the varying idealistic visions of the female nude and the indigenous person. My thesis offers an alternative reading of Iturbide's few published female nudes that valorizes the fluidity and ambiguity of an image's meaning.

From Memory to History: Reinterpreting *Memorias de Bernardo Vega*

Diana Bauza, Spanish

Sponsor: Professor Dylon Robbins, Spanish and Portuguese

Memorias de Bernardo Vega is the memoir of a cigar roller from Puerto Rico who migrated to New York City in 1916. In Puerto Rican studies, it became a canonical working class text upon its publication in 1977 by César Andreu Iglesias who had adapted it from a manuscript written by Bernardo Vega in 1955. Until this past year, the manuscript had been inaccessible to scholars, but its recent recovery necessitates a reinterpretation of *Memorias* in light of the original, which was, in fact, a novel titled *La Familia Farallón*. In *Memorias* and *La Familia Farallón*, the mix of genres—of *crónica* and memoir—complicates the analysis of the two texts. Both genres involve a subject remembering and interpreting actual events that are part of an official history. Though we associate this official history with objectivity, in the sense that it is not personal, these genres illuminate the tensions inherent in these definitions. When *Memorias* and *La Familia Farallón* are considered together, they create a prism through which we can examine the subtle distinctions between fiction and non-fiction; subjectivity and objectivity; and memory and history. By comparing select passages from the published work and Vega's manuscript, we can explore how genre and gender work in these texts in order to identify possible implications of the nuanced and distinct alterations.

Staging Cannibalism, Rebuilding Rome: Du Bellay and the Violent Enterprise to Translate Antiquity
Aurora Bell, Comparative Literature
Sponsor: Professor Jacques Lezra, Comparative Literature

My thesis deals with a web of three texts—Joachim du Bellay's *Deffence et illustration de la langue françoyse* (1549) and *Les Antiquitez de Rome* (1558) and Edmund Spenser's "Ruines of Rome" (1581)—that treat and enact the practices of literary translation and imitation as they were conceived by these sixteenth-century poets. In an attempt to explore the troubling violence that emerges across these texts, I turn to Freud's *Totem and Taboo*, which provides an explanation of why an aggressive and destructive stance towards the object of one's translation might be necessary for poetic production as Du Bellay envisions it in the *Deffence*. I trace Du Bellay's appropriative projects, from his attempt in the *Deffence* to carve a space for a proto-nationalist poetry (in which he equates literary and political power), to his proposition in the *Antiquitez* to poetically transport the ancient Roman ruins to the French court. I then discuss the relation between this transfer of power and literary translation, as it is presented in the *Deffence* and enacted in the *Antiquitez* and in Spenser's "Ruines." Finally, I return to Du Bellay's description of imitation as a violent act of cannibalism that requires the poet to consume an admired model and seek to offer an explanation of the prevailing violence by drawing the parallel to *Totem and Taboo*. While the instances of cannibalism in the *Deffence* and in *Totem* seem to have similar motivations (ambivalent feelings toward a father figure), the results of the violent act are very different. The guilt felt by Freud's band of brothers leads them to erect taboos that will prevent any future violence of this sort. The poet, however, does not actually kill his imitative model, and while he feels guilt at the violence he inflicts upon it, to deny the actions that produced his guilt would be to demand the end of poetry, and instead the feeling of guilt fuels his ultimately productive ambivalence toward ancient poetry.

The Shanghai *Lilong*: a Miscast Type in the Discussion of Colonialism and Westernization in Shanghai
Nora Boyd, Art History
Sponsor: Professor Jon Ritter, Art History; Urban Design and Architecture Studies

In the twentieth century, Shanghai was most often represented in images of the Bund, its turn-of-the-century neoclassical style waterfront. Today this is true of Pudong's space-age skyline. These images of Shanghai represent and reinforce the idea of a colonial Shanghai in the nineteenth and twentieth centuries, and a westernized Shanghai today. This study focuses on a part of Shanghai's built environment that contradicts the notion of a colonial Shanghai, and calls into question its westernization today. The real city was behind the Bund: a housing type called the *lilong,* unique to Shanghai, housed most of the public. The type emerged during the nineteenth century and consisted of space-efficient single-family homes built within a complex. A close study of its development shows that the *lilong* was not a colonial construction, but a product of its merchants' enterprise and political freedom. By the time of the revolution in 1949, the *lilong* housed roughly three-quarters of Shanghai's population. This was the built environment for most Shanghainese, and its differences from traditional Chinese housing facilitated a culture unseen anywhere else in China. In ignoring the significance of this housing type, many scholars omit essential evidence about the development of the city and its unique urban fabric. The *lilong* was one of the determining factors in producing Shanghai's notorious reputation and glamorous history.

Dreaming in the Eighteenth Century: Fuseli's *The Nightmare* and Goya's *The Sleep of Reason*
Victoria Damutz, Art History
Sponsor: Professor Edward J. Sullivan, Art History

Two of the most provocative images of dreams in Western culture—Henry Fuseli's *The Nightmare* of 1781 and Francisco de Goya's *The Sleep of Reason Produces Monsters* of 1799—are often discussed in relation to one another due to their supposed supernatural content. These works are noted for their iconographic depictions of superstitious and folkloric subjects relevant to the themes of Romanticism and the Gothic, but these works also uphold the attitudes of Neoclassicism as dictated by Enlightenment ideals. Though these terms are not rigidly defined, Neoclassicism is often closely associated with reason, which manifests through clarity in form and simplicity in composition, whereas Romanticism places an emphasis on emotion, the artist's imagination, and the sublime. The dichotomies that exist in each artist's work between reason and fantasy, clarity and obscurity, the classical and the Medieval, and the universal and the individual reveals the tension between Neoclassicism and Romanticism in both compositions. The purpose of my research is to demonstrate how these dualities manifest through the artists' unique constructions of dreams. In addition to new conceptions of artistic genius, the late eighteenth century brought a renewed inquiry into the nature of dreams. By examining contemporary eighteenth-century writings on dreams and sleeping, I explain the ways in which the subject matter of each artwork adheres to dream theories of the time. Moreover, through observation of past depictions of dreams in art, I

also determine the extent to which each artist references or rejects these previous representations of dreams in style and composition. Furthermore, in offering a comparison between *The Nightmare* and *The Sleep of Reason*, I explore how the difference between Fuseli's background as an Anglo-Swiss artist and Goya's background as a Spanish court artist influenced their works. Whereas Goya had in mind the concrete realities of his time in rendering the dream as social commentary, Fuseli instead captures the subjectivity of the imagination through a dramatic and introspective glimpse of the nightmare.

The Writing of Allan Kaprow as a Curation of Identity and Historical Presence

Rachel High, Art History
Sponsors: Professors Julia Robinson and Pepe Karmel, Art History

Allan Kaprow is best known as the inventor of Happenings, performance pieces that catapulted painting and art in general into life. Kaprow was also a prolific writer and used his writing as a tool to speak with authority on his own work and the work of his peers; his training as an artist and art historian at the Hans Hofmann School of Painting and Columbia University, respectively, put him in a particularly advantageous position to do so. This study focuses on Kaprow's creation of a historical narrative and an artistic identity through his writings. The following works are discussed in depth: "The Legacy of Jackson Pollock," an essay written before the widespread popularity of his activities; *Assemblage*, *Environments & Happenings*, a book published in the middle of his career; and "The Education of the Un-Artist" series, written during Kaprow's engagement with several experimental educational institutions, including Project Other Ways for Berkeley Unified School District and California Institute of the Arts. Kaprow promoted his work effectively by creating a linear historical narrative for his works of art, following the legacy of Abstract Expressionism. His body of written work contends with preconceived ideas of Happenings and attempts to navigate the changing landscape of the art world into the 1970s. Kaprow's constant struggle to control his public image is apparent when searching through archival materials, charting his influences, and analyzing his writings. This study concludes that his writing is a work of art in its own right. Through his writing, Kaprow not only crystallized his ideas but also cemented his work as part of the art historical cannon. This research is significant not only for understanding the current and contemporaneous attitudes towards Kaprow's work, but also for understanding the work and perception of other artists in his circle including other Happeners and members of the artist collective Fluxus.

Seoul Greenbelt Development and the Necessity of Preservation

In-sung Kim, Urban Design and Architecture
Sponsor: Professor Mosette Broderick, Art History; Urban Design and Architecture

Why did the former President Myung-bak Lee of South Korea initiate the destruction of parts of Seoul's greenbelt, despite his commitment to the city's environmental health? This study specifically concentrates on the history from development to partial abolition of the greater Seoul metropolitan area's greenbelt, also known as Development Restriction Zones. Despite the initial purpose of the greenbelt as a means to protect the nation from North Korea, it has proven to be the main source of environmental sustainability and the apparatus to stop further urban sprawl in one of the most densely populated cities in the world. President Lee decided to take a step to a more sustainable growth model of the nation through what is called the National Strategy for Green Growth. This scheme involves two plans that are contradictory to the new sustainability ideology set about by the Lee administration—the greater Seoul metropolitan area Plan 2020 and the Nest Housing Project. These plans promote greenbelt curtailment, real estate speculation, and conurbation for a megalopolis formation, all of which are in the exact contradistinction to the nation's new green paradigm. This paper thoroughly scrutinizes both the consequences of a top-down policy and the effects of greenbelt destruction on the environment.

"Ask Me": Secular Confession, Self-Archival, and the Ends of Censorship in Irish Literature, 1958–present

Susannah Lawrence, English and American Literature
Sponsor: Professor Gregory Londe, Irish and Irish-American Studies

This thesis examines a trend within twentieth and twenty-first century Irish literature that links an individual's creation of an external archive of memory to a type of confession or testimony that is secular rather than religious. In order to examine this trend, I look at Samuel Beckett's *Krapp's Last Tape* (1958) and Roddy Doyle's *The Woman Who Walked Into Doors* (1996) with a consideration of the histories of Irish media and censorship; through this, I demonstrate how my chosen texts provide a way into an important literary development that has not yet been fully explored. Both *Krapp's Last Tape* and *The Woman Who Walked Into Doors* are presented as fictionalized first-person accounts of a single character's life. I look at the construction of narrative and voice for each of these characters in light of their historical context, as well as through Derrida's theory of the archive, which describes acts of self-archival in terms

of nostalgia, repression, and self-censorship. These three aspects of Derrida's archive theory are also applicable to contemporary Irish history, and are highlighted by the two texts that I have placed into conversation with each other. I supplement my analysis of *Krapp's Last Tape* with primary archival research conducted at Trinity College, Dublin in the summer of 2012, when I explored the Samuel Beckett archives. I also had access to the Roddy Doyle Papers at the National Library of Ireland, in which I was able to look at select manuscripts, drafts, and unpublished works.

The People of Our Tsar: A Translation
Mariya Lipmanovich, Comparative Literature; Spanish
Sponsor: Professor Anne Lounsbery, Russian and Slavic Studies

Liudmila Ulitskaia is a well-established novelist in the contemporary Russian literary scene. Her short story collection *Liudi nashego tsaria* (*The People of Our Tsar*, 2005) represents a sharp political and social critique of the Soviet era and contemporary Russian society. This project translates the first of the book's four parts, consisting of the prologue and ten stories. With the intent of staying accurate to the original and yielding an authentic English equivalent, I have explored various translation techniques and studied the author and her other books (using published English translations as guides for the project). I have employed a self-devised, three-tiered approach which starts with a literal text-oriented translation and gradually moves toward a more free-flowing, reader-oriented translation. This project aims to balance between these two extremes on the translation spectrum, so as to produce a faithful representation of Ulitskaia's writing style, message, and spirit. Since this work has not been previously published in English, I hope it will provide English-speakers with a better understanding and appreciation not only of Russian history, but of their own cultural heritage as well. While these short stories offer a glimpse at cultural particulars, ultimately they illustrate the universal human experience that knows no political boundaries.

Children and Fools: Harry Hay, Mattachine, and Early Ideologies of Gay Liberation
Ben Miller, History
Sponsor: Professor K. Kevyne Baar, History

Early American gay rights activist, Harry Hay, was no fan of history and historians, always railing against what he called the "hetero-dominated calendar of days" and imploring his biographers to focus on context rather than the day-to-day occurrence of events. This paper, while not freeing itself entirely from the calendar, endeavors to place the first segment of Hay's mature career as an activist into some ideological context. It retells the story of the founding of the Mattachine Society, America's first gay rights organization, which Hay founded in Los Angeles with an eye towards that history's relevance to the ideological development of gay, and by extension LGBT, rights in America. Based on original research conducted using Hay's personal papers and the papers of the Mattachine Society, this paper concerns itself with the period between 1933 and 1953: with Hay's ideological development before the founding of Mattachine, and with the construction of the gay identity based on that ideology while Hay worked there. It finds that existing literature is often inconsistent with archival records and Hay's own reminiscences, unearthing several glaring inaccuracies and omissions. Ideologically, it finds that Hay used Marxist cultural theory to fuse elements of folk music, medieval fooling, and Native American religious and gender traditions into a gay identity that could serve as the basis for political activism, radically challenging existing gender and sexual norms in ways that are too often forgotten in the mainstream literature of gay history.

The Private as Partner: A Study of New York's Privately Maintained Public Waterfront Spaces
Alessandro Olsen, Urban Design and Architecture Studies
Sponsor: Professor Mosette Broderick, Art History; Urban Design and Architecture Studies

A staggering gap continues to widen between what the public expects government to provide and what people are actually willing to pay in taxes to support our public resources. This cultural standoff, in conjunction with economic recession and dwindling public funds, makes it difficult for the New York City Parks Department to maintain its 29,000 acres of parkland. Increasingly, waterfront park projects—essential for public benefit, economic vitality, and returning New York's waters to the public—are turning to the private sector for assistance with long-term maintenance. This privatization of public space in the form of public-private partnerships (PPPs) brings up pressing questions about the role of government, the boundary between public and private, and most important, an analysis of sustainable models for funding public space in an era of receding government funds. With tax revenue not likely to increase, examining the sustainability of cross-sector partnerships is more crucial than ever for the sustainability of public initiatives. New York City's three most relevant case studies—Battery Park City, Hudson River Park, and Brooklyn Bridge Park—reveal three unequal models. By outlining the reasons for the relative success of Battery Park City, unpacking the financial planning errors made at Hudson River Park, and delineating practical privatization solutions taken into the plans for the future of Brooklyn

Bridge Park, this thesis brings better transparency to the public-private partnerships, illuminating paths for more sustainable financial models for one of the city's most valuable and vulnerable resources: waterfront parks.

Does Anyone Else See What I See?
Lou Gemunden Spitta, Spanish and Portuguese
Sponsor: Professor Jordana Mendelson, Spanish and Portuguese

With Grete Stern we must begin and end with her photographic vision. In her photographs, Stern defines herself as a function of that vision. She begins this project in Berlin in the 1920s and returns to it in Buenos Aires in the 1930s, but the subjective gaze of the photographer is relevant to all of her work. Meeting Man Ray's 1935 challenge that the past is "impossible to bring forward into the present," I have tried to revive Stern's images by excavating their origins. Stern's 1930's advertising work in Berlin and her later 1940's and 1950's work in Buenos Aires provide two separate contexts to begin addressing the same issue: how do we read Stern's dialectical images from inside and outside of the context of their creation? Since Berlin in the 1930s and Buenos Aires in the 1950s were politically, geographically, and culturally distinct cities, Stern's dialectical images—that engage with specific aspects of each culture—must be contextualized with great care. Although these images have narratives that are more difficult to read from the present moment, Stern's social critique continues to grow with time. The (ever rising) flood of digital images overwhelms the viewer, but images such as *Petrole Hahn* and *Love Without Illusion* stand out in this sea of photographs. Stern's images perform dialectical work that unleashes them from the context of their creation; the layered narrative is a device that transforms the disposable and ignorable image into a dynamic work that occupies space and time. She slows down the viewer, directs the viewer's eyes from one point to the next, and thereby turns sight into thought. This is Stern's achievement. With her eyes she listens, with her hands she creates dialectical images that talk.

A Walk Through Two Neighborhoods of Mumbai
Ihaab Syed, History
Sponsor: Professor Maria Montoya, History

My research focuses on the histories of two neighborhoods in Mumbai, India. I have family in both of these locales, and I wanted to investigate how land use practices in these areas had changed over my lifetime. I researched the development of modern Mumbai as a whole and how these particular regions fit into that history. I explored the streets around Old Lokhandwala Complex in Andheri West and Takshila Cooperative Housing Society on Mahakali Caves Road in Andheri East. Lokhandwala was created through the reclamation of marshland. It has since become a posh commercial center, filled with television stars, gleaming mega-malls, and restaurants. The other region has been continuously inhabited for centuries, but the hills that once stood there were razed, and with them, much of its history was erased. I collected my own primary sources and formed an idea of why these areas developed so differently. Using observations made while walking the neighborhood and conversing with residents, I was able to get a sense of how Lokhandwala expanded over the past three decades by making maps that detailed the locations of businesses and housing complexes, with approximations of the ages of these establishments provided by local merchants and watchmen. I repeated this process on a smaller scale in the second neighborhood. My examination sheds light on why some of the forces of gentrification that transformed Lokhandwala were not as strong in the area around Mahakali Caves. Lokhandwala's more recent creation (in the 1980s) and its proximity to other commercial centers made it a more desirable location for new businesses, especially restaurants, at a time of increasing corporate control of India's retail industries and increasing foreign investment in the country.

Selling a Community: Shopping Centers and the Suburbs
James Walsh, Urban Design and Architecture Studies
Sponsor: Professor Mosette Broderick, Art History; Urban Design and Architecture Studies

Since the beginning of the automobile age, architects and planners have struggled to adapt traditional urban forms to a society in which each person is accompanied by two tons of metal. The enclosed shopping center came to dominate the suburban landscape over the second half of the twentieth century, becoming a despised symbol of sprawl in the eyes of progressive designers. Andres Duany and Elizabeth Plater-Zyberk, two influential New Urbanist architects, sought to break the mold by creating a traditional town center for the suburbs. Critics have praised their work, but is it truly a departure from the conventional enclosed shopping center? Does it have the potential to become an integral part of a community, or will it succumb to the same fate as its predecessors, requiring demolition or substantial renovations within thirty to forty years? This thesis traces the history of American shopping center typology through the examination of five case studies. They include Country Club Plaza, the first shopping center tailored to the automobile; Southdale, the first enclosed shopping center; and Mashpee Commons, Duany and Plater-Zyberk's potential solution. Principles from Jane Jacobs' *The Death and Life of Great American Cities* form the criteria for analysis of each center. Her

standards for urban design, which promote pleasant and sustainable environments as well as economic prosperity, are also applicable to the shopping center.

From Reason and Sense: the Concept of the Body in Enlightenment Rights Discourse

Gloria Yu, History

Sponsor: Professor Stefanos Geroulanos, History

The emergence of rights discourse in Europe leading up to the French *Declaration of the Rights of Man and the Citizen* of 1789 placed the individual at the center of Enlightenment thought. Scholars in philosophy, literature and the sciences formed new theories of the self that attempted to reconcile the immediacy of bodily experience with a rational and reflective mind. This study considers theoretical and practical treatments of the body as a site for cultural and jurisprudential analysis. It examines conceptions of the body held by Julien Offray de la Mettrie, Jean-Jacques Rousseau and Denis Diderot, among others, and reveals both the development of a capacity for empathy and the intrinsically social and moral dimensions of the enlightened individual's self-understanding. I contend that the palpable nature of corporeality provided an impetus for rights in the eighteenth century, offering an understanding of the status of the body in Enlightenment political thought and an evaluation of the period's normative thinking.

The Role of Design Intent in the Preservation of Modern Architecture

Karen Zabarsky, Art History

Sponsor: Professor Carol Herselle Krinsky, Art History

Those who decide whether or not to preserve a building must take into account many facets of a structure's history and composition. Preserving modern architecture poses a particular paradox: products of the movement and architectural style, which rejected established precedents of design and embraced innovation and development, have now aged and require intervention to survive. To resolve these difficulties, preservationists must consider the role of design intent, the conceptual and visual intentions of the architect's original design. Design intent is particularly pertinent when considering Modern buildings, both because of the prominent role of the sole designer in the architecture, and because the intent is usually well recorded. This factor, however, currently holds no standard weight in the preservation process. Through a comparative analysis of three examples—the preservation of Lever House (New York), the Kalita Humphreys Theater (Dallas), and the Aluminaire House (Long Island)—this research emphasizes the importance of design intent as a means of resolving the seeming contradiction between conservation and modernism, and of making informed, case-by-case preservation decisions about these buildings.

The central concern of the social sciences is people. Social scientists try to understand what motivates people's behavior, how people interact and communicate in society, how they produce and distribute goods and services, how they govern themselves, how they create norms, institutions, cultures, and languages, and, in turn, how these institutions and cultures shape their thoughts and their actions. The vast scope of this inquiry, aimed at understanding human behavior and the functioning of our societies, requires a variety of diverse perspectives and approaches. The methodologies of the social sciences range widely from ethnographic studies to historical investigation, formal and mathematical modeling, survey techniques, and statistical analyses of data.

—Jess Benhabib, Paulette Goddard Professor of Political Economy

SOCIAL SCIENCES

Arguing over America

Caterina Andreano, Journalism

Sponsor: Professor Jason Samuels, Journalism

Arguing over America is a documentary telling the stories of two women on either side of one of the most controversial topics on the current political front: illegal immigration. One woman is an undocumented immigrant applying for Deferred Action for Childhood Arrivals (DACA), a new policy that allows certain undocumented immigrants to apply for work permits in the U.S. The other founded the only anti-illegal immigration organization in New York City, NY ICE. With nearly half a million undocumented immigrants, New York City has always been relatively friendly to those without papers. In a city with over eight million people, there are more than a few different opinions on the topic; although there are dozens of support groups for undocumented immigrants in this city, there is only one against illegal immigration. The two women come face to face at National Coming Out of the Shadows Day, a day for undocumented immigrants all over the country to reveal their status. This documentary chronicles their lives up to their explosive meeting at the rally.

The Role of Stress in Conditioning Intervocalic Stop Lenition

Dominique Bouavichith, Linguistics

Sponsor: Professor Lisa Davidson, Linguistics

Lenition is a phonological process defined by the weakening of a consonant from a stop to another consonantal sound lower in the sonority hierarchy. Many have claimed that intervocalic stops are often lenited to fricatives or approximants in connected speech, but few systematic acoustic analyses of factors that affect lenition have been reported for American English. In this analysis, intervocalic voiced stops /b d g/ produced in bi- and trisyllabic words are examined, each embedded in various phonetic environments within five short stories read by thirteen participants. The first result shows that American English speakers never lenite voiced stops to fricatives, but instead produce approximants whenever lenition occurs (with variation to the frequency of lenition among the three target sounds). Second, the placement of stress within the word plays an essential role: 51% of stops are lenited when stress is on the first syllable (e.g. "yoga"), while only 7% of stops lenite when stress is on the second (e.g. "lagoon"). Additionally, the duration and intensity measurements for /b/ and /g/ show that the bilabial and velar equivalents of the alveolar flap /ɾ/ do

not exist in American English. Comparing this study to similar ones of Liverpool English and Florentine Italian shows that lenition processes vary cross-linguistically. The results of this study are partially consistent with the conclusion that lenition occurs to reduce interruption of high-intensity sound and, thus, marks an ongoing prosodic unit, whereas the retention of the stop (or original phoneme) may mark the end of a prosodic unit.

Dos Naranjas or Doh Naranjah: A Study of Coda-s Variation in Buenos Aires Spanish

Salvatore Callesano, Linguistics; Spanish and Portuguese
Sponsor: Professor Gregory Guy, Linguistics

In addition to its various distinctive characteristics (e.g., second person singular pronoun vos in place of tú, use of palato-alveolar fricatives [ʒ-ʃ] as realizations of Castilian /ʎ/), Buenos Aires Spanish (BAS) shares with several other Latin American Spanish dialects the variable realization of /s/ in coda position. Although variability in /s/ has been studied extensively in dialect regions such as the Hispanic Caribbean, it has received less attention in studies of Argentine Spanish. Details of this variability differ considerably across dialects. Much of the previous research on this variable has focused on three possible realizations: [s, h, ø]. This study will also consider an additional intermediate fricative realization that may involve both lingual and laryngeal constrictions. This study presents a quantitative analysis of the social and linguistic contexts of use of the various realizations of coda /s/ in 3505 tokens from 15 speakers of BAS. The data are gathered from sociolinguistic interviews and word-list readings with Buenos Aires natives. Generally, /s/ realization is affected by social status, gender and age, and the historically standard [s] is more common among women and people of higher status. After its completion, this study demonstrates that Buenos Aires is a speech community that follows sociolinguistic patterns; for example, members of the upper middle class and more careful speech styles favor more historical or prestigious features (e.g., [s]). Interestingly, Buenos Aires appears to also be a speech community that primarily aspirates, especially when phonetically conditioned by voiceless consonants and voiced consonants/sonorants. Contrarily, realizations of [s] are more likely to occur before vowels and pauses and higher deletion rates are commonly found with final monomorphemes and voiced consonants/sonorants. With regards to the social aspect of this study, the results show that the interviews (casual speech) provided for higher rates of [h] where the word-list readings (careful speech) favor the historically realized [s]. The primary conclusions of this analysis show that the intermediate realization is tightly constrained to pre-sonorant environments and rarely varies among the BAS speakers. Additionally, the three primary realizations are not in a change in progress as they agree, both linguistically and socially, with previous studies regarding BAS.

Reading Hands: A Morphological Approach in Determining the Sex of Prehistoric Handprints

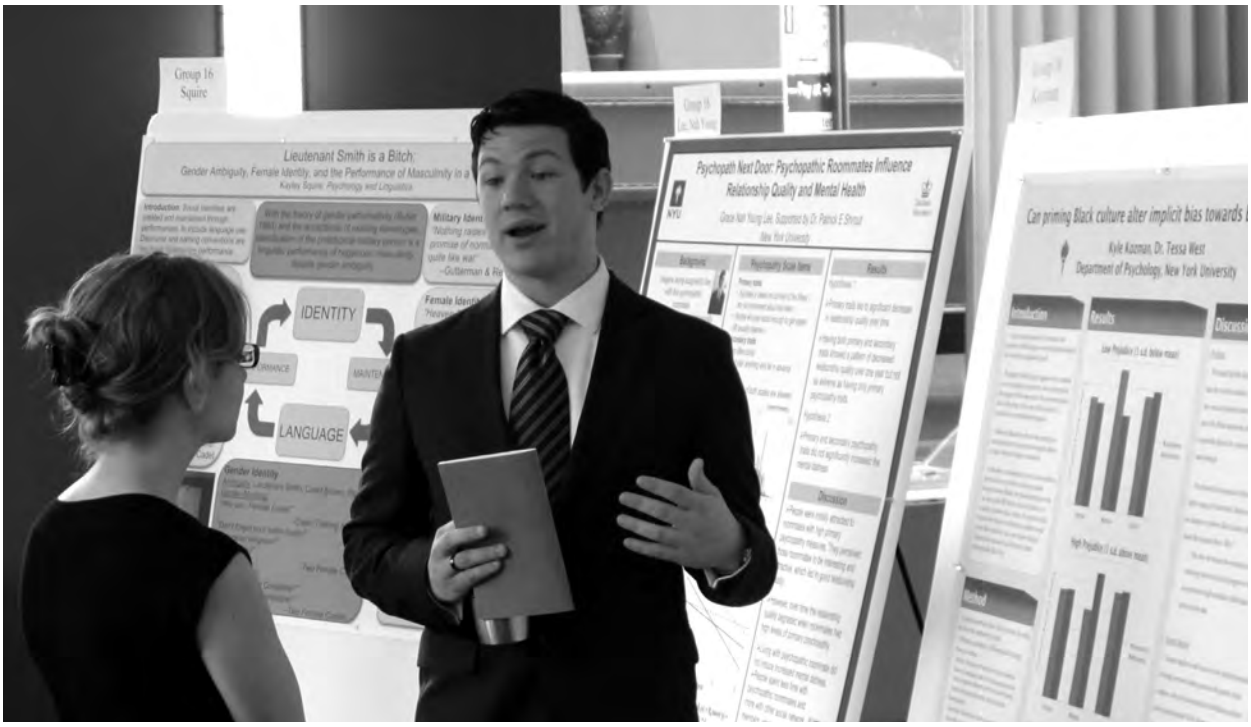
Christina Chopra, Anthropology
Sponsor: Professor Randall White, Anthropology

Despite their prevalence in the archaeological record, morphological analyses of prehistoric handprints have yet to substantiate arguments for their symbolic meaning. Yet, without concrete information regarding handprint variation in cave contexts, it is incredibly difficult to validate theoretical assumptions about their function and significance. The aim of my research was thus to morphologically quantify hand size variation in males and females to determine whether or not sexing prehistoric hand prints is viable. Based on the general lack of dimorphism in modern human populations, I hypothesized that the surface area of male and female hands would overlap, making it difficult to assign prehistoric handprints to a particular sex. After collecting handprint data on a modern sample of males and females and running statistical analyses on measurements of surface area, I have instead shown that it is in fact possible to determine the sex of individuals with a high degree of certainty using my method, as the two groups are statistically significantly distinct. Thus, the "grey area" bridging the two sexes is not substantial enough to eliminate our ability to determine the sex of these individuals. Applying this method to various prehistoric sites where these prints are found will be immensely helpful in unraveling the mystery surrounding these earliest forms of art in human history.

Why All the Rush? The Effect of In-person Early Voting Laws on Turnout

Sydney Egnasko, Politics
Sponsor: Professor Nathaniel Beck, Politics

The recent popularity of early voting laws in the United States has prompted debates between political scientists and legislators over whether or not these laws can and should be used as a mechanism to mobilize new voters. This article joins the debate with an analysis of the impact of in-person early voting laws on voter turnout. In particular, this study examines whether or not these laws increase turnout on average and differentially across states with larger minority and low-income populations. This study employs the Current Population Survey, jointly conducted by the U.S. Census Bureau and the Bureau of Labor Statistics, to analyze voting behaviors during election years 2000, 2004 and 2008. My research reveals



that, on average, in-person early voting laws do not have an effect on turnout. This average effect, however, masks influential heterogeneity effects based on the population share of different minority groups among states. In states where African Americans and Hispanics make up a larger share of the population, turnout increases in response to the law. States with greater shares of citizens of other minority groups and of low-income citizens did not see an increase in turnout. States located in the South also saw a significant increase in voter turnout compared to non-Southern states. From these results this article concludes that race and region are important factors in whether or not in-person early voting laws mobilize voters.

Predicting M1 Size from dm2 in Fossil and Modern Hominins

Evelyn Glaze, Anthropology
Professor Shara Bailey, Anthropology

The study of teeth is very important to the study of human evolution, since fossil teeth can tell us valuable information about a species' diet, life history, and ecological niche. There has been a lack of research in the anthropological community on deciduous (baby) teeth. This can be problematic when a deciduous tooth is discovered, since it cannot be compared to the larger fossil record of permanent teeth. A deciduous second molar found in Longtanshan, China dating to 34.5 thousand years ago is very similar to modern *Homo sapiens* in morphology, but significantly larger (115.5 mm^2). Estimating the size of the adult molar would prove useful in classifying the tooth to a certain species. For my research, I measured the crown area of the second deciduous molar and first permanent molar within the same dental arcade for over 300 individuals. I measured upper and lower teeth, modern and fossil *Homo sapiens*, and Neandertals. I then built a regression algorithm that could be used to predict the size of the Longtanshan adult first molar. My estimates place the size of the adult molar to be as high as 150 mm^2, which is outside the margin of both human and Neandertal crown area by a significant amount. This algorithm is important for classifying the phylogenetic placement of the Longtanshan material, and should prove useful in the future study of deciduous teeth. It is a step toward understanding the relationship between permanent and deciduous teeth.

The Influence of Stress on Extinction Retrieval

Rachel Goldman, Psychology
Sponsor: Professor Elizabeth Phelps, Psychology

The ability to regulate emotional responses to threatening cues that no longer predict danger is critical to healthy functioning. An appropriate paradigm for investigating this process is extinction learning, where a previously aversive stimulus is paired with a new, safe outcome until the initial fear response diminishes. Investigating the conditions under which extinction learning is retained, however, is critical to understanding and aiding those who suffer from persistent fear or anxiety. The ventromedial

prefrontal cortex—essential for retrieving extinction learning—is functionally impaired by stress, suggesting that stress might influence how successfully extinction training is retrieved after learning. We examined the influence of acute stress on extinction recall. Participants underwent a fear-conditioning paradigm in which one stimulus (an image) was paired with an aversive shock while the other was not. Extinction training directly followed, whereby neither stimulus was paired with shock. Fear arousal was measured using skin conductance responses. The following day, participants underwent an acute stressor or a no-stress control task followed by an extinction memory recall test. The stress group demonstrated significantly less extinction retention than controls, suggesting that extinction recall is impaired under stress.

Through the Looking Glass: Examining the Effect of Interpersonal Context on Evaluations of Ambiguous Race Individuals

Amoghavarsha Havanur, Psychology
Sponsor: Professor Tessa West, Psychology

In the current study, we investigated how anxiety cues can affect whether ambiguously raced individuals were perceived to be in a cross-race or same-race interaction. Participants were shown a video of an interaction during which an ambiguously raced target interacted with either a black or a white partner. During the interaction, the target displayed either a) behaviors consistent with a cross-race interaction (e.g. anxiety, discomfort) or b) behaviors consistent with a same-race interaction (e.g. friendliness). We hypothesized that when the target appears friendly, participants would see the target as black if their partner is black and white if their partner is white, and that the opposite would be true if the target appeared anxious. Results showed no significant interaction between the race of the partner and target anxiety on skin tone. We discerned, however, a significant main effect of target anxiety, which was fuelled by a significant interaction between target anxiety and participant race. Minorities rated more anxious targets as significantly lighter-skinned and friendlier targets as darker-skinned. This research therefore has implications for the many situations in which cross-race interactions are more negative than same-race interactions, such as doctor-patient relationships in which minorities might observe mixed-race doctors' interactions from afar.

The Surprising Flexibility of Sanctity

Eugene Jaw, Biology; Psychology
Sponsor: Professor Jay Van Bavel, Psychology

According to French sociologist Émile Durkheim, group-level concerns determine sanctity. In a test of Durkheim's theory, we examined the influence of group-level thinking on people's (un)willingness to engage in taboo tradeoffs between the sacred and profane, and to rate ambiguous actions as related to their core moral values. Currently, the highly cited intutitionist model of moral judgment contends that certain situations automatically elicit moral intuitions, which guide moral judgments. In other words, moral reasoning typically functions as a post hoc justification for the initial judgment rather than the driving force of that judgment. Rather than assume *a priori* that sacred values are always inherent to a particular object or situation, we sought to test whether or not they are subject to flexible evaluative processing. Participants were recruited online via Amazon.com's Mechanical Turk website. In the first study, participants were randomly assigned to one of two self-construal conditions (I vs. We vs. Control), and then responded to 30 tradeoff items. In the second conceptual replication of the first study, participants again were assigned to one of two self-construal conditions ("Write about the most important social group to which you belong and what you share with its members" vs. "Write about the fruit or vegetable that is most important to a healthy diet and why it is an essential component of wellness") and then rated 51 morally ambiguous actions. We predict that group-level thinking will attenuate the willingness to engage in taboo tradeoffs (Study 1) and will amplify the degree to which participants moralize morally ambiguous actions (Study 2). These studies provide insight into the dynamic and flexible nature of moral judgment and decision-making. Our results showed that group-level thinking did not amplify the tendency to moralize morally ambiguous actions across the board. Further exploratory analysis revealed that group-level thinking might amplify the tendency to moralize collective actions (as opposed to individual ones).

Fidelity and Adaptation in Life Skills Training: Striking the Right Balance

Sarosh Khan, Psychology
Sponsor: Dr. Ken Griffin, Weill Cornell Medical College

Life Skills Training (LST) is an evidence-based drug abuse prevention program that targets adolescents during their early school years to prevent alcohol, tobacco, and drug use during their later years. An effective balance of fidelity and adaptation plays a fundamental role in maximizing the program's outcomes. Research has shown that supporting providers through advanced training and assistance can increase fidelity. The current study uses a mixed method approach to examine implementation factors associated with an enhanced fidelity condition (with enhanced multimedia training and technical assistance)

versus a standard approach condition for delivering LST. We also conducted a qualitative analysis of the kinds of adaptations made by teachers in the real world. Results from post-test assessments completed by a sample of 1,000 students showed that students in the fidelity-enhanced condition reported greater improvements in decision-making, problem-solving, stress and anxiety-coping, social, assertiveness, and resistance skills. Results from objective-coder ratings of videotaped LST sessions showed that teachers in the enhanced fidelity condition delivered lessons, covering more material and displaying greater adherence to the instructional strategies outlined in the program manual.

The Effect of Group Membership on Spontaneous Trait Transference (STT)

Gina Kim, Psychology
Sponsor: Professor James S. Uleman, Psychology

Spontaneous Trait Transference (STT) occurs when a person is unconsciously perceived as possessing the exact trait she describes in another person. Past research has demonstrated that STT is a reliable phenomenon that unrecognizably impacts social perception and interaction. To further the study of STTs, I examined the effect of group membership on this transference by presenting participants with two scenarios: a speaker talking about someone else on the same team or a speaker talking about someone else on a different team. I predicted that same-group member pairs would produce STTs more frequently than different-group member pairs, based on the theory of category-based expectancies. Category-based expectancies stem from the knowledge of a person belonging to a particular group. We expect that person to possess features that we think are typical or characteristic of that group. Participants were asked to memorize photo-behavior sentence pairs consisting of a photo of a speaker's face along with his or her description of someone else on the same team or different team. Participants were then asked to correctly identify which trait words had previously been paired with each speaker's photograph from the first memorization task. Participants responded "yes" to the photograph-trait word pairs they remembered as being previously paired together. Using a false recognition paradigm, the false recognition rate was examined since it measures how frequently the participant incorrectly matched an implied trait word to the speaker. The results indicated that Spontaneous Trait Transferences (STTs) occurred regardless of group membership, confirming previous research. The experiment additionally indicated a difference in the magnitude of STTs made based on group membership, confirming the hypothesis. STTs more frequently occurred for same-group members than for different-group members. In everyday communication, people tend to form impressions of others based on what other people say. These results show the generalization of attributes from one group member to another as a function of possible stereotyping, and more importantly can serve as a basis for future research on preventing the transference of these unconscious biases within a group.

Gasoline Taxes: A Comparison of their Effect on Gasoline Consumption and Greenhouse Gas Emissions in the United States and Canada

Sarah Melanson, Economics
Sponsor: Professor Guillaume Frechette, Economics

Gasoline taxes have historically been, and continue to be, significantly higher in Canada than in the United States. This paper examines the impact of this persistent difference in tax levels by analyzing its effect on gasoline consumption and the amount of greenhouse gas emissions released into the environment. In order to examine whether tax increases have the same impact on consumption and emissions in the United States and Canada, two sets of bordering states and provinces that have experienced tax increases in the time period of 1989-2010 are compared. First, to examine the impact of tax increases on consumption, I estimate two regressions of gasoline demand, one for the U.S. and another for the Canadian provinces. Instrumental variable estimation is used to account for the endogenous nature of gasoline prices. Then, to analyze the impact on emissions, I calculate, using the previously estimated price elasticities, the expected change in light-duty vehicle carbon dioxide emissions from future tax increases, as well as for historical increases within the time period. The historical estimations are then compared with the actual changes in emissions when the tax increases occurred. This analysis indicates whether the expected reduction in emissions have materialized, and are the same between, a higher tax jurisdiction such as Canada and a lower tax jurisdiction such as the United States. The results from the regression analysis show that demand is more inelastic at the higher tax level. This implies that consumers in Canada are less responsive to changes in price, including changes in tax, than consumers in the United States. Due to the more inelastic demand in the Canadian provinces, as well as the higher existing price levels and lower per capita consumption levels, it was found that both future tax increases would have, and historical tax increases have had, a small effect on emissions. On the other hand, in the U.S. states, where prices are lower, per capita consumption levels are higher and consumers are more reactive to price changes, tax increases would

have, and historically have had, a meaningful impact on emissions. These results show the potential for tax increases to reduce emissions in the United States and, more broadly, the importance for policymakers to understand the responsiveness of consumers to price changes when determining the effectiveness of a tax increase for reducing carbon dioxide emissions.

A Dream Deferred
Carolina J. Moreno, Journalism
Sponsor: Professor Jason Samuels, Journalism

What does it mean to be American? Is it a Social Security number, or an experience? This question haunts the nearly two million undocumented immigrants under the age of thirty in the United States—many of whom were brought illegally into the country by their parents as children, too young to realize that nine numbers separated them from the so-called legal children in their class. Change did come in June 2012, when President Barack Obama announced the Deferred Action for Childhood Arrivals (DACA) policy, which allows eligible youth to avoid deportation and obtain work authorization. For eight months, I documented the story of one undocumented student's legal struggles to file for DACA as he simultaneously worked on his art-driven activism for undocumented youth. Through 23-year-old Enrique's story, I humanize the immigration debate as he describes what it was like growing up undocumented and how, at the age of six, he and his family crossed the border in search of a better life. As Congress mulls over the immigration conundrum, the nation asks: should these students get a chance at the American Dream they were raised to aim towards, or will their dreams simply be deferred? My documentary aims to shed light on a present social and political issue in the United States. My documentary highlights the struggle and perseverance of those who were brought into the country illegally by their parents as children and now face an uncertain and undocumented future for a decision that was not their own.

Exploring the Coevolution of Human Hands and Feet
Aviva Novick, Anthropology
Sponsor: Professor Scott Williams, Anthropology

In this project, I explore the hypothesis that the hands and feet of humans coevolved. Researchers have theorized that as the hallux (big toe) evolved to be more robust for efficient bipedal walking, the pollex (thumb) co-evolved, becoming more robust as well, which allowed for increased manipulation in the hand. This theory is supported by the fact that hands and feet are serially homologous structures which are genetically linked and share common developmental pathways, making these structures morphologically integrated. To assess this theory, I look at the relationship between the pollex, hallux, and third digits of the hands and feet in five different genera of apes and Old World monkeys, three of which have reduced pollices and two of which do not (the primitive condition). I look at the correlations between these digits in these genera to investigate whether the hallux and pollex are strongly correlated and likely to have coevolved. I specifically look at the possible effects of reduction in the integration between the first digits. I demonstrate that apes generally and Old World monkeys with reduced pollices do not have strongly correlated first digits, while primitive Old World monkeys show high correlation between these digits. Overall, reduction in either the pollex or hallux does not necessarily lead to reduction in the other, and therefore reduction in one set of first digits can lead to the decoupling of the integrated pollex and hallux. Lower correlations between the first digits in apes irrespective of pollex reduction might suggest that early hominins likewise had weaker integration between the first digits, which would allow for a more independent evolution of hominin halluces and pollices.

The Effect of Construal Level on Strategy Emulation
Loren Oumarova, Psychology
Sponsor: Professor Yaacov Trope, Psychology

In an extension of prior studies demonstrating the effect of psychological distance (such as spatial, temporal, social and hypothetical distance) from an object on construal level, the present research experimentally examined how psychological distance impacts emulation behavior. Two complimentary studies were conducted to test how participants would emulate the ambiguous strategy employed by another person (a model figure) in a behavioral task, based upon psychological distance from that person. The first study observed the effects of social distance from a model figure on participants' strategy choices in a ring toss activity. We predicted that the first study would demonstrate that social proximity promotes strategy emulation choices based upon target feasibility, while social distance promotes strategy emulation choices based upon target desirability. The second study observed the effects of spatial distance from a model on participants' strategy choices in a hypothetical stock investment scenario. We predicted that the second study would demonstrate that spatial proximity promotes local, short-term strategy emulation choices, while spatial distance promotes global, long-term strategy emulation choices. We did not find significant differences between the conditions in study one or study two of our research; as such, the present findings do not support the aforementioned hypotheses. Further research is thus

necessary to satisfactorily determine the relationship between psychological distance and emulation behavior in regards to that individual. More and more, our learning environments have shifted to include remote others. The present research begins the process of shedding light on how distance from others individuals influences how we view them and what we learn from them.

The Process Underlying Spontaneous Trait Inferences: A Face-Priming Test of Associative and Attributional Interpretations

Samantha H. Raymond, Psychology
Sponsor: Professor James Uleman, Psychology

Spontaneous trait inferences (STIs) are unconscious, implicit trait inferences made from behavioral descriptions. A new face-priming paradigm investigated the associate and attributional interpretations of the process responsible for STIs. Participants viewed a series of faces paired with behavioral descriptions, some trait-implying and others neutral. Some faces were presented with a behavioral description twice, while others were presented once. Participants then provided trait ratings of new faces primed by the faces previously paired with behavioral descriptions. Results indicate a main effect of repetition of the prime face (once or twice) on trait ratings of new faces, but no effect of type of behavioral description previously paired with the prime face (trait-implying or neutral). Results were discussed in terms of their implications for the attachment of STIs to faces and the process underlying STIs.

The Effects of Power on the Trait-Activation Stage of Spontaneous Trait Inferences

Amanda Rinaldi, Psychology
Sponsor: Professor James Uleman, Psychology

The present study explores the effects of power on spontaneous trait inference (STI). STIs refer to the unconscious, effortless, and automatic inferences people make about others based upon observations of trait-implying behavior. Here, we investigate whether feeling powerful (compared to powerless) will implicitly activate trait-related concepts in people's minds. Participants were primed with powerful, powerless, or power-neutral mindsets in a short writing exercise, and then presented with a series of sentences containing trait-implying behaviors. Activation of trait and non-trait words was tested in a lexical decision task requiring that participants identify a string of letters as a word or non-word. The formation of STIs was indicated by a significantly faster reaction time for affirmative responses for trait words vs. non-trait words. We hypothesized that those primed with power would make more STIs than those primed with powerlessness and power-neutrality (control). By examining the effects of power on STI formation, we aim to gain a more complete understanding of how power influences the social cognitive processes involved with information processing and person perception. Results from preliminary analysis reveal a trend that suggests priming individuals with power may lead to increased activation of trait words.

Sources of Information Used in Preschoolers' Behavioral Predictions

Cyrielle C. Rivera, Psychology
Sponsor: Professor Marjorie Rhodes, Psychology

Children's ability to weigh category-level information against individual-level information to guide their behavioral predictions was examined as a function of theory of mind development. Children in the experimental (*group*) condition were presented with pictures of members of two distinct social groups as well as category-incongruent individuating information about them. Children in the control (*neutral*) condition were presented with pictures of individuals as well as individuating information about them—no category-level information was present in this condition. Children were then asked to predict whom various agents would harm. All children reliably used individuating information when it was presented alone. Only four-year-old children were able to use individuating information in the presence of opposing category-level information. There was a marginal positive correlation between children's use of individual-level information and their understanding of theory of mind, suggesting that children's ability to incorporate different sources of information (category-level and individual-level) increases as their ability to use theory of mind develops.

Salud Para Todos: Addressing the Health Needs of Persons with Disabilities (PWDS) through the Global Medical Brigades Model

Nichole Gail T. Roxas, Self-Designed Major
Sponsor: Professor Rayna Rapp, Anthropology

In an effort to raise awareness of people with disabilities and the exclusion and social stigma they often suffer, I seek to bring their voices to the forefront and show how they experience their interactions with healthcare providers and non-governmental organization (NGO) employees as we discuss whether and how healthcare development addresses their perceived health needs. As a summer medical/dental intern for the NGO Global Brigades (GB) in Honduras in July 2012, I sought to gather data on the concerns, thoughts, and illness narratives surrounding disabilities. As medical GB provided healthcare access

to two of its partner rural communities, I interviewed Honduran patients, providers, community health workers, NGO employees, and a foreign GB employee (n=25 total) to try to understand disability within this local context. These conversations gave me a glimpse into the lived experience of disability in a poor country. Several themes emerged: PWDS do indeed exist within the communities, though what counts as disability remains blurred; people become PWDS not necessarily based on their physical impairments, but rather on their ability to contribute to the community, especially in terms of work; people with intellectual disabilities face more stigma and barriers to community integration than people with physical disabilities; and finally, there is tension among the different subject groups towards the effectiveness of community networking in addressing PWDS' health needs, especially when considering how strong the correlation is between poverty and health. The empirical exploration of social limits placed on people with disabilities reveals society's social and structural forms as they hinder or help community members. My fieldwork serves as a case study to assist health-related international NGOs in understanding the multilayered nature of the lived experience of disability so that they can more fully address the health needs of all in their communities.

Effects of Group Membership, Attention, and Accuracy on Punishment Decisions

Kristin Schneider, Psychology
Sponsor: Professor Emily Balcetis, Psychology

How can people see the same legal evidence but interpret it in completely different ways? Research suggests that group membership may account for some differences in legal decision-making; for example, the American legal system often features predominantly white jury members evaluating defendants, resulting in harsher sentences for minority offenders. Currently, we explore the stages of the decision-making process, to isolate the stage of legal decision-making at which biases of group membership may emerge. We explore whether group membership biases attention to and accurate recall of information, and whether bias at these stages explains some of the relationship between group membership and punishment decisions. We expected that when viewing a videotaped altercation between an out-group and in-group member, participants would preferentially attend to the out-group target in the scene. Our data did not demonstrate the differential attention to the out-group target previous research suggested. We expected that attention to the out-group target and identification with the in-group would interact on participants' punishment decisions. We found that participants who were highly identified with their group and who attended more to the out-group target punished the out-group target significantly more. We additionally found that only attention to a target predicted recall accuracy for that target, showing that accuracy is an object measure not influenced by identification factors. The relationship between attention and accuracy indicated that attention moderates the effects on group identification on punishment decisions, as individuals highly identified with their group use the negative information they gather differently. This research has important implications for how legal decisions are made and influenced. Our research shows that identification with a group is not an absolute influence on legal decision-making, which suggests it is possible to attenuate divergent decision-making that often results in harsher punishment for minority offenders.

How Past Close Others Influence Goal Pursuit in New Relationships

Eric Seitz, Psychology; Economics
Sponsor: Professor Susan Andersen, Psychology

Previous research demonstrates that relationships with past significant others (SOs) affect how we perceive and evaluate new people through a process known as transference. Although there is initial evidence to suggest that transference may also bring to mind the goals associated with a particular SO, the present work tests the hypothesis that transference specifies the way in which one pursues a goal with a newly encountered person who resembles the SO. In a preliminary session, participants described two significant persons in their lives—one significant other whom they tend to play competitively with and the other whom they play non-competitively with when engaging in games. Two weeks later in a supposedly unrelated session, participants played a computer game with ostensibly new persons they learned about, one who resembled one of their SOs from the preliminary session. Results indicate that participants pursued specific goals associated with their respective SOs when encountering the new person. For instance, if participants usually pursue competitive goals with their SO, they pursued competitive goals in the game with the new person who resembled that SO. On the other hand, if participants pursue non-competitive goals with their SO, they pursued non-competitive goals in the game with the new person who resembled that SO. This suggests that relationships contextualize goal pursuits, specifying the types of goals that one pursues when in the presence of a new person who resembles a past close other.

Comparative Study of Skeletal Remains in Equids
Rutu Shah, Biochemistry
Sponsor: Professor Pam Crabtree, Anthropology

This study investigates the anatomical differences between equids from the site of Godin Tepe, Iran. The age range of the bone material spans from the Chalcolithic Age (fourth millennium B.C.) through the Bronze Age (third millennium B.C.) to the Iron Age (first millennium B.C.). Preliminary work on bones from Godin suggested that there was more than one species of equids living in ancient Iran. Later work confirmed the coexistence of species of horse (*Equus ferus caballus*), Persian onager (*Equus hemionus onager*), and donkey (*Equus africanus asinus*). Material from Godin is compared to each other via cranial, postcranial, and dental morphometrics. Multiple measurements, verbal descriptions, drawings, and ratio diagrams will be employed to observe differences in size, proportions, and shapes of the samples. Type A-DNA gels will be run where extracted DNA from the samples will be matched with standards in order to confirm the results. The significance of this project is to obtain known samples of equids for future comparative studies and to better understand the evolutionary history of the Equidae family.

Sour Note Detection in Melodies of Varying Mode
Leland Soiefer, Psychology
Sponsor: Professor Gary Marcus, Psychology

A prerequisite to most music cognition is the implicit recognition of musical mode. While prior research has shown that musicians and nonmusicians can discriminate between familiar modes (Vos & Verkaart, 1999), virtually no work has been done on unfamiliar modes. We investigated the ability of Western musicians and nonmusicians to detect a sour, out of key note in melodies of familiar (major, minor, mixolydian) and unfamiliar (locrian) musical modes. Participants were asked to judge whether melodies generated in real time contained a sour note. Analysis revealed that all participants detected sour notes in familiar modes with greater success than in unfamiliar modes. Results also showed a main effect of musicianship, indicating better performance by musicians than nonmusicians on all modes. The results are consistent with a model in which listeners interpret musical pieces with respect to schematic musical knowledge accumulated through experience, but challenge models in which listeners detect sour notes purely through short-term statistical inferences about which notes were recently used. This study provides important information that helps move the field closer to a general model of music cognition.

Obesity Bias: How a Task Group's Weight Composition Affects Intragroup Evaluations and Bias Toward Obese People
Rachel Steinberg, Psychology
Sponsor: Professor Tessa West, Psychology

Despite its prevalence in American society, obesity remains a powerful social stigma. Previous research indicates that stigma can spread in intragroup settings, such that as the number of females in a task group increases, group members will see their group-mates as less competent, even if the group-mate is male. Our research explores how the number of obese individuals in a group affects expectations about group-mates. Results suggest that the inclusion of obese people in a group affects intragroup expectations of future task performance, but the process by which group weight composition affects intragroup expectation judgments does not appear to function according to stigma by association. Applying research showing that negative contact increases bias, results also suggest that the proportion of obese individuals in a group interacts with the group's level of outcome dependence to affect bias toward obese people in general.

The Larger the Crime, the Smaller the Fine: In-group Members Receive Clemency for More Severe Moral Transgressors
Natasha Thalla, Psychology
Sponsor: Professor Jay Van Bavel, Psychology

Research on moral psychology has demonstrated that the group membership of a moral deviant, or "transgressor," influences how others treat that individual. The current research examines whether the magnitude of the transgression and the group status of a transgressor interact to influence the treatment of these moral transgressors. In two experiments, using a cross-cultural sample of participants, we found that in-group and outgroup transgressors are punished similarly when the transgression is relatively mild and differently when the transgression is extreme. Additionally, we found that there are systematic differences in the moral reasoning underlying the punishments of transgressors based on their group status and the magnitude of their transgression. Overall this research indicates that it is not just the group status of the transgressor which influences the degree to which he will be punished but also the level of the transgression itself.

Reconstruction and Reconciliation in Villa El Salvador
Prachi Vidwans, Anthropology
Sponsor: Professor Thomas Abercrombie, Anthropology

In its first 20 years, Villa El Salvador, Peru, enjoyed a reputation as the home of passionate citizen activists

that were able to win rights and recognition from Lima's government. The narrative of the town's growth and its founders' victories is retold endlessly as a reminder of the community's heritage and identity. Today, activists explain that Villa has been overtaken by political complacency because it has forgotten its roots, and recount its history in order to reinvigorate residents with their previous energy. This collective narrative becomes confused and troubled when it reaches the early 1990s, when the Peruvian terrorist organization, the Shining Path, invaded the community and assassinated many of its leaders. This was a time of paralyzing fear, of distrust, of confusion and uncertainty—and many reflect that this was when the town's spirit was "beheaded." Based on fieldwork conducted in Villa in June 2012, this project examines the narrated history of Villa El Salvador, and especially the way residents remember the Shining Path invasion, to ask how political violence affected local community organization. Further, today's activists have taken the lead of the Peruvian Truth and Reconciliation Commission in 2003 and have attempted to construct a common "true" narrative of the town's experience with the Shining Path in a four-part play, *Diálogo entre los Zorros*. This project argues that the Commission's truth-seeking strategy encounters serious hurdles when employed at the local level, as it is unable to address the deep mistrust and fear that poisoned the community's spirit. Though many have analyzed and debated the merits of the Peruvian Truth and Reconciliation Commission, this project investigates the long-term impact of its strategy on the people in local communities, who have yet to experience true "reconciliation."

Nutritional Therapy as a Treatment for Anxiety and Depression

Carina Wolff, Journalism; Psychology
Sponsor: Professor Brooke Kroeger, Journalism

Experts say ten percent of the U.S. population suffers from depression and another eighteen percent from anxiety, and the treatment of choice for both is prescription medication. Research has shown that these antidepressants are no more effective than a placebo, and even when medications are or appear to be working, they can have unpleasant side effects such as weight gain, loss of positive or negative emotions and increased risk of suicide. Because of this, some sufferers have turned to nutritional therapy, which is the use of foods and supplements to alleviate their symptoms. Research has demonstrated that certain foods, especially animal proteins, foods high in Omega 3s, complex carbohydrates, and certain vegetables can help with elevating mood while other foods—especially those high in sugar, saturated fats and caffeine—have been found to increase anxiety or depression. Through my research, I spoke with doctors, nutritionists, researchers, and people who have used nutritional therapy to write an article that explores how nutritional therapy is a viable alternative in the treatment of mood disorders, as there is an abundance of scholarly research and personal testimony supporting it.

The role of a liberal arts education is to give broad knowledge to students to prepare them to face the world. Students can often graduate from college without gaining the most basic understanding of the sciences. Some may even prefer this, believing that science is reserved for a specific segment of our society. In fact, since Leonardo da Vinci, science has been infiltrating all aspects of society, from communication to energy to medicine, from the vineyards of Bordeaux to the classrooms where philosophical debates take place. Thus, scientific knowledge and an understanding of the basic principles of how it is obtained is absolutely essential for anyone hoping to understand and contribute to the world. As the ultimate goal of a university is to spread and foster knowledge and truth, it must provide a strong scientific education to all students.

—Claude Desplan, Professor of Biology

NATURAL SCIENCES

Crystallization of Larger 3D DNA Crystals Using Two 4-Turn Tensegrity Triangles with Variable Sticky-End Lengths

Salman Ahmad, Chemistry
Sponsor: Nadrian Seeman, Chemistry

This project aims toward building larger macromolecular building blocks based on a 4-turn DNA tensegrity triangle motifs that can self-assemble into 3D DNA crystals via sticky-end interaction. The tensegrity triangle is a rigid DNA motif consisting of three helices that are connected pair-wise to produce a stiff alternating over-and-under motif. The terminal single-stranded cohesive segments (sticky ends) allow for the helices to connect with the helices of other molecules, resulting in a three-dimensional periodic DNA lattice. In the current system, we use a 2-triangle system that contain 42 bases per edge and that cohere via 2- 3- or 4-base sticky-ends. The resulting designed DNA crystal will contain two molecules per asymmetric unit with a repeat of 27.2 nanometers. Creation of such structures will allow the formation of crystalline cavities that are large enough to capture guest molecules Such three-dimensional nucleic acid crystalline systems may be used as the scaffolding of biological molecules for crystallographic structure determination as well as the organization of nanoelectronics. We have grown crystals with a 2-mer sticky end and confirmed its correct structural formation via X-ray crystallography.

Stochastic Expression of Spineless(Ss) in the Eye of *Drosophila melanogaster*

Amrita Balgobind, Biology
Sponsor: Professor Claude Desplan, Biology

Though underappreciated and poorly understood, stochastic gene expression is an important mechanism used to diversify cell fates during normal human development. The eye of *Drosophila melanogaster*provides an excellent model to study the regulation of this type of expression. The transcription factor, Spineless(Ss), is expressed to determine different cell fates in the R7 color vision photoreceptors. This area of research aims to discover the types of mutations affecting regulatory regions upstream of the *ss* gene that affect stochastic gene expression. I first identified mutations that cause observable pheneotypes indicative of changes to *ss* regulatory regions. P elements, which are transposons present in flies, can be used to knock out DNA elements. P element excision lines were generated from the removal

of various P elements upstream of *ss* in regulatory regions. P element removal can cause deletions of enhancers or other regulatory regions of the *ss* gene, that can lead to observable mutant phenotypes such as bristle defects, aristapedia, or death. Two collections were made from two different P elements. I used complementation tests, which determine if two mutations with the same phenotype occur in the same gene or different genes. I crossed flies with an excision upstream of *ss* with flies that contained a null copy of the *ss* gene in order to observe the effects of the excision. From the crosses completed, the flies that display visible phenotypes carry mutations in regulatory regions.

Investigating CD4+ Th Subset Specificity in Melanoma Patients Undergoing Anti-CTLA-4 Immunotherapy

Anuj Bapodra, Chemistry
Sponsor: Dr. Michelle Krogsgaard, NYU Langone Medical Center

Adoptive Cell Transfer (ACT) is a cell-based therapy that shows promise for the treatment of melanoma and other cancers. This therapy introduces engineered populations of tumor-specific T-cells into patients afflicted by various cancer types. ACT using tumor-infiltrating lymphocytes (TILs) in patients with metastatic melanoma shows a 49-72% objective response rate. Previous research focuses on the use of CD8+ killer T-cells for the therapy. These TILs must be patient specific and expanded *ex vivo* (out of the body) to produce sufficient numbers for ACT. This is problematic because the TILs must retain T-cell effector function and homing properties, which is difficult when injecting new T-cells into tumors. Research suggests that CD4+ helper T-cells may contribute to a greater and more robust anti-tumor response in cancer patients than their CD8+ counterpart. Notably, naïve CD4+ cells can be directed toward particular Th (T helper) subsets by inducing specific pathways in the cells. Identifying the most effective conditions for these Th cells is necessary for optimizing anti-cancer treatment. In our experiment, we analyze samples from melanoma patients treated with anti-cytotoxic T lymphocyte antigen 4 (CTLA-4) antibody, an antibody that has been associated with a positive clinical outcome. This treatment is effective because it enhances T-cell proliferation by inhibiting CTLA-4, a protein receptor that stops the T-cell response. A Cytometric Bead Array (CBA) for the cytokines IL-2, IL-4, IL-6, IL-10, IL-17, IFN, and TNF was conducted. RT-PCR for the analysis of transcription factors T-bet, GATA-3, RORγT, and FOXP3 was also performed. The cytokine and transcription factor data together indicate the prevalence of specific Th subsets. This is because Th subsets are regulated by the transcription factors addressed previously, while the CBA data show what cytokines were released by the Th subsets. In conclusion, our data showed a trend towards Th1, Th2, Th17, and Treg. We discovered that the patient samples did not undergo equivalent treatment. Therefore, more samples must be analyzed in further experiments to account for the outliers.

Recognition of DNA Lesions by Eukaryotic Nucleotide Excision Repair Pathway DNA Damage-Sensing Proteins

Givi Basishvili, Chemistry
Sponsor: Professor Nicholas Geacintov, Chemistry

Polycyclic Aromatic Hydrocarbons (PAHs) are byproducts of combustion of fossil fuels and are present in the environment in considerable quantities. In human cells, PAH molecules are metabolically activated to diol epoxides and exhibit carcinogenic properties by reacting with DNA to form DNA base adducts that interfere with transcription as well as replication. Understanding the mechanisms used by the cell's defense system, Nuclear Excision Repair (NER), to identify and repair DNA lesions is of significant interest DNA lesions that are not recognized and thus escape repair. Such repair-resistant DNA lesions accumulate in human tissues and initiate the development of cancer and other diseases. We focus on the protein Xeroderma Pigmentosum Complex C (XPC) and its homologue RAD4 in yeast. These proteins are first to recognize and bind to vast array of DNA lesions induced by reactions of genotoxic benzo[*a*]pyrene (BaP) metabolites with DNA. RAD4, like XPC, then recruits a number of other NER proteins to excise the DNA lesions and repair the DNA. In this study, we seek to characterize the effect of salt concentration on RAD4 binding to well defined BaP-derived lesions as well as to non-damaged DNA. The goal of the study was to determine optimal NaCl conditions for enhancing specific binding to DNA lesions relative to non-specific DNA binding to non-damaged DNA. Specifically, binding of the RAD4 protein to a fifty base pair (bp) double-stranded DNA sequence with a 10R-(-)-*trans-anti*-[BP]-N^2-dG lesion was examined at increasing NaCl concentrations. In order to measure binding, we employed gel electrophoresis to separate bound and free DNA and 32-P radio-labeling to quantify the intensity of binding. We observe nearly 90% specific binding at 100 nM RAD4 protein concentration at 75 mM NaCl buffer concentration, but binding to the BP-modified duplex diminishes as the concentration of NaCl is increased, dropping to a value of 5% at 675 nM. The non-specific binding is affected more strongly than specific binding, and suggests that at intermediate NaCl concentrations the ratio of specific to non-specific binding can be maximized.

The Influence of Post-Encoding Stimulus Re-Exposure During Wakeful Rest on Subsequent Memory Performance

Alice Berners-Lee, Neural Science
Sponsor: Professor Lila Davachi, Psychology; Center for Neural Science

Systems memory consolidation, the process in which episodic memories are strengthened into long-term representations, is thought to be dependent on brain activity during off-line periods, such as sleep and wakeful rest. A mechanism thought to underlie this process is the reactivation of previously active neural ensembles in the hippocampus. Prior work has externally triggered reactivation during sleep; however, it has also been shown that brain connectivity during awake rest may be important for consolidation. To investigate a potential causal link between reactivation during awake rest and subsequent memory, we use a two-day behavioral paradigm to reactivate previously learned associations by re-exposing cues in a sub-threshold manner during a post-encoding restful task. We found that solely for subjects who had no awareness of the re-exposure there was a consolidation benefit for those associations that were re-exposed compared to control. In addition, by creating an across-group manipulation of the duration of the restful task and addition of a short break, we also investigate the changes that both the duration and the nature of the resting period have on overnight changes in memory performance. This work is significant because it tests, for the first time, a causal relationship between reactivation of memory traces during rest and subsequent memory, as well as improving our understanding of awake rest's involvement in systems memory consolidation.

Rehearsal of Spatial Positions in Spatial Working Memory are Associated with Saccade Planning

Michelle Bravo, Psychology
Sponsor: Professor Clayton Curtis, Psychology; Center for Neural Science

Working memory enables us to retrieve elements of our environment when they are no longer present. We implement it in everyday transient tasks, such as memorizing a phone number and then dialing it. Although the storage capacity of working memory has been studied extensively, there has been less research investigating the methods that we use to maintain encoded memories for extended periods of time. Rehearsal is a mechanism we use to reiterate these memories. Questions remain pertaining to how we rehearse the spatial locations of visual stimuli versus repeating a verbal stimulus like a phone number to ourselves sub-vocally. We hypothesize that for spatial working memory, covert rehearsal behaviorally manifests itself in the form of planned saccades that aids in alternatively allocating our spatial attention to two different locations. A two alternative forced choice procedure was conducted to examine the effects of controlled, covert rehearsal (with a metronome prompting rehearsal at a 1.5 Hz rate) on accuracy, *d'* values, and reaction times. The task was to determine whether the probe was to the left or right of the original stimulus. Critically, the delay length between the stimulus and the probe determined if the location was recently rehearsed. Eye tracking data was recorded to ensure no overt saccades were made. Results reveal significantly higher *d'* values ($p < .05$) and higher accuracy trending towards significance ($p = .071$) when participants recently rehearsed a location, which illustrates the link between saccade planning and rehearsal. Our behavioral evidence can be followed up with functional magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) studies to investigate the underlying neural correlates of rehearsal and to assist children with low working memory capacities.

Optimizing the Protocol of Direct Differentiation of Motor Neurons

Chelsea Culbert, Chemistry
Sponsor: Professor Esteban Mazzoni, Biology

Amyotrophic lateral sclerosis (ALS) is a neurodegenerative disease that is characterized by the progressive degeneration of motor neurons. Embryonic stem cells (ESC) have the potential to become any type of cell in the body and thus can be used for cell replacement therapies as well as to study ALS *in vitro*. The current differentiation protocols, however, are not efficient in yielding a large homogenous population of motor neurons. The aim of my project was to optimize the protocol of direct differentiation of ESC into motor neurons. Upon induction of three transcription factors, Ngn2, Isl1 and Lhx3 (NIL factors), ESC are programmed into motor neurons. To optimize the efficiency and speed of motor neuron differentiation by NIL, I performed time course experiments of NIL induction. Immunostaining for neuronal genes (3 b-tubulin) and generic motor neuron markers (Hb9, Isl 1/2) showed that ESC were successfully programmed into a large homogenous population of motor neurons after 24 hours of NIL induction. Therefore, by taking advantage of sets of transcription factors we can program mouse ESC into motor neurons with more efficiency and less amount of time. This has the potential to serve as a platform to study neurodegenerative diseases *in vitro* in the future.

Synthesis of Gold Nanoshells from Mixed Micelle Frameworks for Use in Multimodal Imaging Contrast Agents

Megan Emmanuel, Chemistry
Sponsor: Professor Marc Walters, Chemistry

Imaging techniques are essential tools in modern medicine. These techniques are used in disease diagnosis, prenatal care, drug trials and testing among many other processes. Therefore, the use of contrast agents has become one of the fundamental bases of modern medicine. The development of new, more efficient and cost effective imaging contrast agents is now an important aspect of new materials science as these would play a vital role in early disease diagnosis and ultimately lead to better prognoses and a higher standard of healthcare. The use of gold nanoshells (AuNS) has proven to be effective in ultrasound imaging. New methods are being developed to create tunable AuNS systems to give optimal optical activity that would allow medical practitioners to better detect even small lesions. Further, the efficiency and cost effectiveness of imaging contrasts can be greatly increased by the synthesis of multimodal AuNS imaging agents—conjoined contrast agents that can be used for multiple imaging techniques. By introducing the highly tunable AuNS ultrasound agents within multimodal imaging contrast systems, the potential for early and accurate disease diagnosis would be greatly enhanced. This research project serves to develop a novel, yet efficient, method for synthesizing monodisperse hollow gold nanoshells to be used as an effective ultrasound contrast system. The approach taken in this research project incorporates the synthesis of novel surfactant molecules to build micellar systems, which become the structural framework for silver nanoparticle precursors. The project explores the synthesis of silver nanoparticle precursors, and their reaction with gold ions to form gold nanoshells. We aim to control the size and geometries of gold nanoshells to attain different surface plasmon resonance wavelengths that are required for ultrasound image enhancement. The future goal of this research project is to link gold nanoshells with lanthanide metals, for dual-function particles that enhance both MRI and ultrasound images.

Localization of Translation Machinery at Individual Synapses during Memory Formation and Changes in Spine Morphology Following Learning in the Lateral Amygdala

Sofya Gindina, Neural Science
Sponsor: Professor Joseph LeDoux, Center for Neural Science

The purpose of this study was to investigate learning related structural changes at synapses. Learning and memory formation require *de novo* protein synthesis, also known as the process of translation. In fear, learning translation occurs in the dendritic spines in the lateral nucleus

of the amygdala (LA); the circuitry of the LA makes it responsible for integrating the association between an auditory tone and foot shock. These stimuli are utilized in the fear conditioning paradigm, in which the subject learns to pair the conditioned stimulus (tone) to the unconditioned stimulus (foot shock). Fear learning can be accomplished within a single trial and it generates a persistent memory making it best for the goals of this study. This study sought to examine structural changes indicative of synaptic strengthening at the level of dendritic spines involved in excitatory synapses (asymmetric) via images obtained through serial section transmission electron microcopy (ssTEM) from the LA of rats. The initiation of protein synthesis was examined via localization of eukaryotic translation initiation factor 4E (eIF4E). Previous literature had already illustrated that eIF4E colocalizes with the post synaptic density (PSD) and is involved in its translation-dependent construction and expansion. Also, polyribosome complexes required for translation have been found to redistribute into spines following learning. Furthermore, the current study investigated the effects of inhibition of eIF4E functionality by application of the 4EGi drug. The 4EGi drug inhibits the interaction of eIF4E and eIF4G translation initiation factors. This prevents the association of the mRNA transcript to be translated with the small ribosomal subunit, thereby preventing translation initiation. It has been found that application of 4EGi prevents learning when subjects are exposed to fear conditioning training. The structural changes observed at the level of individual spines following 4EGi infusion and fear conditioning are an increase in sER-free small spines linked to an increase in sER-free spines with astrocyte presence at the synapse and a decrease in their PSD area. It is concluded that 4EGi prevents learning by interrupting translation at the level of individual spines, thereby inhibiting spine enlargement though increasing small spine proliferation. Thus, individual spines regulate and initiate translation independently, which could allow for synapse strengthening and plasticity via spine enlargement. The implications of this study can be utilized in understanding the mechanisms involved in learning and memory formation.

Effects of Cytokine-Induced Lymphocyte Maturity on Antitumor Activity of JR209 T-Cells

Sarah Hobbs, History
Sponsor: Dr. Michelle Krogsgaard, NYU Langone Medical Center

This project explores how adoptive cell transfer (ACT) of T cell receptor (TCR)-engineered lymphocytes may be improved to increase melanoma treatment outcomes. Determining the optimal maturation state of T-cells to use for ACT may help to further improve ACT clinical response as the maturation state of T cells affects their ability to produce an effective immune response. The specific research question being asked is how the maturation state of tumor-specific T-cells affects *in vivo* tumor responsiveness and tumor regression in a mouse model of ACT. The JR209 T-cells, which specifically recognize the melanoma antigen $gp100_{2092M}$ will be matured in IL-2, IL-7, or IL-15 to achieve specific maturation states - effector memory, naïve-like, and central memory, respectively. These cells will be introduced into lymphodepleted HLA-A2.1/K^b mice bearing B16 tumors, in combination with dendritic cell (DC)-based vaccination and high dose IL-2. We will specifically be identifying differences in tumor responsiveness of the injected T-cells by monitoring tumor size progression over a given time period. This project is still in the experimental phase and, thus, no conclusive evidence has been established as of yet.

Altered Dendritic Spine Morphogenesis Pathways in Frontotemporal Dementia

Alexandra Kelly, Neural Science
Sponsor: Professor Catherine Clelland, Columbia University

Alzheimer's disease (AD) and Frontotemporal dementia (FTD) are neurodegenerative tauopathies, characterized by progressive accumulation of misfolded, hyper-phosphorylated Tau protein and progressive cognitive dysfunction and neuronal death. Studies on the rTg4510 mice, a tauopathy model that exhibits progressive Tau accumulation, have shown that early accumulation of aggregated Tau may promote events leading to cognitive decline and show a significant reduction of cortical dendritic complexity and length and decreased dendritic spine density, when compared to wild-type (WT) mice. We want to investigate the link between the presence of mutated Tau (in Alzheimer´s disease and Frontotemporal Dementia) and the progressive cognitive decline observed in patients. Using human brains from patients and a transgenic animal model carrying a Tau mutation (rTg4510), we want to identify altered pathway(s) that could explain the relationship between pathogenic Tau and cognitive decline. Preliminary results showed that one micro-RNA (miR-23a) and its target, a gene coding for a depalmitoylation enzyme (APT1) are dysregulated in the human and murine brains. We now want to show the relationship between miR-23a, APT1 and pathogenic Tau, and understand how the dysregulation of these genes impacts dendritic morphology leading to cognitive decline. Using the cryostat to slice coronal sections of the prefrontal cortex from WT and rTg4510 mice, a Golgi staining technique was employed, which

stained whole neurons, allowing visibility and analysis of the dendritic spines. Using the Golgi technique, morphological changes in neuronal dendrites and dendritic spines can be detected, traced on Neurolucida, which allows for a 3D reconstruction of the neuron, and analyzed using Neurolucida explorer. We will quantify the number/ types of spines and the density of spines/branching of the dendrites. Investigating neuronal morphology will allow us to implicate the miR23a-ATP1 pathway in the dendritic spines alteration observed in the rTg4510 mice, and importantly in the cognitive decline measured in these animals and in patients with tau induced neurodegeneration.

Spectral Preference in *Drosophila*: Linear or Non-Linear Computation?

Dennis Keselman, Spanish and Linguistics
Sponsor: Professor Claude Desplan, Biology

The fruit fly, *Drosophila*, contains a visual system that allows it to make distinctions between lights of different spectral compositions. Spectral preference, an innate visual behavior, is the attractiveness of *Drosophila* towards a certain color, based on sensitivity to and intensity of that color. When a specific photopigment (rhodopsin), a component of the photoreceptor that detects light of a certain wavelength range, is mutated, sensitivity to the respective color is reduced. A linear and a non-linear model to explain the interactions between the photoreceptors have been proposed. The linear model states that the interaction is based on simple summation, whereas the non-linear model implies more complex interactions. In certain mutations, which change the rhodopsin composition in the retina, a deviation of expectations in choice experiments has been observed, suggesting that the different photoreceptors interacted with each other in unexpected ways. These mutations likely cause defects in other parts of the brain. Thus, the function of the photoreceptors employed in color-related behaviors is not well defined. Using more genotypes than were used in previous studies, I seek to clarify whether or not the interaction between the photoreceptors is linear or non-linear; I seek to determine whether the sensitivities of *Drosophila* to distinct wavelengths of light can be easily predicted and based on a simple additive (linear) model, or if these sensitivities follow a complex, largely unpredictable (non-linear) model. This is being done through the use of a behavioral apparatus, a T-Maze, in which *Drosophila* is given a choice between two distinct colors of light. Through numerous ongoing experiments, with a large pool of mutants with decreased sensitivity to a select color of light and with numerous combinations of choice lights, a large quantity of data is collected, which is then used for comparative purposes to determine if the predictable, linear model of interaction between the photoreceptors is followed, or if the largely unpredictable, complex, non-linear model is followed.

Alternating Training with Another Task Enables Visual Perceptual Learning

Young A Lee, Psychology
Sponsor: Professor Marisa Carrasco-Queijeiro, Psychology; Center for Neural Science

In vision and audition, studies have shown that irrelevant training does not yield learning. A recent audition study showed that a given amount of training on one task (frequency discrimination) that is insufficient for learning on its own yields learning when alternated with training on another task (duration discrimination) with a common stimulus. Here we explored whether a parallel effect is present in vision. We used orientation ("A") and spatial frequency (SF, "B") discrimination tasks. On each trial, we presented a standard and a comparison Gabor patch, and asked observers to compare their orientation or SF. During pre- and post-tests, we tested them on both tasks with a standard Gabor. We divided our observers into three groups for each training regimen, while using the same standard stimulus; Group ABAB alternated between the two tasks, while Groups A–A– and –B–B alternated between one task and the same duration of rest. Group ABAB learned significantly in both tasks for trained stimulus, and the learning generalized to untrained stimulus in SF task; however, no learning happened for other two groups. As in audition, a parallel effect was present in vision. This points toward a new visual training paradigm in which task alternation enables learning for both tasks. Research on visual perceptual learning can then lead to exciting new rehabilitation techniques, such as treatment of lazy eye, or amblyopia, which is the loss or lack of development of central vision in one eye, and restoration of complex perception after cortical damage.

CRAC Channelopathies Due to Mutations in ORAI1

Jayson Lian, Chemistry
Sponsor: Dr. Stefan Feske, NYU Langone Medical Center

Upon depletion of endoplasmic reticulum (ER) Ca^{2+} stores, plasma membrane-bound Ca^{2+}-release-activated-Ca^{2+} (CRAC) channels open and allow extracellular Ca^{2+} to enter the cell. This influx of extracellular Ca^{2+} due to CRAC channel activation is called store-operated Ca^{2+} entry (SOCE), a major signaling pathway necessary for chemokine and cytokine production, as well as activation and proliferation of immune cells. CRAC channels operate through a coordinated mechanism involving ORAI1, a hexameric pore-forming plasma membrane channel,

and an ER-Ca^{2+} sensor protein called stromal interaction molecule 1 (STIM1). In this project, four CRAC-deficient patients with clinical syndromes of myopathy, ectodermal dysplasia, autoimmunity, and immunodeficiency are examined. Calcium imaging on patients' fibroblasts and T-cells quantified the degree of SOCE impairment. Transduction of patient fibroblasts with retroviruses encoding wildtype ORAI1 or STIM1 tested possible rescue of CRAC channel function. ORAI1 mutations were analyzed using genomic DNA sequencing, mRNA was quantified through real-time quantitative polymerase chain reaction, and protein expression was analyzed using both western blot and fluorescence-activated cell sorting. In this project, three novel mutations in ORAI1 *(V181SfsX8* and *L194P* in exon 2, and *G98R* in exon 1) were discovered that completely abolish protein level expression and SOCE, but could be rescued using retroviral transduction of wildtype ORAI1. The investigation of these mutations provides implications not only for the mechanisms behind CRAC channel function but also details the clinical importance of CRAC channels on immune, integumentary, and musculoskeletal function.

Quantifying the Influence of Ploidy and Log Phase Growth Time on Stress Survival in Isogenic *S. cerivisiae*

Daniel McLaughlin, Biology
Sponsor: Professor Mark Siegal, Biology,

My research focuses on the differences in heat shock survivability between isogenic strains of the baker's yeast *S. cerivisiae* as a function of chromosome copy number, temperature, and time grown in exponential phase. Theoretical models predict that clonal populations can maximize fitness in an unpredictable environment by increasing phenotypic heterogeneity. We hypothesize that variation in growth rate underlies the ability of rare cells to survive a sudden and dramatic environmental change. Survivability is assessed by a growth rate assay developed in the Siegal Lab that makes use of light microscopy and image processing software to measure the growth of individual yeast micro-colonies. Through the use of this assay we were able to measure the quantity of cells that grew in relation to the quantity placed on the plate. These observations continue to shed light on the bet hedging mechanisms used by yeast to maximize fitness in an unpredictable environment as well as why yeast in the wild alternate between haploid and diploid states. An analysis of factors influencing survival will lead to a better understanding of the basis for superior growth of diploid cells and if there is a stress resistance cost associated with this increased growth rate. A better understanding of yeast bet-hedging and stress response will broaden our understanding of this important model organism. Because many pathogens and cancers are clonal populations that appear to use a similar bet-hedging mechanism, information on how to circumvent the protection that hedging offers is useful from a medical standpoint. The results of this work confirm that haploids produce viable colonies 4x more frequently than do diploids grown under identical conditions.

A New Method to Analyze DNA Fibers at the Molecular Level

Carissa Meyer, Biochemistry
Sponsor: Dr. Eli Rothenberg, NYU Langone Medical Center

DNA is an essential biological molecule, and errors in DNA metabolism often result in disease. Despite extensive research, the small size of DNA renders it difficult to study. Many current research methods involve recording data from samples with many molecules, yielding averaged results representing single molecules. Though these bulk methods have proved valuable, averaging hides minute interactions that may elucidate how DNA and proteins work together on the nanoscale. This information is important for coming up with new drugs that treat diseases related to DNA metabolism, so the need persists for finer methods to probe DNA. Total internal reflection fluorescence microscopy (TIRFM) and super resolution are two techniques which allow single DNA molecules to be imaged with resolution of up to one nanometer. This project seeks to introduce a novel technique to further DNA and protein research. In order to do so, TIRFM and super resolution were combined with fluorescence anisotropy. Including fluorescence anisotropy in data collection has the potential to enhance the amount of information that can be obtained from each experiment. Fluorescence anisotropy relates the relative intensities of two orthogonal polarizations of fluorescent light emitted to the orientation of the molecules in space. Not all molecules exhibit anisotropy, however. It is shown here that DNA labeled with the dye POPO-3 iodide has a strong characteristic anisotropy that changes predictably according to the orientation of the DNA relative to the x-axis. This anisotropy was used in conjunction with TIRFM and super resolution to yield images with both high resolution and valuable orientation information from anisotropy. Though this study was done with individual DNA molecules elongated and tethered to a coverslip, it is a future goal that this technique be adapted for imaging cellular DNA.

Analysis of αβ TCR-CD3 Interaction by 2D Kinetics Measurement

Vidushan Nadarajah, Biochemistry
Sponsor: Dr. Michelle Krogsgaard, NYU Medical Center

The T cell receptor on T cells interacts with the peptide-major histocompatibility (pMHC) complex on antigen presenting cells (APCs) to trigger adaptive immune responses. This requires the coordinated activities of several TCR-associated molecules, which include the CD3γ, δ and ε chains which are noncovalently associated with the TCR. How pMHC ligand binding to a TCRαβ heterodimer subsequently initiates signaling via the CD3 molecules is currently unknown. These events are influenced by a variety of factors including structural features, thermodynamic properties, binding affinity and kinetic rates. The goal of my project is to study the details of TCR-CD3 interactions, specifically focusing on binding affinity and kinetic rates, through two dimensional (2D) mechanical-based assays. Most studies make measurements by three dimensional (3D) techniques in which fluid-phase receptors and ligands are removed from their cellular environment. Mechanical-based 2D assays analyze the first seconds of contact and measure force-dependent off-rates. The idea is that binding results in bonds that physically connect the two surfaces which can be quantified by mechanically separating adherent from nonadherent particles. Experiments are done under conditions that favor single bond interaction. Off-rates are estimated from distributions of bond lifetimes or rupture forces and expressed as a function of force. A red blood cell (RBC) will be used as a force sensor to detect binding. The CD3 components will be coated on the surface of a small bead attached to the apex of a RBC to allow tracking of its position precisely and rapidly. Biotin-streptavidin coupling is used so that the molecules can be uniformly coated on the beads with proper orientations. In order to for this coupling to occur, the protein must have biotin bound to it. DNA constructs of the CD3γε heterodimer, CD3δε heterodimer, and the 2B4 αβTCR heterodimer containing AviTag biotinylation sequences were prepared by cloning. The AviTag was inserted at opposite termini for each protein—C-terminus of the CD3 chains and N-terminus of the 2B4 α-chain. This was done so as to avoid steric hindrance during 2D measurements. The proteins have been expressed, purified and biotinylated, and are currently being studied by the aforementioned 2D mechanical-based assays. These newer generation 2D techniques, with both proteins anchored in apposing plasma membranes, should reveal kinetic parameters of *in situ* TCR-CD3 interactions which should correlate better with T cell functional responses than 3D measures.

Direct Inhibition of Androgen Receptor Through Alpha-Helix Mimetics

Rachel Ness, Chemistry
Sponsor: Professor Paramjit Arora, Chemistry

Approximately 1 in 6 men will be diagnosed with prostate cancer in their lifetime. Many prostate cancers develop due to mutated androgen receptor (AR), which leads to over-activation of downstream cell growth and proliferation pathways. This makes inhibition of AR an attractive target for anticancer therapy. Current inhibitors of AR block activity through binding AR near the hormone binding domain (HBD), which causes a conformational change in the protein that prevents binding of AR co-activators. This allosteric inhibition only prevents progression of the cancer temporarily due to AR's ability to mutate and regain ability to bind its co-activators despite inhibition. The purpose of this work was to design and synthesize inhibitors with the potential to directly block the interaction between AR and its coactivator, potentially resulting in a more effective anticancer agent. Previous research has shown that the FxxFF helical motif on the AR-ligand interface is important for co-activator binding to AR. Importantly, this motif differs from the canonical LxxLL sequence that is employed by a plethora of nuclear hormone receptors. Thus, the designed inhibitors based on these key interacting residues have the potential to specifically modulate AR activity. The inhibitors were synthesized using the various α-helix mimetic scaffolds previously developed in the Arora lab at NYU and are currently being tested for their ability to inhibit AR in prostate cancer cells.

Impact of Sticky End Sequence on the Diffraction of Self-Assembled 3D DNA Crystals

Sabrine Obbad, Chemistry
Sponsor:Professor Nadrian Seeman, Chemistry

The 2-turn DNA tensegrity triangle with 2-base sticky-end (GA:CT) can self-assemble into a 3D crystal having a rhombohedral cavity. The triangles form a crystalline lattice that is stabilized via sticky ends. In the current study, we have analyzed the effect of the sticky end sequence on crystal formation and the resolution of the X-ray diffraction pattern at NSLS-X25. 2-turn 2-base tensegrity triangle motifs having GA:TC, AA:TT and CC:GG sticky-ends all formed crystals. X-ray diffraction data from the same beam line revealed that the crystal resolution was comparatively better for the 2-nt sticky end having an AA:TT base pair (4.75 Å) than GA:CT and CC:GG (8.0 Å). Our results confirm the expectation that the sequences of the sticky ends define the interactions between motifs, and they also have an impact on the resulting resolution. It is important to obtain better

resolution of the 2-turn tensegrity triangle motif so that we can control the formation of the 3D DNA crystal structure. Manipulating the sticky end sequence is expected to allow us to attain better resolution through X-Ray diffraction.

The Optical Activity of Oriented Achiral Sunset Yellow

David Osayande, Chemistry
Sponsor: Professor Bart Kahr, Chemistry

All chiral molecules are known to rotate plane-polarized light—they are optically active. The inverse, however, is not necessarily true; not all optically active molecules are chiral. Unfortunately, the incorrect association between achirality and optical inactivity has been perpetuated largely due to confusion of the differences of optical activity in solids and solutions. Achiral molecules belonging to the D_{2d}, S_4, C_{2v} or C_S point groups can indeed be optically active if properly oriented. We sought to prove this possibility by investigating the optical properties of the achiral azo-dye Sunset Yellow (SY). We oriented SY in chiral ethylene diammonium sulfate (EDS) and achiral potassium dihydrogen phosphate (KDP) crystals and searched for induced circular dichroism (ICD) – optical activity that may result because the chromophore has been placed in a dissymmetric environment or because of the preferential orientation of the molecules in the host lattices. Mixed crystals of EDS containing SY are strongly linearly dichroic, and they exhibit a strong circular dichroism in the absorption band of the dye. We also noted an unexpected blue-shift in the UV spectrum of SY within EDS crystals as opposed to SY in solution, which hinted at exciton-coupling and the formation of SY H-aggregates within the crystals. The mixed crystals of KDP and SY were designed as a control. KDP, unlike EDS, is achiral, but it can still selectively orient SY molecules. In this way, we may be able to parse the two types of ICD.

The Sloan Digital Sky Survey Large Galaxy Atlas

Ekta Patel and David Mykytyn, Physics
Sponsor: Professor David Hogg, Physics

We present the Sloan Digital Sky Survey Large Galaxy Atlas, which contains accurate positions and photometry for galaxies with half-light diameter greater than 1 arcminute. Galaxies of this size have rarely been measured with great accuracy and never before automatically. We present a table of measurements for such galaxies, including their positions, colors, magnitudes, sizes, concentrations, and surface brightness. Our input data has been taken largely from the Sloan Digital Sky Survey as well as the Third Reference Catalog of Bright Galaxies, the Two Micron All Sky Survey Large Galaxy Atlas and the NASA-Sloan Atlas. The measurement of galaxies with large angular sizes is challenging, and has rarely been done well in automated settings because the galaxies have overlapping field boundaries, overlapping foreground stars, and show detailed and confusing internal structure at high signal-to-noise. We take a generative modeling or likelihood approach to making measurements of the galaxies, using very simplified few-parameter morphological models. We specifically highlight those large galaxies that have not been found in the previous catalogs, but have been included in the NASA-Sloan Atlas with 50% light radii in the i-bandpass greater than 30 arcseconds. The creation of this catalog will allow other astronomers to perform statistical analysis of large galaxies that will allow for the detailed study of the evolution of galaxies over time. We have successfully measured the sizes of over one thousand galaxies that will be useful to astronomers who are looking to study these galaxies. The results produce measurements of galactic properties that are in agreement with various other catalogs, showing a very precise correlation between the galaxies in our data set, with a strong focus on radii, colors, magnitudes, and surface brightnesses.

Regulation of MicroRNA miR-9a by Zinc Finger Protein Zelda in Drosophila melanogaster

Utkarsh Patel, Biology
Sponsor: Professor Christine Rushlow, Biology

The zinc-finger protein, Zelda, is an essential activator of the zygotic genome of Drosophila, specifically during the maternal to zygotic transition in the first few hours of embryonic development. Prior analysis indicated that Zelda activates eight microRNAs during the transition, including miR-9a. In zelda mutant embryos, the expression of miR-9a is highly down-regulated. ChIP-seq assays and enhancer-reporter transgenic experiments helped identify a 1.5 kb DNA region as the enhancer of miR-9a. There are six Zelda binding sites (also known as TAGteam sites). The first two TAG team sites in the 1.5kb enhancer were changed by PCR mutagenesis. The wild-type and mutated forms of the 1.5kb enhancer were put into a vector with the lacZ reporter gene. Transgenic flies were generated and the expression patterns of lacZ driven by these two different enhancers were assayed by *in situ* hybridization. The expression of the reporter gene driven by the wild-type enhancer recapitulates the endogenous expression pattern of miR-9a spatially and temporally, which confirms that this region is the enhancer of miR-9a. The expression of the reporter gene driven by the mutated enhancer is, however, highly reduced. Thus, the first two TAG team sites in the 1.5kb

enhancer are important for the activation of miR-9a. Regulation of microRNAs addresses questions regarding embryonic development and can be used to understand human development and the mis-regulation of genes as a common cause of human diseases.

Recruitment of the Tumor Suppressor PALB2 to DNA by Human RPA

Ariana Rabinowitsch, Biochemistry
Sponsor: Dr. James Borowiec, NYU Langone Medical Center

Human replication protein A (RPA) is an single stranded DNA (ssDNA) binding protein essential for DNA replication, recombination and repair. RPA phosphorylation in response to genotoxic stress has been shown to stimulate chromosomal DNA repair. It is thought that the phosphorylation cascade is vital for the recruitment of DNA repair factors such as the BRCA2/PALB2 complex to stalled or collapsed replication forks for RPA removal and subsequent RAD51 recruitment. PALB2 is known to complex with BRCA2 to direct it to DNA lesions as well as to directly bind ssDNA and RAD51. Immunoprecipitation assays were used to study the sites of mutual interaction on PALB2 and RPA. The interaction site on PALB2 was found within a 100 amino acid expanse of the MRG15 binding domain. The interaction between the 100 amino acid portion of the MRG15 binding domain and a DNA binding domain on the N terminus of RPA1 are under analysis. Additionally, the effect of RPA phosphorylation on the level of PALB2/RPA interaction was assessed and found to have little affect *in vitro*. The interaction sites between PALB2 and RPA can potentially be targeted by molecular inhibition to disrupt DNA repair in cancerous cells.

Correcting the Behavioral and Biochemical Abnormalities Observed in a Mouse Model of Angelman Syndrome

Akila Ramaraj, Neural Science
Sponsor: Professor Eric Klann, Center for Neural Science

Angelman syndrome is a developmental disorder associated with autistic behaviors, epileptic seizures, motor abnormalities and deficits in learning and memory. It has been previously reported that expression of the α1 subunit of sodium-potassium ATPase (NaKA) is elevated in hippocampal neurons of Angelman Syndrome model mice. We hypothesized that genetically reducing expression of the α1 subunit of NaKA in Angelman syndrome mice could correct the memory deficits and biochemical abnormalities observed in these mice. In this study, we crossed Angelman syndrome model mice with mice carrying a heterozygous deletion of the gene encoding the α1 subunit of NaKA. In the double-mutant offspring, we observed a correction of the spatial memory tested with the Morris Water Maze. Additionally, the abnormal activation of the signaling molecules ERK2 and CREB observed after treatment with dihydro-ouabain was corrected; however, we did not observe any differences in the novel object recognition test, suggesting that the behavioral normalization in the double mutant may be hippocampus specific. Finally, we did not observe any differences among genotypes in phosphorylation of the memory-related proteins ERK2 and CREB following high-frequency stimulation of hippocampal slices. This indicates that the long-term potentiation deficits observed in the Angelman syndrome mice are not due to the NaKA-ERK2-CREB pathway abnormalities. These findings demonstrate that decreasing expression of the α1 subunit of sodium-potassium ATPase may be important to correct some of the behavioral and biochemical abnormalities observed in Angelman Syndrome. Moreover, the α1 subunit of sodium-potassium ATPase could be used as a target for new drugs designed to treat Angelman Syndrome.

Inhibition of Osteosarcoma Growth via PPARγ Induction and Differentiation to the Adipocyte Lineage

Kirk Rattanakorn, Biology
Sponsor: Dr. Alka Mansukhani, NYU Langone Medical Center

Osteosarcoma is a highly aggressive bone cancer that has a peak incidence at adolescence. Relapse of the disease is common after cessation of chemotherapy, which is postulated to be due to chemoresistance from a subpopulation of cancer stem cells from which the tumor arises. This along with chemotherapy's adverse effects, such as the targeting of actively dividing normal cells in addition to cancerous ones, makes it important to develop alternative therapies for osteosarcoma. Derived from transformed mesenchymal stem cells, this cancer is considered a disease of defective differentiation as the cells cannot form mature, bone-forming osteoblasts. Expression of the transcription factor, Sox-2, plays a role in maintaining the undifferentiated, proliferative state via antagonizing the Wnt/β-catenin pathway that induces bone formation. Since bone and fat formation are alternative mesenchymal lineages, adipogenesis, or differentiation to the fat lineage, can be induced in osteosarcomas to abate their self-renewal cycle. Thiazolidinediones (TZDs) are a class of FDA-approved antidiabetic drugs that can potentially be used to drive adipogenesis as they function as agonists of the nuclear receptor PPARγ, the master regulator of this process. To determine whether a TZD-based differentiation therapy

is feasible for osteosarcoma, we assessed the effect of two TZDs, pioglitazone and rosiglitazone, on growth of various mouse and human osteosarcoma cell lines. These growth assays and subsequent differentiation assays indicate that the TZD-induced growth inhibition leads to terminal adipogenesis. Cotreatment of the tumor cells with FGF21, a newly described adipogenic hormone, shows that the TZDs' effects can be potentiated to drive adipogenesis. Western blot of multipotent, mesenchymal CH3/10T1/2 cells treated with osteo- and adipogenic induction media elucidates that lineage selection is associated with differential gene expression, with Sox-2 and PPARγ being induced in adipogenesis and β-catenin in osteogenesis. Together, this work provides insight on the molecular mechanisms governing differentiation and rationale for a novel, differentiation-inducing therapy for osteosarcomas.

Creating 3D DNA Lattices Using Trimer Nucleotide Sticky Ends

Rutu Shah, Biochemistry
Sponsor: Professor Nadrian Seeman, Chemistry

The length and sequence dependence of hybridization free energies in nucleotide pairs might have an impact on the assembly and resolution of 3D DNA crystals. A DNA tensegrity triangle was reported to self-assemble into a 3D lattice via sticky ended cohesion. The length of the sticky end reported previously was two nucleotides. In this project, three-nucleotide sticky ends are being studied. Sequence variations GAG:CTC, ATA:TAT and ATC:GAT produced crystals of size 10 μm, 50 μm, and 150 μm respectively using a slow annealing protocol. Fast annealing yielded smaller crystals of 10 μm for all sequences. Results will be compared to the nearest neighbor model for nucleic acids which assumes that the stability of a given base pair depends on the identity and orientation of neighboring base pairs. In this context, attempts will be made to crystallize 2-turn asymmetric tensegrity triangles with a mixture of sticky end lengths of 1-, 2-, and 3-nucleotides. Longer sticky ends can be used for fractal assemblies of DNA, in DNA-based computation, and to form crystals at higher temperatures where the reversibility of interactions could occur.

3D Statistical Ray Tracer for mmWave Frequencies

Jocelyn Schulz, Electrical Engineering; Computer Science; George Wong, Mathematics; Physics
Sponsor: Professor Theodore Rappaport, NYU-Poly Electrical and Computer Engineering

The future of the cellular wireless industry is deeply connected to the research of wireless signal propagation, especially at higher frequencies in the mmWave range. A 28 GHz outdoor signal propagation measurement campaign was performed in New York City over the summer of 2012. Using these data, statistics regarding various characteristics of the wireless channel at 28 GHz were found and development of a complete statistical channel model has been begun. The wireless industry and academic centers use tools that model the real world to understand how certain devices behave in specific environments. Ray tracers, specifically, can be used to precisely and accurately model the way a signal propagates through any environment. Such ray tracers can then be used to better understand and predict propagation behaviors. The first step in creating a ray tracer is developing a mathematical and physically accurate model that reflects the nature of wireless signal propagation. This model is then implemented in a computerized environment. The primary components of the ray-tracing model are reflection and scattering—these two behaviors can classify all behaviors of EM radio waves moving through the environment. Both reflection and scattering are modeled according to Lambertian and specular reflection models, both well-known in the field of physics. In our implementation, these schemas make use of the propagation statistics that were calculated from the summer 2012 data. A two dimensional ray tracer has already been implemented and the statistics it generates generally agree with empirically collected data. The current stage of modeling development is rooted in pushing the program into the third dimension.

Long-Term Durability and Dose Escalation Patterns in Infliximab Therapy for Psoriasis

Cindy L. Tsui, Computer Science; Biology
Sponsor: Dr. Jacob O. Levitt, Icahn School of Medicine, Mount Sinai

Psoriasis is a chronic, inflammatory skin disease that affects 3% of the population and is associated with physical and psychosocial comorbidities. Infliximab, a chimeric human-murine monoclonal antibody, binds to tumor necrosis factor-alpha (TNF-α), an inflammatory cytokine (signaling molecule) involved in the pathogenesis of psoriasis and psoriatic arthritis. The Food and Drug Administration has approved dosing of infliximab medication for chronic plaque psoriasis at 5 mg/kg, administered intravenously at weeks 0, 2, 6, and then every 8 weeks. Short and long-term efficacy data reveal that the most common reason for discontinuation of infliximab treatment is a loss of clinical response. This observation is due to the development of anti-infliximab neutralizing antibodies, also called human anti-chimeric antibodies (HACAs). Patients who develop HACAs require dose intensification to optimize the treatment

regimen, with the maintenance dose increased to 10 mg/kg or given as frequently as every 4 weeks. Furthermore, the use of concomitant immunosuppressive medications, such as methotrexate, leads to decreased detection of HACAs in the serum of psoriasis patients, theoretically extending infliximab durability. Since its approval for Crohn's disease in 1998 and for rheumatoid arthritis in 1999, infliximab has proven to be safe at these intensified dosing intervals. Health insurance companies often reject this dosing regimen due to a lack of data. While the practice of dose escalation is well documented in the rheumatoid arthritis and Crohn's disease literature, limited studies address dose escalation in psoriasis patients. In our retrospective study, we summarize our experience with infliximab, dose escalation practices, and use of concomitant methotrexate during long-term maintenance therapy for adult patients with psoriasis or psoriatic arthritis. We show that infliximab dose escalation is well tolerated in our patient cohort and confirm that use of concurrent methotrexate is associated with a significant improvement in maintenance of clinical response on infliximab. Our substantial experience with infliximab doses and interval frequencies that are higher than those recommended in the package insert provides support for the therapeutic utility and safe practice of dose escalation in treating moderate-to-severe psoriasis and psoriatic arthritis.

Perceptual Threshold Difference between Rapid and Gradual Onset Tones in Noise Implicates Slope-Detector Neurons in Auditory Brainstem

Debjani Saha, Neural Science
Sponsor: Professor John Rinzel, Center for Neural Science; Courant Institute of Mathematical Sciences

Binaural perception is influenced by interaural phase differences (IPDs) of sounds. A product of this influence is binaural masking level difference (BMLD), the decibel difference in perception threshold of out-of-phase versus in-phase sounds embedded within a masking signal. For a head-centered masker, an off-center sound (S_{pi}) is more easily perceived than a centered sound (S_o). This phenomenon is well-documented psychophysically and, neuronally, in the inferior colliculus (IC). We ask whether a neural correlate of BMLD exists in the medial superior olive (MSO), the neural station that just precedes the IC. Binaural input is first integrated in the MSO, whose neurons behave as slope detectors, responding preferentially to rapidly rising inputs. To begin exploring the role of the MSO in BMLD, subjects listened to masked tones (either S_o or S_{pi}) in rapid onset (square envelope) and gradual onset (ramped envelope) conditions. We find an increase in threshold for gradual onset tones in both IPD conditions. The enhancement of tone perceptibility by rapid (high slope) versus gradual (low slope) input implicates MSO involvement in BMLD. These findings provide a basis for electrophysiological experiments within MSO neurons to investigate the computational underpinnings of BMLD at the cellular level.

Postmortem Study of Hippocampus Subfields and Layers at 7T MR

Mohammad Yazdanie, Biochemistry
Sponsor: Dr. Yulin Ge, NYU Langone Medical Center

Atrophy of the hippocampus is a key pathological hallmark of Alzheimer's disease (AD). An interest of subfields of hippocampal imaging has emerged in recent years due to the advent of ultra-high-field MR. Ultra-high-field MR may provide a noninvasive direct detection and quantification of hippocampal substructural changes to monitor the disease progression in the human brain. This project evaluates the imaging parameters on human postmortem brain at 7T MR using 3D susceptibility-sensitivity imaging (SWI) with enhanced tissue susceptibility contrast to better identify these layers and hippocampal subfields that are not available on conventional MR in order to better understand the transition of the hippocampus in AD as disease progresses. Coronal brain slices were preserved and fixed in 2% agar for this study. High resolution 3D SWI was obtained with isotropic voxel size 150~320μm. The cell types in the hippocampus showed different intensities with enhanced identification of structural borders that allow us to visualize the hippocampal structural layers and subfields. We established images that exemplify significant atrophy of the whole hippocampal formation and subfields in AD samples with lessening of the low intensity layers. The subfields reduction is seen predominantly in CA1.

Ultra High Energy Mock Cosmic Ray Cross Correlation Tests

Adrian Vatchinsky, Physics
Sponsor: Professor Glennys Farrar, Physics

Using a set of volume limited and flux limited mock galaxy catalogs we calculate the Landy-Szalay cross correlation estimator with mock ultra high energy cosmic ray data to establish a statistical framework for future studies using real data. We establish bounds between the cosmic ray energy threshold and galaxy distance horizon which minimizes the statistical variance in the correlation estimator. Further we consider smearing angle due to galactic magnetic field deflection, cosmic ray purity concentrations, and cosmic ray composition. These studies demonstrate an improvement in resolution using flux limited catalogs with the trade off of losing

information for far off galaxies, which is recovered in the volume limited catalog which lacks nearby resolution. This translates to favoring flux limited catalogs for higher energy cosmic rays and volume limited catalogs for lower energy cosmic rays.

Quantitative Susceptibility Mapping at 7-Tesla

Tianyou Xu, Physics
Sponsor: Dr. Karla Miller, Oxford Centre for Functional MRI of the Brain (FMRIB)

Magnetic susceptibility describes the ease with which a material can be magnetized in response to an external magnetic field. Variation in magnetic susceptibility across different tissue types is well established and relates to tissue constituents such as iron and calcium. MRI scanners at fields of ≥7T are sensitive to slight differences in susceptibility that can be difficult to detect at lower field strength, leading to renewed interest in magnetic susceptibility as a tissue biomarker. Quantitative susceptibility mapping (QSM) offers a marker of tissue properties that is fundamentally different from other MRI measures. Quantifying iron can help assess blood oxygenation or ferritin deposition related to iron toxicity. Calcium diamagnetism may be used to identify osteoporosis or calcification. In the brain, there is increasing evidence that white matter susceptibility is dominated by myelin, which is crucial to brain function. QSM should be more directly related to the tissue components of interest compared to other MRI markers (T2* or phase), which are difficult to interpret. While magnetic resonance imaging (MRI) is an extremely powerful diagnostic imaging technology due in part to its flexible image contrast and potential for quantitative measurements of tissue properties, a major challenge, however, is achieving sufficient sensitivity to detect the differences between tissues, which can often be subtle. This struggle has led to the constant push for imaging at higher magnetic fields, with the current state-of-the-art technology epitomized by Oxford's 7-tesla MRI scanner. My research involves using this scanner to detect, quantify and interpret the property of magnetic susceptibility in brain tissue. The aim of my project is to develop quantitative susceptibility mapping as a robust research tool on the FMRIB 7T scanner. I have already implemented a few existing methods from the literature for both the filtering (pre-processing) and inversion (quantification) stages. Ultimately my goal is to compare the accuracy and robustness of methods on simulations, objects of known susceptibility, and scans of healthy subjects at 7T.

Self-Assembly of Three-Dimensional RNA-DNA and RNA-RNA Rhombic Lattices

Jennifer Yoo, Chemistry
Sponsor: Professor Nadrian Seeman, Chemistry

DNA branched junctions have been extensively used to form unusual crossover motifs to build nanostructures in one-, two- and three-dimensions. It was recently reported by Gautham et al. that a four-arm mobile branched DNA motif designed to form a two-dimensional array can self-assemble into 3D crystals with a high resolution (2.1 Angstroms). The designed junction contained 4 DNA strands that could interact via 2-nusticky-end length dependence of the crystal resolution of the symmetric three-turn DNA tensegrity triangle cleotide sticky-ends. In the current work, we aim to expand to the formation of RNA-based 3D nanostructures. We investigated the formation of immobile hybrid RNA-DNA and RNA-RNA 4-arm junctions. The formations of the different junctions (4DNA, 3DNA/1RNA, 2DNA/2RNA, 1DNA/3RNA and 4RNA) have been demonstrated through native polyacrylamide gel electrophoresis. We also compared the formation of 3D crystals self-assembled from DNA-DNA and RNA-RNA junctions containing 2-nucleotide sticky-ends. The assembled 3D DNA and RNA crystal structures will be determined via X-ray diffraction methods.

Sticky-End Length Dependence of the Crystal Resolution of the Symmetric Three-Turn DNA Tensegrity Triangle

Victoria Zlotnikova, Biochemistry
Sponsor: Professor Nadrian Seeman, Chemistry

One of the key goals of DNA nanotechnology is to control the structure of matter at the atomic level in three-dimensions. Three-dimensional DNA crystals have been shown to self-assemble via sticky-end interactions from tensegrity triangle motifs having either 2, 3, or 4 turns per edge. It was recently shown that a two-turn tensegrity triangle motif with one nucleotide sticky-end yielded crystals that diffracted to a better resolution than triangles interacting via two nucleotide sticky-ends. We want to extend the previous study and determine whether the same pattern applies to the three-turn triangle motif. In the present work, we report on the resolution of 3D crystals assembled from a 3-turn tensegrity triangle motif that can cohere via either 1-, 2-, 3 or 4-nucleotide sticky-ends. In this same study, we correlate the diffraction of the three-dimensional crystals to the UV-absorbance melting profile of the 3-turn triangle tiles containing 1-, 2-, 3- and 4-nucleotide sticky-ends. Such studies will allow us to have a better understanding and control of the annealing protocol of the 3-turn triangle crystals.