

# McNair Scholars Journal 2014

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GRAND VALLEY  
STATE UNIVERSITY  
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Scholarly and Creative Excellence**

Robert P. Smart Ph.D.

**Director**  
Dolli Lutes

**Project Manager**  
Dolli Lutes

**Editor**  
Michelle L. Sanchez

**Cover Design**  
Promotions Office

**Photography**  
John Corriveau/cover  
Bernadine Carey-Tucker

**Graphic Design and Production**  
Promotions Office

**Grand Valley State University  
Faculty Mentors and Research Editors**

Andrew Schlewitz  
*Assistant Professor of Political Science*

Brad Wallar  
*Associate Professor of Chemistry*

Derek Thomas  
*Assistant Professor of Biomedical Sciences*

Ernest Park  
*Assistant Professor of Psychology*

Glenn Valdez  
*Associate Professor of Psychology*

Jim Persoon  
*Professor of English*

John Adamopolous  
*Professor of Psychology*

Kristie Dean  
*Assistant Professor of Psychology*

Lisa Perhamus  
*Assistant Professor of Education*

Matt Christians  
*Assistant Professor of Cell and Molecular Biology*

Pat Colgan  
*Professor of Geology*

Rachel Powers  
*Associate Professor of Chemistry*

Suganthi Sridhar  
*Associate Professor of Biomedical Sciences*

Xu Xiaojuan  
*Professor of Psychology*

## A Message from the McNair Scholars Program

With great pleasure, we present the 2014 Grand Valley State University McNair Scholars Journal. This year our cover has been redesigned to help represent the new national emphasis on the value of undergraduate research.

The Ronald E. McNair Scholars Program, now in its 20th year at GVSU, is a federally funded program providing research opportunities for low-income/first-generation, and underrepresented college undergraduates to better prepare them for Ph.D. programs. At GVSU, our goals and values align with the McNair Scholars Program as we continually strive to provide equitable support for our students and prepare them for success in graduate school.

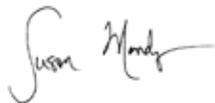
This journal is a culmination of the collaborative research conducted by our student scholars and their faculty mentors. We congratulate each of the McNair Scholars whose research is presented in this journal. This research represents your persistence and growth as future scholars. We thank the faculty mentors who have worked so closely with our McNair Scholars to encourage their intellectual curiosity and foster their goals and dreams. This work represents your dedication to the student's success.

We would also like to extend our appreciation to our colleagues who support and embrace the McNair Scholars Program; it is their dedication and hard work that makes these successes possible.

Sincerely,



Robert P. Smart Ph.D.  
Vice Provost for Research Administration and  
Executive Director of the Center for Scholarly and Creative Excellence



Susan Mendoza  
Director of Undergraduate Research and Scholarship  
Office of Undergraduate Research and Scholarship



Dolli Lutes  
Director  
McNair Scholars Program



**GRAND VALLEY  
STATE UNIVERSITY**

***“Before you can make a dream come true, you must first have one.”*** – Ronald E. McNair, Ph.D.

Ronald Erwin McNair was born October 21, 1950, in Lake City, South Carolina, to Carl and Pearl McNair. He attended North Carolina A&T State University where he graduated Magna Cum Laude with a B.S. degree in physics in 1971. McNair then enrolled in the prestigious Massachusetts Institute of Technology. In 1976, at the age of 26, he earned his Ph.D. in physics.

McNair soon became a recognized expert in laser physics while working as a staff physicist with Hughes Research Laboratory. He was selected by NASA for the space shuttle program in 1978 and was a mission specialist aboard the 1984 flight of the USS Challenger space shuttle.

After his death in the USS Challenger space shuttle accident in January 1986, members of Congress provided funding for the Ronald E. McNair Post-baccalaureate Achievement Program. The goal is to encourage low-income, first generation students, as well as students who are traditionally underrepresented in graduate schools, to expand their opportunities by pursuing graduate studies.



Ronald E. McNair, Ph.D.

## **Ronald E. McNair Post-baccalaureate Achievement Program**

### ***The Purpose***

The McNair Scholars Program is designed to prepare highly talented undergraduates to pursue doctoral degrees and to increase the number of individuals (from the target groups) on college and university faculties.

### ***Who are McNair Scholars?***

The McNair Scholars are highly talented undergraduate students who are from families with no previous college graduate, low-income background or groups underrepresented at the graduate level for doctoral studies. The program accepts students from all disciplines.

### ***Program Services***

The McNair Scholars are matched with faculty research mentors. They receive academic counseling, mentoring, advising, and GRE preparation. In addition to the above services, the McNair Scholars have opportunities to attend research seminars, conduct research, and present their findings orally or written via poster presentations. In the first semester of their senior year, the scholars receive assistance with the graduate school application process.

### ***Funding***

The Ronald E. McNair Post-baccalaureate Achievement Program is a TRiO Program funded through the United States Department of Education and Grand Valley State University.

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# Portrayals of Assimilation in Chicano Poetry



**Crisol Beliz**  
*McNair Scholar*



**Jim Persoon**  
*Faculty Mentor*

My interest in the topic of Chicano assimilation stems from my identity as a fourth-generation American of Mexican heritage. I became interested in the topic of assimilation due to its impact on my family, which has not fully assimilated into Anglo-American culture although we have lived in the United States for a few generations. To better understand myself and my family's experience, I decided to explore the topic of assimilation by reading and researching poetry by Chicanos (i.e., Mexican-Americans). My research studies the concept of assimilation as a common theme in Chicano poetry. My research question was how Chicano/a authors have dealt with assimilation in their poetry. When I began my research I noticed that authors used different approaches toward assimilation. This led me to my thesis, which is that there are four thematic approaches to assimilation. These four thematic approaches include resistance toward assimilation, a struggle to assimilate, a recovery from assimilation, and culture blending.

The writers I studied reflect upon their own, very personal experience and illustrate the difficulty of balancing two cultures, languages, and identities. These authors provide a range of approaches that many other Chicano students at Grand Valley could relate to.

I conducted a literature review on Chicano literature which contained discussions of prominent Chicano authors. I also read the most commonly used anthologies of American poetry in university-level English classes. I focus in depth on four poets that have been the most heavily anthologized—Alberto Rios, Gary Soto, Gloria Anzaldua, and Lorna Dee Cervantes. I did close analytical readings of their poetry using four different lenses: formalism, feminism, Marxist literary theory, and post-colonial theory. Of these four lenses I most often rely on formalism as it deals with reading closely and finding meaning within a text. All of these authors' poetry can be viewed through a post-colonial lens because they have all been affected by colonization.

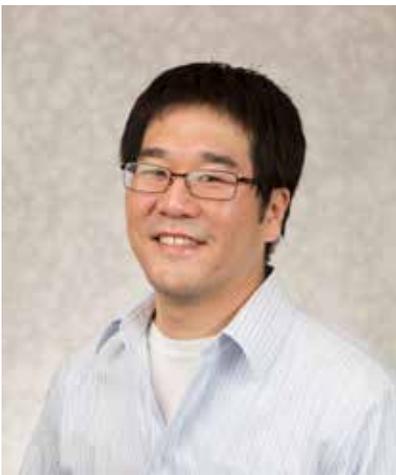
As my research progressed I noticed each author fluctuated in their approach. I found that the four thematic approaches to assimilation are complex and sometimes overlap. The most common approach to assimilation was a struggle to assimilate. A couple of the authors suggested that their skin color, language barriers, and cultural values made assimilation nearly impossible.

This research was my initial exploration of the Chicano experience with assimilation as it appears in literature by its best writers. It has helped me claim an identity as a Chicana that before was unknown to me. The authors' approaches toward identity and assimilation are complex and still need further attention.

# Exploring Unethical Behavior in Group and Individual Contexts



**Lauren Berry**  
*McNair Scholar*



**Ernest Park**  
*Faculty Mentor*

The behavioral inhibition system (BIS) activates in the presence of potential threats or response conflict. To minimize negative outcomes, the BIS inhibits impulses and induces deliberate and cautious thinking. Conversely, past research shows when people feel safe from harm (e.g., anonymous, powerful), the BIS is less active so people are less inhibited and act more reflexively (McNaughton & Gray, 2000).

Unethical behavior often involves acting on initial impulses to pursue self-interest at the expense of others. These unethical or objectionable behaviors occur when people feel safe from harm and are disinhibited, and thus are more likely under conditions of anonymity or power. It is important to explore other contexts where unethical behavior might ensue because these actions can be illegal, immoral, and harmful to others. The purpose of our research was to explore whether group contexts facilitate unethical tendencies. Past research shows that people feel safer in groups because they are less identifiable and can diffuse responsibility by spreading blame among fellow group members if outcomes become negative (Park & Hinsz, 2006). Also, when individuals make decisions in groups they often reach consensus and feel validated and certain on how to act. If people feel more certain and safer in groups they should be less inhibited. Thus, we hypothesize people will be more willing to act more unethically when with others compared to when alone.

To test this prediction we conducted a survey study. Eighty-eight undergraduates from Grand Valley State University participated in the study. Participants were asked to imagine themselves in unethical scenarios and rate how willing they were to engage in the unethical behaviors that were described. We used willingness to behave unethically as a measure of BIS activation since these behaviors are often in the pursuit of self-interest and are typically inhibited to avoid looking bad in front of others. Willingness to behave unethically would

indicate less BIS activity. Half of the scenarios involved acting unethically alone, while the other half involved acting unethically with others. This difference in social context was not brought to participants' attention and the scenarios were in random order.

To test the hypothesis, a paired-sample t-test compared the average composite scores for group and individual contexts. In support of the hypothesis, results show when participants imagined themselves in groups they were more willing to behave unethically compared to when imagining themselves alone. This occurred even though there was no difference in how unethical the scenarios were rated.

This research has important implications as it provides insight into how our behavior changes due to social context. In our individualistic society we would like to think we behave consistently across situations, when in reality we have evidence to suggest the contrary. This research expands our knowledge and increases our awareness of factors that promote unethical behaviors.

# Analyzing the roles of Rfg1 and Tup1 in the interactions between *Candida albicans* and other microbes



**Dorothy Butler**  
McNair Scholar



**Derek Thomas**  
Faculty Mentor

The fungus *Candida albicans* is found in the human microbiota and is usually non-pathogenic in healthy individuals, but it can cause life threatening infections. Nosocomial *Candida* infections are on the rise in the United States, primarily due to an increased number of invasive procedures, transplants, and use of broad range antibiotics and immunosuppressive agents. One important virulence factor in *Candida* species is its ability to transition between two morphologies: yeast and filamentous cells. Filamentous formation is controlled by several transcription factors that induce filamentation and several negative regulators that repress filamentation. Rfg1 is one of several partner proteins thought to function in combination with Tup1 to repress genes associated with filamentation and potentially influence the virulence of *Candida*. In fact, a *Candida albicans* mutant strain lacking Rfg1 was found avirulent in a mouse model, but over-expression of RFG1 has no effect on virulence. Here we investigate the negative regulators Tup1 and Rfg1 in *Candida* and their effect on interactions between *Candida albicans* and various bacteria. In their natural environment, bacteria and unicellular eukaryotes are found together exhibiting both synergistic and antagonistic interactions. Our previous studies have documented decreases in the levels of both RFG1 and TUP1 when wild-type *Candida* was grown near *Acinetobacter baumannii*. Interestingly, during such bacterial-fungal coexistence the levels of Rfg1 and Tup1 are not consistent with the action of a repressor of filamentation. RFG1 and TUP1 transcription is usually elevated in yeast cells, but in the presence of *Acinetobacter baumannii*, their levels do not increase, instead actually decrease. These results suggest TUP1 and RFG1 are impacted by cellular signals that form part of the interactions between *Candida* and other commensals. Here, we looked at over-riding such decreases and how this influences the effects of bacteria on the morphology and hyphal specific gene

transcription of *Candida* when grown as a biofilm. Previously constructed tet-RFG1 and tet-TUP1 strains were used to investigate the effects of regulating the levels of RFG1 and TUP1 on the interactions with *Acinetobacter baumannii*. RFG1 overexpression affects biofilm formation by altering the morphology. Over-expression of TUP1 altered the population of cells present in the biofilm. Further exploration of modulated levels of RFG1 and TUP1 grown near *A. baumannii* showed somewhat alleviated inhibition of filamentation caused by the higher levels of RFG1 or TUP1. These results not only confirm that *Acinetobacter baumannii* acts as a repressor of filamentation, but that RFG1 and TUP1 play a key role in changes observed during fungal-bacterial interactions and that role may be something other than filamentous repression. This will help uncover the multifactorial nature of filamentous repression in *Candida albicans* and the role of regulators in microbial communities. Our findings may have an impact on discovering new therapies for preventing *Candida* infections.

# What Motivates You? Feeling Good, Feeling Right, or Both?



**Kelsie Colley**  
*McNair Scholar*



**Kristie Dean**  
*Faculty Mentor*

This study examined factors that influence motivation during goal pursuit. Hedonic experience has a motivational effect on goal pursuit. This subjective experience encompasses the pains or pleasures of the goal, or the “feeling good” aspect. However, there must be more to motivation during goal pursuit. In addition to feeling good about the goal pursuit or its outcome, a growing literature demonstrates that “feeling right” (i.e., regulatory fit), within the manner in which one pursues a goal, can also motivate goal pursuits. Thus, this study examined whether hedonic experience and regulatory fit have independent or interactive influences on motivation during goal pursuit. There are two types of motivational orientations: a promotion orientation that focuses on ideals and aspirations, which in the context of a goal pursuit heightens sensitivity to potential accomplishments, and positives that signal goal pursuit progress. By comparison, a prevention orientation focuses on duties and obligations, which in the context of goal pursuit heighten sensitivity to obstacles and potential losses that signal impediments to goal pursuit progress. Importantly, distinct regulatory orientations also dictate which goal pursuit means are more effective for goal attainment. A promotion orientation promotes eager means, which creates fit by sustaining the orientation, while a prevention orientation encourages vigilant means. Regulatory fit enhances motivation, performance, value, and enjoyment.

We also examined whether regulatory fit – which results from consistency between one’s motivational orientations and means – occurs when self-construals are considered as motivational orientations. There are two main self-views, or construals, that people hold. An independent self-construal is characterized by distinctiveness and autonomy of the self from others and is commonly demonstrated by those in Western cultures. An interdependent

self-construal emphasizes a harmonious connection and obligation to a larger group of people, which encompasses a value for belonging. This type of self-construal is commonly encouraged by East Asian cultures. Research on these self-construals suggests they are one mechanism underlying cultural variations in cognition, emotion, and behavior. Research also supports that self-construal can be temporarily activated, or primed, regardless of the chronic self-construal of the individual. This study experimentally manipulated self-construal, motivational means, and hedonic experience, measured perceived performance, actual performance (speed x accuracy), and task value, and difficulty and enjoyment during goal pursuit. The results confirm that fit can be created from consistent self-construals and motivational means, which enhanced both perceived and actual performance. Additionally, the data demonstrate an interactive effect of regulatory fit and hedonic experience. When fit (nonfit) is experienced, hedonic experience is more informative when gauging the value (difficulty) of a task. Discussion will center on implications and future directions.

# Effects of an economic crisis on individualistic and collectivist values



**Amaya Guthrie**  
*McNair Scholar*



**John Adamopolous**  
*Faculty Mentor*

The relationship between societal change brought about by economic crises and changes in human values has not been investigated extensively across cultures by psychologists. This investigation examines two questions related to this relationship: (1) what is the connection between major economic or social events that occur in a culture and changes in important social meanings that emerge in that culture? And (2) if there are changes in the availability of resources in a community, will there also be changes in the endorsement of different cultural values? More specifically, this study examines how changes in the availability of economic resources over a 5-year period may affect the endorsement of cultural values. Two nations that experienced significantly different levels of an economic crisis, the U.S (low-to-moderate level) and Greece (high level), will be compared with regard to shifts in the values of individualism and collectivism. The construct of individualism is present in cultures that value independence, emphasize personal goals, and encourage individuals to separate themselves from the collective by highlighting one's uniqueness and autonomy. In contrast, in a collectivist culture individuals conceptualize the self as a member of a collective and all aspects of social behavior are interdependent and a reflection of one's perception of the self in cohesion with others.

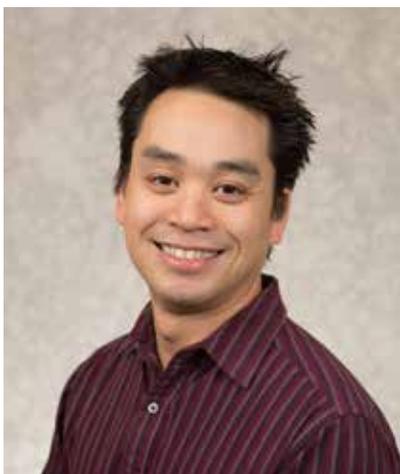
The study will investigate possible changes in the endorsement of individualistic and collectivist values from 2009 to 2014. In addition, subgroups of these constructs--vertical/horizontal individualism and collectivism--will also be considered. Briefly, "vertical" refers to hierarchical and power-based social relations and "horizontal" refers to social equality. The participants in our study are approximately 200 university students from Grand Valley State University (USA) and the University of Athens (Greece). Responses to a scale measuring individualism and collectivism

from 2009 (pre-crisis) and 2014 (post-crisis) will be analyzed via factor analysis and factor-comparison techniques in order to investigate possible changes in both the psychological structure and the relative national endorsement of the two constructs. In preliminary analyses, t-tests performed on the Greek individualism and collectivism scores from 2009 and 2014 showed that there was a general, though non-significant, trend toward lower individualism scores. Analysis of the US data is pending. A possible explanation of this early result could reflect that Greeks, in this period of extended and severe economic crisis, are using reliance on in-group and interdependence as a means of survival.

# Kappa opioid regulation of depressive-like behavior during protracted withdrawal from ethanol



**Sorscha Jarman**  
*McNair Scholar*



**Glenn Valdez**  
*Faculty Mentor*

Alcoholism is a social and public health problem leading to countless annual deaths and money lost in the United States alone. Withdrawal from alcohol can create short- and long-term changes in the brain's physiology, which may lead to mood disorders such as depression. Because adverse mood states tend to accompany withdrawal, periods of abstinence commonly result in relapse. Though the short-term impact of withdrawal has been well characterized, much less is known about the long-term changes in brain function and behavior resulting from prolonged abstinence from alcohol. Recent studies involving animal models of alcoholism have found that changes in the dynorphin (DYN)/kappa opioid receptor (KOR) system may play a role in regulating the symptoms of depression and other mood disorders. The aim of the current study was to examine the role of the DYN/KOR system on depressive-like behavior during protracted withdrawal from alcohol. Male Wistar rats ( $n=18$ ) were placed on an ethanol or control liquid diet for approximately 28 days. Following this period, the liquid diet was replaced with standard food and water, and animals were left undisturbed for three weeks. At the end of this 3 week time period, rats received intraperitoneal injections (i.p.) of a saline solution or 20 mg/kg of the KOR antagonist nor-binaltorphimine (nor-BNI). A full 24 hours later, rats were exposed to an initial 10 minute forced swim session. Twenty four hours following the initial session, rats were exposed to an additional 5 minute forced swim session, which was videotaped and behaviorally scored by a trained observer. The forced swim test occurred 24 hours following administration of nor-BNI because previous studies have shown that nor-BNI is a selective antagonist at the KOR 24 hours after initial administration. No significant differences were found between animals that received nor-BNI versus saline in either ethanol dependent or non-dependent groups. One limitation of this study was the small amount of

nor-BNI available at the time of testing due to a supplier shortage, and this factor led to a small sample size of animals actually receiving nor-BNI ( $n=4$ ). Despite these shortcomings, previous data obtained in our laboratory have found that administration of nor-BNI during the acute withdrawal phase attenuates depressive-like behavior. Additionally, pilot data taken in this laboratory have found that depressive-like symptoms may last up to 6 weeks or more, and taken together, these findings suggest that nor-BNI may be able to reverse the depressive-like symptoms observed at longer withdrawal periods. The lack of significant findings in this study is likely due to its small sample size, and additional animals will be tested in order to address this issue.

# The effects of embryonic lead exposure on avoidance learning in zebrafish



**Natosha Mercado**  
*McNair Scholar*



**Xu Xiaojuan**  
*Faculty Mentor*

Lead (Pb<sup>2+</sup>) is a commonly known environmental toxin. Lead poisoning in humans is detrimental, especially if exposure occurs during development when the blood brain barrier and other mechanisms of defense are still being established. In fact, a relationship between early lead exposure and neurobehavioral deficits including slower reaction time, hyperactivity, lower IQ scores, and increased inattentive behavior, has been established in past research. The zebrafish has become a useful vertebrate model for studying the neurobehavioral effects of developmental exposure to environmental toxins because of the ease with which zebrafish can be bred and taken care of, their short generation times, the large numbers of eggs that females can produce, and the transparency of zebrafish embryos.

The current study utilized an active avoidance conditioning paradigm to explore the effects of embryonic Pb<sup>2+</sup> exposure on learning and behavior in 12-month-old zebrafish. Adult zebrafish were individually placed in a shuttle-box separated into two identical compartments by a manually raised divider. Each trial began with the onset of light on the side of the shuttle-box where the zebrafish was located. After 12 seconds, a mild, repetitive electrical shock was administered until either the fish swam under the divider or an additional 12 seconds had passed, signaling the end of the trial. On Experimental Day 1, through repeated trials, the zebrafish were trained to associate a light (i.e., conditioned stimulus, CS) with an electrical shock (i.e., unconditioned stimulus, US) and to avoid the shock by swimming from the lighted side of the shuttle-box, under the divider, to the dark side. Testing for avoidance learning occurred on Experimental Day 3.

Adult zebrafish that were exposed to 0.0, 0.1, 1.0, or 10.0  $\mu$ M Pb<sup>2+</sup> as embryos were trained and tested within this paradigm. The results indicated that zebrafish that were not exposed to Pb<sup>2+</sup> as embryos learned avoidance

responses during training and showed significantly increased avoidance behavior during the testing session. Zebrafish that hatched from embryos exposed to Pb<sup>2+</sup> did not show significant changes in avoidance behavior from training to testing, indicating that zebrafish that were developmentally exposed to Pb<sup>2+</sup> did not learn avoidance behavior during training. These findings enhance current knowledge of Pb<sup>2+</sup> toxicity in developing organisms in that they support the hypothesis that exposure to Pb<sup>2+</sup> during development impairs learning and memory.

# Underrepresented Identities and Fields of Study within Study Abroad: A Case Study



**Irma Ramirez**  
*McNair Scholar*



**Lisa Perhamus**  
*Faculty Mentor*

The proportions of gender, race, and academic fields in U.S. higher education are not equally reflected in U.S. study abroad participation rates indicating a lack of equitable access (Institute of International Education, 2013; U.S. D. E., National Center for Education Statistics, 2013). White females and students enrolled in the social sciences, business and management, and the humanities proportionately have increased access to study abroad opportunities, while male and racial minority students have statistically smaller access to study abroad opportunities (Institute of International Education, 2013). The goal of this research is to demonstrate the need for context specific participation data to better understand how to improve study abroad access. Therefore, this case study uses statistical analysis to address the following question: How does Grand Valley State University (GVSU) study abroad participation compare to national data in the context of race, gender, and field of study?

A literature review reveals a lack of understanding of how the intersection of social identity and fields of study can result in the underrepresentation of U.S. male and racial minority students abroad. Although past research studies assess the correlation between personal characteristics and study abroad participation, questions within the context of race, gender, and field of study are underexamined. This underexamined literature is important because it is needed to address why national study abroad patterns are inconsistent with the national demographics of institutions of higher education. Through the comparison of GVSU and national data, specific academic disciplines and social identities emerge as significant areas of research to address how to improve study abroad access.

Chi-square goodness of fit tests and post hoc analysis was used to determine the relationship between GVSU and national data along the lines of social identity and fields of

study. The results determine that for the academic years of 2011-12 and 2012-13, GVSU's distribution of health professions, education, math or computer science, and "other" fields of study are significantly higher than national study abroad proportions. Female and white identity distributions are significantly higher for GVSU than national study abroad proportions, while Asian and Hispanic identities are significantly lower. These research findings demonstrate the significant difference of representation between GVSU and national study abroad participants. The differences found between GVSU and national proportions indicate the importance of gathering and understanding single-institutional data. National data is a representation of national trends, but it does not thoroughly explain the local factors that impact individual institutions. Through context-specific study abroad participation research, institutions can identify and better understand factors to improve study abroad access.

A limitation of this study is the non-identified significance between GVSU study abroad participants with the overall GVSU population distribution and the non-identified variables that affect study abroad participation within these sub-populations. Quantitative and qualitative methods, such as chi-square goodness of fit tests and focus group interviews can be used to identify these relationships. Further studies are encouraged to use this case study for comparison or as an example for future research purposes and to promote increased study abroad access to diverse populations.

# The Merida Initiative and US Border Security: An Assessment



**Cody Robinson**  
*McNair Scholar*



**Andrew Schlewitz**  
*Faculty Mentor*

The Merida Initiative began under the administration of George W. Bush in 2008 as part of the long “War on Drugs” that President Richard Nixon launched over 40 years ago. This initiative is a partnership between the US and Mexico to crack down on drug-related organized crime and violence while making sure human rights and law and order are equally protected. The Obama administration has continued this partnership, though it has added development goals to the initiative. This study addresses the question of whether the Merida Initiative has reduced drug-related violent crime along the US side of the border with Mexico. I hypothesize that the violent crime has decreased but not to the extent that the US government claims, nor can we determine with certainty that the decrease is the result of the Merida Initiative. To test the hypothesis, this study first examines the state and county level data on violent crime rates from 1990 to 2012. This examination reveals that violent crime rates in the four border states of Arizona, California, New Mexico and Texas declined before the Merida Initiative went into effect in 2008. However, a sampling of data from the sixteen border counties in this study reveals a far less clear pattern. Moreover, there are dramatic differences between border counties—two Californian border counties have violent crime rates far lower than some of the border counties in the other three border states. As well, there are large differences between these rates within the states of Arizona, New Mexico, and Texas. The stark differences between violent crime rates in these counties suggest we cannot generalize about this phenomenon at the state level, much less across the entire US-Mexico border. In short, the first part of the hypothesis is confirmed only at a very general level and does not hold true for all border counties. The second part of the hypothesis is a much more complex matter; this study reviews the work of the Congressional Research Service and various non-governmental organizations

and think tanks such as Witness for Peace, The Heritage Foundation, Organization of American States and the Center for International Policy that attempt to determine the relationship between the initiative and violent crime rates. This review reveals first that it is difficult to demonstrate a connection between the trade in illicit narcotics and border violence that may spill over into the US. Secondly, there is an array of factors that shape the drug trade which may foment violent crime, such as economic status, political factors (e.g., corruption and weak governmental institutions), supply and demand for the drugs in Mexico, and social norms and acceptance of the drug trade. Thirdly, there is little evidence that the Merida Initiative addresses these factors in a significant way. Lastly, as some argue, the Merida Initiative’s emphasis on military and law enforcement may have made the grave problem of border violence even harder to solve. This study concludes with my assessment that in as soon as 5 years we might see some significant results from the Merida Initiatives.

## Modification of the LRB e3 ligase



**Aron Rottier**  
*McNair Scholar*



**Matt Christians**  
*Faculty Mentor*

Plants utilize a complex system of light responsive pathways to initiate discrete changes in the plant cell's growth and development. The light regulating BTB (LRB) E3 ligase is utilized in the ubiquitin-proteasome system (UPS) to target a group of photoreceptors, the phytochromes, for degradation. The UPS allows for the selective tagging and degradation of proteins in the cell. The phytochrome B complex is stable in FR, but broken down in red light by the LRBs. Evidence suggests that the LRBs become activated in red light by forming a complete E3 ligase complex which includes the protein Cul3. We propose to investigate how the LRBs become activated and bind to Cul3 in red light in the model plant *Arabidopsis thaliana*. Evidence suggests the LRBs are modified by the Nedd8 protein (i.e., a protein used to activate a small group of other proteins in eukaryotes) in response to red light. This project proposes to investigate whether the LRBs are modified by the Nedd8 protein by using an in vitro neddylation assay. The results of this assay will improve the understanding of how LRB E3 ligases function in modifying light responses in plants and will also provide insight into neddylation and its effect on protein activity.

To test our hypothesis that the LRB proteins are neddylated, in vitro testing will be used which limits the need for the genetic transformation of *Arabidopsis* to express the necessary tagged proteins needed for the assay. The assay will be performed using the Abcam Neddylation assay kit that includes Nedd8, along with other components necessary for neddylation with in vitro testing. We will test for neddylation using full-length LRB as well as C terminal and N terminal portions of LRB. For a positive control, CUL3a will be used as that is shown to be neddylated under standard in planta conditions. RBX1 may also be included in any neddylation assay since it has been found to increase neddylation rates. As a negative control, the C-terminus end of LRB1 will be assayed for neddylation

as that domain is not hypothesized to be neddylated.

The results to date do not influence the hypothesis of whether neddylation occurs on the LRB proteins as any of the results obtained are in the preparation of the proteins needed to conduct the neddylation assay. Therefore, no direct findings as to the ability or inability of neddylation of LRBs have been found. The results of the protein production and preparation have been progressing, and the purification of the LRB-full length is upcoming providing the first substrate for the neddylation assay. This progress is in support of the future investigation of neddylation.

# Structural and Functional Characterization of S06017, a Potential Novel Inhibitor of ADC-7



**Stacie Stuit**  
McNair Scholar



**Brad Wallar**  
Faculty Mentor

$\beta$ -lactams, such as penicillin, are the most widely prescribed class of antibiotics. In response to their extensive use and misuse, bacteria have become resistant to a growing number of these drugs. Many antibiotic-resistant bacteria express the enzyme  $\beta$ -lactamase, the most widespread resistance mechanism to  $\beta$ -lactams. These enzymes cleave the defining lactam ring, rendering the antibiotic inactive against its original cellular target, thereby allowing the bacteria to survive. As a result, antibiotic resistance has become a critical concern to human health. An example of an antibiotic resistant bacterial species that has shown pathogenic properties is *Acinetobacter baumannii*. A significant portion of the resistance of this organism is due to its expression of the  $\beta$ -lactamase, *Acinetobacter*-derived cephalosporinase-7 (ADC-7). In order to combat the antibiotic resistance in *Acinetobacter*, molecules were designed that could potentially bind ADC-7 and inhibit its ability to break down antibiotics. However, to facilitate the characterization and optimization of inhibitor design, the molecular structure of ADC-7 needs to be determined. In collaboration with Dr. Rachel Powers, we have recently determined the structure of ADC-7 with and without a bound inhibitory molecule. Currently, we are attempting to identify a specific molecule that can bind ADC-7 with high affinity and sufficiently inhibit ADC-7 to be considered an effective drug. The goal of this study is to characterize a promising new inhibitory compound of ADC-7 (S06017) and determine the efficacy with which this drug can inactivate the  $\beta$ -lactamase enzyme. In order to determine whether the inhibitor substantially decreases the enzyme activity, competition kinetics were performed with S06017 against a diagnostic substrate of ADC-7 (nitrocefin). Competition kinetics assays yield a  $K_i$  value, which is a measurement of the ADC-7/inhibitor binding affinity, with lower  $K_i$  values indicating higher binding affinities. While the resulting  $K_i$

of 6.108  $\mu\text{M}$  demonstrates that S06017 does bind and inhibit ADC-7's ability to break down nitrocefin, the ADC-7/S06017 binding affinity is weaker than other related compounds. For example, the inhibitory compound S02030 binds ADC-7 with a  $K_i$  of 0.0373  $\mu\text{M}$ , and competition kinetics performed with CR192 resulted in an average  $K_i$  of 0.00045  $\mu\text{M}$ . Even though S06017 binds ADC-7 with lower affinity than related molecules, the question remains: what specific parts of these molecules are responsible for binding tightly to ADC-7? By determining the X-ray crystal structure of ADC-7 with S06017 bound in its active site, it is possible to compare the specific orientation and interactions involved in inhibitor binding. In addition, by comparing the ADC-7 structures in a complex with different compounds, it is possible to optimize the molecular structure of compound that will serve as the most efficient inhibitor of ADC-7. Comparing all of the X-ray crystal structures, as well as the  $K_i$  values from competition kinetics, will hopefully lead to the discovery of an inhibitory drug that will significantly inhibit ADC-7, which could aid in combatting antibiotic resistance in *Acinetobacter baumannii*.

## Biological testing of novel telomerase inhibitors



**Katie Uhl**  
*McNair Scholar*



**Suganthi Sridhar**  
*Faculty Mentor*

As of 2011, cancer was the leading cause of death in the United States, second only to heart disease. As cancer continues to become an ever-increasing threat to human health, the race is on to find an effective telomerase inhibitor. This inhibitor has to be functional enough to render the cancer cell unable to divide, while leaving the surrounding healthy cells relatively untouched. Research has established that the molecular structure of a compound known as BIBR 1532 has proven to be an effective telomerase inhibitor. Cancer is often referred to as being “immortal” because of its ability to divide an infinite amount of times. Normal cells are limited in the number of times they can divide by the caps on the ends of their chromosomes, called telomeres. These caps become degraded over time, signaling the cell to die when they become too short. An enzyme known as telomerase lengthens the ends of telomeres in cancer cells, granting them immortality. Current research has shown that BIBR 1532 inhibits telomerase by preventing it from extending the copied strand any further than the length of the original strand of DNA. If telomerase is inhibited, the telomeres of cancer cells can no longer be elongated. Stripped of their immortality, the telomeres of cancer cells will become degraded and die. Research has not yet discovered what portion of BIBR 1532 causes it to be such a good telomerase inhibitor. Research has shown that there are three substructures that must be present in order for it to act as a telomerase inhibitor: an aromatic ring containing a carboxylic acid and a conjugated amine group.

During the summer of 2013, three novel compounds were made via synthesis of cinnamoyl chloride derivatives. These three compounds all contain active sites that are identical to those identified on BIBR 1532, with one key difference in the element attached to the aromatic ring. The compounds were purified and then tested against PC3 prostate cancer cell lines. Prostate, breast, and pancreatic

cancers all have relatively high levels of telomerase activity, which is a primary reason why prostate cancer was chosen as a target cell line. The compounds were tested at three different concentrations: 50uM, 75uM, 100uM. Drug assay were performed in order to determine at which concentration the compounds showed significant anti-cancer activity, while leaving behind enough cancer cells to harvest telomerase and test for telomerase inhibition. After performing the assays, it was determined that the ideal concentration of the compounds was 75uM. All three compounds were shown to be more effective than BIBR 1532 at this concentration. The next step will be to test for telomerase inhibition using the TRAPeze assay. If these compounds prove to be telomerase inhibitors, it would be a breakthrough as to how BIBR 1532 functions and could potentially lead to a more effective cancer treatment. While the compounds were tested using metastatic prostate cancer cells, these potential treatments have applications in both breast and pancreatic cancers as well.

# The Cordell and Engadine Formations at Seul Choix Point, Upper Michigan: Implications for Silurian (Llandovery-Wenlock) environments



**Brittany Ward**  
*McNair Scholar*



**Pat Colgan**  
*Faculty Mentor*

Previous studies of the Cordell and Engadine Formations document localities throughout Upper Michigan and eastern Wisconsin and provide detailed stratigraphic descriptions of lithology and fossil faunas. This study is a sedimentologic and paleoenvironmental analysis of these formations exposed at Seul Choix Point, Michigan. This study includes rock and thin section analysis, faunal classification, a faunal abundance survey, faunal relationship mapping, isotope age analyses, and measurement of cephalopod orientations.

Dolostones of the Cordell and Engadine Formations are wackestones and packstones. Skeletal grains often include fragmented brachiopod shells and corals, as well as many unidentified fossil fragments. Corals, stromatolite, and stromatoporid mounds are the most abundant fossils, with corals constituting ~75% of the total fauna, and stromatoporids and stromatolites constituting ~25% of the fauna. Corals are *Archnophyllum*, *Cladopora*, *Catenipora*, *Coenites*, *Favosites*, *Halysites*, *Lyellia*, *Syringopora*, and rugose corals. Other fossils include bryozoans, cephalopods, brachiopods, and gastropods. The Engadine Dolomite is less diverse, with stromatolites and stromatoporids being the only fossils. A map was constructed on a single bedding surface of the Cordell Formation to record spatial relationships between in situ organisms. On average three specimens of either corals or stromatolite/stromatoporid mounds were located every square meter. Stable isotopes ratios for  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  were determined and correlated with previous studies to estimate a precise age. Cordell  $\delta^{13}\text{C}$  values vary from 0.46 to 1.84‰, and  $\delta^{18}\text{O}$  values vary from -6.0 to -2.5‰. Engadine  $\delta^{13}\text{C}$  values vary from 2.40 to 2.85‰, and  $\delta^{18}\text{O}$  values vary from -5.0 to -4.0‰. Orientation data were collected of cephalopods in the Cordell Dolomite and compared with previous studies to examine Silurian paleocurrents. Mean orientations show three modes of orientation of about 25, 65, and 165

degrees azimuth.

Packstones and wackestones indicate a moderate energy environment at the time of deposition and this is consistent with an environment found at or above the effective wave base of an epicontinental sea. The dominance of corals, stromatolites and stromatoporid mounds indicate a rich coral-stromatoporid community. These specimens grew in flat disc shaped mounds potentially to counteract agitated waters present at the wave base. Data from  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  suggest that the Cordell and Engadine Formation were deposited at about 428.2 Ma (late Llandovery to early Wenlock). During the Silurian, the Michigan Basin was located south of the equator and was rotated approximately 45 degrees clockwise from its current orientation. Given the observed shell orientations it is possible that shells were orientated with the length of the shell parallel to ocean currents caused by the Silurian Trade Winds.

# Structure Based Discovery of a Novel Inhibitor of OXA-1 $\beta$ -lactamase



**Leslie Wyman**  
*McNair Scholar*



**Rachel Powers**  
*Faculty Mentor*

$\beta$ -lactam antibiotics, such as penicillin, are among the most commonly prescribed group of antibiotics. These antibiotics are characterized by a four-membered  $\beta$ -lactam ring in their molecular structure, and they act by binding to transpeptidase enzymes found exclusively in bacteria, also called penicillin binding proteins (PBPs). Once the  $\beta$ -lactam binds to this target, bacterial cell wall biosynthesis is disrupted and the bacteria lyse and die.

Unfortunately, due to the heavy use of these antibiotics, bacteria developed mechanisms that can render  $\beta$ -lactams inactive and lead to resistance. Antibiotic resistance in humans and in animals poses a serious public health threat and is a growing health concern worldwide.

One mechanism for bacterial resistance to  $\beta$ -lactam antibiotics is the production of a  $\beta$ -lactamase enzyme that hydrolyzes the  $\beta$ -lactam ring of the antibiotic, making the antibiotic ineffective against its target, the bacterial cell wall transpeptidase. Currently, there are four recognized classes of  $\beta$ -lactamases (A-D) classified by their unique mechanism for destroying  $\beta$ -lactam antibiotics. Classes A, C and D act by a serine based mechanism for destruction which involves a two-step acylation/deacylation reaction. Despite their increasing clinical importance, class D  $\beta$ -lactamases are among the least understood. To date, about 250 known class D  $\beta$ -lactamases have been identified. OXA-1 is a member of the non-carbapenem-hydrolyzing subgroup of the class D  $\beta$ -lactamases and the first discovered.

$\beta$ -lactamase inhibitors were created in an effort to combat these resistance enzymes. Due to the similarities in structures of both the  $\beta$ -lactam antibiotic substrate and the inhibitor, bacteria have rapidly evolved to develop mechanisms to resist the inhibitors as well. Unfortunately, the common clinical  $\beta$ -lactamase inhibitors do not often inhibit class D  $\beta$ -lactamases. Therefore, the major goal to studying the class D  $\beta$ -lactamase OXA-

1 is to discover a competitive inhibitor that does not have a structure similar to  $\beta$ -lactam compounds because bacteria would not be able to quickly evolve to develop mechanisms to resist these non- $\beta$ -lactam molecules.

The discovery of a novel inhibitor for an enzyme target is a challenging task. We have chosen a structure-based approach using DOCK, a molecular docking program. DOCK computationally predicts binding conformations of a database of small molecules within a target site on the enzyme. The ZINC database of commercially available compounds was used in our docking calculations and allowed for millions of small compounds to be screened against the target OXA-1 active site. Compounds were ranked by favorable interaction energies, and the top compounds in the list suggested possibilities for potential inhibitors. In part, interaction energies are calculated based on the size and shape of the molecule, as well as the non-covalent interactions between the molecule and OXA-1 active site. The top hits, or compounds most likely to inhibit based on their docking score, were experimentally tested.

Structure-based docking led to the identification of several novel leads that inhibit OXA-1  $\beta$ -lactamase. So far, 13 compounds from the lead-like subset have been ordered and tested experimentally for inhibition of OXA-1. Of the 13 compounds tested, five inhibited OXA-1 with a  $K_i < 1$  mM. Optimization of a novel series of OXA-1 inhibitors is currently underway.



## About the TRiO Programs

To fight the war on poverty, our nation made a commitment to provide education for all Americans, regardless of background or economic circumstances. In support of this commitment, Congress established several programs in 1965 to help those from low-income backgrounds and families with no previous college graduates (first generation). The first three programs established were Talent Search, Upward Bound, and Student Support Services. Thus, they are known as the TRiO Programs.

Since then, other programs have been added, including Upward Bound Math and Science, Educational Opportunity Center, The Training Authority, and in 1989, The Ronald E. McNair Post-Baccalaureate Achievement Program. The goal of all of the programs is to provide educational opportunity for all.

The Ronald E. McNair Post-Baccalaureate Achievement Program is designed to prepare highly talented undergraduates to pursue doctoral degrees. In addition, the goal of the program is to increase the number of faculty in colleges and universities that come from a low-income/first generation college background and/or are from an ethnic/racial group that is under-represented in PhD programs.

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**McNair Scholars Program**

1 Campus Drive, 200 STU

Allendale, MI 49401

Phone: (616) 331-3441

Fax: (616) 331-3440

Web: [gvsu.edu/mcnair](http://gvsu.edu/mcnair)

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