Feature Articles


Anthropology and Epidemiology of Dengue Fever in Mexico and the United States  Samantha Schneider

The Moderating Role of Exercise in Stress-related Effects on the Aging Brain  Tara Singh

La Ruta de la Plata de Potosí: Una exploración moderna de la ruta colonial de plata más antigua de Bolivia  Samuel Steinberger & Adam Webb

La Ruta de la Plata de Potosí: A Modern Exploration of Bolivia’s Oldest Colonial Silver Route  Samuel Steinberger & Adam Webb

Summaries of Student Work

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Now in its fifth year of publication, the Washington University Undergraduate Research Digest (WUURD) is recognized across the University and among our peer institutions as an important source of scholarly discourse. This edition of the WUURD features article-length versions of four Senior Honors theses and a report on a summer research experience of two current students. With great excitement and for the first time we feature an article in two languages, further evidence of the scope and reach of Washington University’s outstanding undergraduate educational opportunities. The interdisciplinary nature of each of the feature articles as well as many of the Summaries of Student Work also reflects the breadth of experiences offered to and embraced by students at Washington University.

In her research on the framework that will be necessary to regulate carbon capture and storage, a novel technology to mitigate climate change, Kelley Greenman integrates her interests in environmental science and law. After analyzing potential risks to health and the environment as well as current regulatory frameworks for other environmental technologies, she concludes that it is feasible for private industry to shoulder the costs of CCS remediation and monitoring. Environmental Studies also plays a role in Tara Singh’s interest in the role one’s environment and lifestyle play on an individual’s health. In a study conducted in Psychology, she finds surprising results on the influence of exercise in moderating the impacts of stress on brain structure and function as measured in older adults. Caroline Gutman also crosses disciplines in her investigation of the journalist Edgar Snow’s influence on the historiography of the Chinese communists’ Long March narrative. Studies in comparative literature, history, and political science motivated her research which leads to a call to re-evaluate the narrative as it currently exists and is used by the Chinese Communist Party. Medical Anthropology draws upon the diverse disciplines of biology, political science, sociology and anthropology and is the field in which Samantha Schneider analyses dengue fever outbreaks in Mexico and their implications for the United States. The study takes a novel approach to tracking the spread of the disease by paying particular attention to its distribution along the Texas-Mexico border. Finally Adam Webb and Samuel Steinberger fully embrace the culture of Bolivia, where they conducted an anthropological study of an historic trade route, by presenting their research in Spanish as well as English. The authors have made an important first step in thoroughly mapping the exact route and documenting relics significant to this landmark. The translation of the work contributes to the goals of
providing Bolivians a more thorough understanding of their history as well as preserving what could become an important tourist destination.

The authors, members of the Peer Review Board and editor hope you are informed and inspired by the feature articles and research summaries presented in this volume. We are indebted to the Washington University faculty and staff whose dedication to undergraduate education makes possible these research studies and look forward to continuing to play a role in the academic life of the University.

Respectfully,

KRIStIN SOBOTKA
Editor

Author:
Kelly Greenman
Kelley Greenman is a 2009 Summa Cum Laude graduate of Washington University with a major in Environmental Studies. Her interest in environmental policy and climate change led her to study the policy implications of carbon capture and storage. Currently, she is pursuing her career interests in Washington, D.C. as an environmental policy analyst for the Department of Transportation.

ABSTRACT
Carbon capture and storage (CCS) is being proposed as one of many mitigation options for climate change, in large part because of its potential impacts on the coal industry in the U.S. This novel technology, however, comes with many risks that must be considered in formulating its regulatory framework. Sequestering carbon dioxide, CO2, underground for long periods of time poses potential hazards to human health and the environment. In addition to geological risks, however, a comprehensive policy for CCS must include issues such as liability and financial mechanisms, which ensure the long-term integrity and maintenance of a storage site. Regulatory analogs such as Superfund and RCRA provide a useful background for the success of such mechanisms in other frameworks. The analysis of the risks and regulatory analogs makes it clear that it is reasonable and legally feasible for companies that invest in carbon sequestration to shoulder the costs pertaining to remediation and monitoring.

FACULTY MENTORS: DANIEL GIAMMAR, PH.D., ASSOCIATE PROFESSOR, ENERGY, ENVIRONMENTAL AND CHEMICAL ENGINEERING & MAXINE I. LIPELES, J.D., SENIOR LECTURER AND CO-DIRECTOR OF THE INTERDISCIPLINARY ENVIRONMENTAL CLINIC
Professor Giammar’s research focuses on chemical reactions that affect the fate and transport of heavy metals and radionuclides in natural and engineered aquatic systems. His recent work investigates interactions of lead and phosphate at mineral–water interfaces, adsorption of arsenic to novel sorbent materials, control of lead concentrations in drinking water, environmental applications of nanostructured materials, and the environmental biogeochemistry of uranium.


Acknowledgements
A special thanks to my two fantastic thesis advisers, Maxine Lipeles and Dan Giammar, for their support, guidance, and commitment to my academic process and for pushing me beyond what I thought I could do. I’d also like to thank Tiffany Knight, Bill Lowry, and Jen Smith for the role they played in producing this thesis, and for their part in my academic growth: Glenn Stone, Beth Martin, and Jan Amend.

Peer Editor:
Danielle Wallis, a junior majoring in Educational and American Cultural Studies.

KEY TERMS
- Carbon Sequestration
- Climate Change Mitigation
- Support Groups
- “CCS”
- Carbon Capture and Storage
- Saline Aquifers
Climate change is arguably the number one environmental challenge in the twenty-first century. Although several strategies have been proposed for mitigation, one that has received considerable attention is carbon capture and storage (CCS), a method of capturing carbon dioxide (CO₂) from point sources, compressing it, and injecting it underground for permanent storage. CCS is particularly significant because of its linkage to the coal industry: the adoption and deployment of CCS would allow coal-fired power plants, one of the largest global sources of carbon emissions, to reduce their emissions. This technology is controversial as a strategy for mitigation because it would allow the continued use of coal, an integral part of the U.S. economy but a dirty source of energy in terms of greenhouse gas emissions. Despite controversy, support from the federal government in the form of research funds and proposed regulation suggests that the government is pursuing geological sequestration as a climate change mitigation strategy.¹

Carbon storage, however, comes with several risks, including the potential for leakage from a geological, or underground, storage site, the hazards of CO₂ contaminating drinking water or disrupting ecosystems, and even increased likelihood of earthquakes. These risks pose hazards during and after operation of a site, and must be considered in developing a regulatory framework for the technology. This paper looks specifically at the mitigation of risks after the closure of a site, and the liability and financial mechanisms that will be necessary in light of the government’s choice to pursue CCS as a carbon mitigation strategy.

Carbon Capture and Storage Technology

There are three main components to carbon capture and storage (CCS): 1) capturing carbon dioxide, usually by separating it from the flue gas stream of the power plant, and then compressing it to a much denser state; 2) transporting it to the storage site via pipelines, tankers, or other transport; and 3) storing it, which can be underground or in the ocean. The entire process and all of the technology employed in capturing, compressing, transporting, and storing the stream of CO₂ is considered CCS.²

This investigation will focus primarily on geological sequestration, which involves the injection of CO₂ into permeable rock formations, like deep coal seams, depleted oil and gas reservoirs, and saline aquifers.² Sequestration is the aspect of CCS that allows for climate change mitigation: without effective and permanent trapping of the carbon dioxide, CCS has no benefit and carbon capture has no purpose. The large research and development funds devoted to CCS by the U.S. Department of Energy, as well as the recently proposed regulations issued by the Environmental Protection Agency suggest that the U.S. government is currently moving forward to promote national deployment of geological sequestration.

Regulation of CCS

The United States is home to several pilot scale geological sequestration projects that are currently regulated under the Safe Drinking Water Act (SDWA) as a part of the Underground Injection Control (UIC) Program. The UIC Program governs most
underground injection and as of 2007, issued an experimental well category (Class V) specifically for CCS pilot projects. This regulation is adequate for the current projects since total injection falls in the hundreds to thousands of tons, and the purpose is exclusively experimental. However, because the federal government is choosing to move forward with CCS, the regulation for commercial projects will need to be more stringent than that applied to a few small projects.

Currently, the federal government is moving toward that aim. On July 25, 2008, the Environmental Protection Agency (EPA) issued a proposed rule for geological sequestration of carbon dioxide. A proposed rule is a regulation that is published for review and public comment, but does not have the force of law. The proposed rule for CCS is a good indication of the choices and considerations that the federal government will make regarding this technology and its regulation. However, because this proposed rule is within SDWA, the jurisdiction is limited to protecting drinking water sources from the impacts of carbon dioxide injection.

This limitation allows for the proposed rule to adequately cover many of the risks of geological storage before, during, and immediately after operation, but completely prevents adequate regulation post-closure. SDWA does not have the jurisdiction to impose liability or financial requirements to the extent necessary to mitigate risks for the entire lifespan of CCS projects. Before analyzing such necessary regulations, it is important to understand the geological risks that are a component of nearly all CCS projects.

CCS Risks

There is very limited experience with the combined use of all the different technologies to capture, transport and sequester CO₂ for long periods of time, and with that inexperience comes increased risk to human safety and to the environment. Most risks can be grouped into three main categories: risks as a result of leakage of CO₂ at the surface, subsurface leakage risks, and induced seismicity risks.

Certainly the largest concern of surface leakage is the escape of CO₂ into the atmosphere, which decreases CCS’s effectiveness as a climate change mitigation strategy. Leakage effectively reverses the positive effects of sequestering greenhouse gases. CO₂ leakage from the surface also has the potential to affect the health and safety of humans. Because CO₂ is denser than air, leaking gas could pool in valleys or enclosed areas like caves or buildings. This pooling could be hazardous because high concentrations of CO₂ can suffocate humans and animals. According to the IPCC, however, such accumulation of CO₂ is highly “improbable,” and therefore this risk is minimal.

Surface leakage of CO₂ could also negatively impact oceanic and terrestrial ecosystems. Where sequestration is taking place in saline aquifers underneath the sea floor, leaking CO₂ may dissolve into ocean waters, increasing the acidity in sensitive ecosystems. Terrestrial ecosystems could also be affected by leakage of carbon dioxide if concentrations increased in soils. Although CO₂ can be beneficial to plant growth in the ambient atmosphere, high soil concentrations can cause plants to “suffocate” entirely. This situation would be entirely possible if the gas were leaking up from a geological sequestration site and collect in the soils before escaping into the atmosphere.

It is possible that CO₂ sequestered underground could leak from the intended site but never reach the surface. The contamination of groundwater resources is the largest
concern in this situation. Leakage of CO₂ through a crack or fracture in the caprock into an aquifer above the injection site could directly contaminate a freshwater source by increasing its acidity. The indirect impacts of this acidity are of particular concern, especially the mobilization of heavy metals, including lead. The contamination of groundwater by such heavy metals has the potential to reach dangerous levels, making the water unfit for irrigation or drinking.

The third category of risk associated with leakage from a geological sequestration site is induced seismicity. Seismicity is the fracturing and movement along faults in a given area that can be synonymous with, or cause, earthquake activity. When materials (carbon dioxide or other liquids) are injected underground at a pressure higher than the formation pressure, the integrity of nearby faults can be affected, inducing earthquakes and microseismic events like brittle fault fractures. There are two particular concerns with induced seismicity. One hazard is small seismic events like brittle fracturing or resulting microseismicity (small tremors under the surface). These may cause fracturing in the storage formation, creating new pathways for stored carbon dioxide to escape. The second concern is that activated faults could cause larger earthquakes, causing local damage to human health or infrastructure. In fact, deep well injection has been shown to induce such events, like the 1967 Denver earthquakes.

While it is important to keep in mind the risks of leakage and the hazards that they present, a perspective on the estimated probability of those events is also central to this discussion. The probability of escape, given proper site selection, is actually quite low. The IPCC report on CCS claims that when “injecting CO₂ into deep geological formations at carefully selected sites for long periods of time[,] it is considered likely that 99% or more of the injected CO₂ will be retained for 1000 years.” Indeed, past regulation of geological sequestration activities, like the injection of hazardous waste, has provided the tools and examples necessary to substantially minimized risk. As a result, the proposed regulations released by the EPA for CCS are preventative and would likely foster industry practices that reduced risk and the potential for leakage.

SOCIAL RESPONSIBILITY OF CARBON SEQUESTRATION REGULATIONS: LIABILITY AND FINANCIAL MECHANISMS

Ideally, proper regulation would minimize risks from CCS, and indeed it is likely to do so. However, it is always a possibility that unforeseeable accidents could affect human health, the environment, drinking water supplies, or climate change. Under these circumstances it is important to understand who would be responsible for the accident, and where the funds for remediation would come from. These two concerns are essentially those of liability and financial mechanisms.

There are two major categories of liability and financial mechanism concerns: who is responsible during the operation of the project, and who is responsible after site closure. The former can be addressed using legal tools governed primarily at a state level and covered by existing legal frameworks. However, post-closure liability and financial responsibility has been the source of much debate. This paper will look at the possibilities for how these components could be regulated, and offer policy recommendations in the context of EPA’s proposed rule. From this point on, however, liability is nearly inseparable from financial responsibility; this is because post-closure
responsibility for a site, in most cases, means financial accountability for the costs incurred in monitoring, remediation, or lawsuits.

A geological sequestration site is meant to store carbon dioxide away from the atmosphere permanently or at least on a scale of thousands to millions of years. However, a post-closure site care period of 50 years is proposed in EPA’s regulations. There is an enormous gap between the amount of time that the operator is directly responsible for monitoring the site and the lifespan of the project, during which time monitoring or remediation may need to take place. Because the life of the project is so long, it is widely acknowledged that the government must take over the responsibility of carbon sequestration projects at some point to ensure continual and quality monitoring. Therefore, there needs to be: 1) a defined point where the government assumes liability, and 2) a method for ensuring adequate financial coverage of the costs of monitoring and potential remediation.

REGULATORY ANALOGS FOR LIABILITY AND FINANCIAL MECHANISMS

Looking more closely at analogies such as long-term storage of hazardous and nuclear waste may provide useful examples for how to address the issue of liability within the carbon sequestration regulatory framework.

The Resource Conservation and Recovery Act (RCRA)
The EPA’s Resource Conservation and Recovery Act (RCRA) was passed in 1976 as a “cradle to grave” regulatory system for “generation, transportation, treatment, storage, and disposal of hazardous waste.”

RCRA contains some of the most comprehensive requirements for financial liability that exist in federal regulation. The purpose of the RCRA financial mechanism is to ensure funds for closure and post-closure care in case of company dissolution, bankruptcy or site abandonment. It protects both the government and the public from incurring potential remediation costs because financial responsibility must be demonstrated at the time of permit issuance and through post-closure site care. These funds must be provided by one or more financial mechanisms from two categories: third party instruments or self-insurance instruments.

Third party instruments can be a variety of financial mechanisms, such as trust funds, surety bonds, letters of credit, or insurance. The first three forms effectively place the burden of proof onto the operator, but they are also limiting; because of the lag time between posting the bond and the potential harm, it is harder to guarantee that the firm will still be responsible for the bond. Additionally, the cost of the bond can also be contentious. The RCRA financial responsibility framework assumes that all costs are estimable, whether on-going or a one-time payment. Presently, however, there is much uncertainty in remediation methods and costs for CCS, therefore this information is currently unavailable for CCS projects. Insurance is another third party instrument used by RCRA. Environmental impairment liability, the type of insurance used for RCRA, has had experience with most of the hazards associated with CCS (except for the climate-related risks). It might make a flexible and adequate choice for ensuring financial responsibility for CCS; however, it may not be reasonable to expect
insurance to cover the site for its anticipated lifetime. Self-insurance instruments are usually corporate financial tests or corporate guarantees. These mechanisms are not guaranteed by any third party, but are based on the firm’s financial competence. The long lifetime for CCS projects makes these financial mechanisms impractical.

RCRA is unique in that it allows non-federal parties to take action without the involvement of the government. Specifically, Section 7002 under RCRA allows private parties, to seek damages even if the “harm” took place decades after the initial disposal; under RCRA, liability remains with the operating party indefinitely. It is the present nature of harm that is important in this case, not the recency of the operation. This model could prove especially useful for CCS projects where humans or the environment could suffer damages years after injection ceased. This type of liability also acts as an incentive for operators to exercise extra caution.

Although RCRA is acclaimed as having one of the most thorough financial assurance mechanisms, not all elements of the framework are directly relevant to CCS, and not all of them have been shown to work as planned. As mentioned, RCRA assumes that the risks and costs necessary to determine financial responsibility are estimable and manageable. It is necessary then, that remediation and monitoring costs are more clearly established for carbon sequestration before a detailed framework and estimate of the costs can be generated. Additionally, under RCRA, companies must only demonstrate financial responsibility within the time period of post-closure care. After that point, if remediation or monitoring is necessary, there is no assurance of funds. Rather, the EPA depends on the fact that the firm still exists and is able to pay. This time limit on financial responsibility would pose a problem for CCS projects that encounter remediation or monitoring needs after the 50-year post-closure period. For that reason, the regulation of geological sequestration must provide for the availability of funds even after the post-closure period.

Lately, RCRA has also faced scrutiny from government agencies for certain inadequacies of the regulation. Firstly, RCRA has been criticized for its inflexibility in rapidly changing markets. For example, the regulations do not account for advances in accounting and reporting standards, which have evolved substantially since RCRA’s initial development. Secondly, a recent United States General Accounting Office report noted concerns over the inadequate resources available to the EPA should a firm declare bankruptcy or abandon a site. In response, the EPA acknowledged that there is “insufficient assurance that funds will be available [when needed],” and admitted that the risk associated with financial assurance may be higher than initially estimated. Therefore, while these financial mechanisms are an adequate baseline to use for forming CCS regulation, the importance of flexibility and collecting adequate funds must be stressed to ensure the operability of the framework.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA, better known as Superfund, was created in 1980 to provide a cost-recovery vehicle for the federal government to address problems related to improperly disposed hazardous waste. It imposes taxes on the chemical and petroleum industries, the revenues of which are diverted to a Superfund Trust Fund for cleaning up abandoned or uncontrolled hazardous waste sites. Congress provided that the fund could be
tapped when the original polluters of sites could not be identified, had gone into bankruptcy, or refused to pay for cleanup. When current owners or responsible parties are identified (and still in existence), CERCLA holds them financially responsible for the clean-up of the site. Additionally, CERCLA has the ability to mandate financial responsibility from certain operators of hazardous waste facilities; however, this element of the regulation has never been promulgated.

In 1995, the chemical and petroleum industry taxes that funded Superfund were not renewed, and in 2003 the trust fund ran out of money. Although this section will look at Superfund before the tax cuts, this current situation illustrates the importance of changing political motives, and how they might affect the financial stability of CCS remediation. This should be considered when choosing a financial mechanism.

For the purpose of this discussion, CERCLA has two pertinent financial elements: the financial responsibility requirements for existing hazardous waste facilities and the retroactive fund to pay for hazardous waste clean-ups. Both will be analyzed for their usefulness to CCS projects.

CERCLA includes a provision in which companies that handle hazardous materials must demonstrate financial responsibility to the EPA for potential waste clean-up; this section of the regulation has never been implemented, which limits its usefulness for this discussion. However, should this section be promulgated in the future, the regulation allows companies to demonstrate financial responsibility in a number of ways. Unlike RCRA, CERCLA has built-in flexibility: it allows for hybrid financial instruments—third party coupled with self-insurance instruments. CERCLA’s flexibility led to the evolution of cost-cap insurance, which provides coverage for costs above the expected price of remediation. The model for these financial mechanisms is useful but because it has never been utilized, it is hard to judge the success of this flexibility and how it could be directly useful for CCS.

The signature element of Superfund is the retroactive fund established to clean up abandoned hazardous waste sites. By imposing taxes on the chemical and petroleum industry, the cost of the remediation does not burden taxpayers. This idea could be transferred to CCS projects by taxing carbon sequestration operators. Similar to many Superfund sites, there will be a time when the operators of carbon sequestration projects are no longer in business or in existence. Having the available resources to fund remediation in the future would be favorable, especially if it does not require the government to withdraw funds out of general revenues. Potentially, this financial resource could last longer than the financial responsibility demonstrated by individual companies. However, as Superfund’s current status illustrates, the success of this fund would be dependent on political support in order to maintain the taxes that generate its revenue.

The CERCLA liability statutes that are used by the EPA to charge the responsible parties of hazardous waste clean-up sites are “super-charged [...] in order to cast as wide a net as possible.” This is because most of the contaminations took place at a time when regulation allowed such disposal of wastes, yet defendants must still be held responsible for clean-up. CERCLA allows EPA to charge parties regardless of whether they are at fault. The EPA can also sue multiple parties, each for the full amount of the clean-up; it is then the responsibility of the parties to figure out the percentage each of them will pay towards the full amount. The ability of the EPA to utilize this
stringent liability framework allows for them to recuperate costs of site clean-up more effectively, and would be a useful element of CCS regulation, given the similarly long time period that sequestration sites will be in existence.

Although admittedly the nature of remediation for hazardous waste is significantly different than that of carbon sequestration, many elements of the regulatory framework are analogous to one another. The flexibility of CERCLA’s financial mechanisms is a helpful lesson for CCS regulations. Combining their flexibility with the more stringent regulatory measures found in RCRA might increase the potential for success. Additionally, the signature elements of CERCLA are very important to CCS. The creation of a national fund to pay for remediation measures in the future should be considered, given the time frame of CCS projects. Again, however, the ability to change the revenues of the fund based on differing political agendas represents a limitation. The stringent liability provisions, if applied to CCS, would also benefit private parties and government in collecting the funds necessary for any remediation or monitoring.40

One important difference between CERCLA and CCS that must be noted is the retroactive nature of CERCLA. It was a regulation meant to address the “past haphazard disposal of chemical wastes,” the costs for which were well known due to experience with remediation and clean-up.41 Unlike CERCLA, a fund for CCS may not have the advantage of knowing definite costs beforehand. This lack of knowledge might prove to be a barrier for setting up this type of fund for CCS; however, it is important to acknowledge the potential savings on the part of the U.S. government if such a fund is set up to be fully funded by industry.

Individually, none of the discussed regulations is adequate for addressing the needs of carbon sequestration. Instead, the financial responsibility and liability requirements for CCS should take into account the variety of approaches, and use the best elements of each when producing a framework. It is important to note, however, that for any of these frameworks to function, there must increased data and knowledge about the cost of remediation for CCS.

RCRA’s up-front financial responsibility requirement for remediation and well closure is very important. However, if this is going to be in place, there needs to be a way to ensure that the funds collected are adequate in case of site abandonment, operator bankruptcy, or dissolution. This problem could likely be solved by having more stringent requirements for financial responsibility, coupled with flexibility in combining financial mechanisms. In other words, such mechanisms as cost-cap insurance and hybrid financial mechanisms are encouraged, but the EPA must take more action to ensure adequate funds are available. In particular, the EPA has been admonished by the Government Accountability Office for allowing companies to choose their own mode of financial assurance. This allows industry to choose the methods of the lowest cost, but that prove the highest risk to the government, such as corporate financial guarantees.42 The EPA should set stringent rules that dictate the type of financial mechanisms that may be allowed for each company based on its financial risk profile. This will better ensure that adequate funds are available when remediation is necessary.

In addition to demonstrating financial responsibility that extends through the post-closure period, there should be an ongoing fund to cover costs if a liable party can no longer pay. This would likely require up-front payments into a lasting fund. The Superfund is a useful example for this element. The fund can be supplied by taxes
that come from within the industry, either paid by a general tax or a tax per ton of carbon sequestered. Everyone with a CCS project pays; theoretically, therefore, the liable party would have contributed to the remediation costs. Before such a fund could be established, however, estimates of remediation costs would be necessary. Also, a downside to this mechanism is that it is vulnerable to change under differing political agendas. Also, this fund would likely be unpopular with industry leaders who would be responsible for paying additional taxes and/or holding extra insurance. Arguments could even be made that this would limit deployment by introducing barriers to business. However, these options do ensure the public will not be left with the burden of paying for remediation.

The liability standards from CERCLA also provide an example of a potential framework for CCS. Given the long-term nature of CCS projects, and potentially high costs for remediation, it would benefit the government to allow retroactive lawsuits. Although such a stringent liability framework was very specific to CERCLA and cleaning up abandoned sites, it could be applied to CCS with very positive effects. Not only would it be easier for the government to hold companies responsible for paying remediation or monitoring costs in the event that they abandoned a site, but it would also be additional incentive for companies to minimize risk during the operation phase of the project.

EPA PROPOSED RULE: HOW IT ADDRESSES FINANCIAL RESPONSIBILITY AND LIABILITY

For liability, the EPA has proposed the 50-year post-injection site care period, with proof of non-endangerment necessary for site closure. Despite this proof of non-endangerment, however, operators are indefinitely liable for any harm to underground sources of drinking water. This liability, however, does not explicitly extend to private parties, nor does it cover risks beyond those to sources of drinking water.

The financial responsibility framework for this proposed rule is purposefully incomplete. Although the rule specifies that “the EPA plans to develop guidance in which operators would be required to demonstrate financial responsibility for well plugging and post-closure site care at the time of the permit allocation.” operators would be allowed to demonstrate financial responsibility through third party or self-insurance instruments. This assurance will need to be maintained through the 50-year post-closure site care period, but not beyond it. Throughout the project, this financial responsibility demonstration would require periodic updates of cost estimates for corrective action, and a re-demonstration of the ability to meet the new financial needs. These regulations are based on RCRA, and, in fact, the rule voices concern over the GAO recommendations and refers to an evaluation of RCRA’s financial mechanisms that will be used for providing additional guidance.

As already mentioned, the rule does not provide a thorough assessment of financial mechanisms because of the EPA’s desire to seek guidance on this topic. However, some omissions suggest that the proposed rule is not taking into account all possible methods to ensure the social responsibility of the carbon sequestration industry.

The rule’s indefinite liability clause is unavoidable, due to the fact that the EPA does not have the authority to transfer liability from one entity to another. This may
Table 1: Summary of Regulatory Analogs for Liability and Financial Mechanisms

<table>
<thead>
<tr>
<th>Regulatory Analog</th>
<th>Purpose of Regulation</th>
<th>Elements Useful for CCS</th>
<th>Evaluation of Regulation</th>
<th>Additional Concerns for CCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCRA – Resource Conservation and Recovery Act</td>
<td>“Cradle to grave” regulatory framework for hazardous waste</td>
<td>Delineates specific financial mechanisms that must be used: trust funds, surety bonds, letters of credit, insurance, corporate financial tests, or corporate guarantees</td>
<td>It has been shown that RCRA does effectively ensure that adequate funds would be available</td>
<td>The risks and costs associated with CCS must first be determined before financial responsibility can be measured</td>
</tr>
<tr>
<td>Underground Injection Control</td>
<td>Regulation of hazardous waste injected underground</td>
<td>Operators of hazardous waste injection wells are indefinitely liable for damages</td>
<td>Financial mechanisms for UIC are more ambiguous than RCRA and therefore less effective</td>
<td>The indefinite liability of a company is only sufficient if the company is in existence; CCS needs an additional mechanism to cover damages for the long-term existence of the site</td>
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<tr>
<td>CERCLA – Comprehensive Environmental Response, Compensation and Liability Act</td>
<td>Addresses problems related to improperly disposed hazardous waste</td>
<td>Allows for hybrid financial instruments to be used by current companies</td>
<td>Funding for the Superfund was eliminated because Congress did not renew the taxes</td>
<td>CCS would need a mechanism for retroactive clean-up as well as financial responsibility demonstrations during project operation</td>
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<td>Established financial mechanisms for current hazardous waste facilities to pay for waste clean-up</td>
<td>Trust fund is funded by the industry and does not pose a burden on taxpayer</td>
<td>The financial mechanisms were never promulgated, and therefore their effectiveness cannot be determined</td>
<td>Any fund established for CCS that was susceptible to political changes could endanger the availability of funds for remediation</td>
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<td></td>
<td>Establishes a trust fund funded by taxes on the chemical and petroleum industry to pay for hazardous waste cleanup if the responsible party is no longer able to pay</td>
<td>Imposes strict, several, and joint liability on companies that can be used by government or private parties</td>
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<tr>
<td>Price Anderson Industries Indemnity Act</td>
<td>Insurance program meant to pool risks of nuclear power plants in case of an accident</td>
<td>Encourages deployment by limiting the liability of private parties</td>
<td>Such a program works only when there is a low probability of an accident occurring</td>
<td>An indemnity program would require approximate costs for remediation, which are not yet known for CCS</td>
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<td>Requires parties to hold more insurance than they otherwise might</td>
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<td>Potentially shifts the burden of paying for remediation to the public</td>
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provide additional incentive for companies to minimize risks, since they can be held liable for damages or leakage in perpetuity. Unfortunately, beyond drinking water, the rule does not adequately cover liability of damages to human health and the environment (i.e. health effects of concentrated CO₂, ecosystem damage, property damage) which is also due to the jurisdictional limitations of the SDWA. This suggests a need for other regulations that can cover such topics.

The proposed rule, though its financial responsibility framework is incomplete, overlooks certain issues that should be included in the regulations. One particular issue is that the UIC financial mechanism would not extend financial responsibility “for activities unrelated to protection of USDW’s (e.g., coverage of risks to air, ecosystems, or public health unrelated to USDW endangerment).” This is inherently a concern since the risks to these entities are comparable to those of drinking water sources. Again, this inability on the behalf of the SDWA to cover these risks demonstrates a need for additional regulation that can protect the health of humans and the larger environment. Additionally, operators would no longer need to demonstrate financial assurance after post-injection site care. How then, will the federal government pay for remediation after that period? They propose that indefinite liability is enough to hold owners financially responsible after the site care period ends; if the company is still in existence, this might be true, but what if they are not? The proposed rule should account for that possibility by having an available fund (like Superfund or an indemnity program). Such a fund was discussed earlier and provides an additional safety net on which the government can rely. It ensures that remediation funds are coming from within the industry and prevents the general public from assuming the costs imposed by industrial activities.

DISCUSSION

Financial responsibility and liability frameworks are very important components of any regulation pertaining to carbon sequestration. Companies must be held responsible for the operation of their site, both during and after injection. Additionally, companies that invest in carbon sequestration should expect to shoulder the costs pertaining to remediation and monitoring. Industrial analogs demonstrate that such an expectation is reasonable and legally feasible. EPA’s proposed rule attempts to address these issues, but falls short in several areas. Many shortcomings are due to the limited authority of the Safe Drinking Water Act, and demonstrate the importance for additional regulations. Other omissions in the proposed rule, however, could and should be covered by the SDWA. Operators should be held responsible for human or environmental damage resulting from a malfunction of their site, whether it takes place during injection or several years after site closure. The financial responsibility portion of the rule must ensure that companies demonstrate their ability to pay for well closure and post-injection site care. Additionally, however, it should include a provision for collecting funds for future remediation and monitoring when the parent companies are no longer around to assume financial responsibility.
1 Negative public perception can decrease the feasibility of a project and is considered a critical component of success for carbon sequestration. See generally: Climate change federal actions will greatly affect the viability of carbon capture and storage as a key mitigation option: report to the Chairman of the Select Committee on Energy Independence and Global Warming, House of Representatives, 2008, U.S. Govt. Accountability Office. (Carbon Capture and Storage Report)

2 Enhanced oil recovery, while not a geological formation, is a method of injecting CO$_2$ that is used to recovery hydrocarbons in depleted reservoirs, which therefore provides an economic incentive to sequestration. This method of sequestration will not be covered in this paper.


6 Ibid., 246


9 CO$_2$, when mixed with water, can become carbonic acid.


12 Metz, et al, 249

13 Metz, et al, 246


15 Hiranya, et al, 24


20 Garrett and American Bar Association Section of Environment, Energy, and Resources, 509

21 Klass and Wilson, 36
The GAO Report was specifically targeting UIC regulations for financial assurance. The UIC financial responsibility framework is less specific about the mechanisms that can be used and therefore less effective. The specificity of financial mechanisms, therefore, contributes to RCRA’s marginally better success.
Mao’s March:
The Role of Edgar Snow in the History and Historiography of the Chinese Communists’ “Long March,” 1934-1935

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Caroline graduated Summa Cum Laude from Washington University in St. Louis in May 2009 with majors in Chinese and Political Science. Her love of languages, traveling and history led to her thesis. She became interested in researching the Long March through the combination of a historiography in History and a Chinese political history course in Political Science and during two summers she spent living and working in China. She currently works for a financial research company in Chicago.

ABSTRACT
The Long March (1934-1935), the Chinese Communist Party’s military retreat from the Nationalists, has become the founding myth in modern Chinese history. According to the standard narrative, during the yearlong 6,000-mile journey through Western and Northern China, Mao Zedong’s leadership and military strategy saved the Red Army from Nationalist forces, leading to his position as Party Chairman. Edgar Snow’s Red Star Over China, a travel memoir based on his interviews with Mao after the Long March, established the legend. After examining survivor and second-hand accounts of the March and reviewing Snow’s personal archives, this paper concludes that Snow’s retelling of the Long March is incomplete, and whether intended or not, was and still is used as the Chinese Communist Party’s mouthpiece. As such, the widely accepted Long March narrative must be reevaluated in view of its many flaws.

KEY TERMS
- China
- Mao Zedong
- Long March
- Chinese Communist Party
- Edgar Snow
- Red Star Over China
- historiography

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PROPAGANDA

The Chinese Communist Party (CCP) today would likely maintain that the triumphs on and after the Long March resulted entirely from political shrewdness, a forward-thinking vision, and Mao Zedong’s leadership. But it was also Mao’s intuitive grasp of propaganda and the writing of history during and after the journey that contributed to the Long March’s preeminent interpretation as a successful journey, free from political mistakes. To that end, it was Edgar Snow, a Kansas City journalist in Shanghai in the 1930s, who served as the impetus for Mao’s great story of the Long March.

Like the Great War’s name change to World War I, the Long March (Changzheng, 长征) did not obtain its name until at least 1936. At the outset the Red Guards had no clear plan of action or sense of how long they would walk in “what appeared to be an ignominious retreat through enemy lines towards a vague and seemingly hopeless salvation.”

Whether the leadership had lofty goals of fully transporting the party headquarters or whether they tried to maintain an appearance of full functionality in the face of adversity, the CCP began the Long March as an entirely mobile government, carrying party documents, machinery, and even office furniture. Throughout the March, they published a regular newspaper called the Red Star, edited by Deng Xiaoping, with twenty-eight issues published over the course of the Long March:

[The newspaper] put across the orders of the Party and praised the heroism of the soldiers; it also gave practical advice on how to deal with shoe shortages, disease, and clashes with ethnic peoples. At the same time, it did not shy away from problems: slack discipline, inadequacy of personal hygiene, overzealous confiscation, and desertion.

To have the wherewithal to publish a newspaper while struggling to survive is noteworthy. It is worth asking, however, what the motivation for publishing the newsletter in such treacherous conditions may have been. Did the Central Committee hope it would keep the Red Guards informed of their status and improve troop morale, or did the leadership have the foresight to recognize that it might serve them as valuable propaganda in the Revolution if they survived the journey? In a retreat of survival, maintaining thorough records was likely not a priority—unless it had propagandistic value.

Snow’s Choice – Or Choosing Snow

While Mao’s capability for propaganda helped spread the Long March narrative and the CCP’s Revolution within China, it required a well-published, well-connected and impressionable Western journalist sympathetic to the Communist cause to convey the Marchers’ story of survival to the outside world. Edgar Snow fit the role and became Mao’s and the Chinese Communist’s historian—an often underestimated though truly influential role. Sanctioned by Mao himself, Snow provided the first thorough account of the Long March and his writing set the stage for the CCP’s international debut.
There were two parts to Snow’s fortuitous and significant role in modern Chinese history: his opportunity to enter the Shaanxi Soviet and interview CCP leadership, and his capitalization on the experience by both writing *Red Star Over China* and the selective publication of his interviews with Mao. While Snow portrayed his travels in the Shaanxi Soviet as the result of his own initiative and spirit of adventure, Snow’s trip and subsequent fame—though short-lived—only occurred because Mao invited Snow to enter Shaanxi and conduct interviews.

Snow had shown an affinity for adventure and travel since a young age. In a letter to his parents he confided,

> I have been somewhat depressed by the monotony of existence... while youth, life was slipping by...happiness at the moment meant but one thing. And that was travel! Adventure! Experience! I wanted to overcome difficulties—physical hardships—and enjoy the tokens of triumph! I wish to know peril and danger! I wanted to fill my youth with something more than the pious, pitiful platitudes which I felt surrounded me.5

Snow’s disposition was well suited for the living conditions he would encounter while in the Shaanxi Soviet for four months.

After studying journalism for just one year at the University of Missouri, Snow withdrew from college and traveled by ship to Japan and then Mainland China. He soon found himself in Shanghai working as an assistant advertising manager for the *China Weekly Review* (under University of Missouri graduate J.B. Powell) at a time when China was “changing with a swiftness unparalleled in the history of any country of the world.”6

This rapid change initially captivated Snow, though the Nationalists’ general disorganization and lack of assistance toward struggling provinces later frustrated him. Chiang Kai-shek’s one-party system also did not sit well with him; in one letter, he described Chiang as a “dictator” with “mediocre abilities.” Early on, Snow agreed with J.B. Powell, editor of the *China Weekly Review*, that the Nationalists should control China, but as he learned about and became intrigued by the Chinese Communists, his position shifted further left.

Snow began to believe in Chinese Communism as a viable system, writing in a *Current History* article, “Communism is no longer—if it has ever been—merely the hallucination of alarmists in China.”8 His earlier solo travels through China’s western frontier and time spent among impoverished peasants, whom he believed the Nationalists had neglected, further helped create a sense of Nationalist failure in his mind. While he never outright expressed his political stance, his writings—even before *Red Star Over China*—and growing list of Communist contacts support claims of his personal leftist ideology.

Earlier, Snow had written provocative articles on the Nationalists, referring to Chiang as a model of “mediocrity,” garnering a reputation for left-leaning journalism.9 In an interview with former Guomindang foreign minister Eugene Chen, Snow selectively recorded Chiang Kai-shek’s statement to Chen: “The people will be damned. We will lead them by the ears. They will do as we say.”10 According to his biographer John Hamilton, in trying to find outlets for his work Snow did try to avoid any sense of
Communist-leaning in his writing, and recognized that being labeled a Communist sympathizer by the American press might handicap future efforts at publication. Nevertheless, his earlier writings in China came across as sympathetic to the Anti-Nationalists.

By 1936, Snow had pieced together information on the Communists and their new location in Shaanxi and began to explore means by which he might visit. Snow certainly recognized the significance of both a possible trip itself and the internationally available coverage of it he could provide upon leaving. In a letter to his editor L.M. MacBride at *The London Daily Herald*, Snow eagerly described, “How extraordinary the material from such a trip [to the front in Shaanxi] might prove to be:

There are no firsthand accounts of conditions in the Soviet areas. No interviews with any of the famous Red leaders—Mao Zedong, Zhu De, Xu Xiangqian, Liu Zedan, and others—have been published. If I succeed in seeing them, as I may, it will be a world scoop on a situation about which millions of words have been written, based only on hearsay and highly colored government reports.\\(^11\)

With so much self-placed value on his experience, it is not inconceivable that Snow exaggerated the Reds’ strengths and downplayed their shortcomings. Exotic and exclusive stories bode well for book—especially personal memoirs—and newspaper sales, and Snow’s writing contains no shortage of inconceivable and dramatic episodes. But rather than merely trying to sell copies, it seems Chinese Communism intrigued Snow, leading him to write favorably about what he had seen.

Agnes Smedley, a well-known pro-Communist journalist who frequently visited the *Review’s* office, initially connected Snow with major figures in the anti-Nationalist movement including Song Qingling.\\(^12\) Better known as Madame Sun Yat-sen, Song proved an unexpected though invaluable resource in Snow’s efforts to reach the Soviet. Likely alluding to Madame Sun’s efforts on his behalf, Snow wrote in his preface to *Red Star Over China*, “A report about me [sent to the field] had come from the Communists’ secret headquarters in Xian.” After receiving support from his editors at the *Sun* and the *Herald*, Snow had approached Sun, “so that at least I should be received by the Reds as a neutral, not a spy.”\\(^13\) Madame Sun recommended Snow to the CCP leadership because of his communist-sympathizing writing (though Snow and his biographer refute his title as a communist sympathizer), setting him up for the position in the Shaanxi Soviet.\\(^14\)

While the details of how Snow received permission to enter Red China remain ambiguous, once he arrived in Shaanxi he received a most gracious welcome. As Snow wrote in his diary, “It was the first time I have been greeted by the entire cabinet of a government, the first time a whole city has been turned out to welcome me…I was overcome at the warmth of the greeting, the incredible experience of receiving it far in the interior.”\\(^15\) The CCP leadership, including Zhou Enlai and Mao Zedong, personally greeted Snow; they saw him as the vehicle for spreading the Communist survival story and it was imperative that Snow experience Red China at its best. (In the 1938 edition of *Red Star*, Snow boasts the Red Guards gave him “the foreign-guest treatment,” though this description does not appear in the 1944 version.\\(^16\) During his interview,
Zhou Enlai volunteered, “We have a report that you are a reliable journalist, friendly to China, and that you can be trusted to tell the truth...you will be given every help to investigate.”

Mao knew the importance of the interviews, and went to great lengths to shape the Communist image Snow would provide in his writing. Snow noted, “Frequently [Mao] put aside piles of reports or telegrams, and cancelled meetings, to be with me. After all, I was a medium through whom he had his first chance to speak to the world —and, more important, to China.”

When Snow reached Bao’an, he immediately began the interview sessions with Mao, who had stipulated that Snow provide the interview questions beforehand. Following the interview, Snow would hand over his transcript to Mao’s translator; Mao then would make corrections to the Chinese version as he saw fit before the translator would return it in English to Snow. In the Editor’s Notes to “The Chinese Communists and World Affairs,” a published section of the Mao interviews, Snow’s editor remarked, “Before their release for publication, Mr. Snow’s interviews were re-translated into Chinese and corrected by Mao, and should therefore contain a minimum of errors of reportage.” Snow also commented in a note, “Mao’s recollections were entirely from memory and it is possible that historical inaccuracies [sic] may appear here and there, but as regards his own life, it is the only first-hand account we have primary source available.” Not only did Snow agree to the terms, but he (and his editor) wholeheartedly trusted Mao’s revisions, as they became incorporated into the published interview segments and *Red Star Over China*.

Obtaining any information was better than no information, and it was vital to go to any length necessary to acquire it. Mao, who helped develop modern guerilla warfare and was a guerilla leader himself, decided to stipulate his own conditions. However, what cannot be overlooked is how Snow compromised his journalistic duty; he failed to show skepticism, to double check the facts as dictated to him, or to challenge assertions made by Mao. Snow allowed his exclusive interview to be turned into an official Party hagiography, and failed to portray Mao as a fallible human being.

**Writing about Mao and the Long March**

Based on limited correspondence in Snow’s personal archives, editorial revisions to his articles and *Red Star Over China* appear relatively minor. Instead, Snow’s unpublished interview questions for Mao, and his writing style and content selection for *Red Star Over China* (in its first two editions, 1938 and 1944) reveal the extent of Mao’s influence over Snow’s writing, which Snow later recognized: “Legal access to the press of China was denied [Mao], but his comments published in English [through Snow’s articles] were bound to filter back, he knew, and reach the ears of most literate Chinese, despite Guomindang Censorship.”

This broadcast effect, and the potential to generate international and domestic CCP support, likely factored into Mao’s insistence on virtually controlling the interviews. After all, to Mao, Snow’s visit to the CCP was not the story; the Party’s political history and survival on the Long March were what mattered, and Snow was merely the (unwitting) messenger.

In general, the interview questions Snow posed to Mao appear sympathetic or even supportive in tone. Snow posed the question, “Much has appeared in the press, both
in China and abroad, concerning the “savagery” and “brutality” of the Red Army [on the Long March],” but apologetically continued, “Probably these attacks have been written by gentlemen in Nanking, Shanghai and other cities who have never seen a Red warrior…”21 On another day, Snow asked, “How do you explain the repeated victories of the Red Army, under the greatest odds? What is the secret of its invincibility?” And Mao’s canned response: “First, the Red Army is the people’s army, and they support it in every way… Secondly, our survival is due to the correct strategic and tactical leadership of the Communist Party. Thirdly, the commander of the Red Army is capable, correct, intelligent, loyal and sincere.”22 Snow’s questions had no connection from one to the next, having probed or challenged few, if any, of Mao’s responses.

Mao had credited the Long March with a significant role in both his political ascent and personal development, yet Snow devoted a relatively small part of Red Star Over China to the military expedition—altogether less than fifty pages out of five hundred. In its limited length, the Long March section of the book contains deliberate information, and discounts other facts that may detract from the CCP narrative Mao intended to share. Additionally, Snow does not refer to any documented cases of Red Army violence against civilians or foreigners. The New York Times carried a story on December 14th, 1934, regarding two American missionaries, Reverend John C. Stam and his wife Betty, kidnapped and then killed by Red Guards in Wuhu (芜湖), Anhui province. Mr. and Mrs. S.C. Frenchan, British missionaries kidnapped, reported as dead, then found alive after escaping, described the Reds as taking “a ghastly toll” on the civilians of Ningqian, where they had been captured.23

Snow generally avoided tough initial and follow-up questions in his interviews. His approach raises red flags about the Long March itself and Snow’s entire enterprise in writing about it.

Gaps in the Narrative

In revisiting Long March historiography, most accounts available today cite Edgar Snow’s seminal memoir Red Star Over China as a main source for dates, places, and names. In reading his contemporaries’ works on the March, one can see the extent to which Snow’s memoir influenced what would become the widely accepted storyline of the Long March and how China, America, England and other countries first perceived the Communists’ survival. Nevertheless, new accounts have raised further questions over the validity of Snow’s narrative outline and the portrayal—or lack thereof—of specific events.

The length of the March has been a topic of debate, and its vagueness has only contributed to the Long March legend. Snow cites “an accurate stage-by-stage itinerary prepared by the First Army Corps” in reaching his calculation of 18,088 li (approximately 6,000 miles).24 Snow alternatively refers to the Long March as a “5,000-mile retreat” in Journey to the Beginning.25 Among his papers in fact, Snow had a log of the daily distance covered on the Long March, likely the itinerary he cites in Red Star Over China as having obtained from the First Army Corps. Written entirely in English, the chart is neatly organized by date, and includes nights marched, days of rest, and descriptions of landmarks the Red Army passed. It adds up to 18,000 li and may be the basis for his calculation of 6,000 miles.26
It is not surprising that there is no consensus on the total distance. Pinpointing each Red Army Front’s path has proved difficult in various attempts over the last seventy-five years for historical and political reasons alike. Statistics on the Red Army are just as varied as the length of the Long March. In general, finding reliable statistics on the Long March has been a challenge for historians, and Snow’s version of the March has not helped in the search. The Long March length and Red Army size plays only a small part in the history, but both are critical to the historiography and the Chinese Communist Party’s narrative.

It is also in the Party’s political interest not to disclose the nature of the trip, from the perspective of both the Central Committee and local governments. Publicly disclosing all of the places the Red Army passed on route might leave them responsible to rebuild, provide reparations, erect a monument or, at the minimum, apologize. Regarding the Red Army’s over-harvest and pillaging of the Manchus and Tibetans, Mao impudently told Snow, “This is our only foreign debt, and some day we must pay the Manzu and the Tibetans for the provisions we were obliged to take from them.”

Local governments would likely later conceal the Red Army’s visit—especially during the Cultural Revolution—out of fear of punishment for how they treated soldiers during the Long March. During the Long March, villagers feared pillaging, rape, kidnapping and forced enlistment, and monks abandoned their monasteries at the word of approaching Red Guards, despite Mao’s strictures.

Nevertheless, the difficulty in pinpointing such trivial though central facts regarding the Long March speaks to the nature of written history on the Long March and contributes to the legend surrounding it. One reason Snow’s account has survived and thrived is because newer accounts have yet to substantiate fundamental details of the March, even seventy-five years later.

Additionally, during the Cultural Revolution, Red Guards “struggled against” or attempted to humiliate many of the surviving veterans, denouncing them as enemies of the Revolution to which they had pledged their lives, and sentencing them to hard labor in rural areas. Senior officials of the March were not immune from the purges either. It was not until the 1980s under Deng Xiaoping’s control that the Party rehabilitated many of them. If the survivors have been subjected to such hardships beyond the March itself, then one must ask what the Party has tried to conceal.

Even without validated statistics and suppressed witness accounts, in the last ten years historians have exposed new chapters of the Long March’s story, absent from Red Star Over China.

In her retracing of the Long March, researcher Sun Shuyun discovered a number of survivors who also bring many parts of Snow’s account into question. Wang Quanxuan, one of the few women to take part in the Long March, provided the often-overlooked though critical female perspective, largely unrecorded in the official line, despite Mao’s reference to women as “the true heroes of the Long March.” (Snow makes no mention of women on the Long March in Red Star Over China.) It is estimated that of the 60,000-100,000 soldiers and 15,000 officers, no more than 30 were women. While parts of Wang’s story were “most certainly at odds” with the Party line, according to Sun, Wang still presented the idealism, allegiance and trust of a Red Army guard of the Long March period.

Through her interviews with survivors, Sun Shuyun also posits that soldiers
received inadequate training prior to and along the Long March, accounting for up to fifty percent of casualties. Furthermore, these recruits received faulty weaponry including defective bullets, if they received a rifle at all.

Landmark events of the Long March in the Snow narrative also do not align with survivor testimonies provided by Sun and other recent historians. One such event, a Mao led “purge”—a Communist euphemism for execution of one’s opponents—of supposed anti-Bolshevik party members before the CCP abandoned the Jiangxi Soviet, has only more recently received attention. Red Star Over China contains a brief mention of the event—in Mao’s own words (with emphasis added)—that suggests the necessity of the “purge” outweighs any claims of excessive brutality as it allowed the CCP to survive:

The 20th Army…rose in open revolt, arrested the chairman of the Jiangxi Soviet,…and attacked us politically…to many it must have seemed that the fate of the [Communist] revolution depended on the outcome of this struggle. However, the revolt was quickly suppressed…Our line was re-affirmed, other rebels disarmed and liquidated…and as a result the Soviet movement subsequently scored great gains.33

The Fujian Incident, as it later became known, cemented Mao’s reputation within the CCP as a firm and ruthless leader, yet to this day remains an under-reported and under-analyzed event in Long March histories as well as Mao’s personal biography. Rather, the incident has been historicized as a purge critical to the Communists’ survival. Snow said of Mao, “It seemed to me that he tried to make his philosophy, the dialectics of ‘the long view,’ his criterion in any large course of action, and in that range of thought the preciousness of human life is only relative. This is distinctly unusual among Chinese leaders, who historically have always placed expediency above ethics.” Snow’s rationalization of Mao’s actions recalls G.W.F. Hegel’s description of mass murder as a necessity to human progress—“the slaughter bench of history”—although it is almost certain that Snow was not trying to propound a world historical view. But Hegel’s conceptualization is evidence of the influence Mao had on Snow during and after their time together.

While the Fujian Incident marked a low point for the CCP in the Long March (and Party’s) narrative and thus remains underreported, the Dadu River crossing at Luding bridge instead was written as a great victory for the Party and Red soldiers. “The crossing of the Dadu River was the most critical single incident of the Long March,” Snow wrote in Red Star Over China. According to Snow, the Red Army arrived at the Dadu River in western Sichuan Province in May 1935 only to discover a shortage of boats, forcing them to cross the bridge to escape the Nationalists, close behind. The bridge, which dated back to the eighteenth century, had fallen into disrepair, and when Lin Biao arrived at the bridge with his troops, the Nationalists had removed additional planks, further hindering their crossing. A battle between the armies ensued, and the Red Army victoriously crossed the river. Popular media after the Cultural Revolution further wove this version into the national Long March narrative.

Several works, however, now claim the Dadu episode was not a battle but rather a peaceful crossing in which the Nationalists agreed to let the Red Army pass: “Only a
squadron was at the other end. It was a rainy day...when the [Nationalists] saw the soldiers coming, they panicked and fled—their officers had long abandoned them. There wasn’t really much of a battle.” Furthermore, the family responsible for the bridge’s upkeep (who challenged claims of the bridge’s disrepair and missing chains and wooden planks) asserted in interviews that they heard no gunfire.39, 40

Specific details of such trying events as the Fujian Incident and the Dadu River crossing before and during the year-long March could easily have been forgotten by the soldiers and Mao himself, but if researchers have uncovered relevant facts seventy years later through witness interviews, then Snow’s fact checking—with limitless access to the main players,—arguably could have been more thorough. The influence of politicking that occurred on the March as well as the politics that drove Snow’s invitation to interview Mao indirectly shaped how these pinnacle events have been portrayed ever since, reaffirming the influence of historiography on history.

Lessons of Snow’s Writing of History
Snow returned to the United States in 1941 to great acclaim for his coverage of Red China and general reporting throughout Asia. He met with President Franklin Roosevelt to discuss what he had seen firsthand and to advise him on U.S. foreign policy toward Chiang and the Nationalists. During the domestic Red Scare of the late 1940s and early 1950s, however, Snow became a name of interest to the Federal Bureau of Investigation. The FBI tracked his correspondence and questioned his contacts.41 Some members of Congress accused Snow of supporting Communist China and being a communist himself, leaving his past writings all but discredited and essentially ruining his name and reputation as a journalist.42 While the claims of his political leanings were exaggerated and, to an extent, based on minimal information (such as Snow’s name appearing in the contact books of other accused American communists,43) there are a number of lessons to be learned from his tale.

The recording of history is never immune from politics. There are reasons the party has not revealed more. Chinese politics, that is the interests of the CCP party and Mao’s personal interests, fueled the legend of the Long March. Snow’s reporting contributed to the creation of the Communists and Mao as modern heroes. While indeed a tremendous feat by the Chinese Communist Party, the Long March became as legendary as it has because it served Mao and the Party. One must remember the influence Mao held over all of China in the years to come, as well as over his own biographer Edgar Snow.

It is difficult to change collective memory once it becomes ingrained in a culture as legend. Despite the influx of new writing on the Long March (though it might be argued that some of what comprises this influx is no more than sensational and biased reporting), revising the national and international understanding of the Long March is a challenge in its own right. With the CCP’s insistence on maintaining the Party’s long-standing Long March image of courage and survival, it is not in its interest to allow further research or more critical accounts to modify the current narrative.

The Long March must serve as a cautionary tale of how political legends are made. While it is plausible that Mao manipulated Snow, Snow cannot be absolved from helping create the legend. He was not responsible for helping the CCP come to power but his critical contribution to the Long March legend helped create the cult of Mao.
History itself is nothing without interpretation, analysis, and reflection—and sometimes manipulation—and those who write history determine history. What the authors as filters provide is what often stays on record for the future. As Snow once said, “Each of us is a piece of any history that affects our lives.” In the economically burgeoning and increasingly globalized China of today, the legend of the Long March holds importance for the CCP as both a part of its historical foundation and the call for support of China’s one-party system. Edgar Snow’s historiography affected not only his personal history but also the subsequent development of the image of the CCP, Mao, and modern China.

Notes

3 Ibid.
4 In Edgar Snow’s words, “A Soviet is a class organ of struggle for the seizure of power…” (Handwritten note found in Edgar Snow Collection, courtesy of the University of Missouri, Kansas City Library Special Archives and the University of Missouri, Saint Louis Library Western Historical Manuscript Collection.) Upon arriving in Shaanxi Province, Mao and the CCP established the Shaanxi Soviet, which served as a Party base through the Sino-Japanese War. Edgar Snow would later interview Mao there.
6 Hamilton 23
7 Ibid. 27
8 Edgar Snow Collection, Folder 10
9 Snow, Edgar. “Weak China’s Strongman.” *Current History*, January 1934. 402-8
10 Hamilton 41
11 Draft of Snow’s letter to MacBride. June 1, 1936. Edgar Snow Collection, Folder 10
12 Although Agnes Smedley would likely have jumped at the opportunity to enter the Shaanxi Soviet, the Communists supposedly thought she was “too well connected” and opinionated (Hamilton 67)
14 Sun 199
15 Hamilton 71
17 *Journey to the Beginning* 157
18 *Journey to the Beginning* 161
19 Edgar Snow Collection, Folder 178
20 *Journey to the Beginning* 161. Snow had previously denied Mao’s influence, stating, “[Mao] never imposed any censorship on me,” and in the Chinese edition of *Red Star Over China*, volunteering that what Mao had said was “honest and true.” (Chang 192)
The chart also included the number of districts passed categorized by race, and blunt, uncensored descriptions of each: 246 Han, 92 Yan, 21 Miao, 5 Yi, 4 Mohammad [presumably Muslim], 2 Yao, and 1 Tung. It appeared that no one had looked at the log for quite some time as it still had original fold creases and scotch tape that created one long chart. Chart is in Edgar Snow Collection, Folder 146

Red Star Over China 214


Wilson 69

Sun 122

Sun 9

Sun 30

Red Star Over China 182


Red Star Over China 78

Mao impressed Snow with his knowledge of current world affairs and his beyond-Marx reading list that included “the ancient Greeks, Spinoza, Kant, Goethe, Hegel, and Rousseau” (77). By the same token, Snow also thought Mao was “quite free from symptoms of megalomania”...

Red Star Over China 201

Chang and Halliday 153


Hamilton 196

Snow was not singled out—U.S. General Douglas MacArthur accused Snow’s colleague Agnes Smedley of spying for the Soviet Union in a fifty-four-page report released (Hamilton 198)

Hamilton 207

Journey to the Beginning 18
The reemergence of the dengue virus, an arbovirus transmitted by mosquitoes, poses a serious public health threat to many tropical and subtropical regions. The World Health Organization's International Health Regulations added the dengue virus to its list of potential epidemics in 2005. Due to environmental conditions, the dengue virus is constrained to tropical areas, which typically excludes the United States. However, in recent years, it has begun to transcend the U.S.-Mexico border and infect U.S. citizens and residents. This thesis examines the relationship between the resurgence of the dengue virus in Mexico and implications for the United States given societal and market integration. By investigating the distribution of this virus along the Texas-Mexico border, in contrast with localizations of communicable versus noncommunicable diseases in Mexico, this thesis elucidates the factors that have affected the spread of dengue fever northward in Mexico and into the southern United States.

Professor Benson’s research bridges the fields of medical anthropology, political economy, and phenomenology and is mainly concerned with ethnographic and public health dimensions of international agricultural restructuring. He has most recently co-authored the book Broccoli and Desire: Global Connections and Maya Struggles in Postwar Guatemala.

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INTRODUCTION

The medical anthropologist Paul Farmer illuminates connections between infectious disease and socio-economic inequality via an investigation of both historical and institutional factors. Central to his argument is the idea of “structural violence,” which is defined as a systematic reproduction of harm in a certain social order. This concept underlines the importance of examining an infectious disease in the context of both a country’s and a region’s history and the current political and economic situation. Interweaving multiple levels of the history of political and economic structures is an effective strategy because “those who look only to the past to explain the ethnographically visible will miss the webs of living power that enmesh witnessed misery”1 and “those who look only to powerful present-day actors to explain misery will fail to see how inequality is structured and legitimized over time.”2

Farmer’s approach is useful in studying the dengue virus. It provides a method for looking beyond the science of the disease or the culture of a certain people to provide a broader and more historically informed framework for understanding dengue fever along the U.S.-Mexico border. While Farmer focuses on historical and institutional factors, one can imagine a holistic approach including even more areas of interest. In the case of dengue, the most effective way to investigate this virus is by going beyond ethnography alone into this realm of a multidisciplinary research that emphasizes an approach that complements ethnography with structural features.

DISCUSSION

The reemergence of the dengue virus, an arbovirus transmitted by mosquitoes, poses a serious public health threat to many tropical and subtropical regions. Through its International Health Regulations, the World Health Organization (WHO) added the dengue virus to its list of potential epidemics in 2005.3 Furthermore, the WHO’s Scientific Working Group (SWG) estimates that there are currently 50 million dengue infections annually and that 2.5 million people live in dengue endemic countries, particularly in South-East Asia, the Americas, and the Western Pacific Islands.4

Although dengue is typically a disease localized in certain tropical and subtropical regions, from 2001-2004 the range of the virus has increased to include such places as Hawaii, the Galapagos Islands, and Easter Island.5 In the United States, dengue cases are seen around the U.S.-Mexico border, with the first confirmed case of a U.S. resident contracting dengue within the United States reported in 2005. All other cases of dengue reported outside of this border region are imported cases.6

Dengue is a single stranded RNA virus that is transmitted by Aedes mosquitoes,7 where A. aegypti is the principal vector and A. albopictus represents a secondary vector. Both vectors are present in the United States. A. aegypti is found from the midline of Texas to Florida,8 while A. albopictus has spread to thirty-six of the forty-eight contiguous states. The dengue virus itself is a member of the Flaviviridae family, which includes such viruses as the yellow fever virus, the West Nile virus, and the Japanese encephalitis virus.9 There are four different serotypes of the virus (DEN1, DEN2, DEN3, and DEN4), and DEN2 is considered to be the most severe strain.
The first time that a human becomes infected with any four of the dengue viral serotypes, symptoms remain mostly mild and flu-like. Symptoms can vary greatly from person to person, making the disease difficult to diagnose, particularly in areas where it is rarely seen. Because these primary infections remain mostly mild, they can typically be treated at home with fluid intake, analgesics, and rest.10

Problems in treatment usually arise during a second, and often more serious, infection. When a person is infected with a second serotype, symptoms tend to become more extreme, and include dangerously high fevers and vascular leakage, including bleeding. This scenario of a second strain of the virus creating a more severe bodily reaction is known as the “secondary infection hypothesis.”11 Due to the severity of complications from a secondary infection with the dengue virus, infected persons need clinical management by a medical team capable of monitoring the patient’s status in an effort to avoid a state of decreased blood volume. When a case of severe dengue is managed properly, the case-fatality rate (CFR) drops to below one percent. However, without appropriate medical treatment the CFR can be as high as twenty percent. In many areas of the world that are critically affected by this virus, populations are unable to receive proper medical treatment, which can greatly increase the CFR.12

Dengue in Mexico

To understand the spread of dengue in the U.S. and Mexico, one must first examine its origin in the epidemiological terrain of a modernizing Mexican state. Mexico contains a number of paradoxes that govern daily life. Since the 1970s, Mexico has been increasingly integrated in the global economy, while Mexicans are affected by uneven outcomes of this integration, which is highlighted by the fact that many citizens in Mexico live in low-income conditions.13 In 1995, it was estimated that 60.4% of the population was living in poverty.14 Additionally, there is a contrasting relationship between rural and urban populations that is closely associated with modernization. During the 1990s, Mexican citizens began moving from rural locations in southern Mexico into urbanized areas in the north. Between 1990 and 1995, the percentage of people living in rural areas decreased from 28.7% to 26.5%, while the percentage of people living in urban areas increased from 22.0% to 25.0%.15 Mexico is caught in the middle of an epidemiological transition, which is affecting these paradoxes and in some cases perpetuating them.

Due to ongoing economic growth and development in Mexico, this country is undergoing an epidemiological transition whereby infectious diseases are beginning to be outnumbered by more chronic diseases – a typical pattern for developing nations.16 According to Stevens, “in the epidemiological transition, the profile of population health evolves from one characterized by high mortality and infectious disease (typical of poor countries) to one in which mortality rates are low and noncommunicable diseases cause the majority of deaths (typical of wealthy countries).”17 Diseases tend to switch from infectious disease (e.g. tuberculosis) to chronic disease (e.g. heart disease). Mexico is no exception. This third epidemiological transition is not uniform but has a specific North/South geography; thus, in Mexico, this is not a third epidemiological transition but rather an example of diverging epidemiological paths based on geography and class.

In northern regions in Mexico where modernization is occurring the most rapidly,
noncommunicable diseases cause the majority of the deaths, which follows the pattern of an epidemiological transition for a developed nation. However, in the southern parts of Mexico, communicable diseases are still greatly affecting citizens' health statuses.18

Communicable disease disproportionately affects southern Mexican states mainly due to three factors. First, the oppression of indigenous groups since the colonization of Mexico has led to the marginalization of this group and this institution of structural violence has remained in place throughout history. This form of structural violence has affected the exposure to and burden of disease for different indigenous groups. Secondly, recent structural adjustment programs like the North American Free Trade Agreement (NAFTA) have contributed to rural poverty in Mexico. Mexican farmers have become unable to compete with large-scale U.S. grain operations. Rural Mexicans face economic insecurity and this is a main reason behind labor migration patterns to northern Mexico where factory jobs are present and to the United States for manual labor jobs.19 Finally, uneven spheres of government with respect to public health infrastructures – both within Mexico and in its relationship to the United States – appear to affect rural development and thus the burden of disease in these areas. All three of these factors combine to make socioeconomic status and geographical location important predictors of predominantly communicable versus noncommunicable disease in Mexico.

Dengue fever, however, is an anomaly to this epidemiological transition that defines health of the North as "chronic conditions" and that of the South as "infectious disease" because a significant proportion of dengue cases are found in the northern border region. Because of its atypical geography, the vectors that lead to disease transmission are different for dengue. Examining dengue in the context of an inconsistency within this model requires understanding the disease from both biological and social standpoints. Therefore, one must examine the factors that affect the spread and distribution of the disease itself, such as mosquito vector locations and proximity to human hosts as well as the social determinants that affect disease spread and transmission, such as NAFTA and illegal immigration.

In addition to issues of internal migration patterns, one must consider the distribution of the virus and the vectors within Mexico. It has been hypothesized that in recent years, *A. aegypti* has begun to repopulate deserts in the southwestern part of the United States as well as northwestern Mexico.20 Dengue transmission requires optimal conditions for mosquito breeding, such as locations of stagnant water (typically in rubbish such as tires), which tends to correlate with poorer regions. "Lack of street drainage appears to limit the ability of mosquito abatement and garbage collection trucks to enter these neighborhoods after a heavy rain. Also, the presence of water-holding containers facilitates vector proliferation in close contact to human hosts."21 Thus, it is the expectation that poorer regions, where proper waste removal as well as drinking water coverage is lacking, would have higher rates of dengue. Yet one of the key aspects missing in more southern rural regions is high population densities whereby mosquitoes can easily bite human hosts while the mosquito is still infected with the virus. Further north, shanty towns provide the most ideal environments for mosquitoes since they typically have excess rubbish and water collection containers for mosquito breeding sites, as well as increased population density for the mosquito feeding pool.
Dengue in the U.S.

Within a context of ongoing labor migration from Mexico to the United States, there are three scenarios to consider in terms of possible outbreaks in the United States: (1) spread via formal “guest worker” labor recruitment programs\(^{22}\) that relocate Mexicans into the United States; (2) spread via undocumented labor migration from Mexico into the United States; and, (3) an outbreak in a border town. Due to conditions of structural violence present in Mexico, many Mexican citizens are faced with few choices with regards to supporting their families. As migrant workers in the United States, Mexicans “typically earn ten to fifteen times what they could earn in Mexico.”\(^{23}\)

As far back as the early 20th century, Mexicans have been formally or informally recruited as workers in the U.S., usually as farmers and miners.\(^{24}\) Many Mexican migrants come from rural areas and have large families that are difficult to support otherwise. Due to these differences between conditions in the United States and Mexico, Mexican immigrants tend to migrate for economic reasons.\(^{25}\) This reflects Farmer’s idea of structural violence by implying that societal factors are forcing Mexicans from rural areas who can no longer compete with American industrialized farming to immigrate to the United States to support their families.

The first two scenarios involve a discussion regarding the localization of the virus (i.e. the location within the United States of the potentially dengue-infected Mexican immigrants) as well as the geographic range of the mosquito population within the United States. Although the majority of Mexican immigrants (72.7%) settle in the border states of California, Arizona, Mexico, and Texas, there is still a large population that settles outside the border region.\(^{26}\) These Mexican immigrants settle primarily in six other states: Illinois, Florida, Georgia, Colorado, North Carolina, Nevada, and New York.\(^{27}\) Additionally, migrants from Mexico tend to come from more rural locations\(^{28}\) such as Veracruz – a dengue endemic state.\(^{29}\) Over the last two decades, the origins of migrant populations have shifted southward within Mexico,\(^{30}\) which suggests that Veracruz could be a potential source of infected migrants. Because possibly infected migrants are relocating to the United States, it is important to examine the distribution of the dengue vectors (i.e. the mosquitoes) within the U.S.

The principal dengue vector, *Aedes aegypti*, is only located in several relatively small and confined southern areas of the United States such as parts of Florida, Louisiana, Arkansas, Texas, and Arizona. *Aedes albopictus*, on the other hand, has a much greater geographic range in the United States; however, it is not an effective vector and as of yet has not been shown to successfully transmit the dengue virus. Thus, examining the distribution of this secondary vector could indicate a potential risk at some future date but it does not indicate potential risk areas at this point in time. Apart from border states, Florida appears to be the only state that has both a documented Mexican migrant population and the primary vector co-localized. According to the Florida Department of Health, there were an average of 1.3 cases per year in Florida from 1987-1996 and a jump to 18 cases identified in the laboratory in 1997 and 1998,\(^{31}\) which suggests that this risk might be real for Florida. Furthermore, it is important to remember that these migrants from Veracruz migrate to multiple areas in the United States, which limits the population of infected individuals establishing themselves in Florida. In sum, it appears that Mexican labor migration to the United States via any formal recruitment program does not pose a significant risk for causing an outbreak of dengue in the U.S.
The second scenario outlined involves examining the case of undocumented Mexican immigrants. This situation, on the other hand, represents a more complicated issue due to the lack of knowledge about their origins, their settlement patterns, and a lack of surveillance of disease patterns as well as obstacles to preventative healthcare. A study performed by Fosados et al., documents the movement of immigrants from Colima (a dengue endemic state) as well as from Jalisco (the state directly north of Colima). Colima has a higher percentage of citizens that speak an indigenous language (12.2% in Colima versus 2.0% in Jalisco) and is more rural. Furthermore, migrants from Colima tend to stay in the United States longer than those migrants from Jalisco. For the immigrants that are legal, one would be able to screen or control their location within the U.S. to prevent settlement in areas with large population of the mosquito vectors. The problem is that more than 40% of migrants from Colima are undocumented and thus escape any public health or surveillance infrastructures. A lack of public health surveillance poses a notable risk for potential outbreak in the United States because of the lack of knowledge on origins and settlement patterns. Without basic surveillance data (such as where these Mexicans from Colima are going within the United States), one is unable to discern whether or not there is a potential risk for the United States from undocumented migrant workers. Current talks regarding immigration reform should discuss these ideas regarding public health and surveillance infrastructures as part of new policies in order to account for this potential public health risk.

The final scenario to consider involves an outbreak in a border town. The potentially infected Mexican worker that commutes across the border daily for work creates the possibility that a mosquito could pick up the virus from within the United States. With a population of predominately uninfected people, the newly infected mosquito has the potential to transmit the virus to a vulnerable population. Historically, cases of dengue occurring in the south of Texas were rare, with only 64 cases reported over the period from 1980-1999 while there were 62,514 cases reported just across the border in Mexico. In August of 2005, there was an outbreak of dengue in Tamaulipas, Mexico that reported 1,251 cases of dengue fever including 223 cases of severe dengue, which accounted for 17.8% of cases. During this outbreak, there was a case of dengue reported in a resident of Brownsville, Texas, which sparked the fear of dengue potentially beginning to cross the border. Due to the spread of dengue into the United States, at this time the Mexican health authorities, the Texas Department of State Health Services, and the CDC conducted studies to analyze the situation. They found that the percentage of severe dengue cases associated with outbreaks of dengue fever along the Texas-Tamaulipas border has increased. This increase suggests a real possibility of dengue spreading into the United States.

As stated previously, in order for dengue infection to occur, the virus and the mosquito vectors must be co-localized. In order for severe dengue to occur, one must add the additional factor of at least two different circulating dengue serotypes. As measured in 2005, 38% of residents surveyed in Brownsville, Texas had evidence of IgG antibodies to dengue, indicating that they had been previously infected but were not currently acutely infected. This data suggests that it is possible for a larger number of people residing in southern Texas to become infected with severe dengue upon infection with a second dengue serotype. And, since the 1980s, there have been multiple dengue serotypes circulating around the southern Texas region including Brownsville.
It has already been illustrated that both *A. aegypti* and *A. albopictus* are well established in this region. Thus, it is clear that “entomologic, serologic, and virologic conditions are now such that locally acquired severe dengue can occur in south Texas.” With this in mind, the United States needs to take steps towards proper medical preparedness in hospitals as well as good methods of reporting for dengue surveillance.

**CONCLUSION**

The practical conclusions regarding this study of dengue fever leads to a set of policy recommendations that could be put into place to help control the spread of dengue fever along the U.S.-Mexico border.

- Educate the public on both sides of the border about dengue fever and the risks associated with that geographical area. This should include programs on how to eliminate stagnant water, keeping windows and doors closed as much as possible, and wearing bug spray when outdoors during prime biting hours.

- Physician education both in Mexico and in the United States is critical to preventing and controlling dengue outbreaks. In Mexico, physicians must be educated with respect to treating cases of dengue. These same physicians should have better access to treatments and supplies in an effort to decrease morbidity and mortality associated with dengue. Particularly in the United States but also in Mexico, physicians should be aware of dengue symptomology to allow for appropriate treatment as well as better case reporting. Additionally, dengue surveillance programs must be improved in order to provide better access to serological testing to confirm suspected cases of dengue fever in the laboratory.

- Create a broader community-based approach to dengue surveillance that would provide access to laboratory testing in the border region and encourage case reporting by family members. Such an approach should target prevention initiatives in communities in addition to their focus on the clinical setting.

- Encourage public health and anthropological research on mosquito and human ranges and interactions. Similarly, continue to monitor the capacity of the *Aedes albopictus* mosquito to carry and transmit viral diseases like dengue to prepare for a potential increased risk of dengue in the United States.

- Human immigration is partly a vector of dengue transmission, so public health measures need to be included in debates on immigration policy in and across bordering countries.
Immigration reforms must be developed to include not only official immigration policy restructuring, but also public health measures, especially surveillance, primary healthcare, and other healthcare services for immigrants and in sending and receiving communities. Furthermore, it is important to consider that free trade and lax government enforcement of existing labor laws may have a negative impact on public health by promoting the employment of undocumented workers, a population that is itself vulnerable and usually lacks health services and escapes public health infrastructures and surveillance.

With an international border comes a division between the healthcare and public health jurisdiction of one country and that of the neighboring country. The most appropriate method for approaching this delicate issue of increasing surveillance without marginalizing populations would be a balance between a public health and an anthropological approach to problem-solving strategies. Anthropology helps us to understand these two vectors of disease as contingent historical outcomes as well as from the perspective of socio-cultural factors. Approaching the study of infectious disease from a structural violence point of view clarifies the other factors that could be involved in the epidemiology and the spread of a given disease. For instance, the economic and political policies regarding immigration and trade become important parts of studying dengue fever. Socio-cultural factors, on the other hand, remain equally important in understanding the epidemiology and the spread of dengue fever. Using anthropology as a tool to contextualize an infectious disease permits a fuller understanding of the disease and can thus lead to more appropriate practical conclusions and policy recommendations.

Notes

2 Ibid.
5 Ibid.


Formal recruitment programs refers specifically to the H-2A temporary agricultural program that recruits foreign workers to the United States to perform agricultural work for a set period of time (i.e. seasonally or temporarily).


Ibid.


35 Ibid.

36 Ibid.


The Moderating Role of Exercise in Stress-related Effects on the Aging Brain

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Tara Singh graduated in 2009 as a Psychology and Environmental Studies major, and is deeply interested in understanding how an individual’s lifestyle and environment impacts his or her health. Witnessing the lifestyles of aging individuals in Dharavi, one of Asia’s largest slums, has exposed her to a spectrum of stressful conditions that people throughout the world face. She is particularly interested in the process of aging, and the role of one’s environment on health-related choices. Currently, Tara is helping to conduct a variety of research and hopes to continue her education in the field of Public Health, ultimately applying what she learns on an international scale.

Abstract

Stress over the lifetime has been shown to negatively impact brain structure and cognition in animal models. In addition, advancing age has been observed to have negative effects on brain structure and function. Lifetime stress may contribute to the observed detrimental effects of aging. Aerobic exercise has been shown to be beneficial for brain structure and cognition. Thus, the primary goals of the current study were to assess the effects of lifetime stress in older adult humans and to examine possible moderation of these effects on brain structure and function in older adults through exercise engagement. MRI-based volumes of the prefrontal cortex, orbitofrontal cortex, hippocampus, and amygdala were obtained for 60 healthy adults aged 55 to 87. Cognitive function was measured through a battery of cognitive tasks measuring immediate memory, working memory, executive functions, and processing speed. Data were also obtained through retrospective questionnaires on lifetime stress and exercise engagement. Smaller brain volumes associated with stress were demonstrated for the orbitofrontal cortex and amygdala. Lower capacity for cognitive functions of executive functions and processing speed with a non-significant trend for the hippocampus were also demonstrated. In addition, there was a non-significant trend for participants with higher levels of lifetime stress to demonstrate steeper age-related decline in immediate memory. There were non-significant trends for exercise engagement to moderate the effects of stress on orbitofrontal cortex and immediate memory: for individuals with lower amounts of stress those who exercised more evidenced less age effects. The potential impact of exercise in moderating the impacts of stress on brain structure and function clearly warrant further research as well as exploration of such factors as amount of exercise, a threshold for beneficial exercise effects and personality factors.

Faculty Mentor: Denise Head, Ph.D., Assistant Professor of Psychology and African and African-American Studies

Professor Head conducts research on the neural basis of cognitive aging using behavioral testing and both structural and functional neuroimaging in healthy and pathological aging (e.g. dementia of the Alzheimer type) populations. A particular focus is on executive control processes including working memory, inhibition, temporal processing and task switching.

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Key Terms

- Brain Aging
- Brain Structure
- Cognition
- Executive Function
- Processing Speed
- Immediate Memory
- Working Memory

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INTRODUCTION AND BACKGROUND

Accumulated effects of lifetime stress can have a deleterious impact and may be particularly evident for the aging brain structure and cognition. Through the normal process of aging, and its expected effects on brain structure and cognition, older individuals tend to exhibit heightened vulnerability to the effects of lifetime stress on the brain’s structure and function. The positive impact of exercise on general health, as well as on brain structure and cognition has become a popular subject of research. The current study attempts to combine these factors and explore relationships between them. This paper begins with presentation of the concept of brain aging in terms of structure and function, followed by the additional influence of stress, and that of exercise.

Brain aging, defined as the cumulative effects of age on the brain’s structure and function, is marked by great individual variability. The structure of the hippocampus plays an important role in spatial, episodic, and contextual memory, while the prefrontal cortex is responsible for executive function and integration of cognition and emotion through neurotransmitters. Aging has broadly been associated with decline in brain size, loss of myelin (the protective sheath covering axons of neurons), region-specific loss of neuronal bodies, and reduced synaptic density. It is important to note that in terms of cognitive function, executive functions, such as planning, scheduling, and working memory may be particularly affected by age. In addition, while fluid intelligence and processing speed are targets of age, crystallized intelligence is intact, and in some cases, improves.

According to Radley and Morrison, “Stress may be defined as any type of threat, either real or perceived, that requires compensatory responses for maintenance of homeostasis” (p. 271). Normally, a stressful event activates the amygdala, the emotion-processing structure, which in turn activates the HPA system or axis which releases glucocorticoids to activate the hippocampus, and terminates the stress response. When this system is deregulated by too much glucocorticoid release, neuronal communication is damaged by reduced neurogenesis in the dentate gyrus, dendrite growth in the amygdala, and dendrite and synapse loss in the hippocampus and prefrontal cortex. Subsequent effects of such deregulation result in increased likelihood of depression associated with hippocampus-atrophy, increased sense of fear due to higher density of dendrites in the amygdala, and a disrupted ability to integrate cognition and emotional stress due to damage of the prefrontal cortex.

As noted by Radley and Morrison, exercise may present a potential method for reversing or preventing the detrimental impacts of stress on brain structure and function, particularly important for older individuals who are more vulnerable to the effects because of the “the interactive effects of stress and aging” (p.281) One study conducted by Larson et al., assessed adults above the age of 65 in terms of their self-reported performance of physical activity per week, and found a significantly higher rate of Alzheimer’s disease development in those individuals who exercised less than three times per week after 6.2 years. Similar effects have been seen in randomized clinical trials like that of Colcombe et al., which demonstrate better attention and focus for people who were aerobically trained compared to those who were trained in stretching and toning.
The current correlational study aimed to examine the negative effects of aging and stress on brain structure and function, and the moderating role of exercise. Originally, the study sought to examine a potential moderating role of internal locus of control and high self efficacy on the relationship between exercise, stress, aging, and brain structure and function; however, though data was collected for these variables, they were not included in final analyses. Hypotheses for the study include that higher levels of stress would be associated with smaller regional brain volumes (particularly in the hippocampus) and lower cognitive performance (particularly in memory) in older adults. Additionally, based on prior research, it was predicted that aerobic exercise would moderate the effects of stress on regional brain volumes and cognition. Specifically, older individuals who had dealt with comparable levels of stress, but who exercised, would demonstrate larger brain volumes and higher cognitive performance than those who did not exercise.

METHOD

Participants
Participants include 60 healthy adults aged 55 to 87 (mean age = 74; SD = 8) all of whom have participated in a previous study conducted by Dr. Denise Head, Department of Psychology, Washington University in St. Louis. Participants were screened for any gross signs of cognitive dysfunction with the Mini-Mental State Exam. Participants were also screened for neurological (e.g., Parkinson’s disease, head injury, stroke) and psychiatric illnesses (e.g., major depression). All participants were right-handed, native English speakers. The current sample consists of 47 females and 13 males, and there are 37 Caucasian-Americans and 23 African-Americans of varying socio-economic status. The mean education level was 15.1 years (SD = 2.9). Participation in the past study by Dr. Head is critical because relevant data concerning brain structure, cognition, and lifetime involvement in exercise were already obtained on the current participant pool.

Measures
Lifetime Stress. The Cumulative Trauma Scale is a recently developed measure of lifetime stress proposed and validated by Kira which utilizes the definition employed by the APA (American Psychological Association) Trauma Group, “A process that leads to the disorganization of a core sense of self and world and leaves an indelible mark on one’s world views…” (p.63). The CTS lists a series of chronic stressors throughout one’s life and measures the stress based on an objective and a subjective scale. Participants first respond by stating the number of times a particular stressor was experienced, responding with once, twice, three times, or many times. The participant then ranks the stressor’s affects in terms of how positively or negatively the event has impacted their life. Frequency and intensity of stressful events combine to measure a cumulative load of stress across life span. The scale was found to have adequate internal consistency for the whole sample, as well as for the specific gender and age groups, convergent validity, divergent validity, and predictive validity.
MRI Acquisition and Processing. Up to four repetitions of a high resolution 3D-MPRAGE sequences were acquired. The study specifically investigates structural changes in the amygdala, hippocampus, prefrontal cortex and orbitofrontal cortex. Images were analyzed using the Freesurfer software suite, determined to be a valid and reliable automated labeling system for dividing human cerebral cortex on MRI scans. By assessing the degree of mismatch between manual (the gold standard) and automated labeling, the automated labeling system was found to be highly accurate, valid and reliable.9

Cognitive Performance. Cognition was measured through a battery of tasks, focusing on multiple domains of cognition to account for a number of different changes that might occur. The study aimed to account for changes in memory, processing speed, executive function, working memory, fluid intelligence, and crystallized intelligence. The ultimate aim is to see if people with comparable levels of stress show differences in cognitive ability and in what areas these deficiencies emerge. Composites estimates for each domain were created by standardizing and summing the scores for tasks within a domain.

Memory. The Wechsler Memory Scale-III (WMS-III) (Logical Memory Subtest)10 Participants must recall two paragraphs immediately after presentation and again after a 30-40 minute delay. The California Verbal Learning Test-III is a measure of list learning. Participants must learn a list of 16 categorizable words and recall the list after a 30-minute delay. For the Building Memory task, participants are asked to study a map for four minutes and are then given a new map, on which they must recall the locations of the buildings.

Processing Speed. For the Wechsler Adult Intelligence Scale-III (WAIS-III) (Symbol Search Subtest)11, participants must search a set of symbols and indicate which symbols match up as quickly as possible. For the Letter Comparison and Pattern Comparison tasks participants are given two series of letters and patterns (respectively) side by side and must indicate whether these sequences are the same or different as quickly as possible.

Executive Functions. For the Trail Making Test, Part A, participants must draw a line from point 1 to 25 as quickly as possible. A second level, Part B, requires participants to incorporate ordering based on letters as well. The Wisconsin Card Sorting Test (WCST) requires the participant to sort cards that display geometric designs into categories by the shape, color, or number of the designs that appear on the cards. The WCST provides an estimate of perseveration (i.e., continuing to respond based on an incorrect, previous sorting rule) (Neuroscan Corp., Herndon, VA). For the Stroop Color-Word test, participants must read the word, the color of the ink used for the word, and finally the color of the ink of a word which spells another color as fast as possible for 45 sec.

Working Memory. In the Listening Span task, participants hear a series of sentences (ranging from two to seven). The participant must answer a question about the sentences and recall the last word of each sentence. For the WMS III Letter-Number sequencing task participants hear an intermixed series of numbers and letters and are then asked to repeat the sequence in order with numbers first and then letters.

Exercise Engagement. Participants were asked to complete a Walking, Running, & Jogging Questionnaire12, which assesses engagement in these activities over the past
ten years, and considers frequency, duration and distance traveled separately. Responses were converted to Metabolic Equivalent (MET) values reflecting the energy cost of an activity. (e.g., walking at a slow pace (2.0 mph) = 2.5 MET; running at a 6 mph pace = 10 MET). Findings of construct validity have been reinforced by past research which has validated self-reported historical fitness against treadmill tests.

Self-Efficacy. The General Perceived Self-Efficacy Scale used to assess whether a person has a low or high self-efficacy based on participants’ ratings of validity of 10 statements about the self. An example item is “I am confident that I could deal efficiently with unexpected events.” The rating scale ranges from not at all true, barely true, moderately true and exactly true.

Locus of Control. The Rotter’s Locus of Control Scale was used to determine whether the participant demonstrated an internal or external locus of control through their selection of one of two versions of 32 statements. An example item is: a) many of the unhappy things in people’s lives are partly due to bad luck; b) people’s misfortunes result from the mistakes they make.

General Procedure
Following acquisition of verbal assent to participation in this study, Rotter’s Locus of Control Scale was administered over the phone. The Cumulative Trauma Scale was completed next, and finally, the scale for General Perceived Self-Efficacy was administered. The participants were asked to write down the scales for response so that they could recall them more easily. The participants were debriefed after completion of each questionnaire, and told that any question could be repeated if needed. Following completion of the three questionnaires, participants were asked a series of questions for the processing of their payment for participation, $15. Completion of the questionnaires took approximately 30 to 45 minutes, and participants were informed that their payment would not be contingent on their completion of the questionnaires, and that they should feel free to skip any question. Additionally, during the final debriefing, participants were offered a list of referrals for psychological services, should there have been any concerns that they wanted to discuss with a professional.

Data Analyses
Following acquisition of data on the variables of locus of control, lifetime stress, and self-efficacy, all data, including already obtained data on lifetime exercise, brain structure and function, were analyzed with a series of hierarchical regressions. The dependent variable was either regional brain volume (e.g., hippocampus) or cognitive performance (e.g., memory). The first stage of analysis was to examine the effects of lifetime stress. In these analyses, age was entered first in the model, followed by lifetime stress and then the interaction between age and stress. A main effect of stress would support the hypothesis that stress has an impact on brain structure/cognition. A significant interaction would suggest that lifetime stress moderates age effects on brain structure/cognition. In the second stage of analysis, the potentially moderating role of exercise engagement on the effects of stress was examined only for those brain regions/cognitive domains that showed an effect of stress. The independent variables for the analysis of exercise were age, lifetime stress, exercise engagement and all interactions between age, stress and exercise with the 3-way interaction entered last. A significant interaction
would support the hypothesis that exercise moderates the impact of stress on brain volume/cognition.

RESULTS
Data collected about the personality factors of locus of control and self-efficacy were ultimately excluded from analysis due to insufficient power for multiple analyses. Instead, analyses focused on examination of the adverse effects of lifetime stress on brain structure and cognitive function and the potentially moderating role of exercise.

Stress, Exercise, and Regional Brain Structure
We hypothesized that along with the adverse effects of normal aging on brain structure, high levels of cumulative stress would be associated with smaller regional brain volume, particularly in the hippocampus and amygdala. Exercise was thought to potentially moderate these adverse effects on brain volume. The following analysis examines the prefrontal cortex, orbitofrontal cortex, hippocampus, and amygdala.

As expected, age accounted for a significant amount of variance in the prefrontal cortex \((\Delta R^2=.225, F(1,53)=15.413, p<.0001)\). There was not an effect of lifetime stress on prefrontal cortex volume \((\Delta R^2=.021, F(1,52)=1.442, p=.24)\). The age x lifetime stress interaction was also not significant \((\Delta R^2=.007, F<1)\).

Similarly, age accounted for a significant amount of variance in the orbitofrontal cortex \((\Delta R^2=.069, F(1,53)=3.903, p=.05)\). Stress also accounted for a significant amount of variance in orbital frontal cortex with higher frequency of stress events associated with smaller orbitofrontal cortex volume \((\Delta R^2=.085, F(1,52)=5.244, p<.05)\) (see Figure 1A). The interaction between age x stress did not have a significant effect on orbitofrontal cortex volume \((\Delta R^2=.016, F(1,51)=.999, \text{n.s.})\). There was a non-significant lifetime stress x exercise interaction \((\Delta R^2=.044, F(1,50)=2.722, p=.11)\); however, it reflected a greater effect of stress on orbitofrontal cortex for those with greater exercise engagement. There was a non-significant trend for the age x lifetime stress x exercise engagement interaction to account for a significant amount of variance in orbitofrontal cortex volumes \((\Delta R^2=.045, F(1,47)=2.799, p=.10)\). However, the interaction was not entirely consistent with hypotheses as there were trends for high lifetime stress and high engagement in exercise to be associated with the greatest age-related declines (see Figure 4A). In the lower stress individuals there was a trend for those who exercised more to evidence less age-related decline than those who exercised less.

Age also accounted for a significant amount of variance in hippocampal volume \((\Delta R^2=.151, F(1,53)=9.408, p<.01)\). There was a non-significant trend for stress to account for a significant amount of variance in hippocampal volume \((\Delta R^2=.053, F(1,52)=3.473, p=.07)\) with stress associated with smaller hippocampal volume at higher levels (see Figure 1B). However, there was no significant effect on hippocampal volume from the age x lifetime stress interaction \((\Delta R^2=.000, F<1)\). The lifetime stress x exercise engagement interaction was not significant \((\Delta R^2=.002, F<1)\). Additionally, the age x lifetime stress x exercise engagement interaction did not account for a significant amount of variance in hippocampal volume \((\Delta R^2=.000, F<1)\).

Age also predictably had a significant effect on amygdala volume \((\Delta R^2=.100, F(1,
53)=5.891, p<.05). Stress had a significant impact on this region's volume as well, coinciding with smaller volumes at higher levels (ΔR²=.083, F(1, 52)=5.290, p<.05) (see Figure 1C). However, the age x lifetime stress interaction failed to have a significant impact on amygdala volume (ΔR²=.001, F<1). The lifetime stress x exercise engagement interaction was not significant (ΔR²=.023, F(1, 50)=1.502, n.s.). Additionally, the age x lifetime stress x lifetime exercise interaction did not account for a significant amount of variance in amygdala volume (ΔR²=.001, F<1).

**Stress, Exercise, and Cognition**

We hypothesized that stress would have a detrimental effect on cognitive function, particularly in memory. Additionally, we predicted that higher levels of exercise engagement would potentially moderate the impact of aging and stress.

There was a non-significant trend for an effect of age on immediate memory (ΔR²=.040, F(1, 58)=2.407, p=.12). There was not a main effect of stress (ΔR²=.028, F(1,57)=1.698, p=.20). Additionally, there was a non-significant trend for the age x lifetime stress interaction in immediate memory (ΔR²=.042, F(1,56)=2.652, p=.11) with individuals with lower stress demonstrating a shallower slope (more gradual decline) in age-related decline than higher stress individuals (see Figure 2A). There was with greater stress having a negative impact on immediate memory in the low exercise individuals (see Figure 3). There was a non-significant trend for a main effect of age in the analysis of executive functions (ΔR²=.050, F(1, 55)=2.908, p=.10). Stress accounted for a significant amount of variance in executive functions (ΔR²=.068, F(1, 54)=4.196, p<.05). Higher levels of stress were associated with lower executive functioning (see Figure 2B). The lifetime stress x exercise engagement interaction was not significant (ΔR²=.006, F<1). Additionally, the age x lifetime stress interaction did not account for significant variance in executive function (ΔR²=.014, F<1).

Age also accounted for a significant amount of variance in working memory (ΔR²=.102, F(1,58)=6.609, p<.05). Stress, however, did not demonstrate a significant impact on working memory (ΔR²=.002, F<1). Nor did the age x lifetime stress interaction account for a significant amount of variance in working memory (ΔR²=.000, F<1).

There was a non-significant trend for a main effect of age in the analysis of processing speed (ΔR²=.050, F(1, 55)=2.908, p=.10). Stress accounted for a significant amount of variance in processing speed (ΔR²=.069, F(1, 58)=11.812, p<.01). Additionally, there was a non-significant trend for lifetime stress (ΔR²=.000, F(1, 57)=2.448, p=.12) with greater stress associated with slower processing speed (see Figure 2C). However, the age x lifetime stress interaction did not account for a significant amount of variance in processing speed (ΔR²=.000, F<1). Also, the age x lifetime stress x lifetime exercise interaction did not account for a significant amount of variance in processing speed (ΔR²=.007, F<1).
Figure 1. Stress effects on brain regions. A) Orbitofrontal volume. B) Hippocampal volume. C) Amygdala volume. Lifetime stress and volumes are residuals controlling for age.

Figure 1A. Orbitofrontal volume

Figure 1B. Hippocampal volume
Figure 1C. Amygdala volume

Figure 2. Stress effects on cognition.

Figure 2A. Immediate memory
Figure 2B. Executive functions

Figure 2C. Processing speed
Figure 3. Interactive effects of stress and exercise on immediate memory. Lifetime stress and memory scores are residuals controlling for age.

Figure 4. Interactive effects of age, stress, and exercise. A) Orbitofrontal volume. B). Immediate memory. Data points are derived from the regression equation. See text for details on the regression analyses.

Figure 4A. Orbitofrontal volume
DISCUSSION

Our initial hypotheses, as well as findings in past research and literature have been supported in a variety of ways. We expected that brain aging would place older individuals at higher risk in terms of the effect of stress on brain structure and function. Due to the abundant literature supporting exercise's beneficial impact on brain structure and function, we further predicted that exercise engagement might moderate the effects of stress. Thus, our first task was to replicate findings supporting the impact of age.

In congruence with literature on this subject, age-related brain shrinkage was found in each region of interest including the prefrontal cortex, orbitofrontal cortex, hippocampus, and amygdala. Importantly, we demonstrated that lifetime stress had a significant negative effect on brain volume in orbitofrontal and amygdalar regions with a non-significant trend for the hippocampus. This unique result extends findings from the animal literature to psychologically healthy non-demented older adult humans. According to past research in animals, chronic or high levels of stress result in damage of the hippocampus, ventromedial prefrontal cortex (including orbitofrontal), and amygdala. These regions are involved in the brain's stress response, emotional processing and memory. In order to examine interactions between age and stress, such that high levels of lifetime stress intensify the impact of aging on brain structure, we conducted regressions examining for an age x lifetime stress interaction with each region of interest. Surprisingly, we found no significant interactions between age and stress. Thus, it appears that although stress has a negative impact on brain structure it did not exacerbate age-related cross-sectional declines.
Interestingly, a three-way interaction between age, lifetime stress, and exercise engagement approached significance in relation to volume of the orbitofrontal cortex. There were trends for the orbitofrontal cortex volume to demonstrate the sharpest cross-sectional rate of decline for those participants who reported high levels of stress and high levels of exercise. One possible explanation of such an effect is that participants with already high levels of stress, who exercised with relatively greater frequency over their lifetimes, had additional stress concerning fitness and body image (issues which were not considered stressors by the Cumulative Trauma Scale). Additionally, in congruence with our predictions about exercise moderating the negative impacts of age and stress on brain structure, orbitofrontal cortex volume of participants with low levels of stress who reported relatively lower amounts of exercise engagement demonstrate a trend for a sharper rate of decline than those who reported relatively higher levels of exercise over the last ten years. It is possible that for a certain level of lifetime stress, exercise can benefit brain volume by moderating effects of age and stress; however, beyond a certain threshold of cumulative stress, exercise may no longer provide this function and may in fact become a negative factor itself. It is unclear why such an interaction is not exhibited in the remaining regions of interest where stress had some effect (i.e., hippocampus and amygdala) and exercise has been shown to have a positive effect.\(^1\)

In terms of cognitive function, we predicted that the negative effects of stress on brain function would particularly damage memory. Our analysis included examination of immediate memory, working memory, executive function and processing speed. Age, as expected, significantly affected working memory and processing speed with non-significant trends for immediate memory and executive functions in congruence with existing literature. Stress however, significantly affected executive functions with a non-significant trend for processing speed, whereas working memory was unaffected. Additionally, a non-significant trend for an interaction between age and stress was only observed in the immediate memory domain. We found that the participants who reported relatively higher levels of lifetime stress exhibited a sharper slope of age-related decline in immediate memory capacity. This finding supports our predictions of stress exacerbating the negative effect of age in terms of brain function. Once again, it is unclear why such an interaction was not exhibited for other areas of cognitive function like working memory, executive function, or processing speed.

While a three-way interaction between age, lifetime stress, and lifetime exercise was not observed for working memory, executive function, or processing speed, there was a non-significant trend for immediate memory. Participants who reported high stress levels and high levels of exercise demonstrated a trend for the steepest rate of decline in immediate memory function. As noted previously, one hypothesis is that beyond a certain threshold for stress, exercise no longer serves its beneficial functions and may become harmful rather than helpful in terms of brain structure and function. A notable observation of the study is within the low stress level group, between participants who reported high levels of exercise and those who reported low levels of exercise. Those with low levels of lifetime exercise exhibited a trend for general decline in immediate memory whereas those with high levels of lifetime exercise exhibited a trend for maintained immediate memory! Such a dramatic benefit of exercise on cognitive function has great implications for the potential plasticity of cognitive function.
for older individuals. However, it is important to note again that the three-way interaction did not reach significance in the current sample.

Potential limitations of the current study include the self-report nature of measures of lifetime stress and exercise engagement. Participants of an average age of 69 years were asked to recall different stressful events in their lives over the telephone, making the responses subject to boredom, or forgetfulness. The same potential flaw exists in the measure of exercise engagement. A retrospective questionnaire concerning frequency and intensity of activity level throughout one’s life is subject to limits in validity and reliability, though the questionnaire was validated previously. The 60 participants who completed this questionnaire for the current study may have incorrectly recalled their levels of activity. In terms of lifetime activity levels, the potential gender bias in this study involving 47 older women and 13 older men has implications also. Activity levels and stress experiences of women and men of this generation may differ. Thus, responses for activity levels may have been skewed from the beginning. Such disparities in gender composition and the use of self-report based measures may in part contribute to the some of the lack of expected findings noted above. Certainly, a longitudinal study that examined exercise activity and stress levels from an early age into older adulthood in a large sample of healthy individuals would be a great design to address methodological limitations. In addition, the sample is relatively small and clearly, replication of the significant results is necessary. Furthermore, the relatively small sample likely limited the power to detect differences across conditions. It would be interesting to replicate the study and see if results differ.

Along this line, in addition to replication of the study to confirm findings with a larger, more gender-balanced sample, I would like to further explore the possibility of there being a certain threshold level of stress, beyond which point exercise is no longer helpful. Further research is also necessary to elucidate how much, and what kind of exercise is most beneficial and why. Considering that exercise has the potential to impact brain structures and functions that are so critical to daily life, further research into this area is warranted. More importantly, the trends for interactive effects of age, lifetime stress, and exercise engagement on orbitofrontal cortex and immediate memory suggest that exercise can have extremely beneficial effects in geriatric life, demanding further research.

Overall, the finding of negative effects of stress on brain structure and cognition in older adult humans is an important extension of the animal literature, particularly as the individuals did not report any history of psychological disorders. In addition, the finding of trends for moderating effects of exercise on the negative impact of stress and age on the orbitofrontal cortex and immediate memory are extremely promising. However, further research is necessary to confirm these results as well as clarify why activity levels appear to benefit certain areas of structure and function, but not others.
Notes


5 Colcombe et al 2004


La Ruta de la Plata de Potosí: 
Una exploración moderna de la ruta colonial de plata más antigua de Bolivia

Los autores:
Samuel Steinberger & Adam Webb

Sam se graduó Summa Cum Laude de la Universidad de Washington en diciembre de 2009 con una licenciatura en Antropología. Él planea regresar a Bolivia, tan pronto como sea posible, y también disfrutar de la escritura y la fotografía.

Adam se graduará en mayo de 2010 con una doble licenciatura en ingeniería química y la antropología y una Maestría en Administración de Empresas. Ha disfrutado participando en trabajo de campo antropológico desde la edad de diez años. Después de la graduación trabajará en ExxonMobil Corporation.

RESUMEN

Nuestra investigación provee a investigadores futuros observaciones preliminares y información sobre la ruta de las caravanas de plata del siglo dieciséis que anda de Potosí, Bolivia hasta Arica, Chile. La primera prioridad del proyecto es verificar la existencia de las señales actuales de la ruta de las caravanas y hacer mapas de la ruta probable usada por los españoles coloniales para mover la riqueza mineral de los Andes a la costa pacífica. Caminamos sobre ciento cincuenta kilómetros durante tres semanas, siguiendo la pista con un Sistema de Posicionamiento Global (GPS) y recopilando observaciones, incluyendo documentación fotográfica. Partes del camino todavía existen, pero la modernización de la infraestructura de transportación y la intensificación de agricultura en el área amenazan a los sitios coloniales. La ruta provee una oportunidad económica para los bolivianos, quienes pueden desarrollar el área como destino turístico. Investigaciones sobre este tema en el futuro crearán un entendimiento más fino de los efectos de la colonización en Bolivia y Sudamérica, pondrá énfasis en la importancia histórica de la riqueza mineral para los colonizadores europeos y creará un entendimiento más completo de la historia de Bolivia.

FACULTAD MAESTRO: DAVID L. BROWMAN, PH.D, PROFESOR DE ANTROPOLOGÍA Y DIRECTOR DEL PROGRAMA DE ARQUEOLOGÍA

Profesor Browman tiene interés en los Andes altos del Perú, Bolivia, y Chile. Su interés ahora está en asuntos y implicaciones de la aumentación de sedentarismo. El pastoreo de los camélidos es un aspecto de sus investigaciones. Aunque los Andes centrales son su foco primero, los asuntos no están limitados por geografía y él tiene interés en asuntos prehistóricos e históricos de la región.

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Queremos agradecerle a Gumercindo Cruz por darnos a conocer por primera vez la ruta de las caravanas. Agradecimientos adicionales debe ser extendidos al Rubén Ruiz, el director de la Casa Nacional de Monedas, Hernán Susaño, quien nos permitió, gentilmente, hospedarnos en su hogar y compartió su pasión por la cultura y historia de Bolivia, Don José Fuertes, Estanislao Mamani, Carlos Serrano, Yamil Delgado, Padre Daniel Rossibassinger, quien nos permitió hospedarnos con él en La Paz, Don Boris y a la comunidad de Lagunillas. Agradecemos la ayuda de Jesús Figueroa en sus sugerencias claras y correcciones a la traducción. Damos gracias especiales a José Capriles, nuestro contacto boliviano y candidato doctoral en Washington University in St. Louis, Dr. David Browman, nuestro asesor del proyecto, y el Center for Programs, por proveer los fondos de investigación. Este proyecto fue hecho bajo un convenio con el Unidad Nacional de Arqueología de Bolivia.

PALABRAS CLAVES
- Ruta colonial de plata
- Potosí-Arica
- Tambo
- Altiplano
- Hilario Malavez
- Caravana de llamas

Editor de pares:
Anna Sobotka, graduado en 2009, que se especializó en inglés.
ABSTRACT

This investigation provides future researchers with preliminary observations and information regarding the sixteenth century silver caravan route stretching from Potosí, Bolivia to Arica, Chile. The first priority of the project is to verify the existence of actual traces of the caravan route and map part of the probable route used by the colonial Spanish to move mineral wealth from the Andes Mountains to the Pacific coast. We hiked more than one hundred fifty kilometers (approximately ninety miles) recording observations, including photographic documentation. We find that parts of the trail still exist, but modernization of the transportation infrastructure and agricultural intensification in the region threatens colonial sites and further research is crucial. The route provides an economic opportunity for Bolivians, who can develop the area into a tourist destination. Future research resulting from this project may create a more nuanced understanding of the effects of colonization in Bolivia and South America, emphasize the historical importance of mineral wealth for European colonizers, and create a more thorough Bolivian history.

FACULTY MENTOR: DAVID L. BROWMAN, PH.D, PROFESSOR OF ANTHROPOLOGY AND DIRECTOR OF ARCHAEOLOGY PROGRAM

Professor Browman holds a particular interest in the high Andes of Peru, Bolivia, and Chile. His current research focus is on issues and implications of increasing sedentism, as viewed from the grass-roots level. While the central Andes are his primary regional focus, the topical questions investigated are not limited by geography and he has active research interests in local regional prehistoric and also historic archaeological questions.

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We would like to thank Gumercindo Cruz for first introducing us to the caravan route. Additional gratitude must be extended to Rubén Ruiz, the director of the Casa Nacional de Monedas, Hernán Susaño, who graciously let us stay with him and shared his passion for the culture and history of Bolivia, José Fuertes, Estanislao MAMANI, Carlos Serrano, Yamil Delgado, Padre Daniel Rossibassinger, Don Boris, and the community of Lagunillas. We appreciate the help of Jesús Figueroa for his insightful suggestions and corrections to the Spanish translation. A special thanks to José Capriles, our Bolivian contact and Washington University in St. Louis doctoral candidate, Dr. David Browman, our project advisor, and the Center for Programs, for providing research funds. This project was completed under a convenio with the Unidad Nacional de Arqueología de Bolivia.

KEY TERMS

• Colonial Silver Route
• Potosí-Arica
• Tambo
• Altiplano
• Hilario Malavez
• Llama Caravan

Authors:

Samuel Steinberger
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Sam will graduate Summa Cum Laude from Washington University in December 2009 with a degree in Anthropology. He plans to return to Bolivia as soon as he is able and he also enjoys writing and photography. He hopes to incorporate his training in anthropology with his passion for photography, travel, and meeting new people.

Adam will be graduating in May 2010 with a double major in chemical engineering and anthropology and a Masters in Business Administration. He has enjoyed participating in anthropological field work since the age of ten, and could not pass up the opportunity to undertake this project with his good friend Sam. After graduation Adam will work for ExxonMobil Corporation.

Peer Editor:

Anna Sobotka, a 2009 graduate, who majored in English.
INTRODUCCIÓN

El presente artículo contiene las conclusiones de un primer estudio sobre la ruta de caravanas de llamas más antigua de los españoles en Bolivia, usada para transportar plata desde las minas de Potosí, Bolivia, hasta el puerto de Arica, Chile. Se llama esta ruta la ruta de la plata de Potosí, o la ruta de la plata. El estudio cubre aproximadamente 150 kilómetros (90 millas) de los 500 kilómetros de la ruta. Tareas de la investigación incluyeron hacer un mapa de la ruta, sacar fotos, hablar con la gente del lugar y recopilar evidencia arqueológica pertinente. El estudio señala signos tangibles del camino, incluyendo secciones cubiertas con piedras al igual que lugares de descanso, llamado tambos, los cuales son usados por viajeros de esta ruta. El objetivo principal del proyecto es ayudar a investigadores del futuro a través del estudio de estos fragmentos intactos de la ruta Potosí-Arica, resumiendo los procedimientos y requisitos para investigaciones en el futuro y clarificando el potencial que existe para más investigaciones. Objetivos secundarios incluyen evaluar amenazas a la conservación del camino, analizar el potencial económico del camino, especialmente como destino turístico, y proveer a los bolivianos más información sobre una parte de su cultura.

TRASFONDO

Empezando con el descubrimiento de los yacimientos de plata en Potosí en 1545, las actividades de la minería en el Cerro Rico durante los medios y finales del siglo dieciséis transformaron la mina en “la fuente singular más rica de este mineral en el mundo.”1 Los españoles necesitaban una manera para transportar plata desde sus colonias en Sudamérica hasta España y otras partes de Europa. Para esto, le encargaron a llameros locales la tarea de dirigir caravanas de llamas, mientras los supervisores españoles se aseguraban de que toda la carga llegara a su destino.

Las llamas eran usadas como los animales de carga principales porque están acostumbradas al forraje de la ruta y a viajes de larga distancia en alturas extremas.2 Los machos pueden llevar hasta treinta kilogramos (66 libras) de carga por entre quince y veinticinco kilómetros (nueve a quince millas) por día.3,4 Necesitan agua limpia, pastos, y tiempo para descansar y comer cada día.5 Sus patas no son muy resistentes a la tierra dura y los animales son incapaz de viajes largos sobre salares, limitando las posibles rutas que las caravanas podían usar sobre el altiplano, la meseta montañosa entre las cordilleras orientales y occidentales de los Andes.

Los llameros y sus supervisores españoles usaron tres rutas principales para transportar plata de la cordillera oriental de los Andes hasta los barcos localizados tanto en el Océano Atlántico como en el Pacífico.6 Los exportadores de plata primero usaron las dos rutas que cruzan el altiplano para llegar al océano pacífico, pasando al norte o al sur del Salar de Uyuni, el cual es bastante grande. Como se puede ver en el mapa del Apéndice A, la ruta más antigua hasta la costa pacífica viajaba al noroeste del Potosí, por Yocalla, al norte del Salar y de allá al oeste hasta el puerto de Arica, hoy en día de Chile.7 La segunda ruta para el océano pacífico pasaba por la comunidad minera importante de San Cristóbal al sur del Salar y usaba el puerto de Antofagasta, Chile. La tercera ruta terminaba en la costa atlántica por la ruta al sur que pasaba por lo que
INTRODUCTION

The following contains the findings of a pilot project conducted on the oldest Spanish llama-caravan route in Bolivia, previously used to transport silver from the mines of Potosí, Bolivia, to the port of Arica, Chile. The study covers approximately 150 kilometers (90 miles) of the 500 kilometer route. Research tasks include mapping the trail, making photographs, speaking with locals, and documenting pertinent archaeological evidence. The study notes tangible signs of the trail including sections paved with rock and rest areas, called *tambos*, used by travelers en route. The project’s primary objective is to assist future investigators by surveying these intact fragments of the Potosí-Arica silver trail. Secondary objectives include assessing the developing threats to the trail’s conservation, analyzing the trail’s economic potential, especially as a tourist destination, and providing Bolivians with more information about a part of their cultural heritage.

BACKGROUND

Beginning with the discovery of Potosí’s silver deposits in 1545, mining activity at the Cerro Rico (Rich Mountain) over the middle and late parts of the sixteenth century transformed the mine into “the single richest source of this mineral in the world.” The Spaniards needed a way to transport silver from their colonies in South America to Spain and other parts of Europe. The Spaniards charged *llameros*, or indigenous llama drovers, with caring for the llama caravans, while Spanish overseers ensured that all the cargo reached its destination.

Llamas were used as the principal pack animals because they are both accustomed to the vegetation of the area and adept at long-distance travel in the high altitude. Male llamas can carry up to thirty kilograms (66 pounds) of cargo for about fifteen to twenty-five kilometers (nine to fifteen miles) per day. They need clean drinking water, plentiful pasture, and time to rest and eat daily. Their relatively soft hooves are incapable of extended travel over salt flats, limiting the possible routes the caravans can take over the *altiplano*, a highland plateau between the eastern and western Andean ranges.

The *llameros* and their Spanish overseers used three main caravan routes to transport silver from the eastern arm of the Andes to ships in both the Atlantic and Pacific Oceans. Silver exporters first used two trans-*altiplano* Pacific coast routes, passing to the north or south of the massive Salar de Uyuni. As seen in the map in Appendix A, the oldest of the Pacific coast routes traveled northwest out of Potosí, through Yocalla, north of the Salar, and then west to the port of Arica, in present-day Chile. Along all the routes were a series of *tambos*, rest areas used by travelers and operated by innkeepers who maintained stocks of food, water, and other supplies. Remnants of these structures still exist today. *Calvarios*, small chapels built outside population centers, are another tangible remnant of Spanish occupation.

The Potosí-Arica trail is one of the oldest links between the expansion of European power and the devastation of colonialism. Fueled by New World resources, including the mineral wealth produced at mines like Potosí, European global hegemony can be
ahora es Argentina. Por todas las rutas había una serie de *tambos*, lugares de descanso usados por viajeros y operados por posaderos quienes mantuvieron reservas de comida, agua y otras cosas. Ruinas de estas estructuras todavía existen hoy. Calvarios, capillitas hechas fuera de centros de población, son otros ejemplos tangibles de la ocupación de los españoles.

El camino Potosí-Arica es uno de los vínculos más antiguos entre la expansión de poder europeo y la devastación de colonialismo. Impulsado por los recursos del Nuevo Mundo, incluyendo los ricos minerales producidos en minas como Potosí, se puede encontrar el principio de la hegemonía global europea con la entrada de bienes provenientes de tierras colonizadas. La ruta Potosí-Arica es la menos estudiada de las tres rutas principales usadas para transportar plata desde minas hasta la costa. El terreno difícil, altura extrema y prevalencia de idiomas indígenas hace que investigaciones en esta área sean de proporciones particularmente enormes. A pesar de estos obstáculos, delinear la ruta de plata Potosí-Arica es más y más importante ya que su integridad está amenazada por la expansión de proyectos de riego, prácticas agrícolas más intensivas, el crecimiento de proyectos de infraestructura moderna para transportación y una pérdida general del conocimiento de prácticas tradicionales, como la crianza de llamas y las rutas de intercambio doméstico no-mecanizadas.

**METODOLOGÍA**

La expedición atravesó aproximadamente una tercera parte de la ruta de plata: ciento cincuenta kilómetros (noventa millas), a lo largo do diecinueve días. La altura de esta región nunca descendió bajo 3.400 metros (aproximadamente 11.150 pies) sobre el nivel del mar. Nuestra ruta está ilustrada en la Figura 1. Distancias entre pueblos y lugares importantes están en el Apéndice D.

Herramientas de navegación incluyeron mapas topográficos publicados en 1970 por el Instituto Geográfico Militar (IGM) y dos receptores de mano equipados con el Sistema de Posicionamiento Global (GPS). Fuentes locales y la Casa Nacional de Monedas en Potosí proveyeron información adicional.10

![Figura 1. La línea de puntos representa la ruta recorrida por los investigadores.](image)
traced to the influx of goods from colonized lands. The Potosí-Arica silver route is the least studied of the three major routes used for transporting silver from inland mines to the coast. The area's challenging terrain, high altitude, and the prevalence of indigenous languages makes research particularly daunting. Despite these obstacles, documenting the Potosí-Arica silver route is increasingly important because its integrity is threatened by the expansion of irrigation projects, more intensive farming practices, the growth of mechanized transportation and the infrastructure to support it, and a general loss of familiarity with traditional practices, such as llama herding and non-mechanized domestic trade routes.

METHODOLOGY

The expedition traversed approximately one-third of the silver route, one hundred and fifty kilometers (90 miles), over nineteen days. The altitude of this region never drops below 3400 meters (approximately 11,150 feet) above sea level. Our route is shown in Figure 1. Distances between important towns and landmarks are shown in Appendix D.

Navigational tools included topographic maps published in 1970 by the Bolivian Military Geographic Institute (IGM) and two handheld Global Positioning System (GPS) receivers. Local sources and the Casa Nacional de Monedas in Potosí provided additional information.10

Figure 1. The dotted line represents the researchers' traveled route.
EL PROYECTO

La investigación empezó con información sobre la ruta de plata Potosí-Arica provista por la Casa Nacional de Monedas. Información básica provista por el museo, los archivos, y varios expertos de la Casa sugería que las primeras caravanas hicieron paseos bianuales al puerto de Arica. La información más importante provista por la Casa Nacional de Monedas fue una copia de uno de los pocos mapas coloniales en los archivos del museo, dibujado por Hilario Malavez en 1787: dicho mapa ilustra las tres rutas de plata principales (Apéndice A).11

Fuentes locales explicaron que las caravanas salieron de Potosí por el Arco de Cobija, un arco pequeño de piedra (Figura 2a) que está orientada de este al oeste. De este arco el camino baja por un serie de pueblos pequeños antes de une con que ahora es la carretera moderna en el pueblo de San Antonio (Figura 2c). Casas y minas cubren esta parte del camino, de hecho borrando alguna evidencia de su paso (Figura 2b).12

El primer pueblo afuera del área metropolitana de Potosí era San Antonio. Siguiendo por el Río Molino, muy contaminado con escorrentías de las minas, notamos varios puentes de piedra cruzando el río. Aunque históricos, no son contemporáneos con las caravanas de llamas coloniales. La construcción de la carretera moderna destruyó casi todos los indicios de la vía adyacente más antigua. A casi cinco kilómetros del primer pueblo está el pueblo de La Puerta, ubicado estratégicamente en la entrada del cañón que lleva a Potosí. Dos kilómetros después de La Puerta, una carretera secundaria que lleva a la comunidad minera de La Palca y sigue al oeste.

El camino probable sigue al lado del Río Molino, pasando por la comunidad de El Molino, probablemente una ubicación de un antiguo tambo. No se puede encontrar el tambo debido a que un centro de producción de artesanías yace encima del probable emplazamiento. Varias fuentes locales hablan sobre un camino que cruza por las montañas entre El Molino y Totora D, pero el número de llamas usadas por los españoles coloniales hace que los llanos del río, con comida y agua fácil de conseguir y terreno más manejable, sean la ruta más probable.13 Después de pasar Totora D, la que posiblemente tenía otro tambo cerca de su iglesia ornamentada, llegamos al desfiladero de Tres Cruces. Un camino empedrado con piedra (Figura 3a) corre desde el desfiladero por el pueblo de Quinta Cruz y se reúne con la carretera moderna. Antes de llegar a Yocalla, cruzamos el Puente del Diablo, un puente de piedras del siglo dieciséis (Figura 3b) que cruza el Río Pilcomayo.14 Esta estructura importante debe haber sido el único método seguro de cruzar el río sin barcos durante la época colonial.

Don Hernán Susaño, un historiador que vive en Yocalla, nos informó de tambos en San Antonio, La Puerta, El Molino, Totora D y Yocalla. Según Don Hernán, la escuela en San Antonio (Figura 2) está construida en los cimientos de un tambo, y el tambo de El Molino se llama La Pata.15 Un tambo cercano sin nombre, mencionado por Don Hernán, está adyacente a la continuación del camino empedrado de Tres Cruces (Figura 4a). El tambo pareció ser convertido en una granja, pero paredes de piedras antiguas y otros cimientos todavía existen (Figura 4b). El tambo en Yocalla consiste de un patio central, con señales de empedramiento, rodeado de dormitorios de adobes orientados hacia el centro, sobre cimientos de piedra. Está justo frente a una taberna que no se utiliza, al lado de un camino empedrado. El patio es aproximadamente quince metros de largo por quince metros de ancho, y la estructura entera es de aproximadamente treinta metros de largo por treinta metros de ancho. Aunque está
THE PROJECT

Research began with information about the Potosí-Arica silver route obtained from the Casa Nacional de Monedas. Basic information provided by the museum, archives, and several scholars from the Casa suggests that early caravans made biannual treks to the port of Arica. The most important piece of information provided by the Casa Nacional de Monedas was a copy of one of the few colonial maps at the museum’s archives, drawn by Hilario Malavez in 1787, which illustrates the three major silver routes (Appendix A).\textsuperscript{11}

Local sources explained that caravans left Potosí through the Arco de Cobija, a small stone archway (Figure 2a) that faces east to west. From this arch the trail descends through a series of small towns before linking up with what is now the modern highway at San Antonio (Figure 2c). Houses and mines cover this section of the trail, effectively erasing any evidence of its passing (Figure 2b).\textsuperscript{12}

The first town encountered outside the Potosí metropolitan area was San Antonio. Following the River Molino, heavily polluted from mining runoff, we noted several stone bridges crossing the river. Although historic, they are not contemporaneous with the colonial llama caravans. Construction of the modern highway destroyed nearly all traces of the older, adjacent roadbed. Nearly five kilometers later is the town of La Puerta, strategically situated at the entrance of the canyon leading to Potosí. Two kilometers after La Puerta, a side road leads to the mining community of La Palca and then continues west.

The probable trail continues alongside the River Molino, passing through the community of El Molino, a likely tambo location. The tambo could not be located, since an artisanal production center sits over the probable site. Several local sources mention a path that leads through the mountains between El Molino and Totora D, but the sheer number of llamas used by the colonial Spaniards made the river flats, with readily available food and water and an easily navigable landscape, a more probable route.\textsuperscript{13} After passing Totora D, likely containing another tambo near its ornate church, we arrived at the Tres Cruces pass. A stone-paved road (Figure 3a) runs from the pass through the village of Quinta Cruz and reconnects with the modern highway. Before arriving in Yocalla, we crossed the Puente del Diablo, a sixteenth-century stone bridge (Figure 3b) that crosses the River Pilcomayo.\textsuperscript{14} This important structure would have been the only reliable means of crossing the river during the colonial era.

Don Hernán Susaño, a local historian residing in Yocalla, informed us of tambos in San Antonio, La Puerta, El Molino, Totora D, and Yocalla. According to Don Hernán, the school in San Antonio (Figure 2) is built on the foundations of the tambo, and the tambo in El Molino is called La Pata.\textsuperscript{15} A nearby unnamed tambo, mentioned by Don Hernán, sits adjacent to the continuation of a stone-paved road leading from Tres Cruces (Figure 4a). The tambo appeared to be converted into a homestead, but older stone walls and foundations still exist (Figure 4b). The tambo in Yocalla consists of a central courtyard, with traces of stone-paving, surrounded by inward-facing adobe-brick dormitories, sitting on stone foundations. It is located across from an apparently unused tavern, off a stone-paved road. The inner courtyard is approximately fifteen meters by fifteen meters, while the entire structure is approximately thirty meters by thirty meters. Although well preserved, the tambo is overgrown and used as a garbage depository (Figures 4c and 4d).
Figure 2a. The Arco de Cobija with the Cerro Rico.
Figura 2a. El Arco de Cobija con el Cerro Rico.

Figure 2b. Development on the initial section of the trail.
Figura 2b. Desarrollo en la sección inicial del camino.

Figure 2c. The modern school in San Antonio.
Figura 2c. La escuela moderna de San Antonio.

Figure 3a. Paved stone road running toward the village of Quinta Cruz.
Figura 3a. Camino empedrado corriendo hacia al pueblito de Quinta Cruz.

Figure 3b. El Puente del Diablo, a sixteenth-century bridge located below the modern highway.
Figura 3b. El Puente del Diablo, un puente del siglo dieciséis ubicado debajo de la carretera moderna.
Figure 4a. A paved trail leading down towards a possible *tambo*.
Figura 4a. Un camino empedrado corriendo hacia un posible tambo.

Figure 4b. Ruins of a possible *tambo*.
Figura 4b. Ruinas del posible tambo.

Figure 4c. Interior of Yocalla *tambo* with central plaza and surrounding dormitories.
Figura 4c. Interior del tambo en Yocalla con patio central y dormitorios circundantes.

Figure 4d. Exterior of Yocalla *tambo*.
Figura 4d. Exterior de tambo en Yocalla.
Bien protegido, el tambo está cubierto de vegetación y usado como depositario de basura (Figuras 4c y 4d).

Saliendo de Yocalla, la ruta sigue la carretera hasta el pueblo de Ch’ullpa Khasa y las ruinas de una hacienda antigua de los españoles. Aquí se separa de la carretera y corre al noroeste hasta Laguna Wara Wara, subiendo un camino empedrado (Figura 5) el cual estaba hecho para viajes con llamas. La pendiente del camino es leve, a pesar del terreno empinado. Después de medio kilómetro, el camino se divide en dos por aproximadamente cien metros; una sección sube poco a poco en forma de zigzag; la otra sube rápidamente, cruzando los zigzags. El camino en zigzag es para los animales, que tienen dificultades con subidas extremas y de repentina cuando están cargados. El camino más corto con la subida más rápida es para los humanos.

El camino claro, fácil de seguir y empedrado hasta llega a la meseta alta al final de la subida. Aquí el camino se cruza con un campo moderno, que borra todo los rastros del empedramiento y es un ejemplo del empeoramiento del camino. Hicimos muchos intentos de encontrar la ruta, pero sin éxito. Es posible que la ruta cambie en dirección más al norte de este lugar, pasando al norte de la Laguna Wara Wara antes de correr al oeste y bajar de la meseta al norte del Tambo de Alcalá, que está al lado de la carretera moderna.

Al suroeste de Laguna Wara Wara la ruta baja de la meseta y cruza la carretera. Una carretera de grava desciende de Belén Pampa, una comunidad moderna al lado de la carretera, hasta el valle del Río Pilcomayo. La carretera sigue por Puitokho, que debe tener un tambo, dada la distancia entre este lugar y otros tumbos. Habitanes locales, sin embargo, no pudieron corroborar la existencia de dicha estructura. Siguiendo por el valle del río, el camino pasa por la comunidad de Cahuayo y asciende a una meseta para entrar a la comunidad de Lagunillas. Pocos pastos crecen por esta ruta y el camino hubiera sido demasiado largo para los llameros. Por tanto, no creemos que fueran muchas las caravanas españolas que pasaron por el valle del Río Pilcomayo.

El último tambo que encontramos en la expedición (Figura 6a-6c) está ubicado al suroeste de la comunidad moderna de Lagunillas. El diseño del tambo es similar a los otros tumbos que hemos visto: hay dormitorios arreglados en un rectángulo con patio central. Un túmulo parecido a un conchero al noreste del tambo sugiere ocupación frecuente. La plaza está a un nivel más bajo y parece haber cimientos de un corral en el este del tambo. Muchos fragmentos de cerámicas están dispersos al norte del tambo, especialmente cerca de un pequeño arroyo. Un corral moderno, construido de piedra, se encuentra al suroeste del tambo. Dos paredes de menos de un metro de altura están al oeste del dormitorio norte, y la sección del medio del dormitorio oeste es más elevada en altura.

Fuentes en la comunidad nos hablaron de un camino más antiguo que pasa al sur de la ruta que usamos y corre directamente de Puitokho al Lagunillas. El presunto camino pasa por el pueblo de Willca Pujio, pero mapas topográficos no muestran un sendero por la región. La existencia de este camino es una posibilidad definitiva, pero lo necesita ser explorado por expediciones futuras.

Saliendo de Lagunillas, viajamos al noroeste hasta Thola Palca para reponer nuestras reservas de alimentos. No encontramos ningún tambo en el área, y fuentes locales reiteraron que el camino sigue al suroeste de Lagunillas.

De Thola Palca viajamos al suroeste por las comunidades de Nazacara y Culi. En
Leaving Yocalla, the route follows the highway until the village Ch’ullpa Khasa and the ruins of a hacienda, a former Spanish plantation. Here it leaves the highway and leads northwest toward Lake Wara Wara, ascending a stone-paved trail (Figure 5) which was clearly made for llama travel. The trail’s incline is gradual, despite the steep terrain. After half a kilometer, the trail diverges for approximately one hundred meters; one section makes a gradual ascent utilizing switchbacks; the other climbs steeply, cutting the switchbacks. The switchbacks are intended for pack animals, which have difficulty with sudden, steep ascents while carrying cargo. The distance-saving steeper route is intended for human use.

The road is clear, easy to follow and stone-paved until it reaches a high plateau at the top of the ascent. Here the path intersects a modern field, which erases all traces of the stone paving and is an example of the trail’s deterioration. We made multiple unsuccessful attempts to recover the trail. It is possible that it veers in a more northerly route from this location, passing north of Lake Wara Wara before cutting west and descending from the plateau north of Tambo Alcala, situated along the modern highway.

Southwest of Lake Wara Wara, the route descends the plateau and crosses the highway. A gravel road descends from Belen Pampa, a modern community just off the highway, into the River Pilcomayo valley. The road continues through Puitokho, however no evidence of a tambo remained at the expected site. Continuing along the river valley, the trail passes through the community of Cahuayo until ascending a plateau and entering the community of Lagunillas. Little forage grows along the route and the road would have been too circuitous for the caravan drivers’ preference. No major Spanish silver caravans would have passed through the River Pilcomayo valley.

The last recorded tambo of the expedition (Figure 6a-6c) is located southwest of the modern community of Lagunillas. The layout of the tambo reflects the other tambos seen: dormitories arranged in a rectangle with a central plaza. A midden-like mound to the north and east of the northerly section of the tambo suggests frequent occupation. The plaza is slightly sunken and there appears to be foundations of a corral to the east of the tambo. Many ceramic fragments are scattered north of the tambo, especially near a washout. A modern corral constructed of stone sits to the southwest of the tambo. Two walls of less than a meter in height stand at the west end of the northern dormitory, and the middle section of the western dormitory unit is greater in height.

Sources in the community mentioned an older trail that passes to the south of the route we followed and runs directly from Puitokho to Lagunillas. The alleged trail passes through the village of Willca Pujio, but topographic maps do not show a footpath through the region. The existence of this trail is possible, and should be explored in future research.

Traveling northwest to Thola Palca we did not find a tambo in the area and local sources reiterated that the trail goes southwest out of Lagunillas.

From Thola Palca we traveled southwest through the communities of Nazacara and Culí. Footpaths are the primary trails in this region and we reached the highest altitude of our trip, a pass of slightly more than 4400 meters (14,400 feet). More indigenous language usage was noted in the region: Lagunillas marks the linguistic transition zone from Quechua, used to the east, to Aymara, used in the area we were entering and on the altiplano. Upon arrival at the altiplano, the trail descends 500
Figure 5a. The paved stone path leading towards Lake Wara Wara.

Figura 5a. El camino empedrado corriendo hasta Laguna Wara Wara.

Figure 5b. Close-up of paved path.

Figura 5b. Foto cercana al camino empedrado.

Figure 6a. Various views of the Lagunillas *tambo*. The central plaza with dormitories in background.

Figura 6a. Varias vistas del tambo de Lagunillas. La plaza central con dormitorios en el fondo.
Figure 6b. Various views of the Lagunillas tambo. A midden pile.

Figura 6b. Varias vistas del tambo de Lagunillas. Un conchero.

Figure 6c. Various views of the Lagunillas tambo. View of the town of Lagunillas with tambo in foreground.

Figura 6c. Varias vistas del tambo de Lagunillas. Vista del pueblo de Lagunillas con el tambo en el primer plano.

Figure 7. An old trail is visible cutting through the small rises of the altiplano.

Figura 7. Un camino antiguo es visible, cortando por las cumbres pequeñas del altiplano.
esta región, los caminos principales son senderos. Aquí alcanzamos el punto de mayor elevación de nuestro viaje, recorriendo un desfiladero de un poco más de 4.400 metros (14.400 pies). Notamos también más uso de idiomas indígenas. Lagunillas marca la zona lingüística de transición de Quechua, usado en el este, a Aymara, usado en el área que estábamos entrando y en el altiplano. Cuando llegamos al altiplano el camino baja 500 metros (1.600 pies) hasta el valle del Río Paria. La ruta colonial de la plata no pasó por aquí y probablemente fue más al sur de esta posición, llegando al altiplano cerca de Urmiri. Transportación a Urmiri no fue posible; por tanto, decidimos investigar pistas alternas y viajamos por bus a Salinas de Garcí-Mendoza (Apéndice A y C).

En Salinas de Garcí-Mendoza el director del colegio nos habló de posibles ubicaciones de tambos inmediatamente al este de Salinas de Garcí-Mendoza cerca de la carretera moderna; también hay tambos probables cerca de Abra Tambillo y Rancho Jachacha Phuiro. Otras poblaciones a notar incluyen Isbaya, Uyuni y Challa Kkollu. Esta ruta corre al sur de Salar de Coipasa y no llega a Arica, Chile. Limitaciones de tiempo nos impidieron la confirmación de la información presentada por esta fuente, pero recomendamos investigaciones en el futuro.

Aprovechamos de otra oportunidad y volvimos por bus al pueblo central de Quillacas y caminamos al pueblo vecino de Pampa Aullagas. Habitantes de Pampa Aullagas citaron dos tambos entre Quillacas y Salinas de Garcí-Mendoza: uno un poco al norte del pueblo de Vengal Vinto y otro en pueblo de Tambo Tambillo. Decidimos viajar por tres días al noroeste de Pampa Aullagas e investigar y delinear un sendero alternativo mencionado por los habitantes como ruta colonial de plata de los españoles, el cual pasa al norte del Salar de Coipasa y probablemente sigue a Arica, Chile.

El camino pasa por una región llamada Cruz Uma y eventualmente anda cerca del Río Laca Jahuira. La región está dedicada casi su totalidad a la crianza y uso de llamas, indicando que la misma puede apoyar grandes poblaciones de llamas. El camino ya no es usado pero es más o menos fácil seguirlo. Es visible como una zanja hundida (Figura 7) que corta por cumbres pequeñas y contiene vegetación distinta a la del área que la rodea. El camino supuestamente anda por Mara Mara, un pueblo pequeño. Esta información nos guió al noroeste para buscar tambos y hablar con los habitantes locales. En Mara Mara, sin embargo, no había señales de la ruta de plata ni tambos, por lo que concluimos que el camino anda más al sur.

SUGERENCIAS Y CONCLUSIONES

La ruta de la plata de Potosí-Arica que proponemos se encuentra en los mapas en los Apéndices B y C. Basamos nuestra ruta en información compuesta sacada de las características de caravanas de llamas, el mapa de Hilario Malavez, informes históricos y conocimiento local.

Llamas con carga necesitan agua y pastos cada día, por lo que necesitan fuentes fiables del agua y paseos sin obstáculos con subidas y bajadas pequeñas. Los españoles responsables de supervisar las caravanas y los llameros indígenas necesitaban alojamientos, que encontraron en los tambos, ubicados por lo menos a la distancia que pudieron viajar en un día. Estas estructuras todavía están más o menos visibles y proveyeron una referencia definitiva para ubicar el camino. Suponemos que los calvarios e iglesias ornamentadas generalmente estaban construidos al lado de las rutas
meters (1600 feet) into the River Paria valley. The colonial silver route did not pass through here and likely went to the south of this location, arriving at the altiplano near Urmiri. Because transit to Urmiri was unavailable, we pursued alternative research leads and traveled to Salinas de Garci-Mendoza (Appendix A and C).

In Salinas de Garci-Mendoza we were informed of probable tambos locations immediately to the east of Salinas de Garci-Mendoza near the current roadway, as well as tambos near Abra Tambillo and Rancho Jachacha Phuiro. Other populations of note include Isbaya, Uyuni, and Challa Kkollu. This route runs south of the Salar de Coipasa and does not lead to Arica, Chile. Further research of this area is recommended.

Locals in Pampa Aullagas identified two tambos between Quillacas and Salinas de Garci-Mendoza: one slightly north of the town of Vengal Vinto and another at the village of Tambo Tambillo. They also identified another trail as a colonial Spanish silver route that passes north of the Salar de Coipasa and likely continues to Arica, Chile. The trail passes through a region called Cruz Uma and eventually approaches the River Laca Jahuira. The area is almost exclusively devoted to llama herding, indicating that the region can support large llama populations. The trail is no longer utilized but relatively easy to follow. It is visible as a sunken trench (Figure 7) that cuts through hilltops and contains vegetation differing from that of the surrounding area. The trail supposedly led through Mara Mara, a small community, however, there are no signs of the silver route or tambos in this area and we concluded that the trail passed further south.

SUGGESTIONS AND CONCLUSIONS

The Potosí-Arica silver route proposed by this research is shown on the maps in Appendices B and C. It is based on composite data drawn from llama caravan characteristics, Hilario Malavez’s map, historical accounts, and local knowledge.

Cargo-carrying llamas need daily water and pastureland, necessitating reliable water sources and a relatively smooth path with gradual inclines and declines. The Spaniards responsible for overseeing the caravans and the indigenous llameros needed lodging, which they found in the form of tambos, located at least a day’s travel apart. Some of these structures are still partially visible and provide a reference for locating the trail. We assume that calvarios and ornate churches were generally built along important routes, although future research is needed to confirm the relationship between the route and these structures.

Hilario Malavez’s map shows one route north of the Salar de Uyuni. The oldest route was no longer in use at the map’s publication, so it is probable that Malavez was unfamiliar with this route. We suspect this single route on the map was actually two routes. One route traveled immediately north of the Salar de Uyuni, through Salinas de Garci-Mendoza to the port of Iquique. The other ran northwest from Quillacas, through Tambo Quemado and Azapa Valley, before arriving at Arica. It is likely Hilario Malavez combined the more important route through Arica with another route that passed through Salinas. Seasonal precipitation could have prevented accessibility to one route, necessitating the use of alternative routes. Future research should explore the possibility of multiple routes through the altiplano.

Although there are no records at the Casa Nacional de Monedas indicating the number of llamas used, the Spaniards did record the amount of silver leaving the
importantes, aunque investigaciones en el futuro son necesarias para confirmar la relación entre la ruta y estas estructuras.

El mapa de Hilario Malavez muestra una ruta al norte del Salar de Uyuni. La ruta más antigua mostrada en el mapa no estaba en uso durante el tiempo de la publicación del mapa, por lo que es probable que Malavez no estuviera familiarizado con esta ruta. Sospechamos que esta única ruta es en realidad dos rutas. Una ruta viajaba inmediata-mente al norte del Salar de Uyuni, por Salinas de Garci-Mendoza al puerto de Iquique. La otra corría al noroeste de Quillacas, por Tambo Quemado y el Valle de Azapa, antes de llegar a Arica. Es posible que Hilario Malavez combinó la ruta más importante por Arica con la otra ruta que pasó por Salinas. Lluvias estacionales pudieron impedir acceso a una ruta, lo haciendo necesario usar una de las rutas alternas. Investigaciones futuras deben investigar la posibilidad de múltiples rutas en el altiplano.

Aunque no hay documentos en la Casa Nacional de Monedas que indiquen el número de llamas usadas, fuentes nos dijeron que los españoles anotaron la cantidad de plata saliendo de la Casa.16 Esta información, con las características de la llama mediana que puede cargar, indica que usaron una cantidad grande de animales, quizás en el orden de millares. Cobb (1949) anota una caravana de 5000 llamas usó en 1603.17 La enorme cantidad de animales limitó las rutas disponibles a las caravanas de plata.

El camino necesitaría apoyar las necesidades de comida para las llamas por lo menos dos veces por año, si los españoles usaran un camino diferente para la época de lluvias y otro diferente para la época seca, y tanto como cuatro veces por año si no hubieran caminos alternos disponibles. Esta información es útil para disminuir las posibles rutas para las caravanas.

La ruta de plata ofrece una oportunidad de primera calidad para turismo y crecimiento económico en los departamentos bolivianos de Potosí y Oruro. La infraestructura ya existe para treks turísticos por esta región escasamente poblada, que podría aumentarse con recorridos de la ruta de la plata. Rutas de treks podrían aumentar oportunidades económicas para los habitantes en sus comunidades nativas. Ahora fuerzas económicas obligan a algunos habitantes trabajar estacionalmente en las ciudades grandes, mientras otros se han mudado a centros urbanos para encontrar trabajo. La expansión de oportunidades turísticas en la región aliviaría estas presiones urbanas y estimularía la viabilidad económica rural con trabajos locales que apoyen la conservación de sus propias identidades culturales.18

El proyecto piloto logró sus objetivos principales y secundarios, proveyendo documentación fotográfica, datos de GPS y conocimiento experiencial de las dificultades que confrontan investigadores en el futuro. La conservación del camino depende de esfuerzos futuros. Lamentablemente, la expansión de sistemas de irrigación y otros proyectos de desarrollo cercenan y destruyen secciones restantes de la ruta, mientras las ruinas de tambos y partes de la ruta empedrada siguen empeorando. Medidas rápidas son imperativas para asegurar la conservación y documentación de esta ruta histórica tan importante.
This information, combined with the characteristics of the average cargo-carrying llama, indicate a large number of animals were utilized, perhaps in the thousands. Cobb cites a caravan of 5000 used in 1603. The enormous number of animals limited the routes available to the silver caravan. If the Spanish used a different trail for the rainy season and the dry season, the trail would have needed to support the grazing habits of those animals at least twice per year and as many as four times a year if no alternative trails were available.

The silver route offers a prime opportunity for tourism and economic growth in the Bolivian departments of Potosí and Oruro. The infrastructure already exists for touristic trekking through the sparsely populated region, which could be augmented with silver route tours. Additional trekking routes could increase economic opportunities for the villagers in their native communities. Economic forces dictate that some villagers work seasonally in larger cities, while others permanently relocate to urban centers to find employment. Expansion of regional tourist opportunities would relieve urban pressure and promote rural economic viability by providing locals with employment opportunities that support the preservation of their own cultural identity.

The pilot project achieved its primary and secondary goals by providing photographic documentation, GPS data, and experiential knowledge of the difficulties facing future researchers. Future efforts hinge on the conservation of the trail. Unfortunately, irrigation system expansions and other development projects encroach upon and destroy remaining sections of the route, while the ruins of tambos and portions of the paved route continue to deteriorate. Immediate action is essential to ensure the preservation and documentation of this significant historical route.
Appendix A — Apéndice A

Appendix B — Apéndice B
Appendix C — Apéndice C

Appendix D — Apéndice D

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<th>Town (T)/Landmark</th>
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<th>Distance from last reference point (km)</th>
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<td>Castilla Huma</td>
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- Huari: 174.1, 15.9
- Quillacas: 211.2, 37.1
- Salinas de Gerci Mendoza: 303.7, 92.5

- Traveled (by foot):
  - Pampa Aullagas: 317.2, from Quillacas 13.5
  - Mara Mara: 344.4, 27.2
Notas


10. Debido limitaciones con Autorizaciones de Sujetos Humanos, no podemos citar los nombres de muchos de nuestras fuentes locales.


12. Mientras hacíamos investigaciones sobre las características de las caravanas y planeábamos nuestra ruta, hablamos con guías locales sobre las regiones por las que planeábamos pasar. Varias fuentes nos advirtieron que era posible que no nos recibieran porque éramos ciudadanos estadounidenses viajando fuera de las rutas de tránsito de las caravanas. Aunque eventualmente estas preocupaciones resultaron ser equivocadas, contactamos la oficina de gobierno del Departamento de Potosí para conseguir un pasaje seguro por la región. Después de varias demoras, recibimos eventualmente una carta de pasaje seguro de la secretaría de turismo. A cambio, proveeremos un abstracto y copias de nuestro proyecto para la Prefectura.


15. Don Hernán Susaño citó información de las siguientes fuentes que los investigadores no pudieron encontrar: Modestro Omiste, *Cronicas Potosinas: Volumen 1*; Brocha Gorda, *La Villa Imperial de Potosí* (La Paz: 1974); Bartolomé Arzáns de Orsúa y Vela, *Relatos de la Villa Imperial de Potosí*.

16. Investigadores futuros deben consultar archivos en Lima, Perú. Fuentes en Potosí nos dijeron que hay información adicional y más rigurosa sobre la ruta de plata en los archivos peruanos.


18. Aunque creemos con pocas dudas que estas expansiones turísticas en la ruta beneficiarían a los habitantes locales, es necesario recordar que los turistas son solamente invitados. La ruta pasa por las tierras natales de los bolivianos, un pueblo que mantiene un patrimonio rico que se merece respeto. Cualquier crecimiento económico debe ser aprobado y cumplido bajo los auspicios de gobiernos locales y debe beneficiar sin dudas los habitantes indígenas.
Notes


6 Hilario Malavez, “Carta Geográfica” *Guía de la Provincia de Potosí* (1787).


10 Due to limitations with Human Subjects Clearance, we are unable to cite the majority of our specific local sources.

11 Malavez has been cited by other historians including Alfredo Tapia Vargas (see Alfredo Tapia Vargas). “La Geografía de Potosí en la Colonia” *Geografía del Departamento de Potosí*. (Potosí: Edición del Autor, 1992)

12 While researching the caravan characteristics and planning our route, we spoke with local guides about the areas we planned to pass through. Several sources warned that we might not be welcomed as United States citizens traveling outside of major transit routes. Although eventually these concerns proved to be unwarranted, we contacted the Department of Potosí’s government office in an effort to secure safe passage through the area. After several delays, we eventually received a letter of safe passage from the secretary of tourism. In return, we agreed to provide an abstract and copies of our report for the Prefectura.


15 Don Hernán Susaño cited information from the following sources which the researchers were unable to locate: Modestro Omiste, *Cronicas Potosinas: Volumen 1*; Brocha Gorda, *La Villa Imperial de Potosí* (La Paz: 1974); Bartolemé Arzáns de Orsúa y Vela, *Relatos de la Villa Imperial de Potosí*.

16 Future researchers are advised to consult archives in Lima, Peru. Sources in Potosí cited additional and more thorough information about the silver route in Peruvian archives.


18 While we strongly believe these tourist expansions along the route would benefit the local inhabitants, it is vital to remember that tourists are merely guests. The route passes through the homeland of Bolivian peoples who maintain a rich heritage that deserves respect. Any economic growth must be approved and carried out under of the auspices of the local governments and genuinely benefit the indigenous inhabitants.
Summaries of Student Work

Toward a Better Understanding of...

Novel Mutation in Pancreatic $K_{\text{ATP}}$ Channels Leads to Inactivation-Induced Congenital Hyperinsulinism

Alejandro Akrouh

Mentor: Colin G. Nichols

The ATP-sensitive potassium ($K_{\text{ATP}}$) channel is a critical regulator of insulin secretion. Increased intracellular ATP/ADP ratio causes $K_{\text{ATP}}$ inhibition, which initiates a sequence of downstream events (membrane depolarization, activation of voltage-gated calcium channels, $\text{Ca}^{2+}$ influx) culminating in secretion of insulin. Mutations that increase $K_{\text{ATP}}$ channel activity cause a broad spectrum of diabetic phenotypes while loss-of-function mutations cause hyperinsulinism. We report a novel mutation (Kir6.2[V290M]) identified in an infant with congenital hyperinsulinism (CHI). In radioactive rubidium efflux assays, cells heterologously expressing mutant channels showed a $0.79 \pm 0.11$ reduction in efflux rates relative to WT, both coexpressed with SUR1. Coexpression of V290M and WT subunits, to recapitulate the heterozygous state, showed a $0.39 \pm 0.20$ reduction in efflux rate. No difference in cell-surface expression was apparent between WT and V290M channels. Instead, decreased activity of V290M channels results from channel inactivation, observed electrophysiologically as a rapid current decay after relief of ATP inhibition. Residue 290 is located near the Kir6.2 intersubunit interface, adjacent to a salt bridge essential for channel function. The V290M mutation may destabilize this region, explaining the observed inactivation in excised inside-out membrane patches.
This research presents a formal theory of voter mobilization and demobilization with a model intended to approximate aspects of the American political system. The model developed describes the strategic interaction between parties when posed with incentives and constraints to mobilizing and demobilizing groups of potential voters. After performing comparative statistics on the model to understand its implications, we buttress these insights with knowledge of actual party-group alignments in American politics and establish the incentives for each party to mobilize or demobilize particular groups of citizens. The model enables us to determine which party is likely to find relative success for each given group and then looks to the 2004 election to see specific strategies in action. Ultimately, a case is presented for recasting the Republican Party’s anti-voter fraud efforts and emphasis on social issues as political maneuvers of demobilization and mobilization.
Cognitive biases, which are decision-making tendencies that challenge the assumption of rationality, have been influential in some Social Sciences. The question to be answered is two-fold. First, how can cognitive bias be expected to affect the NSC decision-making process? Second, what techniques and structures within the NSC can mitigate such tendencies?

I argue that both the Psychology literature and the Political Science literature suggest that the multiple-actor model proposed by Alexander George is least susceptible to the negative effects of cognitive biases. The multiple-actor model holds that there ought to be various independent centers of equally distributed analytic and persuasive resources within the NSC. This productive deliberation has strong commonalities with the debiasing procedures found effective in psychological experimentation.
This research examines studies and statistics related to homelessness in the United States, as well as interviews with thirty homeless members of the St. Louis community. The resources available to the homeless are not always compatible with their individual situations, which vary widely. The services offered might keep people off the streets, but these services may also keep them away from other people; this may make them feel invisible or unwanted. Resources which would promote movement, job maintenance, and visibility of the disenfranchised, such as public transportation passes or bicycles, are usually not provided. Interviews were used to examine how invariable long-term plans and impersonal, uniform handouts may have unexceptional effects compared to the sway of the nation’s economy, the availability of jobs and reliable transportation, and the attitudes of others. It is argued that homelessness is a problem whose complexity is not often fully addressed. With more in-depth consideration for individual needs, and a system of aid based on these needs, it may be possible to find better, more personal ways to aid St. Louisans in need and to incorporate them fully into the community.
Happiness and Political Attitude Change: Mood-as-Information and Heuristic Processing for Sub-Constructs of Ideology

Rick Andrews

Mentor: Alan Lambert

Past research on happiness and attitudes has shown two reliable effects. One, Mood-as-Information, occurs when people use their happy mood as information for judging a target, rating it more positively than they otherwise would. A second effect, Heuristic Processing, occurs when people in a happy mood rely heavily on their heuristics to make judgments. Research was conducted examining these effects in the realm of political attitudes. Subjects were placed in a happy mood (Please think about a time in your life when you were happy and write about it) or a neutral mood via a control condition (Please write about your everyday routine). All participants were then presented with a battery of political attitude questions. Results focus on two prototypical ideological constructs: a Belief in the Goodness of Human Nature (BGHN) index, and an Authoritarianism-Traditionalism (A-T) index. The present study finds a dissociation of the two happiness effects amongst sub-constructs of ideology. We find evidence that happy mood leads to a Mood-as-Information effect for BGHN, while producing heuristic processing for A-T. Important implications for both the happiness literature and ideology literature are discussed.
This research examines prevailing land tenure and property rights theories and compares them with customary land use amongst rural Bambara populations in the Malian Sahel. Though existing land tenure theory urges individualization and privatization of land in order to encourage investment and profit maximization, traditional land ownership in Mali is often shared or elusive and is therefore not conducive to policies that create formal, demarcated land parcels for farmers. The customary Bambara land system contains a number of social mechanisms which promote ethics of equality and community amongst village members. Its largest asset is its enforcement of the “subsistence ethic,” which ensures that all village members have the right to subsistence and allocates land accordingly. In light of increasing population pressures on arable land, environmental concerns and a general push for land formalization by local governments and international donors, I examine the ways in which land tenure reform can work customary land ownership in order to benefit rural Bambara farmers without deteriorating traditional social mechanisms like the subsistence ethic. Using research collected in Mali, cooperative farming is examined as one potential solution for this challenge.
The purpose of this work is to study the way political opinions are expressed in the public spaces of Israel/Palestine during the Israeli-Palestinian conflict of recent time, focusing on the period after the First Intifada. It will examine three media of expression: graffiti, bumper stickers and memorials. All three of these media stand on their own as lenses through which to look at expression in public, but I believe that linking them together will prove insightful in shedding light on public opinions surrounding the conflict.

The idea of analyzing political expression in public space is by no means a framework unique to the Israeli-Palestinian conflict. However, it is my belief that the space takes on a greater significance in this conflict. This conflict revolves around territories and claims on holy sites. Space takes on new meaning when every bit of it is contested.

The goal is to assess whether public spaces have become more or less political. Within each society there is much evidence of increasing frustration with ongoing conflict. From the election of Hamas in the Gaza strip to the decreasing voter turnout in Israel, mounting frustrations with politics are evident. This body of work functions to give substance and insight to those trends. Instead of scrutinizing percentages of people voting for a certain party, analyzing how citizens express their political opinions for the public illuminates the nuances of these statistics.
China has undergone vast changes in the post-Mao era especially in the realms of art and gender identity. During the Cultural Revolution, a system of “state feminism” was instituted for the purpose of what scholar Mayfair Yang termed “gender erasure.” Under this system, women were punished for having long hair, wearing short skirts, make-up or anything associated with bourgeois culture and instead were forced to dress in the same loose-fitting uniforms as men. These strict regulations resulted in the creation of a desexualized feminine body and the birth of the ‘asexual iron-girl’ of the Cultural Revolution. Consequently, contemporary Chinese women have been turning toward more essentialized notions of the female body and female identity in order to reclaim what was taken from them during the Cultural Revolution.

One area in which we can see evidence of this reclamation of the essentialized feminine body is in the works of art created by contemporary Chinese women artists. The four artists studied – Xing Danwen, Cui Xiuwen, Chen Lingyang, and Yin Xiuzhen, all produce provocative works of art in media that ranges from photography to video to used materials. The works of these four artists succeed in subverting traditional gender roles and fearlessly bring ‘private’ issues into the public sphere. However, despite their concentration on female identity and the female body, these four women also create works of art that go beyond themes of gender identity and creates a linkage between China’s quickly dissipating past and ever more globalized and modernized present. Thus, it is important not to simply categorize these artists as ‘feminist’ because of their biological gender and the thematic concentration of some of their work, but instead, to view their body of work in its cultural and historical context in order to truly understand its intentions and achievements.
As African colonies transitioned into independent states in the four decades following World War II, liberation leaders faced the difficult tasks of fighting for independence, designing new states, and simultaneously campaigning to be elected. While eventually losing out to Robert Mugabe, Bishop Abel Muzorewa’s role in the formation of Zimbabwe acts as a case study in understanding the difficulties involved in postcolonial state formation. A nonviolent clergyman, moderation helped Muzorewa reach an elevated position of authority early in the movement yet this position later proved unsustainable. Disillusioned with negotiation and optimistic about guerrilla war, others in the movement demanded radical military action, a demand to which Muzorewa briefly tried to cater. Rejected by the guerrilla movement, however, Muzorewa reluctantly turned to negotiations with the settler government. This solution proved unacceptable, however, because the international community set preconditions that precluded a solution based on moderation or compromise and effectively required a hard-line militant leader to take charge of Zimbabwe. Muzorewa’s political rise and fall demonstrates that moderation did not represent a viable option for transitional leaders in the initial phase of Zimbabwean national politics and suggests an explanation for the failure of moderation in the postcolonial transition throughout the continent.
Toward a Better Understanding of…

Cortico-Cortical Connections of the Dorsolateral Prefrontal Cortex

David Brodell

Mentor: Joseph Price

The prefrontal cortex is composed of many architectonic regions characterized by intrinsic and extrinsic axonal connections. The Price lab has studied this area in macaque monkeys and repeatedly identified two systems or “networks” within the orbital and medial prefrontal cortex (OMPFC) that have distinct and differential connections, both within the OMPFC and with other parts of the brain. The present study will examine the systems within the OMPFC in Squirrel monkeys (*Saimiri sciureus*). Squirrel monkeys are “New World monkeys”, which diverged at an early evolutionary stage from “Old World monkeys” such as macaques. Since Old World monkeys originated primarily in South America while New World monkeys have always lived mainly in Asia and Africa, this novel comparison will provide insight into the evolution of our human ancestors.

Retrograde and anterograde axonal tracers were injected into the OMPFC in two squirrel monkeys. Each brain was then stained and partitioned in coronal sections. A microscope digitizing system linked to a computer was used to map sections rostral to caudal. General agreement among labeled systems was found between both squirrel monkeys.

The patterns of axonal connections generated by this procedure confirmed many anatomical similarities between the macaque and squirrel monkey in the OMPFC networks, while a small number of important differences were found. In particular, the orbital network is connected with somatic sensory and visual areas in the insula, frontal operculum, and inferior temporal cortex, while the medial network is connected with the superior temporal and cingulate cortex and with limbic areas. Understanding of common neural networks has definite behavioral implications across primate families and species.
Before children learn that letters represent sounds, their early spellings are dismissed as random strings of letters. However, Pollo found that children sometimes perceive and utilize statistical patterns present in written language. Children might pick up these patterns from text to which they are exposed, such as books and signs. This study seeks to determine if success on later spellings can be predicted by the extent to which children’s prephonological, earlier spellings correlate with a corpus of such text. I examined spelling samples from 124 Portuguese-speaking Brazilian children, collected in 2 sessions, 6 months apart. For Time 1, children (mean age 5 years, 7 months) were deemed prephonological (“random”) if letters of their spellings were no more likely to correspond to the sounds of the stimulus words than one would expect by chance. Overall letter and bigram frequencies were obtained from a corpus of Brazilian children’s books. The degree to which the letter and bigram frequencies present in the children’s spellings correlated with corpus frequencies was calculated. Those children whose initial spellings correlate well with the corpus demonstrate attentiveness to text and, thus are expected to exhibit improved spelling accuracy at Time 2.
Shakespeare develops as a problem the relation between one’s internal and external self in *The Merchant of Venice*. In this work, I pay particular attention to two modes of navigating that boundary. First, the study considers sincerity, in which one communicates unreservedly one’s internal experience to others and second, prudence, in which one hides one’s intentions and feelings. While Shylock behaves with sincerity when he refuses to dissimulate in order to fit community demands for mercy, Portia acts with prudence when she uses the discourses of femininity and masculinity to pursue Bassanio. I claim that in the trial scene in *Merchant* punishment shifts from focusing on bodies to focusing on internal selves, much like the historical shift that Michel Foucault traces in *Discipline and Punish*. This change in punishment also involves a change in the relation between the internal and external; by forcing him to convert to Christianity, the community requires that Shylock not only be sincere, but be sincere in line with community demands. By critically depicting Shylock’s forced conversion, Shakespeare suggests that sincerity does not resolve the problem between the internal and the external. Rather, in *The Merchant of Venice* individuals need that tenuous boundary between the internal and the external.
This study explores two video camera methods for measuring 3D positional information at a distance in order to study primate locomotion in the wild. Direct Linear Transformation (DLT) techniques were used for camera calibration and 3D reconstruction. Calibration was accomplished by recording two camera images of a reference object from different vantage points. The reference object contained precisely measured control points, which were digitized in both camera views using computer software to resolve the DLT coefficients of the camera setup. In the first method, a single camera was used for calibration and reconstruction. Then movement was captured with the same camera in high-resolution video. 3D measurements for moving objects were determined using a scaling factor derived from dimensions between landmarks in the scene, either measured on site or estimated via DLT reconstruction. The second method used two digital web cameras running simultaneously from a laptop computer. 3D positional information was measured directly from synchronized stereo videos.

Methods were experimentally tested for accuracy, and the limitations of each system were considered in terms of portability and functionality. The techniques were then applied on three primate species from captive enclosures of variable size: *Pan troglodytes*, *Allenopithecus nigroviolids*, and *Macaca selenus*. Additional data from *Pongo pygmaeus* was included for comparison. Stride frequency, stride length, and velocity were calculated and compared to examine variation within and between taxa. Results suggest little inter- or intraspecific variation across primates. Testing also indicates that both systems reliably reconstruct gait variables, although the dual-camera method appears more promising.
Myosins are a family of motor proteins that walk on actin filaments, partaking in various cellular processes such as intracellular transportation and muscle contraction. Recently one of its members, myosin VI, was shown to stabilize actin structures formed during *Drosophila* spermatogenesis, a previously unknown role for myosins. Myosin VI is essential for the proper formation and movement of actin cones, which mediate cellular remodeling during spermatid individualization. To better understand this process, characterizations of the biochemical and physical properties of myosin VI and its mechanism of action are underway. Here, the potential mechanism of myosin VI in actin cone stabilization is explored by three separate approaches that analyze the behavior of myosin VI and actin cones when 1) the activity of androcam, a potential regulator of myosin VI, is altered, 2) the arp2/3 complex is manipulated to better stabilize actin cones, and 3) the expression of cofilin, an actin depolymerizer, is knocked down. In all cases, effects of alteration in these proteins are being measured in myosin VI loss of function defects. We hope that these different approaches will lead to a greater understanding of myosin VI’s mechanism in this process and be applicable widely to its role across the animal kingdom.
Toward a Better Understanding of...

Role of Phosphorylation in Cell Cycle Transcription

Lauren Chircus

Mentor: Barak Cohen

Tumors and cancers are associated with cell cycle defects and uncontrolled divisions. The mechanisms that drive the cell cycle in yeast are highly conserved in all eukaryotic cells. Thus, a comprehensive understanding of the yeast cell cycle can provide headway into understanding defects in less-easily manipulated cells, such as mammalian cells. Both cyclically expressed transcription factors and phosphorylation machinery drive the cell cycle in yeast; however, the interactions between these remain poorly characterized. *HCM1*, a transcription factor that drives the expression of genes involved in chromosome segregation, spindle dynamics, and budding during late S phase, is an *in vitro* substrate of the cyclin-dependent kinase Cdc28. This study aims to determine the role of phosphorylation in the function of *HCM1* by comparing cell cycle progression in cells with wild type *HCM1*, cells lacking *HCM1* function, and cells carrying mutations that prevent phosphorylation of *HCM1*. Early studies comparing the effects of plasmids containing the wild type and mutant genes in deletion strains remained inconsistent. Preliminary data indicates that integrating wild type *HCM1* into deletion strains complements the buildup of cells in G2. We hope to test our hypothesis that phosphorylation plays a role in *HCM1* function by integrating the phosphorylation immune mutant and testing whether it complements the deletion.
Toward a Better Understanding of...

**Barriers to Access: Evaluating the Accessibility of Judicial Bypasses to Minors in Missouri**

*Shyamali Choudhury*

Mentor: Barbara Baumgartner

Abortion-regulation law has a short, complex history. Several Supreme Court cases join together in defining and setting the precedent for a woman’s right to an abortion. Pregnant minors are similarly protected under the law, but have been subject to a special set of regulations, namely state mandates requiring parental consent for an abortion. Parental consent laws for minors seeking abortions have been found unconstitutional without the inclusion of a judicial bypass option. Judicial bypass allows a minor seeking an abortion to replace parental consent with leave of the juvenile court. Although Missouri has a judicial bypass option in place, the accessibility of this option to pregnant minors was previously unknown. This study assesses the reality of the statute’s accessibility. Evaluation of data collected shows a widespread lack of knowledge throughout the court system about the judicial bypass option. Every Missouri circuit court failed to provide complete and accurate information about the availability and nature of the judicial bypass. Whether courts are insufficiently informed, unwilling to dispense information or otherwise ill-equipped remains a question for future research. However, the effect upon pregnant minors remains the same; this study reveals significant barriers for minors attempting to exercise their Constitutional rights.
Though Herring Gulls (Larus argentatus) and Great Black-backed Gulls (L. marinus) breed in mixed-species colonies from Maine to New York, in the last century the number of Great Black-backed Gulls has increased over that range while the number of Herring Gulls has decreased. Aggressive competition by Great Black-backed Gulls over nest sites, foraging habitat, and prey may be contributing to the Herring Gull’s decline. Previous studies have examined the foraging habits of the two species in the rocky intertidal zone, but little work has examined how they interact with regards to anthropogenic food sources. The spatial and temporal use of the rocky intertidal zone by the two gull species on an offshore New England island during the breeding season was quantified in this study. Additionally, to examine how the two species interact over lobster fisheries discard, a lobster boat was mimicked by experimentally discarding lobster bait (Atlantic herring, Clupea harengus) at offshore sites around the Isles of Shoals, ME. The density of gulls in the intertidal zone varied by species and with time during the breeding season, with peak density and foraging activity occurring most often in the mid- to late-July period, which is when chicks require the most nourishment. Great Black-backed Gulls were the most abundant species overall as well as the most abundant forager per kilometer, and they were densest along two specific regions of the coastline. The majority of gulls in the intertidal zone were loafers (resting, preening, etc.) rather than active foragers. In the fisheries discard experiment, Great Black-backed Gulls took more bait (26%) than did Herring Gulls (9%), though the amount of bait lost (65%) exceeded the amount of bait retrieved by either species of gull. It appears that as the proportion of Herring Gulls in a lobster boat-trailing flock increases, more pieces of bait go to Herring Gulls; in contrast, as the number of Great Black-backed Gulls in a flock increases, no greater amount of bait is taken by Great Black-backed Gulls, and the amount of bait taken by each individual may even decrease. This pattern may be related to inter- and intra-specific kleptoparasitism: though both species were observed engaging in kleptoparasitism, the majority of thefts (94%) were initiated by Great Black-backed Gulls and the most common form of theft was Great Black-backed Gull from Great Black-backed Gull (56%). This has implications for the foraging activities of each species and may in part explain observations that Herring Gulls attend vessels in large numbers whereas Great Black-backed gulls do not.
Inbreeding is the mating of biological relatives that leads to an increase in homozygosity. Inbreeding depression is the reduction in fitness between inbred and outbred individuals due to deleterious alleles in homozygous form. Environmental stress factors are known to magnify the expression of inbreeding depression. Though much research has been focused on the effect of single stress factors on the expression of inbreeding depression, few studies have looked at the effect of multiple factors. In this study, the effects of multiple types of competition on the expression of inbreeding depression in the perennial plant *Mimulus ringens* are analyzed. Interspecific competition with the invasive purple loosestrife (*Lythrum salicaria*) and intraspecific competition with varying densities of *M. ringens* were used as the two environmental stresses. I found significant 2-way interactions between cross and each environmental factor, as well as two marginally significant 3-way interactions between cross, density, and competition in biomass and leaf length. The 3-way interaction trend shows that as stress increases, inbreeding depression actually decreases. The results of this study show a trend that multiple stresses may interact with cross. These results also have implications for conservation, as species of concern may suffer from inbreeding depression and multiple environmental stresses simultaneously.
In February 1939, St. Louis-born illustrator Al Parker published the first of what would eventually become a series of covers for the *Ladies’ Home Journal*. Showcasing a blonde mother-daughter duo participating in myriad activities, from ice-skating to swimming to baking, the covers ran for thirteen years. Moreover, they chronicled more than the lives of their two figures, but also of a nation affected by World War II. Throughout the series, mother and daughter share an uncanny resemblance and physical proximity that highlights their attachment to one another. As such, Parker’s cover series posits mother and daughter as a unit, one whose members’ physical and psychological identities intertwine. The closeness of their relationship reflects psychoanalytic discourse in use during the period of the covers’ publication, particularly the concept of the pre-Oedipal phase. However, these covers are more than expressions of mother-daughter bliss. Featuring a young daughter experiencing pre-puberty, these images hint at her development and eventual separation from the tight-knit relationship shared with her mother.

Parker’s covers also reveal much about World War II-era American society, including expected female gender and social roles. Depicting the cover mother simultaneously caring for her look-alike daughter and engaging in acts of patriotism with her, these covers underscore the ways in which the requirements of the war pulled women in various directions. In their evocation of domestic and familial duties as important women’s work and as vital avenues of patriotism, Parker’s covers also operate as modernized visualizations of “Republican Motherhood.” Rich and complex, the *Ladies’ Home Journal Mother-Daughter* illustrations are visual and cultural texts that illuminate the dynamics of the mother-daughter relationship, as well as women’s place within American society during the 1940’s and 1950’s.
Toward a Better Understanding of...

The Role of the Nutrient Mass Balance in Urban Land Use Decisions

Devki Desai

Mentor: Jeffrey Catalano

Urban environments have been found to significantly alter local biogeochemical cycles, necessitating their consideration in land use decisions, as the growth of urban land often outpaces even that of the urban population in the United States. A literature review and nutrient mass balance was conducted to synthesize and analyze the findings of urban-rural biogeochemical gradient studies on the effects of urban ecosystems on nitrogen, carbon and methane cycling while providing a practical application. Urban systems were found to be lower quality methane sinks than unaltered ecosystems of similar climate and soil type, while difference in accumulation of organic carbon in urban versus pristine environments was largely dependent on location of study. Many temperate urban environments were characterized by an accumulation of nitrate. While multitudes of nutrient mass balances have been constructed for agricultural systems and rural watersheds, very few have considered urban systems. The aim of this project was to construct a nitrogen mass balance for the urban environment of St. Louis, Missouri and analyze the utility of the nutrient mass balance as a tool for urban planners and an aid for land use decisions.
The regulation of heterochromatin and euchromatin in eukaryotes is an area of active research due to the effects of this DNA packaging on gene transcription and its subsequent roles in development, differentiation, and cancer. One question of particular interest is the causalities of constitutive heterochromatin formation based on local sequence organization. Previous studies have correlated the density of repetitious elements with heterochromatin formation. Using data mining approaches and novel annotation transformation techniques, we have analyzed a region of chromosome 3L of *Drosophila melanogaster* for potential sequence-specific targets and sequence patterns for constitutive heterochromatin formation using H3K9me2 values from a ChIP-chip experiment as indicators of the chromatin state. This approach is also being applied to the fourth chromosome, where regions of euchromatin and heterochromatin appear to be interspersed. Of the eight DNA sequence functions tested, LINEs, LTRs, GC content and somatic piRNAs contributed most to the prediction of heterochromatin status. A window of 20 kb captured most of the impact of any element. Computational prediction across the region of chromosome 3L resulted in 95% accuracy, which was far above the null hypothesis of 50%. In contrast, the analysis of chromosome 4 resulted in very poor algorithm performance, only yielding accuracy 4% above the null hypothesis. Using the region on chromosome 3L for training and testing on chromosome 4 also resulted in very poor algorithm performance. Chromosome 4 is recognized as heterochromatic in terms of DNA elements, but reported values for H3K9me2 are lower than those observed in chromosome 3 heterochromatin, resulting in this failure. Future work may add new datasets, modify parameters, or apply these techniques to related species of *Drosophila* to predict chromatin structure.
On January 1st 1994, the governments of Canada, the United States and Mexico implemented the North American Free Trade Agreement (NAFTA). Key goals of the agreement included more jobs, improved working and living standards, and clear and mutually advantageous rules of trade. The agreement sought to encourage competitiveness, cooperation, and development, with the final intention of using this as a model for other Latin American countries. Since then, the agreement has seen economic crises and many changes in political regimes. Attempts at improvements or renegotiations of the agreement are known as “NAFTA-Plus” models. How have these changes altered the perceptions of NAFTA and thus the trajectory of international trade within NAFTA?

The final restrictions and tariffs that had remained under NAFTA were eliminated as scheduled on January 1st 2008. However, the current global economic crisis has led to protectionist actions by Congress that are counter to the goals of NAFTA. The sources of changes in perception are as diverse and complex as the countries themselves and the debate about NAFTA has continually ebbed and flowed in the past 15 years. Mexican concerns include uneven growth and development challenges while Canadian interests include continued bilateral connections with the U.S. and increased relations with Mexico. The United States stands between these two neighbors and its concerns, which dominate the discourse, include job protection and national security. Using media coverage and progress reports mandated by NAFTA, I examine contemporary issues within the North American community that affect the perception of and consequently the effectiveness of NAFTA.
Hippocampal principal neurons, including dentate granule (DG) and pyramidal neurons, are key regulators of physiological and pathophysiological information flow through the hippocampus. DG neurons are considered a “gateway” to the hippocampus, as they receive strong extrahippocampal input and regulate the propagation of signals into the hippocampal circuitry. Recently, we have reported striking differences in the intrinsic axonal excitability between rat hippocampal DG and CA3 pyramidal neurons in vitro, including a 10mV depolarized granule neuron action potential (AP) voltage threshold. This may be vital to the filtering function of DG cells, which includes prevention of seizure propagation into the hippocampus in animal epilepsy models.

Here, we explore the basis for the depolarized AP threshold by characterizing the expression pattern of voltage-gated sodium channels (Na_v) in DG and CA3 axons. Na_v play an important role in generating APs by allowing rapid influx of sodium ions resulting in the upswing of an AP. Previous studies have found a high density of axonal Na_v clustering ~40 µm from the soma in CA3 pyramidal neuron, but axonal Na_v clustering in DG neurons remains unexplored. Additionally, previous studies have shown Na_v mRNA expression levels vary between hippocampal subfields and biophysical differences such as channel activation kinetics differ among Na_v isoforms. Differences in axonal Na_v clustering patterns, total quantity, and isoform expression between hippocampal principal neurons may contribute to AP voltage threshold differences.

Preliminary studies using multi-compartment modeling (NEURON software) suggest that both Na_v distribution and density contribute to the depolarized AP threshold in DG neurons. This can be understood by realizing that the AP voltage threshold is the highest at the site of AP initiation. Because of a more proximal AP initiation site in DG neurons, DG somatic recordings yield a more faithful reflection of this axonal voltage threshold. Therefore, the proximal location of axonal Na_v clustering leads to apparently weaker excitability as measured by AP voltage threshold. An understanding of factors controlling cellular excitability may eventually be exploited for the treatment of epilepsy and other brain disorders.
Toward a Better Understanding of...

**Correlates of Disordered Eating in Undergraduates**

*Spencer Kay Eastman*

*Mentor: Robinson Welch*

Full-syndrome eating disorders are rare in the population, with prevalence of Anorexia Nervosa estimated at .5%-.7% and prevalence of Bulimia Nervosa estimated at 1%-3%. However, eating pathology exists on a continuum, and those showing elevated sub-clinical pathology may experience substantial distress despite not suffering from full-blown disorders. These sub-clinical symptoms may develop into full disorders and may share the same causes and may therefore benefit from treatment similar to that used to treat clinical-level disorders. Dieting behavior considered “at risk” for development of an eating disorder is estimated at about 19% in college undergraduates. Intervention with this population can prevent transitions into full-syndrome eating disorders and address the dysphoria that may accompany intense dieting behavior. The present study draws on results of previous scholarship to identify correlates of disordered eating behavior, whether sub-clinical or clinical, which may serve as indicators of emerging or present pathological eating attitudes or behaviors.

Forty-eight undergraduates completed a battery of questionnaires on eating pathology, self-esteem, dietary restraint, stress, perfectionism, depression, social and physical competence, importance of social and physical competence, and academic expectations. Eating pathology correlated significantly with low self-esteem, dietary restraint, stress, depression, and lower expected GPA. Significant sex differences were observed in eating pathology, self-esteem, dietary restraint, stress, and importance of social and physical competence.

Findings are discussed in terms of detecting disordered eating in undergraduates by identification of their correlates and implications for intervention. Sex differences are also addressed and implications for early psychosocial intervention are discussed.
Nerve guidance conduits (NGCs) offer an alternative to autograft repairs of peripheral nerve injuries. Unfortunately, current NGCs are unable to induce axonal regeneration across large nerve defects, prohibiting clinical use. Prior studies demonstrate that aligned nanofiber materials provide unique topographical cues which enhance and guide axonal regeneration in vitro. The present study aimed to determine whether similar nanofiber materials could encourage functional nerve regeneration in vivo. Nanofiber NGCs were constructed using aligned, electrospun poly(ε-caprolactone) nanofiber mats which were formed into tubular conduits. Nanofiber NGCs were microsurgically implanted in rat sciatic nerve for 8 weeks. At the terminal time point, axonal regeneration within nanofiber NGCs, and functional nerve regeneration through nanofiber NGCs was assessed and compared to that of standard silicone NGC controls. Morphological and histomorphometric analysis of regenerated nerve tissue confirmed that nanofiber NGCs supported equivalent levels of axonal regeneration compared to silicone NGCs controls. Walking track analysis demonstrated that nanofiber NGCs induced greater functional recovery than silicone NGCs at later time points, which was confirmed by measurement of evoked force production in extensor digitorum longus muscle upon sciatic nerve stimulation. Together, these results suggest that nanofiber materials may provide a unique approach to enhancing functional nerve regeneration in vivo.
Toward a Better Understanding of...

The Influence of Person-Activity Fit on the Effectiveness of Happiness Training Programs

Marissa Fiorucci

Mentor: Michael Strube

For the past three decades, research regarding the maximization of happiness has become one of the primary topics for experimental inquiry. Recent work in the field has suggested the potential benefits of using person-activity fit models to enhance the efficacy of happiness training programs for the individual. This study used a diagnostic tool that tested the four dimensions of self-concordance in order to assign happiness exercises based on an individual’s best fit score. Participants assigned a best fit activity were compared to those who received a randomly assigned happiness treatment, no treatment, and a best fit placebo treatment. This study found that there were no significant differences in happiness levels between the treatment conditions across a period of three weeks. These unexpected findings may have been due to a number of factors. More specifically, reported levels of adherence to the treatment were particularly low and baseline happiness measurements as well as the reported influence of negative external circumstances over the treatment period were particularly high. Despite these limitations, multiple trends in the data suggest self-concordant happiness training has its merit. A number of changes may be made in future research in this area in order to improve the significance of findings.
New institutional economic theory emphasizes the importance of institutions in economic development. One of the most essential of these institutions is a strong system of property rights. The extremely robust protection of property rights in the United States is recognized as being a major factor in the enormous prosperity that this nation has enjoyed. However, within the United States, there is significant variation in how well property rights are protected. The goal of this project is to identify which institutions have an effect on the security of property rights, as measured by the foreclosure rate and housing prices. Data was collected on institutions in 41 United States cities in the four states of Illinois, Missouri, New Jersey, and Michigan. Results indicate that sales tax rates, property tax rates, burglaries, and the school ranking have the most significant effect on these two factors.
Bridging the gap between theory and reality: Does the Fair Trade Certified (FTC) model really have the potential to create real social change, and is it doing so today? In this thesis, the work of César Chávez, an activist for the rights of migrant workers in the U.S., and Paolo Freire, a Brazilian educator and theorist on social revolution are used to create a model of elements that are necessary for social change to occur. These elements include: consciousness, dialogue, power, the oppressed as non-passive actors in the process of social change, both long-term and short-term change, and a multi-cultural, multi-level approach to change. This model is then compared to (1) the current FTC model, (2) the goals that the founders of FTC originally had for the movement, and (3) on-the-ground research based on interviews with FTC coffee farmers in Oaxaca, México. I conclude that (1) the FTC model and (2) the founders’ “dreams” are essentially in line with the model of social change created in this work; however, there still seems to be a disparity between the theory of FTC and what is actually occurring on the ground. In particular, this disparity is attributed to the lack of consciousness and dialogue among producers within the movement, arguing that without these two basic elements, none of the other elements necessary for social change are possible.
This work is an exploration of the reasoning behind Fidel Castro’s first official announcement of Socialism on April 19, 1961. The factors affecting his ultimate decision are considered to be heavily influenced by the internal Cuban situation, the position of the United States, and the interest of the Soviet Union between January 1959 and April 1961. Ultimately, what is revealed is that rather than a decision entered into on the basis of Soviet coercion or United States oppositional pressure, Cuban Socialism, and specifically the time at which it was announced, was a result of the political milieu at the time the revolutionary regime came to power. With an unstable economy, a weak political structure, and a nonexistent military structure Fidel Castro was in a desperate situation. As Fidel Castro’s internal ties to the People’s Socialist Party grew, so did his fear of United States’ aggression, and desperation for Soviet support. His formal announcement of socialism, therefore, can be seen as an international plea for concrete and continued support from the Soviet Union and a statement of defiance and opposition towards the United States.
The Protective Effect of EGF in Septic Mice Is Intestine-Specific and Dependent on NFkB Activation

Heng Gan

Mentor: Craig Coopersmith

Sepsis is one of the leading causes of mortality in the intensive care unit. Exogenous administration of the peptide epidermal growth factor (EGF) has been shown to prevent intestinal epithelial apoptosis and improve survival in a murine model of ruptured appendicitis. However, it is unclear whether these protective effects are enterocyte-specific. Furthermore, previous studies have shown that inhibition of NFkB activation effectively blocks targets of EGF signaling. Therefore, EGF’s anti-apoptotic effect in septic mice may be dependent on NFkB activation.

Our lab utilized transgenic mice that overexpress EGF specifically in enterocytes (IF-EGF) to determine if the intestine-specific overexpression of EGF is sufficient to prevent sepsis induced apoptosis and improve survival. We also generated IF-EGF/NFkB and IF-EGF/No NFkB mice, both enterocyte-specific, to investigate if NFkB plays a role in EGF’s anti-apoptotic effect. We performed cecal ligation and puncture (CLP) or sham laparotomy on these transgenic mice. One cohort of mice was sacrificed for quantifying intestinal epithelial apoptosis. Another cohort of mice was followed for survival.

Septic IF-EGF mice exhibited normalized intestinal apoptosis and survival rate comparable to sham mice. However, these normalizing effects of EGF disappear in the absence of functional NFkB. We found that septic IF-EGF mice without functional NFkB showed significantly higher intestinal apoptosis and lower survival rate when compared to septic IF-EGF mice with NFkB. These results suggest that enterocyte-specific overexpression of EGF is sufficient to prevent sepsis-induced intestinal apoptosis and confer a significant survival advantage. Furthermore, EGF’s anti-apoptotic effect is dependent on the activation of NFkB.
All Are Welcome: The Roman Catholic Women’s Ordination Movement and the Motivations of Its Participants

Caitlin Gaskell

Mentor: Barbara Baumgartner

This thesis examines the contemporary movement for the ordination of women in the Roman Catholic Church and sheds light on the primary motivations of members of the movement. First, the historical, theological, and sociological background of the movement is outlined. The personal motivations of members of the movement are then analyzed through a case study of Therese of Divine Peace Inclusive Community, a parish founded by two women who have been ordained by Roman Catholic Womenpriests, a women’s ordination activist organization. It is argued that perceptions of exclusion from the institutional Roman Catholic Church are the prime motivators for those who choose to participate in communities founded on women’s ordination. While the presence of female priests is important to the members of Therese of Divine Peace, they primarily choose to worship there because the parish allows them to practice their Catholic faith while maintaining their commitment to beliefs about gender, sexuality, and spirituality that the institutional Church finds unacceptable. Thus, strength of the women’s ordination movement is not found solely in its promotion of women’s leadership; the movement’s emphasis on the principles of feminist theology and inclusivity is equally important to its success.
Toward a Better Understanding of…

**The Reattribution of a “Spanish” Dagger at the Royal Military College of Canada**

*Lucy Gellman*

Mentor: Alan Darr

Since its purchase for the Royal Military College of Canada in 1938, the Douglas Arms Collection has laid claim to an *Othello*-themed “Spanish Dagger,” dated c. 1890 and formerly in the collection of Mexican President Porfirio Diaz. While the Dagger’s “Spanish” origin has been largely uncontested by the museum because of its Toledo blade, this presentation will examine compelling stylistic similarities with daggers done by and in the manner of French artist Félicie de Fauveau (1802-1886), with the ultimate contention that this dagger should be reattributed to a follower of Fauveau, perhaps one using the same mold. The work examines in particular three compelling arguments: Fauveau’s general oeuvre, stylistic analyses of Fauveau’s Daggers in the Detroit Institute of Arts, the MFA Boston and the Louvre, and Diaz’s relationship with France during and after his Presidency.
This series of three projects has focused on developing natural language processing software for three Celtic languages: Irish, Scottish Gaelic, and Manx. These languages are “under-resourced” in the sense that they lack many of the computational resources we take for granted in English.

Two projects focused on developing machine translation (MT) software for Irish-Scottish Gaelic and Irish-Manx, building upon the framework provided by Apertium, an open-source MT platform that is developed at the University of Alicante in southeastern Spain with contributions from software developers around the world. The researcher’s contributions included coordinating the provision, processing, analysis, and integration of linguistic data required for the construction of morphological analyzers and bilingual dictionaries.

The third project focused on word sense disambiguation (WSD) for the Irish language. WSD is the computational task of determining the correct sense of a word having multiple possible meanings, given an instance of the word in context. A common example is determining whether an instance of the English word “bank” refers to a financial institution or to a side of a river. For this task, the presenter developed a naïve Bayes classifier with Yarowsky bootstrapping techniques to allow for supervised and semi-supervised machine learning from Irish text corpora.
How do students’ personalities moderate the negative emotions they experience as they progress towards an academic goal? Do specific emotional responses predict later changes in students’ academic performance? To answer these questions, forty-two undergraduates chose a course in which they were currently enrolled that they considered important to their long-term goals. During an initial visit they completed personality measures of the Big Five traits (Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness), and the traits of self-esteem, self-efficacy, locus of control, motivation orientation, optimism/pessimism, self-consciousness, and need for cognition. During four subsequent visits they reported their performance in their chosen course, and their emotional responses to this performance.

Results indicated that students’ personalities moderated the effects of emotion on their progress towards an academic goal by influencing their interpretation of both academic and emotional events. Each personality trait was associated with unique patterns of negative emotional experience, and unique patterns of subsequent academic performance in conjunction with certain emotions. This study suggests that the role of negative emotion in academic goal-attainment differs as a function of personality, and that further work must be conducted in order to more fully determine how each personality trait influences this process.
Christoph Hoerl argues that a person cannot be a moral agent without episodic memory. In particular, he argues that episodic memory is necessary for having a concept of time and that, without a concept of time, one is unable to consider or appreciate the future consequences of their actions. Understanding such consequences is necessary for a person to be considered a moral agent. Thus a person without episodic memory cannot be a moral agent.

I deny the first premise on empirical grounds. Patients with severe episodic amnesia are still able to understand time. This residual concept of time may be grounded in the window of working memory that remains even when episodic amnesia is complete. Thus, that episodic memory is not necessary for a concept of time or to be a moral agent.
Political Scientists often grapple with questions surrounding judicial politics. In order to have a complete, informed, and comprehensive study of the United States Supreme Court, we must fully understand all aspects of the selection, nomination, agenda setting, and decisionmaking process of Justices. Recent Supreme Court nominations have revived the discussion of what information is relevant for discussion during confirmation hearings. One area of research that could aid in understanding each of the aforementioned areas necessary for an informed, comprehensive study of the Court is the study of ideological drift. Concretely identified by Lee Epstein, Andrew Martin, Jeff Segal, and Kevin Quinn, ideological drift is the phenomenon of Justices moving across the ideological spectrum once they are seated at the Supreme Court bench. This research takes off where Epstein and her colleagues left off—examining the possible causes of ideological drift. Hypothesizing, drift is caused by changes in public opinion, length of a Justice’s tenure, and previous professional experience. This work ultimately concludes that while each factor appears to have a negligible effect on drift, the ultimate cause of ideological drift has yet to be determined.
Mlf1 is an Important Regulatory Protein Involved in Cilia Biogenesis and Maintenance

Kimberly Jenkins

**Mentor: Steven Brody**

Motile cilia line the respiratory tract and are extremely important in the defense against foreign particles and pathogens. Proteins that compose the structure of cilia have been investigated in some detail, but the specific pathways of cilia biogenesis are unclear. We have found that the transcription factor, Foxj1, is a powerful regulator of cilia biogenesis. A microarray study identified Myeloid leukemia factor 1 (Mlf1) as a highly expressed Foxj1-dependent protein. Prior to this study, Mlf1 was identified as a protein expressed in primitive hematopoetic cells of the bone marrow with an important role in determining leukocyte proliferation, apoptosis and differentiation. In these cells, nuclear Mlf1 has been shown to regulate proliferation and apoptosis with its involvement in leukemogenesis. Others have found that Mlf1 binds DNA and can activate genes for bone cell differentiation. We found Mlf1 is expressed in the nucleus and cilia of developing airway cells and adult airway cells, respectively. Therefore, it was hypothesized that nuclear Mlf1 plays a key role in airway epithelial cells by regulating programs for cell proliferation, apoptosis, and cilia biogenesis. In previous work we predicted that cigarette smoke would interrupt Foxj1-regulated pathways and, in particular, the Foxj1/Mlf1 pathway. To determine the effect of cigarette smoke on Mlf1 expression, in vivo and in vitro smoke exposure studies were preformed. In vitro, primary culture mouse tracheal epithelial cells (mTEC) were treated with cigarette smoke extract in media for 24 hours and analyzed 2, 4, 8, 11, and 14 days after treatment was initiated. We found that Mlf1 trafficked out of the cilia, into the cytoplasm, and then into the nucleus 4 days after treatment. By day 14, Mlf1 expression was again found in the cilia. In vivo, mice were exposed to cigarette smoke daily for 4 weeks, then evaluated for expression of Mlf1. Following cigarette smoke exposure, mouse cilia had decreased expression of Mlf1 in the cilia. Therefore, this suggests a mechanism that impairs function and motility of these cilia when exposed to cigarette smoke. Since we hypothesized that Mlf1 has a role in the nucleus and in the cilia, the focus will now shift to the nuclear role. We propose that over expressing a mutant form of Mlf1, which remains in the nucleus, early-on during development will result in altering cilia biogenesis. Based on studies by others, we have made mutant Mlf1 in a lentivirus vector, which others have shown remains in the nucleus. We have developed a method of using a lentivirus vector to overexpress genes in cultured airway epithelial cells that develop cilia. These studies, using mutant Mlf1, will help in understanding and characterizing the nuclear role of Mlf1 and determine whether it functions similar to Mlf1 found in bone marrow, which regulates proliferation and apoptosis, or takes on a completely different role. Knowing the mechanisms of cilia biogenesis and the pathways involved can further help in the advancement of methods used to care for patients suffering from respiratory diseases.
Toward a Better Understanding of…

Residential Identities: Wealthy Urban Housing as it Pertained to the Social Interaction Between the Upper and Middle Classes in Bath, Manchester, and London circa 1760-1840

Ann Johnson

Mentor: Steven Hause

How does urban elite housing in England at the beginning of the nineteenth century relate to the social structures? Homes were the means by which upper and middle class families defined themselves to both public and private circles. A family could proclaim moral rectitude, polite behavior, cultured taste, wealth, and membership in elite society.

The examination of three different cities revealed the language of homes in the upper and middle classes and buildings’ importance in the communication between the two classes. Research on Bath’s aristocratic housing examined traditional architecture and social norms. Manchester was a counterpoint to Bath, since its elite housing was almost exclusively middle class. Finally, the study of London showed both middle and upper class housing and the communication between the two classes.

In these cities, the research showed that how upper and middle class people lived and their public identities were inextricably linked. From layout to materials used, the house was the visible expression of social class. The style of furniture and arrangement of rooms were thought to declare the resident’s culture, politeness, and even morality. Linking architecture and social history reveals the increasing fluidity between the upper and middle class in England at this time.
Sovereign wealth funds, particular types of government-managed investment vehicles, have garnered increasing public attention as their portfolio sizes have swelled enormously over the past few decades. Much of this recent interest has been focused on the potential for foreign political involvement in public markets, with many fearing nefarious play by the world’s sovereign wealth fund holders, most of whom are non-Western authoritarian regimes. However, despite some speculation, little systematic attention has been paid to the investment motivations of these sovereign wealth funds. This paper postulates five distinct hypotheses as to why these funds might exist as extensions of their host governments’ domestic and foreign policies. Attention is paid to the ways a portfolio might be constructed to achieve each of these objectives. The second part of the paper uses this hypothetical framework to examine the investments and investment strategies of China’s various funds. A thorough examination of all of the known and forthcoming investments of China’s funds points to the fact that the country has largely acted as an economically motivated, rational investor despite much commentary hinting to its potential politically driven intentions.
The newfound economic prosperity in The People’s Republic of China has reached its citizens unevenly. This research analyzes the effects of economic modernization on the political structure for two Muslim minorities: the Uighurs and the Hui. The Uighurs suffer from dire economic inequalities and thus their low standard of living alienates them from the rest of China. They often react to these inequalities with separatist movements and sometimes even violence. Conversely, the Hui have built on a historical reputation of entrepreneurial and trade-related skill and made vast contributions to the Chinese development agenda. Accordingly, the Hui are arguably the best assimilated into Chinese society of any of the nation’s fifty-six minority groups. Ultimately it is clear that the political structure affecting the country’s different groups is influenced by economic status and state policies perpetuate the circumstances of both groups. These findings have important implications for the Chinese government, which should try harder to economically and socially incorporate all of its minority groups, and for the International Community, which can apply lessons learned in China to separatist movements in other parts of the world.
Exploring the Roles of Connexins and Their Influence on Congenital Heart Defects

Silvia Kim

Mentor: Patrick Y. Jay

With heterozygous mutations of Nkx2-5, a cardiac transcription factor, the affected hearts develop morphological abnormalities or conduction defects. Connexins are gap junction proteins that form channels between cells, allowing for communication between cardiomyocytes. Hence, these transmembrane proteins were suspected of being involved in propagation of electrical impulse and cardiogenesis. In this study, we attempted to discover whether the two connexins, Cx40 and Cx45, and Nkx2-5 reside in common pathways that govern cardiac morphogenesis. By investigating the influence of genetic background on the incidence of various congenital heart defects in the murine model, we analyzed the interaction between the three cardiac genes.

Results indicated that the incidence of heart defects associated with double mutations was not significantly higher than the sum of incidences for hearts with single mutation. Similarly, the incidence of defects for triple heterozygous mutations was neither significantly higher than nor equal to the sum of incidences for hearts with one gene knocked out. High incidences of heart defects were associated with Cx40 homozygous null mutants, in which many complete atrioventricular canal defects (CAVC) were observed. In the presence of this Cx40 homozygous mutation, Cx45 mutation seemed to increase the number of defects in a single heart, and exacerbate the risk for CAVCs. Results suggest that incidence of defects is not necessarily additive when there are two different genes knocked out but that there is evidence for synergism when both genes are knocked out for Cx40. These findings could lead to richer understanding of the genetic network governing congenital heart defects.
Toward a Better Understanding of...

The Impact of Foreign Aid Dependency: Sustainability of Antiretroviral Therapy in Uganda

Jennifer Klein

Mentor: Shanti Parikh

This research explores social roles and relationships resulting from delivery of antiretroviral drugs in a resource-limited setting. Obstacles to scaling-up HIV treatment with antiretrovirals in Uganda include: poverty, stigma, corruption and ineffective management. Additionally, antiretroviral treatment regimens, nutrition, other costs and relationships developed during treatment, contribute to the complexity of antiretroviral therapy. Thus, the most successful therapy programs are the most comprehensive and, consequently, the least sustainable. Uganda heavily relies on donor funds to support antiretroviral therapy programs. I propose that intense donor involvement in these programs contributes to a hierarchy of dependence akin to relationships created by other development and health efforts. Individuals and institutions at all societal levels are adapting to this system. The viability of HIV treatment must be considered as scale-up initiatives are developed and implemented. Despite successes achieved in Uganda, there remains a need for improved access to antiretroviral drugs. The mentality of dependence is important to consider when evaluating the efficacy of antiretroviral treatment initiatives in resource-limited settings, such as Uganda. This thesis concludes by briefly discussing various successes and areas to be further explored in order to make progress in adjusting to, or overcoming, this dependency system to ultimately achieve sustainability.
Activated Astrocytes Suppress Amyloid Plaque Pathogenesis in an Alzheimer’s Mouse Model

Andrew Kraft

Amyloid plaques and associated reactive gliosis are hallmark pathological features of Alzheimer’s disease (AD). Activated microglia are believed to play a role in the direct phagocytosis (albeit impaired) of amyloid, suppressing plaque progression; however, the precise role of activated astrocytes is not well-defined. To examine the role of astrocytosis in AD, we deleted the genes of two intermediate filaments required for astrocyte activation-glial fibrillary acid protein (GFAP) and vimentin (Vim)—in APP/PS1 mice. Previous studies have shown that gene deletion of gfap and vim results in normal-appearing astrocytes that are incapable of producing a reactive phenotype in response to brain injury or inflammation. Plaque load (% area), number, and size (um2) were compared between APP/PS1 gfap/-/vim-/- (g-v-) and APP/PS1 gfap+/+ vim+/+ (g+v+) mice, using a high-resolution “virtual microscopy” digital scanner and Image J software (to delineate plaques). Aβ levels in brain tissue were determined using ELISA. Astrocyte morphology in these two genotypes was examined by injecting mice with lentiviral vectors carrying green fluorescent protein (GFP) driven by a GFAP promoter 2 weeks prior to microscopic examination. APP/PS1 g-v- mice had significantly greater plaque burden than APP/PS1 g+v+ mice at 8 and 12 months of age, but not at 4 months of age (very early in plaque pathogenesis). Cortical plaque load was 0.19% in g-v- mice vs. 0.22% in g+v+ mice at 4 months (n.s.), 4.15% vs. 1.96% at 8 months (p < 0.05), and 9.73% vs. 5.63% (p < 0.05). Corroborating the plaque load data, guanidine extracts from g-v- brains showed greater Aβx-42 levels than in g+v+ brains (527.90 ng Aβ /mg protein vs 755.74 ng Aβ /mg protein, p < 0.05), while PBS and triton extracts were similar. Furthermore, the distribution of plaque sizes was altered by gfap/vim gene deletion: g-v- mice had more plaques of larger size. Astrocytes in both g+v+ and g-v- mice were closely associated with plaques; however, g-v- astrocytes showed finer processes and demonstrated attenuation of hypertrophic processes compared to g+v+ astrocytes. These results suggest that astrocyte activation does not affect initial plaque deposition, but limits subsequent progression of amyloid plaque pathogenesis.
The origin and legitimacy of private property rights have been the source of heated debate in political philosophy for the last few centuries. In order to be relevant, every theory of justice must address the question of whether or not it is possible for some individual to gain private rights to the use of some natural resource and to exclude others from its use. This central question underlies the issue of justice in property acquisition, which itself lies at the heart of the debate over property rights. The work examines Robert Nozick’s libertarian theory of justice and its conception of just property acquisition in contrast to two major competing theories: left-libertarianism and G.A. Cohen’s analytical-Marxism. The central claim is that—when properly clarified and supplemented to include a bargaining process of acquisition—Nozick’s theory of a robust and expansive system of property rights satisfies the demands of justice and better respects the ideal political equality than its leftist alternatives using numerical examples and real experiments.
Toward a Better Understanding of…

**When Generation Is Not Needed: Taking a Test Enhances Subsequent Reading Strategies**

*Glenn Kunkes*

Mentor: Mark McDaniel

One of the central questions about the generation effect, the retention advantage found for material that is self-generated compared to material that is simply read, is how it can be eliminated through improved reading performance on read material. The current study expands on deWinstanley and Bjork’s research which suggests that exposure to generated items with read items leads to the “spontaneous development of processing strategies for future to be read material that render it just as well learned as generated material.” Using different materials and participants, Experiment 1 replicates and extends deWinstanley and Bjork’s finding that exposure to contrasted generated and read items enabled participants to develop better processing strategies and eliminate the generation advantage on future readings. Experiment 2 attempts to disentangle Experiment 1 to determine what enabled participants to utilize improved reading strategies. By varying the exposure to contrasted generated and read items and the presence of an initial test with 97 participants (ages 19-26), Experiment 2 found that participants did not need generated words to serve as a “cue” or even exposure to contrasted generated and read items to recruit better processing strategies. It also found that having an initial test was critical for enhancing reading performance. These findings suggest that there is a learning to learn effect which affects participant’s abilities to improve their reading performance.
The breast is one of the most visible—and most highly objectified—aspects of a woman’s body. The ways a woman chooses to present her body often influence how society views her and—more importantly—how she views herself. Breasts are part of the human experience from birth, and the ways in which breasts affect a woman’s life are largely ignored and infrequently studied. Through examinations of the adolescent narratives of Judy Blume, Nancy Osa, and an anonymous writer; the fiction of Jeanette Winterson, Ntozake Shange, and Linda Hogan; memoirs by Audre Lorde and Jennifer Finney Boylan; and breast cancer narratives by Margaret Atwood, Audre Lorde, and Christina Middlebrook, this study draws on the wide array of women’s experiences with their breasts and is an effort to gain understanding of women’s relationships with their bodies. It serves as an exploration of how late twentieth-century American women’s writing discusses the modern female consciousness of the breast from a developmental and cross-cultural perspective. Breast dissatisfaction is a prominent issue for many women, but through gaining a women-centered understanding of the breasts women can gain a sense of fulfillment through their bodies. Writing the breast not only has the potential to promote social change but is also a mechanism for women to increase their personal sense of body satisfaction. In a society that encourages women to distance themselves from their bodily experiences and distrust the signals their bodies send them, an exploration of how women represent their breasts through their writing provides a potential space for women to validate and value their varied and connected experiences with their breasts so they can redefine what their breasts mean to them.
Toward a Better Understanding of...

“If You Don’t Have Money You Aren’t Going to Education Any Child:”
A Comparative Study Challenging the More and Less Developed Country Dichotomy
Gwen Leach

Mentor: Bret Gustafson

In development discourse, a distinction is made between more and less developed countries. More developed countries are those with a high level of social and economic development, while less developed countries are those with low standards of social or economic development or a general low level of material well being. The specific criteria used to formulate this distinction, however, is an issue around which there is much debate. This study uses a comparison of the education systems of Uganda, a country labeled as less developed, and the United States, a country labeled as more developed, to enter into that debate by questioning the practicality of the more and less developed distinctions. In both regions, access to substantive and high quality education requires significant financial resources, such that without money, no child will be educated.
While some individuals may be resilient in the face of an environmental stress, others become highly impaired. An example of inter-individual variability can be found in the severity of cognitive deficits and the amount of sleepiness observed between individuals in response to sleep disturbances. Thus, we evaluated the impact of a single gene polymorphism in foraging which results in altered levels of Protein kinase G (Pkg) activity. Flies with high levels of PKG (for\textsuperscript{R}) were resilient to 12 hours of sleep deprivation as measured by low sleep rebound and the absence of learning impairments. In contrast, sleep deprived flies with low levels of PKG (for\textsuperscript{S}, for\textsuperscript{S2}) displayed a wild-type sleep rebound and were learning impaired. Surprisingly, starvation reversed this resilience. Importantly, the differential response to starvation extended beyond sleep homeostasis and learning to long-term survival. Thus, for\textsuperscript{R} flies died more quickly than for\textsuperscript{S},for\textsuperscript{S2} in response to starvation. The for\textsuperscript{R} phenotype was recapitulated when the levels of foraging (UAS-for\textsuperscript{wt}) were increased in the \(\alpha\beta\) lobes of the mushroom bodies of otherwise for\textsuperscript{S} flies. Thus the ability of a single gene polymorphism to confer resilience/vulnerability to an individual is complex and depends upon both the environment and the behavioral outcome investigated.
Leishmania are protozoan parasites that cause disfigurement and death, infecting more than 12 million people. Current chemotherapy is poor, and drug resistance an increasing problem. Antifolates can treat other parasitic diseases, such as malaria, but not Leishmaniasis. *Leishmania* are pteridine auxotrophs and require exogenous pteridines (pterins or folates). *Leishmania* contain two pteridine reductases: a bifunctional dihydrofolate reductase-thymidylate synthase (DHFR-TS) and a novel pteridine reductase (PTR1) that bypasses inhibition of DHFR by inhibitors such as methotrexate. Thus, dual-target inhibitors, such as the quinazoline compound 34, were identified that inhibit both enzymes. Although these drugs are potent inhibitors, their mode of action appears to involve other targets, since overexpression of *PTR1* or null mutants of *PTR1* or DHFR-TS had little effect on drug sensitivity in attenuated lines.

This study validated that this situation holds in both attenuated and virulent lines by creating transgenic parasites overexpressing PTR1 and/or mutant DHFR-TS proteins that vary either their DHFR or their TS activities. Previous work aimed at generating *dhfr-ts* or *ptr1* null mutants suggests that there is a difference in pteridine metabolism between attenuated and virulent lines. We therefore used both specific and dual-target inhibitors to examine the variation between attenuated and virulent lines in their requirement for DHFR and PTR1.

As predicted from virulent lines’ inability to lose the DHFR-TS gene, these parasites are more sensitive to methotrexate (MTX) than attenuated lines and PTR1 overexpression did not produce a large increase in MTX resistance. However, manipulations of DHFR-TS levels had no significant effect on compound 34 sensitivity, either in attenuated or virulent lines. This is further evidence for a novel mode of action for folate analogues in *Leishmania* that cannot be explained by their inhibition of DHFR-TS and PTR1 alone. Ultimately, understanding the mechanism of these inhibitors may allow the design of more effective antiparasitic drugs.
The textiles of Sumba, an island located among the Lesser Sunda Islands of Eastern Indonesia, are integral to the Sumbanese understanding of their environment as they link the craft with their worldview of the island and prescribe ritual behavior. Ikat cloths, the most prevalent type on Sumba, are created by resist-dyeing cotton threads before weaving, wrapping sections in palm fronds to preserve the color underneath. Depicted in these textiles are stories and symbols drawing from the interaction of cultures throughout the island’s history. Indigenous animism and ancestor worship blend with Dutch colonial Christianity, imported trade goods including Indian *patola* cloth, and tourist tastes, resulting in a variety of multi-faceted cloth designs, which, it is argued, represent a “woven history” of the island. Similarly, I use Alfred Gell’s theory of Polynesian tattooing as images that protect and identify the human body, theorizing that Sumbanese ikats aim to accomplish the same function. Through the ritual context of funerals, I contend that the corpse is wrapped in textiles in order to protect them on their journey into the afterlife and the cloth designs help identify the deceased to their deified ancestors, or *marapu*. In practice, Sumbanese weavers create a woven history of their island, incorporating locally and foreign-derived motifs, ultimately arriving at a condensed, pictorial story of the evolution of Sumbanese ikat which, when placed on the body, serve to protect and identify it.
Toward a Better Understanding of...

Neoliberalism in Highland Guatemala: Global Impacts on the Local Maya

Jessica Lin

Mentor: Pamela Jakiela

This research project explores the effects of neoliberal trade policy on the development and implications of the non-traditional agricultural export sector in highland Guatemala. An anthropological analysis of how economic liberalization in this context changes experiences and meanings for the Maya is emphasized as part of the attempt to consider qualitative impacts of neoliberal development doctrine. The conclusions are that the modern connections to the global market do not necessarily negatively impact traditions and Maya identity yet engaging in the global market does pose great challenges for small farmers that should not be understated.
The 2008 Beijing Olympics marked unprecedented international focus on China. A series of anti-Chinese protests around the world leading up to the Games created tensions between China and other states; global media covered the protests in depth, debating what their significance would be for China’s foreign relations. This work examines media coverage of a specific series of Tibet-related protests that took place in Paris during the fifth leg of the Olympic Torch Relay. Media representations of these events revealed stark differences in the way China and France interpreted them, and the media were instrumental in exacerbating the controversy by promoting such different interpretations. It is argued that reporting in both countries was able to play such a critical role in amplifying oppositional sentiment because it made effective rhetorical use of long-standing national narratives to evoke the emotions of the public.
Despite considerable investigation into water transport and use in trees, research on grass hydraulics remains lacking. In this study, sap flow densities in 14 culms of an individual of the tropical, sympodial bamboo *Guadua angustifolia* were recorded using Granier heat dissipation sensors. Variations in sap flow dynamics were analyzed across the variables of culm age, size, height of measurement, and tissue type. Dynamics and trends were used to deduce conclusions about hydraulics in this species. Neither total daily sap flow nor maximum instantaneous sap flow correlated with culm size. Sap flow was found to occur predominantly between 23:00 and 09:00, suggesting positive root pressure as the primary mechanism for hydraulic movement in *G. angustifolia*. Sap flow measurements at different heights and a general lack of substantial diurnal hydraulics further suggest that nocturnally-pumped sap is stored within internodal cavities (lacunas) for daily use. In addition, differences among tissue sap flow profiles add that root pressure-induced sap flow is mediated by internodal tissue, while subsequent distribution to leaves and branches is carried out by nodal tissue.
Invasive plants are important threats to biodiversity that impact natural ecosystems through both direct and indirect effects on communities. Although direct effects have been well-studied, little is known about the indirect effects of invasions. It is hypothesized that invasive species may have indirect effects on native plants by impacting small mammal seed predators. This study examined 1) the effect of an invasive shrub on changes in rodent foraging behavior due to changes in perceived predation risk by the rodent, and 2) the impact of rodent preference for invasive shrub cover on removal of native seed species in invaded areas. The first part of the study measured giving-up densities in foraging trays that varied in presence of an artificial cover in forest patches of high and low *L. maackii* density. Significant changes in behavior and preference for artificial cover between high and low density habitats which co-varied with moon illumination were found and it is concluded that rodents prefer to forage in areas with high *L. maackii* density because of lower perceived predation risk. This indicates that invasive shrubs do change rodent behavior. The second part of this study examined apparent competition effects between *L. maackii* and native plant species (*Cornus drummondii* and *Symphoricarpus orbiculatus*) by measuring seed removal by rodents in the forest patches. No significant differences in seed removal rates across any of the effects examined were found. Slightly higher seed removal in high *L. maackii* plots might imply that rodents prefer those areas for protection from predation. However, native seed predation is not affected, possibly because the abundance of *L. maackii* seeds in the environment can supplement the rodents’ diet. Instead of competitive interactions between native and invasive species, *L. maackii* may provide a refuge for native seeds by supplying an alternative abundant food resource. Further research is recommended to examine invasive plant and rodent seed predator interactions across different spatial and temporal scales so that indirect effects of invasions will be better understood.
In this paper we analyze the strategies by which authoritarian regimes control the Internet. In specific, the policies adopted by the Cuban Government both under Fidel Castro and under Raúl are studied. It is hypothesized that, despite recent reforms by the new Castro administration, the Cuban government still follows a strategy of proactive control. To test this hypothesis we utilize both difference of means and a negative binomial regression model, and find that, though the government is following these strategies of control, they are not as effective as hoped.
This study investigates the origins and implications of an example of collective memory through a case study of an Advanced English class in Rabat, Morocco. The research analyzes three interconnecting elements building social memory: memory in daily life, texts and narratives translating memories among individuals across time, and salient symbols encoded in individuals. These three levels build into how social movements are imagined and implemented. The main sources of data were discussions with this class and other Moroccans; general observations while in the country; and written, personal interpretations of the story of Moroccan independence from the class. Six main symbols of the three levels of social memory were discovered. These include the king, Islam, the Western/Moroccan Sahara, human rights, women’s rights, and Berber rights. The class agreed that the king is the heart of the nation, Islam is a unifying force, Moroccan claims to the Western Sahara are central to Moroccan identity, and human rights are worthy of pursuit. However the class held more ambivalent opinions about women’s rights and Berber interests. The level of acceptance each symbol has at the individual level may be used to gauge the effectiveness of various redefinitions of Moroccan-ness and prescribe actions to solve social ills.
Toward a Better Understanding of…

To What Degree Do P Element Reporters Reflect the Expression State of the Genes Near Their Insertion Site?

Elizabeth Messer

Mentor: Sarah Elgin

In the eukaryotic nucleus, DNA is associated with a variety of proteins, forming chromatin. Chromatin is often classified into two forms, euchromatin and heterochromatin. The small fourth chromosome of *D. melanogaster* is of interest because it has a high gene density – usually a characteristic of euchromatin – yet exhibits the biochemical marks associated with heterochromatin. In previous genetic screens, the Elgin lab isolated a number of P element reporter lines mapping to the fourth chromosome of *D. melanogaster*. Our goal is to investigate how the expression levels of the P element reporters relate to the expression levels of endogenous genes at or near the insertion sites. Gene expression patterns of 13 fourth chromosome genes with P element insertions have been analyzed across ten developmental stages using quantitative PCR. We find that several fourth chromosome genes are expressed late during development, indicating that they are expressed regardless of the heterochromatin state of chromosome 4. We have chosen P element reporters from different genic regions, two that show full expression, and two that show a variegating expression, indicative of heterochromatin packaging. Expression of *hsp70-white* in late larval and pupal stages correlates with the eye phenotype, with low levels of expression being associated with a variegating eye. Expression levels of the *hsp70-white* reporter differ from the expression levels of the genes at the insertion site in several instances. Insertion of the P element can disrupt expression of the endogenous gene (seen for *Dyrk3* and *Syt7*), but in some cases (*sv* and *zfh2*) we find high levels of transcript with primers downstream of the insertion site at several developmental stages. The data generated by this project will illuminate the relationship between the behavior of a reporter gene derived from a euchromatic site and the behavior of an adjacent gene normally present in the heterochromatic fourth chromosome.
This paper examines women’s quest for equality in Switzerland. In order to understand the current issues, a brief history of the Swiss women’s suffrage movement is presented. In 1971, Swiss women received the right to vote in federal elections; however, they faced additional problems in asserting their autonomy. New legislation and projects at national and cantonal levels have enhanced women’s rights since the 1970s, yet problems remain in preventing women from entering the public sphere. These problems relate to domestic traditions that support stay-at-home mothers. As the government tries to overcome these obstacles, they encourage more hospitable work environments for women and families, allowing women to work part-time. I look into the factors that have helped women leave the home as well as what keeps them there and relate this to women’s varied success in the workforce. Most notably, it is more difficult for women in higher education and business to overcome obstacles than for women in the political sector.
Size-Structured Cannibalism and Role Reversal in Intraguild Predation Systems: A Theoretical Perspective

Joseph R. Mihaljevic

Mentor: Jonathan M. Chase

Classic intraguild predation (IGP) theory predicts a narrow three-species coexistence potential due to a strict competitive trade-off between the IG prey and predator. However, empirical tests often violate these criteria, showing that IGP systems can coexist without such a trade-off and generally within a wide parameter space. Recent models incorporating size-structured populations and cannibalism into IGP systems show that the initial predictions of the classic theory can be relaxed with high enough cannibalism rates in the IG predator. However, as both the IG predator and prey are predatory species, the IG prey has the potential to consume young (small) individuals of its IG predator. By incorporating such “role reversal” into previous size-structured models, this study demonstrates that the competitive trade-off between IG predator and prey becomes virtually obsolete. Additionally, this added interaction makes coexistence along a productivity gradient quite likely, even without a competitive trade-off. The synergistic interactions between cannibalism and role reversal in the IG prey may play a critical role in explaining the discrepancies between current and past IGP theory and empirical studies.
Toward a Better Understanding of Genes Linked to Breast Cancer—Bettering Prognosis and Treatment

Elana Mitchel

Mentor: Mark Watson

This research seeks to understand the relationship between gene expression and breast cancer prognosis. Specifically, the project has been to define the cell signaling pathways associated with breast cancer metastases. This involves computational analysis using MetaCore and IPA, two computer programs, to generate signaling pathways which correspond to genes identified as important in breast cancer metastases. New gene expression signatures in bone marrow cells that appear to predict the presence of breast cancer metastases have also been identified. The work involves isolating RNA and performing microarray analysis of patient’s bone marrow with metastasis to control patients who have never had cancer. In addition, we are validating previously identified gene markers in additional bone marrow specimens from breast cancer patients. This is accomplished by studying whether the expression of the eight genes previously identified appear to change over the clinical course in breast cancer patients.
This research explored the relationship between two closely-related species of the genus *Dodecatheon* in Southern Illinois: French’s Shooting Star (*D. frenchii*) and Mead’s Shooting Star (*D. meadia*). *D. frenchii* may have split from *D. meadia* by losing half its chromosomes, which would make it the only natural polyhaploid identified in the world. These two species of *Dodecatheon* grow in geographic sympatry but survive in very different ecological niches. The study focuses on the role of the hybrid population from Ferne Clyffe State Park that displays intermediate morphological and ecological characteristics between the two species. Provisional cytological evidence shows that the population is composed of triploids, the expected ploidy level of a hybrid.

If this hybrid population is viable, it might allow an indirect pathway for exchange of genetic information between the two species. The most basic way to assess this possibility is to determine the relative fitness of the intermediate population. We broke fitness into three components (fertility, fecundity, and viability) and compared the hybrid population to nearby populations of *D. meadia* and *D. frenchii*. To measure fertility, the populations were scored for the presence or absence of seeds in their seed capsules. Fecundity was measured by assessing the number of seeds found in these capsules. Finally, viability was measured by conducting a germination experiment that counted the percentage of planted seeds that eventually sprouted. We observed that both the hybrid population and *D. frenchii* had lower fitnesses relative to *D. meadia* but were still reproductively viable. The presence of a viable intermediate between the two species suggests that gene flow might still be ongoing in these two species despite barriers presented by different ploidy levels.

Further genetics studies were undertaken to gauge the level of gene flow, if any, taking place between the two species. The chloroplast DNA of 120 specimens of *D. frenchii* and *D. meadia* was extracted, sequenced, and scored for haplotypes. The results portrayed a system with significant geographic and taxonomic structure. Additionally, the level of population subdivision was significantly reduced in the population containing hybrids, which suggests that there maybe chloroplast gene flow facilitated by hybrid individuals in Ferne Clyffe. The exchange of genetic information appears to primarily flow from *D. frenchii* to *D. meadia* and is born by seeds. Given the rarity of polyhaploids and dynamic polyploid systems, we would recommend that its conservation reflect its natural instability and redouble efforts to preserve populations for the invaluable scientific information they can provide.
This thesis is an in-depth analysis of the impact of the International Criminal Court (ICC) in Sudan since the July 14th, 2008 indictment of President Omar al-Bashir. Several measures to determine the success of the ICC’s involvement were selected. These include rate of change in Internally Displaced Persons, number of humanitarian attacks, number of attacks on refugee camps and rate of change in troop deployment. Using data gathered by various NGOs, these indicators demonstrated a negative impact. However a significant change in the rhetoric of the Khartoum regime since the ICC involvement was also noticed. In an attempt to understand this more subtle change, the five-phase spiral model was applied to the situation in Sudan. Using this theory and the data gathered clearer conclusions could be drawn about the overall negative impact of the ICC both on the ground and on the Sudanese government.
Toward a Better Understanding of…

THE REMOVAL OF WASHINGTON UNIVERSITY: A CASE STUDY OF EDUCATION AND UNIVERSITY-COMMUNITY RELATIONSHIPS

James Mosbacher

Mentor: Heidi Kolk

Washington University is perhaps the most renowned and documented of St. Louis’ many academic institutions, and thus shall serve as a case study to understand the origins of the role that education plays in shaping community relationships in the St. Louis area. The beginnings of the relationship between Washington University and its influence in the surrounding community can be traced to the period between 1870 and 1910, during which rapid urban growth encouraged educational institutions across the city to relocate. Specifically, Washington University was one of many institutions that reconfigured its location, organization, and appearance in an attempt to ground and strengthen its position and the importance of education in the community. Such noble goals forced the University to take a stance on the type of community it would serve. The University’s architecture not only contains an institution, its values, aims, students, faculty, and administrators, but gives permanence to the relationship of the institution to the community it serves. For this reason, the implications of the decision to relocate the University at the turn of the century are still present today.
People with diabetes suffer from an inability to sufficiently control their own blood sugar which can lead to a range of various vascular diseases including heart attack and stroke. Although insulin therapy offers people with diabetes the ability to control their blood sugar, it carries with it an increased risk of lowering blood sugar too low, thus resulting in hypoglycemia. If severe enough, hypoglycemia can lead to brain damage, long-term cognitive impairments, and even death. Thus, determining ways to attenuate hypoglycemic brain damage is of the utmost importance for diabetic patients taking insulin. In other models of brain damage such as ischemia, brief, mild episodes of ischemia (pre-conditioning) cause a beneficial adaptation that protects the brain against a subsequent episode of more severe ischemia. In a similar fashion, we hypothesized that recurrent episodes of moderate hypoglycemia will “pre-condition” and protect the brain against damage caused by a subsequent episodes of more severe hypoglycemia (SH). Previous data has shown that such pre-conditioning has led to a reduction in brain damage in both the cortex and in the CA1 and dentate gyrus regions of the hippocampus—areas critical to memory. We hypothesize that this reduction in neuronal damage will translate to an increase in long-term cognitive ability. To test this hypothesis, 9-week old male Sprague-Dawley rats were made moderately hypoglycemic (~30 mg/dl) with insulin for three consecutive days (RH) and compared to saline injected controls (CON). On the fourth day, matched levels of severe hypoglycemia (~10 mg/dl) were induced in both groups for 90 minutes. The data suggests that the decreased brain damage in RH rats correlates with improved cognitive ability. RH rats took less time and traveled a shorter distance to find the platform during Morris Water Maze testing. These findings indicate that recurrent moderate hypoglycemia serves to “pre-condition” the brain, limit damage caused by severe hypoglycemia, and preserve long-term cognitive ability.
The Power of Collective Memory: Consequences for Affective Experience and Sociopolitical Attitudes

Thomas O'Brien

Mentor: Alan Lambert

The present research was concerned with gaining further insight into the consequences of collective memory, especially those memories that reflect unfavorably on the ingroup’s image. We randomly assigned undergraduates to conditions such that they were, or were not, provided with detailed reminders of the Battle of Wounded Knee (1890), which represents one of the most well-documented examples of the pain and suffering inflicted upon Native Americans by the United States government. Prior to that manipulation, participants either were, or were not, given the opportunity to express their feelings of attachment to the United States. Among the control (no attachment) condition, participants who were reminded of this historical event later expressed less positive opinions of the United States (and more sympathetic attitudes towards Native Americans) compared to participants not reminded of that event. However, among those initially assigned to the national attachment condition, the effect of reminding participants of this historical event was diametrically reversed: In this case, participants actually expressed more positive opinions of the United States, and less sympathy towards Native Americans, compared to participants not receiving this reminder. Implications of these findings for several theoretical paradigms in social psychology (e.g. dissonance theory, Social Identity Theory) are discussed.
As our world becomes increasingly wired in, the online community has seen an explosion in Internet weblogs. These online journals have evolved from an outlet for personal expression to a form of amateur journalism that is influencing, and in some ways replacing, the mainstream media. While blogging is still in its earliest stages in the Middle East, it is still having profound impacts on Middle Eastern society, media and governments’ relationships with their populace.

The work explores the historical purpose of the blog and examines the different ways weblogs are redefining the role of the traditional media both in the United States and Middle East. The research shows blogs are expanding their roles as second level agenda setters and are beginning to play a bigger role in priming the public’s perception of current events. Most importantly, blogs are redefining journalism in a way that promotes civic engagement and dialogue. While there are very real criticisms of the reliability and accuracy of blogs, the research shows blogs are de-evolving power away from those in control of the mainstream media, both state and corporate controlled.

This study looks at the rapid growth of blogging in the Middle East, with a case study focus on Iran. Blogs in the Middle East are redefining traditional public space and allowing typically marginalized groups such as women and dissidents a voice in the civic sphere.
In humans, cancer spread, or metastasis, is the leading cause of cancer related deaths. Epithelial mesenchymal transition (EMT) is a cellular process whereby epithelial cells lose their adhesiveness to one another and assume mesenchymal cell features. EMT has recently been appreciated to contribute to cancer metastasis due to a set of transcription factors that directly repress epithelial gene transcription while indirectly activating a mesenchymal gene program. The Snail (SNAI1) family is one such family of transcriptional repressors. Snail directly repress transcription of E-cadherin (CDH1) a suppressor of cancer metastasis. Snail levels are transcriptionally induced in the cells at the leading edge of invading cancer, yet are also post-transcriptionally regulated through protein stabilization and nuclear cytoplasmic trafficking.

A plasmid that produces a fusion protein human-Snail and the bioluminescent protein clic beetle green (CBG) was created. Clones of human HEK293 cells stably expressing Snail-CBG were isolated and characterized. Several control experiments to ensure that Snail-CBG functions appropriately (similarly to endogenous Snail) in HEK293 cells were conducted. Presently a single HEK293 Snail-CBG clone is used to screen for kinases and phosphatases that directly or indirectly influence Snail-CBG stability. Confirmed candidates will then be investigated in cancer samples for evidence of altered expression levels or activity in metastatic disease.
Prior to 16 May 2003, Morocco was an exception in the Greater Middle East. Its state and people had not yet been the targets of an extensive terror attack. On 16 May, several Moroccans from the Casablanca shantytown of Sidi Moumen carried out violent attacks against symbols of Morocco’s close relations with western powers. The individuals responsible for the attacks subscribed to the ideology of Salafism and chose violent means to carry out their goals. This study aims to examine the culturally specific case of Salafiya al-Jihadiya in Morocco and the ways it is manifested in response to Morocco’s reputation as having turned against Islam. Focusing counter-terrorism measures in Morocco on preventing and countering radicalization through socioeconomic programs rather than aggressive, military-based strategies could prove to be beneficial in targeting the root motivating factors of terrorism. Previous scholarship on the study of poverty and terrorism has denounced poverty as a causal factor in contributing to “global jihad,” but in this work I propose that “global jihad” is too broad a category to be studied effectively. In Morocco specifically, social marginalization often occurs in congruence with poverty. Concentrating on efforts that aim to reintegrate these marginalized populations into the larger society may reduce violent manifestations of Salafiya al-Jihadiya in Morocco.
Functional neuroimaging studies often reference cortical activations in terms of Brodmann’s areas. However, there exists no organized repository of the functions that occur in each area. Such a tool would provide access to consolidated information regarding the functions occurring in each Brodmann’s area. The objective of this research was to provide a comprehensive, interactive online tool that shows the functions correlated to each of the 52 Brodmann’s areas, as cited in published abstracts of fMRI and PET studies.

Abstracts that included the words “fMRI” OR “PET” and referenced a specific Brodmann’s area or its anatomical correlate were reviewed on PubMed. Searches were limited to studies involving normal volunteers. 2,275 abstracts were further reviewed. 869 abstracts were cited for findings of functions occurring in certain brain areas. These citations were used to create a webpage for each Brodmann’s area. Each page provides a categorized list of the functions associated with that area, listed hierarchically in order of functional importance. Links to supporting abstracts are provided parenthetically beside each function. Users navigate the site by: (1) clicking on lateral and medial graphics of the brain, (2) selecting an area number on a table, or (3) scrolling through axial slices of MRI brain images and choosing an area of interest. Additionally, there is a Directory of Functions, a table that shows relationships between different Brodmann’s areas by grouping the numbers of multiple areas that have been correlated to the same function. The website URL is: http://www.fmriconsulting.com/brodmann. It is intended that the Brodmann’s Interactive Atlas will provide access to the many functions that have been correlated to Brodmann’s areas.
Upon injury, most central neurons have limited capacity for repair. Peripheral neurons, however, are able to repair and regenerate. A better understanding of this mechanism would provide insight into treatment of central nervous system trauma. Studies suggest that signals are transported to the cell body to trigger a shift in gene expression initiating axonal repair.

One component of axon damage signaling is c-Jun N-terminal Kinase (JNK), which appears to be activated and transported retrogradely from the injury site. Sunday Driver (syd), a JNK-scaffolding protein, possibly regulates retrograde transport of activated JNK. Upon axonal damage, syd interaction with the dynein-dynactin retrograde motor is increased. Activated JNK also phosphorylates syd at three threonine residues. We hypothesize that syd phosphorylation by activated JNK upon axonal injury promotes an enhanced interaction between syd and dynein-dynactin.

To test this hypothesis, three potential phosphorylation sites were mutated from threonine to either glutamine, which mimics constitutive phosphorylation, or alanine to prevent phosphorylation. To assess whether these mutations affect syd transport, we examined the subcellular localization of these mutants in N2A cells. The biochemical interaction of these mutants with dynein-dynactin was also examined. Preliminary data suggest that phosphorylation of at least one residue increases syd interaction with dynein-dynactin.
This thesis provides a general theory suggesting that the electoral interests of state lawmakers may explain why states pass laws allowing our armed forces to vote from overseas through an Internet-based system. Two general hypotheses were posed: (1) that the level of Republican control over state lawmaking institutions will be predictive of the likelihood of bill passage, and (2) that states with a higher proportion of military persons will be found to be more likely to pass laws allowing Internet-voting. Eight of the ten states that have passed specific statutes to allow military Internet-voting were analyzed. Statistical analysis indicated that the relationship between GOP control of state lawmaking institutions and the likelihood of bill passage was not significant. The relative size of state military populations was not found to be significantly associated with bill passage either. However, other important trends were observed, and the model remains plausible. As more states take the initiative to pass laws allowing Internet-based voting for overseas military personnel, a more conclusive relationship may emerge, and this remains an important and timely area of study.
Necrotizing enterocolitis (NEC) is an inflammatory disorder of the intestine affecting preterm infants. Epidermal growth factor (EGF) is a developmentally expressed peptide that promotes intestinal maturation and cytoprotection. Premature infants are deficient in EGF and NEC patients are further deficient, suggesting a role for EGF/EGFR in the genesis of NEC. To determine if variants in *EGF* or *EGFR* are associated with NEC among infants, we sequenced all exons/splice sites of *EGF* and *EGFR* from DNA obtained from a case-control cohort of infants. We identified 5 synonymous, 11 non-synonymous, and 28 intronic SNPs in *EGF*. Three infants with NEC had one damaging *EGF* variant; one infant with NEC had two. Six infants without NEC had one damaging variant. We identified 12 synonymous, 5 non-synonymous, and 41 intronic SNPs in *EGFR*. A damaging *EGFR* SNP in an alternatively spliced transcript and was found in one infant without NEC. *EGFR* genotypes at an intronic SNP and a synonymous SNP were over-represented in infants with NEC. Although this cohort is underpowered to detect association of rare variants of *EGF* or *EGFR* with NEC, 35% of the cohort carried potentially damaging variants in *EGF*. This excess of variants suggests the possibility that a proportion of NEC is attributable to genetically determined deficiency of EGF.
The average American today spends roughly half the money he/she spends on food each year at restaurants, a percentage which has doubled in the last quarter of a century. Likewise, interest in the environmental impact of the food service industry has increased sharply. Restaurants represent a particularly intensive use of resources including energy, water, and paper in addition to problems with pollution. Large corporate restaurants and small locally-owned businesses demonstrate differing approaches to improving environmental performance; so which is more efficient in achieving environmental goals?

To compare these two styles of environmental management, a study was conducted which draws on economics, ethics, and business theory to investigate environmental decision making in the restaurant industry. Personal interviews were conducted with restaurant owners and managers and information was gleaned from company literature in order to collect comparative data on corporate restaurants and locally-owned eateries located within the St Louis Delmar Loop District. The research finds that both restaurant types maintain advantages and disadvantages in addressing environmental concerns. These attributes result from differing roles of publicity, strategic versus opportunistic environmental action, and unique methods of innovation. Moreover, understanding these distinct decision making processes provides insight into furthering environmentally-minded actions for the future.
Why are Muslim communities better integrated in some European countries than in others? Muslims are currently the largest religious minority in Europe, but also the most severely disadvantaged in the European labor market. This work presents an empirical analysis of the effects of three specific factors – antidiscrimination laws, citizenship requirements, and political activity and representation – on the success of Muslim integration in France, Germany, the Netherlands, Spain, and the United Kingdom. The unemployment disparity between Muslim immigrants and native European citizens is used to measure the success of Muslim integration in the five countries. The results of this analysis show that of the three factors studied, Muslim political representation has the greatest positive correlation with Muslim integration and reflects citizenship, as well as a high-level of societal investment and integration. Citizenship laws are also an essential component to a successful model of integration because non-citizens are often denied access to the labor market, are unable to vote in elections or hold national office, and are not protected by national antidiscrimination laws. Finally, antidiscrimination policies are also an extremely important tool to increase employment, but they must prohibit discrimination on the basis of religion or religious beliefs in order to be effective for Muslim integration.
Toward a Better Understanding of...

**The Contribution of Demography and Dispersal to Relative Invasiveness in a Dandelion Congeneric Pair**

*Katherine J. Seidler*

Mentor: Ellen I. Damschen

Invasiveness is a phenomenon that is of interest in ecology for the prevention of significant financial and biological costs, as well as for our understanding of fundamental aspects of community structure, such as species’ distributions and abundances. In order to explore the contributing factors to differential invasiveness, a congeneric pair in the family Asteraceae: *Taraxacum officinale* and *Taraxacum erythrospermum* were studied. *T. officinale* is more widely distributed than the native *T. erythrospermum* and is considered to be invasive.

In order to realistically parameterize a model of invasion speed, empirical data on both species at Tyson Research Center was collected during the summer of 2008. For each individual in the survey, I measured available sunlight, competitive ability, plant height and reproduction as represented by seeds produced. Dispersal was quantified by collecting seeds from sticky traps placed at proportionally increasing distances from source plants in the field. Finally, seed viability was determined by performing triphenyl tetrazolium assays on seeds collected both this summer and the previous year.

Survey data showed that *T. officinale* individuals are significantly taller than *T. erythrospermum* individuals. The dispersal data showed that *T. erythrospermum* released more seeds at the first few distance increments near the source, while *T. officinale* released fewer seeds at each distance increment, but dispersed over a greater distance overall. While according to the tetrazolium assays a greater percentage of *T. erythrospermum* seeds are viable, the survey showed that *T. officinale* produced significantly more seeds. These data were used to create a demographic projection model that derived a population growth rate for *T. officinale* of 5.9, which is slightly higher than the rate of 5.6 derived for *T. erythrospermum*. In addition, an elasticity analysis of the data in the demographic matrix showed that reproduction was the most significant contributor to the greater population growth rate of the invasive dandelion.

Both the demography and dispersal data were used to model the invasion wave speed. According to this model, *T. officinale* has nearly double the invasion rate of *T. erythrospermum*, with a value of 3.65 as compared to 1.86. Thus, the data show that small differences in height and fecundity have significant impacts on invasion speed. These results suggest that since both demography and dispersal play vital roles in determining species distribution patterns and the importance of specific transitional life stages is not always obvious from raw empirical data, more realistic modeling approaches are needed to understand and prevent invasion.
The Mississippi River is America’s greatest natural resource. It is an essential source of recreation and drinking water for numerous communities. The Mississippi River must not only be sustained for current generations but for future citizens as well. Creating comprehensive models of resource management that balance every interest remains complicated. Collaborative institutions have arisen over the last thirty years to meet this challenge. The Upper Mississippi River Basin Association formed in 1972 and the Lower Mississippi River Conservation Committee formed in 1994 exemplify cooperative innovation. How effective are these institutions in promoting stakeholder cooperation? In answering this question, this study examines the structure and functions of both organizations in the context of Edward Weber’s *Pluralism By The Rules* (1998), which presents six rules for effective collaboration. Via Weber’s model, one sees the UMRBA possessing greater capacity to achieve cooperation through the Navigation and Ecosystem Sustainability Program and the Environmental Management Program, both basin-wide programs. In contrast, the LMRCC lacks similar basin-wide programs. However, it has been entrepreneurial with its Natural Resources-based Economic Development model, integrating Lower Basin restoration into economic growth. Understanding collaboration’s effectiveness on the Mississippi River has many implications for scholars creating solutions to protect America’s natural resources.
As with many issues in Spain’s society, the national government and the local
governments of the Autonomous Communities lie in conflict over immigration and
the integration of immigrants. While the national government pushes policies that
address immigrants as a whole, the local governments have to deal with the intricacies
and differences that come about through the regional nature of immigrant patterns.
The lack of alignment between the two governments creates safety and quality of life
problems for both immigrant groups and the native Spanish population. In this project,
research was conducted on news media, surveys done at immigration offices, and
Spanish government documents and laws. In particular, the research focused on two
groups: Moroccans and Ecuadorians, as the largest immigrant populations as of 2009.
The research suggests that in the cases of both immigrant groups, greater success in
integration, and the avoidance of danger while immigrating, will come from allowing
the local Autonomous Community governments to exercise more control in creating
and implementing immigrant policies.
Toward a Better Understanding of...

**FUNCTIONALIZED ELECTROSPUN NANOFIBERS SERVE AS A DYNAMIC, INTERACTIVE SCAFFOLD FOR PRIMARY CARDIOMYOCYTES IN VITRO**

*Daku Siewe*

*Mentor: Daniel W. Moran*

The ability to successfully harvest, culture, and maintain functional monolayers of primary cardiomyocytes is critical to future developments in cardiac tissue engineering. Previous studies have demonstrated that aligned, micropatterned surfaces improve both the differentiation and function of primary cardiomyocytes in vitro. However, prior substrates are limited to in vitro applications and have only employed large-scale topographical features as a means of organizing seeded cardiomyocytes. In the present study, flexible, biodegradable nanofibers were utilized to construct scaffolds capable of supporting primary cardiomyocytes. Novel substrates were prepared by electrospinning poly(ε-caprolactone) nanofibers in a variety of patterns (aligned, crossed, and random). The effect of nanofiber orientation on cardiomyocyte organization, survival, and function was determined by seeding primary cardiomyocytes obtained from embryonic (E8) chicks on nanofiber materials for 6-28 days. Fluorescent microscopy demonstrated that aligned and crossed nanofibers directed cardiomyocyte orientation and enhanced elongation of seeded cells. Time lapse optical microscopy also demonstrated the ability of monolayers to spontaneously contract and mechanically alter nanofiber matrices, revealing the intimate interface between seeded cells and nanofibers. Results indicate that nanofiber topography effectively modulates the growth, differentiation, and function of seeded cardiomyocytes, and that such scaffolds may be useful in organizing cardiomyocyte monolayers for in vivo applications.
As Americans began to turn their interest outward after the end of the Civil War, they were faced with determining what their role would be in a world increasingly divided between colony and colonist. Over the second half of the nineteenth century, the increasing American preference for imperialism over isolationism can be traced through changing attitudes to the Orient, which was a convenient signifier for European imperialism. As inheritors of European culture, Americans also inherited the European interest in the Middle East, both as a site of exotic foreignness and as the source of Biblical tradition, yet this was a tradition still reliant upon European culture. This work examines the ways in which two popular texts, Mark Twain’s *Innocents Abroad* (1869) and Lew Wallace’s *Ben Hur* (1881), represented attempts to rewrite the Orient according to specifically American needs. By allowing the United States to experience the Middle East directly, these authors attempted to place their nation in a position of power, outside of the shadow of Europe.
This work investigates the effects of immigration into the European Union and how changing demographics are affecting the concept of a transnational identity. A product of the age of globalization, the relocation of Muslim immigrants to Western Europe is shaking the historical foundation of what it means to be European. This project both documents the development of the EU as a conceptually revolutionary multinational polity and how it has changed the character of Europe. Furthermore, the project examines three case studies, taking an in-depth look at France, Spain and Germany, and how each of these Western European nations is approaching the influx of Muslim immigration. The debate between the value of domestic cohesion through rapid societal integration versus the celebration of multi-ethnic diversity and the maintenance of traditional European culture is complex. However, examining the successes and failures of immigration policy, as well as patterns of social unrest across modern Europe, it becomes clear that a harmonious national culture directly strengthens a transnational sense of identity which, in turn, bolsters the influence of the European Union as a mutually beneficial political-economic system.
A Proteomics and Systems Biology Approach for Biomarker Discovery in Radiation-Induced Lung Inflammation

Sarah J. Spencer

Mentor: Issam El Naqa

Patients with advanced lung cancer receive radiation therapy as their main course of treatment, but radiation-induced lung inflammation, clinically known as pneumonitis, is a potentially fatal condition that damages normal lung tissues and limits treatment success. To control the risk of pneumonitis, radiation oncologists currently use physical factors such as dose-volume metrics and tumor location in treatment planning. However, these physical metrics suffer from limited predictive power when applied to lung cancer patients prospectively. In this work, we used a systems biology approach based on proteomics profiling to delineate complex biophysical interactions and to build a predictive model of lung injury. Samples for proteomic analysis were extracted from blood sera in a prospective clinical trial at various time points. We utilized a three-way proteomics strategy to screen for relevant proteins that may be involved in the onset of pneumonitis. Preliminary experiments yielded 43 candidate biomarker proteins for radiation pneumonitis. These proteins are related to various processes, including tissue remodeling and cytokine expression. With biochemical validation in a larger patients’ cohort and additional research on signaling interactions between candidates, investigations will work to advance the clinical goal of stratifying radiotherapy patients into risk groups based on individual proteomic profiles.
The testing effect is a robust phenomenon in which previous exposure to material through quizzing enhances later test performance on the same material. Although well established in the laboratory setting, relatively little research has been conducted in ecologically valid settings, i.e., the college classroom. Critical differences exist between laboratory and classroom settings; thus, to address this gap in the literature, we varied exposure to learned material in an experimental psychology course through short answer quizzing, read facts, or no exposure. Although data were based on a small N, the general trends revealed that items previously exposed through quizzing fared better on exam questions than both read items and unexposed items. Future studies may look to replicate this study’s results with a larger sample.
Circadian Gene Regulation of Bmal1 in Astrocytes

Adrienne Swanstrom

Mentor: Erik Herzog

Circadian clocks control daily rhythms in many organisms including plants and animals. These rhythms are generated by an intracellular transcription-translation negative feedback loop. In some mammalian cells, the canonical model posits that CLOCK and Bmal1 proteins heterodimerize to induce transcription of the Period and Cryptochrome genes. PERIOD and CRY then heterodimerize to suppress Clock and Bmal1 transcription so that this transcription cycle repeats approximately every 24-h (Ko and Takahashi, 2006). To ascertain whether this molecular clock functions in mammalian astrocytes (a type of glial cell), we monitored Bmal1 and Period2 gene expression in astrocytes of nine different genotypes (wild-type, NPAS2-/-, Per1-/-, Per2-/-, Clock/Clock, Cryptochrome 1-/- Cryptochrome2-/-, Cryptochrome 1 -/- Cryptochrome 2+/-, Bmal1-/-, Bmal1+/-, and Vip-/-). We transfected cultures with a firefly luciferase gene driven by the promoter of either Period2 or Bmal1. We found circadian rhythms required Per1 and Per2, Cry 1 and Cry2, and Bmal1, but not Npas2 or Vip. The Clock mutation also disrupted circadian gene expression in astroglia. The study concludes that astrocytes require the same clock genes as other cell types to generate circadian rhythms.
For the past three decades, global leaders have championed the cause of alternative energy development in order to reduce dependence on oil and to mitigate the environmental impacts of fossil fuels. However, despite proven strategies and successful technological developments, the pace of alternative energy implementation across the world has failed to reach any significant level. This paper takes a micro approach by analyzing alternative energy development in the electricity sector for thirty-three countries around the world, both developing and developed. Looking at the breakdown of energy production, two hypotheses are formulated. The first is that in countries where electricity prices are high for consumers, there is a greater likelihood of investment in alternative energy and secondly, that alternative energy development is more likely to occur in countries where industries pay less for electricity, demonstrating the power of the industry sector to reduce electricity costs. By categorizing countries as either developed or developing, we are able to observe and compare price variation with different levels of alternative energy development between countries.
Toward a Better Understanding of...

**The Social Construction of Curiosity in *Curious George***

*Rebecca Tsevat*

*Mentor: Rachel Slaughter*

Curiosity has long been considered a virtue in Western society, because it promotes discovery, learning, and exploration. Contrary to what might be expected in a children’s book, however, curiosity actually appears to take on negative connotations in *Curious George Takes a Job* by H.A. Rey. Throughout the story, George’s curiosity is repeatedly criticized by authority figures and treated as a form of disobedience. By examining the motivations behind George’s numerous displays of curiosity and the responses of others to his behavior, this paper addresses the question of why the book would discourage the development of a trait that would enable George to actively explore his surroundings. Of crucial importance to both George’s conduct and the perceptions of others is the recognition that his African background and animal identity separate him from the rest of the society in which he has been placed. On the one hand, his isolation motivates his curiosity, as it prompts his search for belonging. Just as significant, however, is the fact that George’s isolation causes him to be classified as an object of curiosity by other characters. That the adults in the story show curiosity about *him* is made apparent throughout the story but is never remarked upon or criticized by the narrator; thus, curiosity appears to be socially coded as acceptable for only the “normative” characters in the story. By establishing certain conditions for which curiosity is tolerated, these authority figures not only neglect to resolve Curious George’s isolation but in fact assert their superiority over him.
This work is a discussion of democracy, which seeks to answer the question: can protest aid the transition to democracy? The various definitions of democracy have been evaluated and used the example of Bolivia to show that protest is necessary for a democratic transition in societies with gross social inequalities. Through the examples of Tupac Katari and the 1952 National Revolution in Bolivia, I analyze how protest movements have historically created the possibility of democracy. The overthrow of President Gonzalo Sánchez de Lozada by popular protest and the election of Evo Morales demonstrate how protest aids a transition to democracy. However, I have found that protest only aids the initial transition to democracy. Other measures must be taken to stabilize democracy, as has been proven by the presidency of Morales. In Latin America, protest movements must be institutionalized to assure that their voices are heard by the State system. Economic inequalities must also be eliminated through wealth redistribution and educational reform for democracy to be successful in the region Morales is currently in the process of implementing such reforms in Bolivia. His success in stabilizing a democratic system in Bolivia will be important for the state of democracy throughout Latin America.
Since 9/11, suicide missions have been brought to the forefront by the U.S. government and media as the worst representation of terrorism. Generalizations and images of violence have created a false impression in the American psyche of what a terrorist is, what he does, and what he is fighting for. This work seeks to understand the differences in how two distinct organizations, the Tamil Black Tigers and Hamas, employ suicide missions and how the international community perceives these organizations. In order to understand these differences an investigation was carried out of the recent histories, religious backgrounds, and social situations that have shaped an environment in which suicide missions have become acceptable in Tamil and Palestinian society. Findings show that each of these organizations utilizes suicide missions to achieve different goals. For example, the Black Tigers use suicide missions as military weapons while Hamas uses them to gain concessions from Israel. Understanding that there are differences and that these organizations are responding to individual challenges will greatly alter how the United States approaches “terrorist organizations” and how we go about attempting to come to peaceful conclusions in the international community.
Much of the literature responding to Michelangelo’s Last Judgment focuses on his rejection of tradition. Scholars cite the intense emotion and violent interactions throughout the fresco as evidence of his innovation. However, Michelangelo was not the first to portray the Last Judgment with heightened tension and violence. A late fourteenth century depiction of the subject in Pisa’s Camposanto is a precedent for many of the dramatic and innovative elements of Michelangelo’s fresco.

The Last Judgment in the Sistine Chapel is arresting in its ambiguous blend of mercy and condemnation. This union of oppositional attitudes is embodied in the figure of Christ. He is at once terrible and compassionate. The exact meaning of his dual hand gesture is difficult to ascertain. It is generally accepted that the right hand condemns while the left hand blesses as it calls attention to the wound in Christ’s side. The Christ in the Camposanto fresco has the same position as Michelangelo’s example. Of the many Last Judgment precedents available to him, Michelangelo chose an unusually expressive and ambiguous example. Michelangelo brought traditional methods to new heights of expression. His innovations would not have been possible without the advancements made by the artist of the Camposanto fresco. Examining both works provides an opportunity to investigate the probability of a lesser-known visual source for Michelangelo’s Christ and clarify the choices that he made in one of his most monumental works.
Family Planning in Kalleda:
How Women Achieve Their Ideal Family Size

Trisha Wolf

Mentor: Geoff Childs

This research investigates how women in the rural village of Kalleda in the Warangal District in the state of Andhra Pradesh, India achieve their ideal family size. The focus is on the methods that the women use to achieve a specific family size, namely various forms of contraceptives, specifically highlighting periods of abstinence and surgical procedures used to permanently end reproductive capabilities. It also looks at the influence gender has in determining family size and reproductive decisions. Data from sixty-two interviews conducted with women in the village about their personal experiences are tied to literature on regional education, family planning policy, reproductive span compression, son preference, and India’s North-South divide. Different theories of demographic transition are presented to gauge which one(s) are most applicable in this specific village. Diffusion of knowledge about different types of contraceptives to rural areas will have a major impact on future population trends in India. This thesis considers the perspective of local women because they have been understudied and because the village is very typical of those found in the rural southern portion of India.
Elucidating the Role of Erd1 in Localization and Function of Pfa3, a Protein Acyltransferase in Yeast

Musi Ye

Mentor: Maurine Linder

Protein palmitoylation, a post-translational lipid modification, has essential roles in cellular functions, particularly for cell signaling and membrane trafficking. It is carried out by protein acyltransferases (PATs), but how these PATs are trafficked and targeted has not been fully characterized. Pfa3p, a yeast PAT localized to the vacuole, was shown to palmitoylate Vac8p, a yeast protein with multiple functions at the vacuole. Previous research demonstrated PFA3 knockouts to have fragmented vacuoles when grown in stressed conditions. To explore the function and regulation of Pfa3p, a candidate genetic screen was performed to search for other knockout strains with this same phenotype. This screen identified a candidate gene ERD1. Erd1p is predicted to be an integral membrane protein located in the endoplasmic reticulum/cis Golgi region and may have roles in protein sorting and trafficking. A previous large-scale two-hybrid screen also revealed a physical interaction between Pfa3p and Erd1p.

A co-purification was set up to confirm Pfa3p and Erd1p’s physical interaction. Findings showed that there was a lack of biochemical association between the two proteins. To analyze whether an erd1Δ mutant’s fragmented vacuole is due to Vac8p, I performed membrane fractionation on knockout strains transformed with Vac8p constructs to examine changes in Vac8p localization. Previous work has shown that there was increased cytosolic Vac8p in pfa3Δ mutants, but results revealed Vac8p membrane association in erd1Δ mutants was comparable to widetype strains. To examine the role Erd1p plays in protein trafficking, Pfa3p was chromosomally tagged with 3xGFP in an erd1Δ strain and viewed with a fluorescence microscope. Preliminary data exhibited no significant change in terms of Pfa3p localization in an erd1Δ strain. A PAT assay was also performed to detect changes in Pfa3p PAT activity in an erd1Δ strain, but results demonstrated no change.

Present data does not support Erd1p involvement in Pfa3p localization and function. It could be that interactions between Pfa3p and Erd1p are too transient to be detected in our current biochemical conditions. Or, more likely, it is an indication that the shared fragmented phenotype is the result of independent or complex pathways and not a direct physical interaction.
An acoustic vector sensor (AVS) measures all the three components of the acoustic particle velocity and the pressure at a single point in space. Through real experiments, the study evaluated the advantages of AVS for source localizing problems, compared with standard pressure-sensor arrays. For this aim, we built a linear array of four AVS and design a graphical user interface for processing the measurements and estimating the source location in 3D. This research considered the source identifiability using a single AVS, as well as 3D location estimation using a linear array of AVS.
Evoking Peripheral Nociception with 15-delta PGJ2 via Activation of TRPA1 Ion Channel

Tim Young

Mentor: Gina Story

In humans, mechanical hypersensitivity is characterized by sensitivity to simple movements and is described as shooting and stabbing pain; it is a hallmark of many inflammatory and neuropathic pain conditions. The prostaglandin D2 metabolite, 15-deoxy-Δ12,14-prostaglandin J2 (15d-PGJ2), is best characterized as an anti-inflammatory prostaglandin. Recently we showed 15d-PGJ2 activates thermoTRP ion channel TRPA1 in heterologous expression systems and in dorsal root ganglion (DRG) neurons, inducing nociceptive behavior in mice via a TRPA1-dependent mechanism. Here we report that 15d-PGJ2 is also a peripherally acting anti-nociceptive compound, attenuating hypersensitivity to mechanical stimuli in several pain models. It was hypothesized that the mechanism of 15d-PGJ2 attenuation of mechanical hypersensitivity is via initial activation followed by desensitization of TRPA1 channels. This hypothesis will be tested by utilizing behavioral, molecular and electrophysiological tools. These studies lay the foundation for future work in which we will explore the efficacy of 15d-PGJ2 as a peripherally acting pain therapeutic.
Previous research has demonstrated that the decisions individuals make for others are not always the same as the decisions they make for themselves (e.g., when choosing between two methods of payment for receiving a lottery prize, participants may choose for another student to receive the larger prize at a later time, but choose for themselves to receive the smaller prize immediately). Furthermore, the decisions individuals make for others can also differ depending on the level of closeness between the decision-maker and the recipient. The current experiment examined whether these findings generalize to the discounting framework. Specifically investigated was whether individuals discount delayed and probabilistic monetary rewards differently when making choices for themselves, a close friend, and another person whom they do not know. Participants completed computer tasks in which they made choices between amounts of money that could be received immediately and amounts that could be received after a specified delay. They also made choices between amounts that could be received for certain and amounts that could be received with a specified probability. With respect to delayed rewards, participants made decisions similarly for themselves and for other people. For probabilistic rewards, although participants made decisions similarly for themselves and their close friend, they were more risk-taking (i.e., discounted the value of probabilistic rewards less steeply) when they were making decisions for a person whom they did not know.
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Feature Articles


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La Ruta de la Plata de Potosí: A Modern Exploration of Bolivia’s Oldest Colonial Silver Route  Samuel Steinberger & Adam Webb

Summaries of Student Work