Immigration and Education: Windows into National Identity in Madrid and Barcelona  Matt Adler and Ben Kastan

Beyond Culture: Successes and Failures of Multiculturalism at the American Church in Paris  Jacqueline Dodd

Between Domestication and Wildness: A Study of North American Bison bison on Contemporary Private Herd Ranches in Maine, Massachusetts and Missouri  Sylvia Hardy

Construction of an IR/Visible Fluorimeter with Chopper/Lock-in Amplifier Detection  Jesse G. McDaniel

SUMMARIES OF STUDENT WORK

OFFICE OF UNDERGRADUATE RESEARCH
Umrah 100
Campus Box 1026
Phone: (314) 935-7342
Fax: (314) 935-4384
E-mail: research@arts.wustl.edu
Web: http://ur.wustl.edu
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UNDERGRADUATE RESEARCH PEER REVIEW BOARD
Foreword

In the publication of this volume of the Washington University Undergraduate Research Digest, the Office of Undergraduate Research at Washington University in St. Louis underscores its commitment to supporting research conducted by undergraduates. Faculty from the Sam Fox School of Design and Visual Arts and School of Medicine, as well as the College of Arts and Sciences mentored the research projects reported on in the four feature articles and Summaries of Student Work presented here. Feature articles were selected and peer-edited by the Undergraduate Research Peer Review Board. We are indebted to the excellent work of this group who continue to increase student participation in the Digest and would particularly like to recognize the leadership of Morgan Grossman-McKee.

Anthropological studies are well-represented in this volume. During a trip to Spain, Matt Adler and Ben Kastan explored the educational systems in two different cities as they struggle to meet the needs of growing numbers of immigrants. They detailed their findings in their Senior Honors theses, portions of which are published here. Jacqueline Dodd also investigated the immigrant experience while studying the American Church in Paris as she explored the meaning of ‘multiculturalism’. These students present important findings which may direct future studies of how traditional European cultures adjust to twenty-first century changes in their populations. Sylvia Hardy’s photographs lend further meaning to her study of confined Bison on ranches across the U.S. She investigates the pathway to domestication taken by a species once on its way to extinction and the various and sometimes conflicting motivations of the ranchers who currently raise Bison.

Research in the physical sciences is represented in the work of Jesse McDaniel. The need to reduce the signal to noise ratio in measurements of photo-induced fluorescence of quantum wire structures led to his research on an improved lock-in amplifier system. Test runs of the chopper/lock-in fluorimeter developed in his work show promising results for future use in studying quantum wires which may lead to more efficient photovoltaic devices.

Finally, the work of twenty-six other undergraduate researchers is summarized in this volume. Their work in diverse disciplines has contributed to the body of knowledge within their fields as well as to each student’s intellectual growth and expertise as a researcher. The staff of the Office of Undergraduate
Research hopes that the reader is inspired by these works and enjoys this edition of WUURD. We offer congratulations to all of our authors and appreciation to the Peer Review Board and all faculty mentors.

Respectfully,

KRIStIN SOBOTKA
Editor

JOY ZALIS KIEFER
Assistant Dean, Co-editor
Immigration and Education: Windows into National Identity in Madrid and Barcelona

Authors:
Matt Adler & Ben Kastan

Matt Adler is a senior majoring in Spanish with minors in Institutional Social Analysis, Jewish, Islamic, and Near Eastern Studies, and American Culture Studies. He speaks several languages and therefore has a strong interest in immigration and multiculturalism. His has experience mentoring Latino youth in St. Louis as well as advocating for immigrants’ rights. He plans to spend next year on the campaign trail and cares deeply about electing a President who values immigrants in our society.

Ben Kastan is a senior majoring in International and Area Studies, with minors in Arabic and French. This international research experience has been an amazing catalyst for personal growth as a traveler, researcher and student. He intends to pursue a JD to launch a career in international conflict resolution.

ABSTRACT

Immigration is a contentious and timely topic in Spain, a country which until recently was known for its high levels of emigration. This sudden change has produced cultural responses throughout the country, particularly in large urban areas with heavy immigration such as Madrid and Barcelona. Written and oral interviews were conducted with teachers and education officials in these two cities to study how educational paradigms have been changed by immigration. This study also analyzed official documents on immigrant integration. The data showed that important differences existed between the school systems’ approach to how an immigrant becomes a member of society. In Barcelona, a much greater emphasis was given to linguistic competency in moving up the social ladder. However, the school systems shared important reasons for why an immigrant must become a member of society. Both societies (and their respective school systems) seem to place a great importance on integration for the sake of social cohesion. The differences in methods for attaining this cohesion seem to stem from distinct configurations of their respective national identities.

FACULTY MENTOR: SUNITA PARIKH, PH.D., ASSOCIATE PROFESSOR OF POLITICAL SCIENCE

Professor Parikh’s primary areas of interest are comparative politics, race and ethnicity, institutions, comparative methods. She has published a book on the institutional development of affirmative action in the United States and India, using comparative historical and rational-choice methods, and has also written on law and politics, education, social movements in the United States and India, and federalism.

ACKNOWLEDGEMENTS

This project could not have been conducted without the generous support of the Washington University Center for Joint Projects in the Humanities and Social Sciences. In particular, we would like to thank Kathleen Fields for working with us over the course of several months to improve our proposal and make this idea a reality. We would like to thank all our academic advisors and mentors for their constant support in this process: Professors John Bowen, Sunita Parikh, Tabea Linhard, and Cindy Brantmeier. In Spain, we would not have gotten very far without the assistance of Professors Lucile Nussbaum and Melissa Moyer of the Universitat Autònoma de Barcelona. They gave us invaluable information and contacts and made our on-site research much more effective and enjoyable. We are also incredibly grateful to all the professors, schoolteachers, education officials, and activists who took time out of their busy schedules to grant us interviews. Lastly, we owe a special debt to Professor Virginia Braxs of Washington University, whose support for us on the ground was above and beyond what any student could rightfully expect.
INTRODUCTION

This study examines how Catalan and Spanish identities operate by comparing how their school systems conceptualize the integration of immigrant students. The research was conducted in Spain during the summer of 2007. This article outlines existing research related to the topic and then presents the study’s research methodologies and data. The article concludes by generating hypotheses for future research on immigration and national identity in Spain.

The topics of immigration, education, and national identity are timely, contentious issues of significance in many areas of Europe and America. Taking an interdisciplinary approach was beneficial in providing a more holistic view of the complicated and interrelated processes at work. This project benefited from the researchers’ strengths in multiple related fields such as international relations, linguistics, Spanish, immigration studies, political science, and sociology. The research is unique in that it addresses immigrants as a community, how the system proposes to interact with immigrant students, and the ways in which national identity is reflected in the educational system’s approach to immigrants. While existing research has focused on one or several of these aspects, this paper fills an important gap in bringing these elements together.

BACKGROUND

The goal of this study is to explore Spanish and Catalan national identity by examining the response of the Madrid and Barcelona education systems to immigrant students. Immigration brings to light issues of national identity because it challenges local cultural norms. Madrid and Barcelona are seen as emblematic of Spanish and Catalan national identities respectively. They are comparable because both are large urban centers with significant immigrant populations. This study uses education as a window into national identity because schools are where nations promote their view of an ideal citizen. Therefore, by examining each educational system’s approach to immigrant students, this study provides insight into the construction of Spanish and Catalan national identities.

The existing research examines the issue at hand from five primary perspectives: 1) specific national groups within the school system (e.g. just Moroccans or Ecuadorians as opposed to all immigrants); 2) how teachers and students (particularly immigrants) interact in the academic environment; 3) the impact of specific educational policies on immigrant students; 4) the process of “integrating” and “normalizing” immigrant students; and 5) the cultural context of immigration in the broader society (but not specifically the school system). Researchers who have investigated individual national groups within the educational system center on the unique cultural, religious, and political characteristics of the group at hand and the way in which the group interacts with Spanish or Catalan norms. Other studies have examined intra-student and teacher-student interactions to understand underlying ideologies about language and identity as they apply to immigrants. There has been substantial research on the impact of specific policies on immigrant students. Perhaps the most popular research
focused on immigration and education focuses on the “integration” (i.e. normalization) of immigrant students and the factors that contribute to or detract from this process. Many researchers have also probed the intricacies of immigration and Spanish/Catalonian national identity, though not primarily or explicitly in the context of education.

Over the past twenty years, immigration has become a particularly contentious subject in Spanish society as the number of migrants has rapidly increased. Between 1990 and 2005, the percent of immigrants in the population increased from 1.6% to 8.46%. In 2006 alone, 156,000 immigrants moved to Madrid and 180,321 migrated to Catalonia, mainly to Barcelona. Combined, these two regions received about 42% of the 2006 immigrants to Spain. While heavy immigration from outside of Spain is a recent phenomenon, internal migration is not. In the first half of the twentieth century approximately one million Spanish citizens from Andalusia moved to Catalonia. As Spanish speakers, these newcomers were seen by many Catalonians as foreign immigrants despite their shared citizenship. There was also significant migration from rural areas to Madrid, but these immigrants were never perceived as foreigners.

In Spain, education is compulsory from age six to sixteen. The system is divided into the optional Educación Infantil (age three to six), Educación Primaria (age six to twelve) and Educación Secundaria Obligatoria (age twelve to sixteen). The regional and central governments each determine a part of the curriculum. Generally, the central government sets standards for basic competencies, such as math and literacy in the Castillian (Spanish) language, while the regional governments control the history and language curricula. The language of instruction in Catalonian schools is primarily Catalan instead of the standard Spanish. Regional governments also formulate their own plans to integrate immigrant students. Comparing these plans can thus illuminate local concerns and conceptions.

METHODOLOGY

The research consisted of 1) face-to-face semi-structured open-ended interviews with education system professionals in Madrid and Barcelona, 2) emailed structured open-ended interviews with the same professionals, and 3) textual discourse analysis of the Madrid and Barcelona school systems’ official plans for integrating immigrant students. Each of these three methods has particular strengths and limitations, but when looked at collectively, they allow us to analyze the school systems’ approaches to immigrant students on a variety of levels and in a more comprehensive manner.

The study consisted of sixteen face-to-face interviews, ten in Madrid and six in Barcelona with a variety of public school system professionals from diverse demographic backgrounds. Participants were selected only from the public school system, as these are the schools that primarily educate immigrant students. The interviewees were not meant to be a random sample of the school system, but rather a purposive sample of those with direct knowledge of the issues being researched. Furthermore, these schools are funded exclusively by taxes and their structure, employment, and curricula are determined by the local government, which as many scholars have noted uses education to impart its values and create model citizens. The primary dependent variable was location (Madrid vs. Barcelona), as the study was intended to compare
official constructions of regional identity. Questions were semi-structured, meaning that many were standard across the board (e.g. for teachers and principals, Madrid and Barcelona, alike), but the interviewers were permitted to craft new questions during the discussion. The questions were open-ended, allowing interviewees to expound on what they found most compelling.

Upon returning to the United States, these same participants were emailed written, structured, open-ended interviews. The questions were structured in the same way across locations, but varied according to type of interviewee (for example, different questions for school system officials than for principals). Approximately five questions were asked of each participant, with a more explicit and exclusive focus on their views about immigrant students than the oral interviews. The interviews were presented as “follow-up” questions to the oral interviews and were designed to allow interviewees to elaborate on common themes previously discussed. Participants had no particular time limit in responding. While participants likely felt less pressure to give answers suitable to the interviewer, requiring a written response may generate officially sanctioned and socially respectable answers. This methodology thus provided less uncensored personal opinions than the oral interviews, but more insight into how official discourses on immigrant students are reproduced by school employees.

Finally, the study concluded with an examination of each school system’s written plan for integrating immigrant students, with the goal of confirming conclusions generated by the interviews. The Catalanian system’s document is entitled Plan for Language and Social Cohesion ("Pla per a llengua i la cohesió social") and was published in Catalan by the regional government’s Department of Education. The Madrid document is entitled Plan of Integration ("Plan de integración") and was written in Spanish by the government of the Community of Madrid for 2006-2008. Unlike the Catalanian plan, this integration plan was written for more than one sector of society (e.g. employment, sanitation, housing, etc.), so the study focused primarily on the education section. These documents provide insight into how the official bureaucracy articulates its vision for immigrants in the classroom, as they required local government approval.

DATA

ORAL INTERVIEWS IN BARCELONA

One common value nearly all interviewees in Barcelona emphasized is the tolerance and diversity of Catalan society. They argued that this value is reflected in school curricula in the form of “intercultural education”, a process by which students share their different cultures, customs, and religious practices in order to avoid misunderstanding and stereotypes. At the same time, many interviewees expressed a need for immigrant students not only to share their customs, but also to accept and use local ones. For example, a principal noted with satisfaction that one of his Moroccan students called another one “moro,” a pejorative term for Arabs. The principal implied that this action was a sign that the Moroccans students were well integrated into the local culture. Several of the interviewees, particularly those with ancestors from other parts of Spain, emphasized that Catalonia has a long tradition of welcoming and
integrating immigrants. They argued that their ancestors had the opportunity to learn Catalan and eventually move up in society, and that today’s immigrants must do likewise in order to prevent intercultural conflict and social inequality.

Every respondent equated learning and speaking the Catalan language with integration into society. One of the interviewees explained that if people speak Catalan, they are not perceived as foreign. Several people also claimed that Catalan is the primary vehicle for social and economic mobility. In fact, one education official mentioned that schools emphasize language training because “the more of the language [Catalan] they speak, the quicker they integrate” into the school system and society at large. Additionally, several interviewees noted a complex relationship between Catalan and Castilian. One official, originally from Salamanca (a Spanish city not in Catalonia), mentioned that speaking both languages helps increase the mental capacity of students and the richness of their experience in the school. However, another official said that speaking Catalan is so important because the language’s survival is threatened by the encroachment of Castilian. In conjunction with the emphasis on language as a tool of normalization, the relevance of an immigrant’s country of origin was of note in terms of language. As one interviewee explained, if the immigrant student’s native language is very different from Catalan, his or her integration process will be that much more difficult.

**ORAL INTERVIEWS IN MADRID**

The interviewees in Madrid addressed some of the same points made in Barcelona, though there was noticeably less emphasis on language and more on cultural background as a factor affecting integration. This emphasis often took the form of comparing the national origins of immigrant groups. For instance, Argentinean and Chilean immigrants were presented as more “integrateable” than other Latin Americans. These particular nationalities were described as more educated and prepared for the Spanish classroom than other Latin Americans and certainly more so than Moroccans or Sub-Saharan Africans. In Barcelona, a student’s ability to integrate was rated in terms of the distance between his or her native tongue and Catalan. In Madrid, however, a student’s ability to integrate was framed in terms of the adequacy of his or her prior education in the home country. Interviewees often made reference to the Aulas de Enlace program as vitally important for learning Castilian to enter the mainstream education system. One interviewee noted, however, that many Argentinean and Chilean students do not even need this “Compensatory Education,” which is reserved for immigrants from other countries, the mentally handicapped, Roma and delinquents.

Many of the interviewees in Madrid focused on Muslim and Moroccan immigrants (terms often used interchangeably) in reference to cultures that are more challenging to integrate. Gender roles were frequently mentioned as a source of cultural conflict. One female principal remarked that the father of a Moroccan student in her school refused to meet with her because she was a woman. However, the principal added that they avoided this cultural conflict by bringing in a man from the school system to speak with Moroccan families. She, like many other interviewees, followed comments about cultural conflict with recognition of the positive aspects of immigration. For example, she noted the efforts of the school to celebrate its diversity through events
such as “multicultural day”. Another interviewee, a school official in charge of Compensatory Education, expressed mixed feelings about multiculturalism. He did, however, also draw special attention to Muslim treatment of women as being in direct conflict with Spanish values and the Constitution. Like the school principal, after mentioning this contentious reality, he was sure to note that immigrants are beneficial to the Spanish economy and to the cultural richness of the country.

BARCELONA WRITTEN INTERVIEWS
While there were many similarities between the written and oral interviews, the emails tended to focus more on the importance of family and social situation in integration. For instance, two principals from Barcelona explained that a student benefits from presence of others of the same background who “are already more or less well integrated.” However, one principal cautioned that if there were too many immigrants in the school they could end up creating “ghettos in the school.” According to several interviewees, having students from a very diverse cultural background presents unique challenges to successful integration. In order to overcome these challenges, one principal noted several programs to facilitate “native” students’ and teachers’ understanding of the immigrant experience. For example, one school is in the process of organizing an exposition about the experiences of recently arrived students. Additionally, both a principal and education official noted a new program to train instructors in multiculturalism and cultural sensitivity in order to prevent racist and xenophobic attitudes from fomenting. At the same time, one education official noted the importance of “transmitting our culture in an effective manner” to facilitate immigrant participation in the host culture. In this same vein, several respondents contended that there is a limit to the school’s ability to integrate students. A large part of the integration process, they contend, is the role of families. Therefore, the schools enact programs to engage the parents directly in the integration process of their children.

MADRID WRITTEN INTERVIEWS
The Madrid interviewees differed from those in Barcelona largely with regards to how they conceptualized the classification and integration of immigrants in their schools. For example, one interviewee from Madrid described the ethnic composition of her school in terms of the students’ nationalities. Unlike in Barcelona, this principal in Madrid did not categorize Latin Americans as one group, but rather specifically referenced their national origin (eg. Bolivian, Columbian, and Argentinean vs. South American). This principal also took a more “one size fits all” approach to integration programs by arguing that all immigrants are welcomed equally in the school, obviating the need for individualized strategies for each student. Additionally, the principal echoed much of what was said in the oral interviews by associating her school’s religious and cultural programs (“acogida, intercultural orientation, flexible groupings”) with “compensatory education.” Equally important is that the word “intercultural” was used to describe an orientation program for students, whereas in Barcelona the same word was attached to the concept of education, a bi-directional process of sensitizing both teachers and students.
CATALAN SCHOOL SYSTEM INTEGRATION PLAN

The Catalan school system’s plan establishes from the outset the importance of the school as a primary site of integration that is part of a wider social net responsible for receiving and incorporating newcomers. Indeed, the school system is portrayed as a tool for eliminating social inequalities, avoiding “social fracture”18 and providing equality of opportunity for all students. The document highlights the importance of this integrative role by juxtaposing “risk of social exclusion”19 and “welcoming and integration.”20 Immigrants are thus considered a threat to society (“social fracture”) and a threat to themselves (“risk of social exclusion”) if they do not integrate. Indeed, the document portrays immigrants as a danger to society and themselves due to their failure in school, low levels of education, and familial problems.21 A section of the document includes charts and figures on the numbers of immigrants in the school system, with a special emphasis on their rapid growth and high concentrations (“60% of the total”) in the student bodies of certain schools.22 The inclusion of statistics on the rapid growth of the immigrant student body gives the reader a sense of urgency and plants the idea that integration must proceed at an ever faster pace to avoid social fracture.

This plan consists of three interlocking elements: integration, social cohesion, and strengthening the Catalan language. Language in particular is described as a crucial factor for integration, as seen in the idea that every teacher must be a language instructor regardless of his or her specialty.23 Learning Catalan is equated with social inclusion and integration. Therefore, the plan requires that every immigrant student must first learn the language in a “welcoming room”24 before entering mainstream classrooms.25 Education in the Catalan language is presented as a benefit for the immigrant’s integration and for the society as a whole. To this end, the document emphasizes the importance of maintaining Catalan not only as language of instruction, but also as a vital language outside the classroom.26 Immigrant students’ usage of Spanish outside the classroom is framed as problematic for their own integration and for the survival of Catalan.

MADRID SCHOOL SYSTEM INTEGRATION PLAN

Madrid’s plan, much like Catalonia’s, emphasizes the need for intercultural education and mutual respect between the immigrant and “native” populations. The process of integration is described as a bi-directional process involving “the native population as much as the immigrants.”27 The government describes immigrants as enriching Madrileño society economically and culturally, in strikingly similar words to one of the interviewees from the Madrid Department of Education.29 This “interculturality” and tolerance for others is framed in terms of making Madrid a more effective integrator. Indeed, the document states that Madrileño society must become more open so that it can “adequately incorporate the immigrant population.”30 In almost the same words as the Catalan school system, “integration” and “incorporation” of immigrants are portrayed as necessary for the sake of “social cohesion.”31 Likewise, the school system is portrayed as holding society together by providing “equality of opportunities”32 regardless of people’s origins or social class.33

These ideas are almost identical to those found in the Catalan document, with the exception of the intense emphasis on language as an integrative force. Indeed, the
Madrid plan includes a similar language-immersion concept to Catalonia's Aulas de Acogida in their Aulas de Enlace, yet outside of a brief mention of the need to learn Spanish, language is not a focal point of the document. Like the Catalan plan, there is a concerted emphasis on normalization of immigrants, yet instead of focusing on language, there is a focus on improving immigrants’ access to resources and giving “attention to diversity.” Similarly, this diversity consists not only of immigrants, but also of other “vulnerable” sectors of society to which the schools must attend. Although the Madrid plan is less explicit about language's role in integration, it does note the importance of the fact that a majority of foreign students in the city are “Spanish speakers, originating from South America.” The Madrid plan places a greater emphasis on immigrants’ national origins, as well as their rapid growth, as evidenced by the inclusion of many graphs and statistics on these two topics. There is also an extensive breakdown of where students come from, something that figures much less prominently in the Catalan plan. National origins are also seen as having long-term importance in the Madrid plan. Children of immigrants are discussed hand-in-hand with immigrants themselves, indicating a sort of permanency of condition. In contrast, the category “immigrant” is not depicted in the Catalan document as a term applicable to children born in Catalonia. In the Madrid plan, integrating immigrants is described as a technical issue requiring better methods and tools in order to keep pace with rapid cultural changes. The issue is described as one of finding adequate educational expertise to deal with the phenomenon on a local level. Interestingly, the Madrid document frames the issue as one pertaining to the “autonomous” city government, whereas the Catalan plan refers to the “country” of Catalonia. In Madrid, the city is responsible for tackling immigrant integration, whereas in Catalonia, there is a broadening of the issue to a question of national identity.

ANALYSIS

While each educational system is unique, both Madrid and Barcelona share significant objectives and methods. Specifically, both focus on the idea of “integrating” immigrants into the school system as a way to enhance “social cohesion.” This cohesion is to be achieved through “intercultural education,” which is described as an approach to education founded in respect for other cultures. It seems clear that intercultural education illustrates the degree to which both societies fear that immigration will bring about cultural conflict. Additionally, both school systems appear nervous about the difficulty of integrating large numbers of immigrants in a short period of time. Both places seem to have established a sort of hierarchy of immigrant groups. While in Barcelona, this hierarchy is framed in terms of linguistics and in Madrid in terms of education in country of origin, both societies privilege Argentines and Chileans while questioning Moroccans’ ability to integrate. Also part of this schema is that immigrants are associated with other “marginalized communities” such as the mentally handicapped, Roma, and the poor. Education is valued as a primary tool of integration, and in both locations the school systems have established special acogida programs to facilitate linguistic acquisition and entry into society. While the two systems share much in terms of general objectives and strategy, there are significant differences in their approach towards language. In Barcelona, for
example, learning Catalan is the primary criterion for integration. In order to protect
the Catalan language from Castilian, it is clear that the school system places the utmost
priority on making Catalan necessary for immigrants. The success of their plans is
seen as crucial to the future of the language, and by extension the Catalonian nation
as a whole.

In Madrid, on the other hand, the school system places a greater emphasis on
students’ national origins, educational background on arrival, and cultural norms
beyond just language. Students were described in terms of the countries they come
from, with a particular emphasis on distinguishing between different types of Latin
Americans. This distinction was evident in discussions which critiqued the “quality”
of immigrants’ Spanish, particularly those coming from countries other than Chile
and Argentina. Far more so than in Barcelona, there is an explicit preoccupation with
students’ religious background, specifically the difficulties posed by Muslim immi-
grants’ treatment of women. It also appears that being an immigrant in Madrid is
conceived as a long-term and inherited status, perhaps explaining why they are more
closely associated with other marginalized groups than in Barcelona.

CONCLUSIONS

These results reveal a great deal about the larger questions of national identity and
immigration in each society. The Catalan school system’s approach to immigrant
students underlines the society’s fears about the future of its language in light of the
possibility that immigrants may prefer Castilian. The Madrid school system’s vision of
immigrant students seems to point to a societal concern with cultural and religious
diversity as a potential point of conflict. The school system in Barcelona appears to
promote an idea of civic nationalism, allowing for anyone who learns the Catalan
language to achieve equality in society. Yet it is clear, particularly from these oral inter-
views and informal conversations, that other factors, such as national origin and race,
do in fact play a role in gaining access to Catalonian identity. On the other hand,
Madrid schools do not place the same level of emphasis on language as a social unifier,
indicating the Castilian’s strong position in society (i.e. not in competition with
another local language).

The most interesting conclusion is that despite some important (mainly linguistic)
differences, Madrid and Barcelona societies seem to approach the issue of immigra-
tion in very similar ways. This similarity is contrary not only to the history of animos-
ity between these two cities, but also to what we assumed at the outset. It seems that
the overall goal in both territories is to preserve the dominance of “native” culture in
a globalized world which has brought millions of newcomers to their doorsteps. The
principal differences between the two cities’ visions of immigrant integration come,
then, from what it means in each case to preserve local culture. The data is valuable,
but not yet sufficient to draw wide-ranging conclusions about immigration and
national identity in these two cultures.

In addition, this study has raised questions that the data cannot answer. For exam-
ple, to what degree do factors such as national origin, native language, and religion
influence the experience of an immigrant in these societies. This study indicates that
there are clear differences in how various immigrant groups are perceived, yet further
research could shed light on precisely how and why their experiences differ. One possibility would be to choose a specific immigrant group and focus on a particular factor, such as Latin Americans and language use in Barcelona. Future research along these lines is needed to test the important questions this study raises about the relationship between national identity, immigration, and globalization.

Notes
10 All translations are our own, unless otherwise noted.
12 Oral Interview BM.
13 “Aulas de Enlace,” or “linking classrooms” are the Madrid school system’s main acogida program. In this program new immigrant students are not in the mainstream classes during the integration process.
14 “otros alumnos de su misma procedencia ya más o menos integrados.’ Written Interview JN.
15 “la creación de guetos en la escuela.” Written Interview MV.
16 “Transmisión de nuestra cultura de manera eficaz.” Written Interview BM.
17 “acogida...ambientación intercultural....argupamientos flexibles...educación compensatoria.” Written Interview MA.
18 “fractura social” (“Pla per a la llengua”, 3).
19 “risc d’exclusió social” (“Pla per a la llengua”, 7).
20 “l’acollida i la integracio” (“Pla per a la llengua”, 7).
21 “Pla per a la llengua”, 11.
22 “Pla per a la llengua”, 9.
23 “Pla per a la llengua”, 6.
24 “aula d’acollida” (“Pla per a la llengua”, 34).
“Pla per a la llengua”, 16.

“Pla per a la llengua”, 7.

“implica tanto a la población autóctona como a la inmigrada” (“Plan de integración”, 5).

Spanish adjective describing something of or pertaining to Madrid.

“Plan de integración”, 34.

“incorporar adecuadamente a la población inmigrante” (“Plan de integración”, 5).

“Plan de integración”, 34.

“igualdad de oportunidades” (“Plan de integración”, 35, 68-9).

“Plan de integración”, 70; “la efectividad en el acceso y el desarrollo de una educación intercultural en igualdad que favorezca una sociedad integrada y cohesionada” (“Plan de integración”, 71).

Acogida, or Acollida in Catalan, is the noun form of the verb “acoger” in Spanish, which means to receive or welcome, often used in reference to immigrants arriving in Spanish society.

“Plan de integración”, 69.

“atención a la diversidad” (“Plan de integración”, 69).

“Plan de integración”, 70.

“de habla hispana, procedente de América del Sur” (“Plan de integración”, 75).

“Plan de integración”, 68.

“Plan de integración”, 68.

“Plan de integración”, 71, 82.
Many educators and activists present multiculturalism as a lifestyle of tolerance that could counteract the twenty-first century’s extensive intercultural conflicts. However, multiculturalists have not yet developed a practical application of their philosophy. This research, conducted at the culturally diverse American Church in Paris, contributes to a growing body of scholarship that investigates the complexities of real multicultural situations. As this study will show, a culturally diverse institution can organize its community in many different ways, and each method of organization affects cross-cultural interactions between church members differently. This research demonstrates that members are most likely to form cross-cultural relationships when culture is not treated as the primary attribute of the participants; they are least likely to enact multicultural principles when presented with the idealism of mainstream multicultural philosophy. These and other findings demonstrate that the individual’s particular situation and practical concerns are the most powerful factors in her/his willingness to relate cross-culturally. A successful multicultural environment must therefore provide a supportive forum for individuality and personal experiences.
INTRODUCTION

Globalization, diversity, and multiculturalism are regarded as the catchphrases of twenty-first century society. These phenomena, supposedly emblematic of our era, have captured public attention as universities strive for diverse student bodies and activists encourage cross-cultural awareness. However, the ultimate goal of these movements is not always clear. Few have taken time to realistically define the multicultural community for which they fight. This study contributes to the demystification of multiculturalism which scholars such as Alicia P. Rodriguez and Cynthia Levine-Rasky have called for by analyzing the implementation of multicultural principles at the American Church in Paris, a functioning multicultural institution.

The American Church in Paris, commonly called the ACP, is an interdenominational Protestant, Anglophone, multicultural church serving Paris’ ex-patriot community. At this particular institution, multiculturalism must fit into the ACP’s long history of social support for ex-patriots; diversity is a relatively recent development. Founded in 1857 by a small group of Americans, the ACP has been a vital site of American ex-patriot social networking for roughly one and a half centuries. At the church, ex-patriots could join together to participate in programs that alleviated the difficulties of life abroad. These programs, still active today, range from information sessions on the logistics of living in Paris to fellowship groups and community service activities.

Current church leadership claims that the goal of its programs and religious services is to provide a “home away from home” to lonely ex-patriots. However, during the last few years of the twentieth century, the church’s calling has been complicated by the influx of ex-patriots who are not American. The ACP philosophy must now be applied to a congregation of Filipinos, Africans from various countries, Americans, and numerous other cultures. ACP leadership has welcomed these newcomers; indeed, in the 2006 documentary A Glimpse of Heaven, interviewees of many backgrounds affirmed that before they found the ACP, they lived in depression resulting from extreme solitude, linguistic difficulties, and cultural unfamiliarity. Nonetheless, such a diverse congregation poses a challenge to the church’s long-standing tradition of community-building: how can the church be a “home away from home” for everybody? The situation of the ACP provides the prime research environment to discover whether or not multiculturalism can satisfy the need for a home. This study analyzes the ACP’s system of organization for its diverse community, and it identifies the approaches to multiculturalism that best encourage cross-cultural connection.

MULTICULTURAL IDEALS AND ALTERNATIVES

The popular use of the term “multiculturalism” in contemporary culture is broad; educators, activists, and social change-minded people all employ it to describe any drive for tolerance, compassion, and world peace, especially on a global level. Scholar Levine-Rasky identifies this popular approach, which often takes the form of transcendent, depersonalized rhetoric, as an outgrowth of liberal humanism. The liberal humanist approach, exemplified by theorist Charles Taylor’s foundational discussion of multiculturalism posits “a desire for respect for individual rights and property,
spiritual values, [and] the goodness of human nature” as universal human characteristics through which we can relate to each other. While every human being may indeed be intrinsically good, Taylor’s characteristics obfuscate the reality of cross-cultural interaction: the world is rife with examples of some cultures oppressing other cultures, and history’s wounds are difficult to heal, especially when we do not acknowledge them.8

Taylor’s philosophy is as unrepresentative of individuals as it is of groups. Individuals have personal histories of experiences, relationships, and prejudices just like groups, however idealistic liberal humanism prevents them from acknowledging and potentially separating from those histories. Cecil Foster validates anyone struggling with multiculturalism by reminding those who “would rather forget and converse only about the good and beautiful ... [that] by not retelling the entire story we run the risk of forgetting that multiculturalism was a difficult decision and that not everyone chose this path.”9 When theorists discuss multiculturalism as if it were easy, they deprive people of tools with which to undertake its difficulties.

A combination of theory from scholars Levine-Rasky, Alicia P. Rodriguez, and Cecil Foster10 provides an alternative formulation of multiculturalism. It will be termed lived multiculturalism, in contrast to the idealistic multiculturalism previously discussed. These scholars recognize the practical, specific difficulties of cross-cultural communication that idealism does not address. For example, the Canadian mothers Levine-Rasky interviewed in a quickly diversifying neighborhood felt uncomfortable with certain behaviors of their children’s new friends, and they worried that the school’s learning environment would suffer as a result of the introduction of children from poorer, less effective schools. Any true portrait of multicultural dynamics in this community must incorporate and address the complexities of these mothers’ “subjective experience”11 of multiculturalism.

Levine-Rasky, Rodriguez, and Foster emphasize the perils of demonizing or overlooking such complexities. Though part of the mothers’ anxiety was admittedly caused by stereotyping and lack of knowledge, their concerns were also a natural effect of the human desire for stability, comfort, and familiarity. Both Levine-Rasky and Rodriguez acknowledge that seeking and maintaining groups is humans’ primary method of achieving these desires.12 While, as in the case of the Canadian mothers, being mono-cultural can help groups meet these needs, there is no reason why successful multicultural groups cannot exist. As long as multicultural groups provide comfort and familiarity, they can become stable and enjoyable. Recognizing that groups satisfy these basic human needs clarifies the functions that a multicultural group must fulfill in order to replace a culturally monolithic group.

Redefining “individual” and “culture” provides substantial aid to individuals on their personal multicultural journeys. The idealistic definition of multiculturalism retains a definition of culture as monolithic and stable. In reality, culture is not one definable entity, but a plethora of ever-changing structures and drives. For this reason, every individual is multicultural. This paper will use a formulation of multiculturalism as personal, interaction-driven, and exploratory in order to emphasize that the end goal of multiculturalism should not be the interaction of different cultures, but the interaction of different people, or as Rodriguez says, the development of “independent thinkers who can make connections across knowledge regimes and social experience.”13
METHODOLOGY

The American Church in Paris stands on the left bank of the Seine, and includes a multi-story community center with a theatre, gymnasium, and rooms of varying sizes and functions. Some of the countless programs held in these rooms are church-related, while others are conducted by non-religious organizations that rent space. The researcher was essentially a temporary member of the church for six weeks. Sunday services, post-service coffee hours, fellowships, youth ministries, church-wide special events, and non-religious activities were attended regularly as well as special events including a one hundred fiftieth anniversary play about ACP history and a Bateau Mouche ride down the Seine. Non-religious programs included a film group, a French-English conversation hour, and an aerobics class. Printed and online information on the non-religious groups renting space throughout the week was collected. Research methods consisted of participant-observation, document analysis, and informal interviews with congregation members.

The way in which each program or event approached multiculturalism affected the amount and depth of cross-cultural interaction occurring. Some of the programs organized the congregation by culture, separating one culture from another. Some brought the entire congregation into one space. Some organized the congregation by interest or age, disregarding cultural characteristics. These allow each individual to choose the extent of her/his cross-cultural exploration, with as much access to culturally unified environments as culturally mixed environments. Such a system of choice makes the success or failure of these multicultural structures extremely salient. The ACP’s ex-patriots will not choose a multicultural environment unless it satisfies the members’ need to feel accepted, understood, and supported; if it does not satisfy this need, the congregation will not look to multiculturalism for a sense of belonging, and cross-cultural communication will falter.

THE AMERICANS’ BITTERSWEET HEGEMONY

The American Church in Paris occupies an extremely difficult transitional zone; its historically strong connection to American culture is being eclipsed by the virtually equal numbers of white and non-white worshippers. Consequently, Americans are in an ambiguous situation; they are actually neglected by some aspects of the ACP’s present-day multiculturalism, yet retain positions of prominence and power in the organization of programs. Examining how this bittersweet hegemony came to exist sheds light on the kinds of challenges a transitioning multicultural institution must face.

The development of a multicultural philosophy at the ACP was somewhat tumultuous. Middle and upper class white Americans comprised the majority of the congregation for more than a century. During this period, the programs created by the church for its constituent population became a fundamental aspect of the church’s identity. Charting how such programs change over time is a useful indicator of the ACP’s shifting identity. One such example is the yearly luncheon and conference called Bloom in Paris, founded by the group Women of the American Church roughly fifty years ago. This large-scale social gathering provides practical information about living in Paris, normalizes the participants’ hardships, and encourages networking for future
friends. With the recent arrival of non-American immigrants, the ACP started to provide additional services of support and advice that detract from the importance of Bloom in Paris. Newer programs vying for space and attention slowly change the orientation of the church as a whole.

This shift of orientation made some of the Americans feel that their cultural space had been invaded and their solidarity compromised. Tensions emerged in various disputes at the level of the church's community leadership; one contributed to a multiculturalism-oriented pastor's decision to leave the church a few years ago. More subtle manifestations of tension were evident during this period of research, such as an initiative to create an American Fellowship that would complement the African and Filipino Fellowships. This development indicates that some Americans feel left out of the ACP's new multicultural system. What used to be a familiar community of Americans has become a diverse community of many cultures, and the Americans do not have a fellowship as do the Africans and Filipinos.

However, the American feeling of neglect cloaks the reality that Americans are still the most powerful group in the congregation. The church is Anglophone and, as its name points out, American. In this context, “multiculturalism” actually points to “non-American” cultural identities, and the unquestioned norm from which those identities differ is Americanism. The structure of the service, for example, is firmly entrenched in Western Christian tradition and American culture. While Filipino and African traditions are identified as culturally specific and in need of fellowships, the Sunday service assumes universal applicability. In addition, Americans still constitute a large portion of the skilled leaders in various church programs, and they tend to shine during the church's special events; for example, the church felt that it was more appropriate to use a Western musical comedy than a Filipino stick dance to commemorate its one hundred fiftieth anniversary. From these structural seats of power, the Americans maintain their solidarity.

UNSUCCESSFUL MULTICULTURALISM

The Service

Of all the forums for multiculturalism treated in scholarly literature, venues like the ACP are the most appropriate for idealism. In contrast to nation-states, which are the typical subjects of multicultural research, the ACP need not worry about practical matters such as citizenship, immigration, and work capacity; it focuses instead on spirituality, transcendence, and community building. However, the practicalities that Levine-Rasky mentioned are always present. The congregation still must negotiate how to speak to one another, how to share space and program capacity, how to worship, how to dress, how to sing, how to say “amen”, and how to walk down the hallway. Though the sermons attempt to address everyday situations, they still fall under the framework of Taylor’s idealism. They do not prepare members to practice lived multiculturalism in their cross-cultural interactions.

The Sunday service might receive much less of a member’s time than the myriad nonreligious and social activities that occur throughout the week, but it is still assumed to be a centerpiece of the church and is heavily attended. However, gathering
people of different cultures in one space does not fully enact multiculturalism, just as the diversity of a New York City subway car cannot make people talk to their neighbors. At the ACP, Sunday services are a strange mix of the most articulate multiculturalism and the most non-multicultural practices. For example, one hears the pastors speak about the reality of fear underneath prejudice, the necessities of seeing commonalities between various denominations of Christianity, and even the challenges of worshipping in a multicultural congregation, but the service provides no space for interaction between worshippers.

This lack of interaction during services affects the church’s potential for providing a comfortable, familiar “home away from home” for its congregation. Like multiculturalism, the theme of home is mostly present in the service as an ideal, rather than enacted, form. The pastors regularly address the congregation’s desire for belonging with empathy for the struggles of integrating. However, the comfortable, trusting environment this empathy could create in a less formal context does not exist. Sometimes, the congregation even seems uncomfortable with participating in the service, saying “amen” halfheartedly, for example, and hesitating to sing the psalms. These may be subtle details, but they attest to a lack of surety, and a heightening of reserve, that do not normally characterize “home.”

The Fellowships

Home-making is in full force, however, in the Filipino and African fellowships. These groups were created to provide these sizable populations a place to honor their own traditions and enjoy the comradeship of their respective communities. None of the Sunday service’s awkwardness is present during monthly African and weekly Filipino events. Sunday’s diversity is also missing; the majority of fellowship participants are of the specified cultural background. In a multicultural environment, this separated celebration of one culture has flaws that are often overlooked.

The primary complication with separated celebration is that by providing the Filipinos or Africans with their own cultural space, the church implies that its members need culturally specific support that collective congregation life cannot provide. In fact, the fellowships do provide the spontaneous, enthusiastic, and personal social support missing from the Sunday service. These events are gregarious social gatherings complete with chitchat, laughter, and extensive potluck meals. Children who had been hushed throughout the service are encouraged to form a giddy group of running, jumping, perhaps crying members of the congregation on the floor between the packed tables.

Not all the people attending these fellowships are from the culture being celebrated. Other cultures are explicitly welcome, and people from all around the world enjoy the fellowships’ good food and fun. It is interesting to note, though, who tends to make this cross-cultural leap and who does not. Congregation members who are leaders in the church, conduct Bible study, or hold a place on the church council tend to come to events outside of their respective cultures; they are active in the leadership of the ACP’s multicultural project. In addition, the ACP’s diverse array of young adults is likely to be found at these gatherings; this group is accustomed to exploring and accepting different cultures because they are held together by age more than any ethnic background. There are also people who choose not to step into an unfamiliar
cultural environment. Many Americans spend most of their time associating with other Americans, and in turn, many Filipinos and Africans can be seen at their fellowships and the Sunday services, but not at many other events. While separately celebrating cultural groups makes the overarching system multicultural overall, it does not provide a multicultural environment in itself.

PARTIALLY SUCCESSFUL MULTICULTURALISM

The Coffee Hour and Bateau Mouche Ride
The ACP gives every member the chance to choose cultural solidarity over cross-cultural interaction. There are many occasions on Sundays and during special events when the entire congregation is present and members are able to socialize with whomever they choose. At the coffee hour after the Sunday service, for example, all members are free to seek their friends. The “Bateau Mouche” ride down the Seine that commemorated the one hundred fiftieth anniversary of the ACP in July 2007 provided a similar opportunity to socialize. These forums partially succeed in creating a feeling of home within a culturally mixed environment. While some members gather into culturally monolithic groups, all must at least wait cooperatively in the coffee line or applaud the young congregation members who showed off their musical talents on the Bateau Mouche. Co-participation in these activities contributes more to a multicultural environment than a ritualized, formal, transcendent activity like the Sunday service, or the homogeneity of the fellowships. Within this system of free choice, these events may slowly pave the way to deeper cross-cultural relationships.

SUCCESSFUL MULTICULTURALISM

Idealism, cultural separation, and unstructured gatherings do not constitute a majority of the ACP’s voluntary associations. Two other collectivities have a non-cultural but specific focus. These are groups based on age and interest. How multiculturalism and home-making interact in these groups is extremely different from the systems discussed previously, which are either culturally-separated (like the fellowships) or all-inclusive (like the sermon, coffee hour, and Bateau Mouche ride). Cultural mixing occurs as a side effect while people join together on the basis of age or their enjoyment of chorus, movies, or aerobics. Sharing these activities highlights the participants’ common humanity without idealistic philosophizing; they come closer to lived multiculturalism.

Youth Ministry
While many of the ACP’s interest-based associations are secular, the church’s youth ministry can be included in this category as well. The youth ministry exchanges the Sunday service’s formal worship and depersonalization for informal spirituality and personal engagement with the Bible in a culturally diverse environment. Fun and religion are combined differently in each of the three groups, which are divided by age; the elementary schoolchildren play basketball and do artistic activities, those of junior high and high school age attend fieldtrips to various sites in Paris, and those
from nineteen to twenty-nine years of age switch weekly between pizza nights and Bible study. The actual mode of engagement with religious texts and precepts is vastly more personal as well. The youth pastor emphasizes “honest questioning,” encouraging participants to grapple with the relevance of Biblical texts in their own lives. She enhances this approach to worship with group traditions that explicitly invite the individual to share personal stories and details about his/her self. For example, at the beginning of REACH meetings (the oldest age group), the youth pastor asks everyone for a positive and negative experience from the past week, so that the participants can then show support for their peers. In the same vein, the youth minister will sometimes call on everyone to give encouragement to a particular individual or a few people during times of personal difficulties. Often, everyone will gather around the person, providing a physical manifestation of solidarity by holding hands or putting their arms around each other’s shoulders. Through these techniques, REACH creates a tightly knit community that provides the “home away from home” ex-patriots need.

In keeping with REACH’s personal approach, culture is treated as part of each participant’s individuality, not a depersonalized category to which individuals belong. By emphasizing questioning, exploration, awareness, and basic humanitarian principles of compassion for self and others, the youth ministry provides the tools necessary to develop deep relationships across cultures. Indeed, REACH participants often become friends and gather outside of the church to have picnics, go on outings, and drink a daily coffee in Parisian cafes. The personal relationships of REACH members with each other span cultural backgrounds from South American to North American, Central European, and East Asian. This is lived multiculturalism in action.

Non-religious Activities
A similarly successful, interest-based multicultural system extends into all sorts of secular activities housed by the church’s community center. People of many backgrounds choose to explore groups that pique their interest, from movie-watching to French-English conversation sessions. Dance, aerobics, sports, karate, and concerts are all activities that occur on a weekly basis at the church. The multiculturalism of these groups is further enhanced by their connection to wider society; non-members from the outside community, including the French, flock to the church to take advantage of the offerings. As in the youth ministry, these groupings are successful in home-making and cross-cultural communication because all are engaged in an activity they enjoy and enjoy doing with others.

The Multicultural Couples Group
The multicultural couples group bears mentioning because its criteria differ from all the others’. Created in 2003 by an ACP pastor, this group explicitly requires cultural mixing, deep cross-cultural relationships, and open engagement with multiculturalism’s home-making potentials and shortcomings. The founding pastor created this group in recognition of the challenges couples face when normal communication difficulties are compounded by different cultural backgrounds. All the couples gather with the pastor once a month for a potluck and to discuss issues such as raising bicultural children, celebrating holidays differently, and dealing with bicultural families. The group is virtually the only ACP program that encourages its participants
to delve into their personal difficulties with multiculturalism. The groups based on interest and age provide tools for participants to explore cross-cultural friendships, however they lack the forum for personal concerns and experiences that can bring participants to a new level of awareness about multiculturalism and themselves. While diversity challenges are most salient for multicultural couples, every ACP member interacts with people from different cultural backgrounds at the church. Thus, an open, realistic discussion of how multiculturalism is experienced on a personal level would help the ACP’s congregation be more conscious of, and able to overcome fears and prejudices.

CONCLUSION

This study concludes that groups based on a common interest, in which culture is a secondary characteristic of the participants, succeed at creating and supporting a culturally diverse environment. Groups that directly discuss the challenges and benefits of multicultural relationships are also successful in providing support. In contrast, idealistic philosophizing about multiculturalism does not encourage culturally diverse communities to form. Neither does the creation of groups centered on a single culture. Unfocused gatherings in which people can choose with whom to interact lie in the middle of the spectrum.

These findings can help policy makers and multicultural institutions bring “multiculturalism” down from untenable ideals to workable interrelations and a sustainable way of life. This is undoubtedly a challenging task; what is at stake is the very definition of modern citizenship. As we search for home in a global world, multiculturalism seems to offer belonging. As we search for less bloody belonging, multiculturalism seems to offer peace. These benefits have yet to appear in a noticeable and practical way. However, scholars, educators and pastors alike are all grappling with the issue, and their efforts have uncovered a great deal about making multiculturalism livable. The ACP’s multicultural project is not an easy one; fulfilling the demands of home-making and multiculturalism is fraught with complications. That the project has succeeded at stimulating lived multiculturalism in so many ways, however, is a positive sign for the future of multicultural institutions. The ACP has already been recognized as an example for other programs. Scholars now have the responsibility to continue contextualizing and researching the complexities of multiculturalism so that multicultural institutions can better understand how to create a tolerant, peaceful, personal, and culturally mixed community.

Notes

1 Alicia P. Rodriguez, “Adjusting the Multicultural Lens,” Race, Gender, and Class. 7 (3) (2000), 150.
3 “Home away from home” is a prevalent slogan of church.
4 This documentary was made in 2006 by the church. It serves as promotional and informational
material for those who have just arrived at the ACP or would like to know more about its philosophy.


13 Alicia P. Rodriguez, “Adjusting the Multicultural Lens,” Race, Gender, and Class. 7 (3) (2000), 150.

14 As far as I can tell from the ACP’s listing of programs on its website, this fellowship has yet to be established.

15 “Honest questioning” is emphasized in the description of the youth ministry on the ACP’s website, and the youth pastor spoke of it as the core of her program when she discussed her philosophy with me.

16 The most positive indicator of multicultural success at the ACP is the church’s ability to change. The transition discussed in this paper, though complex and sometimes unsuccessful, was also remarkably fast and often effective. In addition, tracking recent developments at the church indicates fresh engagement with the ACP’s potential for improvement. For example, the website announces that a new “Contemporary Service” was just established to provide a “relaxed and dressed-down atmosphere” in which to “worship God in a different, less traditional setting.” This service, held on Sundays after the traditional service, might provide the comfortable, personally supportive sense of home that was missing from the Sunday services during this research.
ABSTRACT

This study examines how the choices that private bison ranchers make influence the confined bison’s trajectory of becoming a more domesticated animal. The framework for the study is ethno-archaeological: contemporary material collected during the research was interpreted alongside archaeological and biological literature on the process of domestication in mammals and on the bison's recorded past. The research consists of a series of surveys taken on privately owned bison farms in Maine, Massachusetts and Missouri. Formal interviews with the private herd ranchers, in addition to many casual discussions, contributed to the data. Analysis of bison behavior, the environment which the bison inhabit, and the interactions between the ranchers and the bison were investigated through direct observation and photography. It appears that bison on private ranches are in the process of becoming domesticated. However, since ranchers make diverse (and at times drastically different) decisions regarding human interaction, diet, artificial selection by controlled breeding, and the social structure of the herds etc., it is apparent that the various populations of confined bison are at different degrees in the domesticating process. Bison ranchers are motivated by many factors including health concerns, sustainable ecology issues, and a desire for symbolism of the American West. These issues contribute to the variety of environments in which bison are raised. The majority of rancher decisions are intentionally made to create a more docile and meat-producing bison.

KEY TERMS

• Artificial selection
• Bison behavior
• Bison docility
• Bison ranching
• Buffalo symbolism
• Domestication

ACKNOWLEDGEMENTS

I would like to give many thanks to mentors Dr. Fiona Marshall and Professor Richard Krueger. Thank you to the Hoopes Undergraduate Research Award for funding this project.

Peer Editor:

Shweta Murthi, a senior majoring in Biology
INTRODUCTION

The shift from hunting wild bison to raising confined bison for food production has occurred rapidly in North America. The species *Bison bison* has a rich history in the United States that includes extreme shifts in population, from estimates of approximately 28-30 million at their peak around 1700 A.D.\(^1\) to near extinction in 1883.\(^2\) Recently, however, their numbers have been rising—by 2003 there existed more than 320,000\(^3\) bison in the United States. Private ranchers own the majority of bison while smaller numbers of bison live on public land and on Native American reservations. As bison transitioned from roaming the North American landscape to the fenced farms and parks of contemporary society, they have become exposed to new environments that are predominantly under human control. The methodological framework for this study was inspired by the ethno-archaeological approach: contemporary material collected during the research was interpreted with an eye to the existing archaeological and biological literature, data on the process of domestication in mammals and on the bison’s recorded past. The research consists of a series of surveys on privately owned bison farms in Maine, Massachusetts and Missouri: Sayersbrook in Potosi, Mo.; Oak Creek Buffalo Ranch in Pineville, Mo.; Alta Vista Bison Farm in Rutland, Mass.; Beech Hill Farm and Bison Ranch in North Waterford, Maine. Formal interviews were conducted with private herd ranchers, but data was also collected from many casual discussions held on their ranches.

Examination of bison behavior, their environment, and interaction with ranchers, was conducted through direct observation and photography. The photographic element is intended to capture the unique sense of time and place of these particular confined bison rather than a more typical documentary style. The portfolio focuses on human-bison interactions and the complexity of trying to place the bison in a contemporary visual reality. Attempts were made to put aside preconceived notions of what bison imagery should be. This was a challenge since the ‘buffalo’ has a strong symbolic heritage in the United States as a wild animal of the American West. Although the representation of bison in this photographic series may appear inconsistent, the work is a deliberate reflection of the complex notion of domestication vis-à-vis wildness as the bison struggles to adapt to the confines of a domesticated role in American society.

The integration of photography and ethno-archeological research methods was instrumental in shedding light on the role of captive management on the bison’s behavioral and physical characteristics. Ultimately, the research sought to clarify what parameters constitute domestication and whether these bison fulfill such criteria.

ISSUES

“A uniform overall concept for the ‘domestic animal’ phenomenon may acquire practical significance over and above purely scientific interest in fundamental knowledge, as the domestic animal is an essential element in the development of human civilization.”

-Helmut Hemmer\(^4\)
The motivation to confine bison is one of two main factors in discerning the degree to which domestication takes place. The other factor is whether the bison has the necessary behavioral traits to accept their new environment, which would inevitably lead to domestication. Both of these factors are fundamental in rating the degree to which bison ranches have the potential for domesticating bison. In *Guns, Germs, and Steel*, Jared Diamond argues against the actuality of domesticating bison. He claims that all large mammals that are capable of becoming domesticated were domesticated over 4,500 years ago. Since that time, humans have never succeeded in domesticating any other large mammals, despite numerous attempts. In particular, he claims that the American bison may never become domesticated because our society does not place enough “economic value” on raising bison in the environment necessary for domestication. In other words, Diamond’s argument is twofold: the domestication of bison has not happened because of lack of motivation in our culture, and is unlikely to happen because bison retain unfavorable traits such as a “nasty disposition” or the tendency toward unpredictability causing them to be difficult, if not impossible, to domesticate.

Yet, the research concludes that until recently, there have not been urgent reasons to domesticate bison although in the past few decades, motivation is emerging. It is important to note that domestication is a process that may evolve over generations before obvious physical changes are noticed in the animals. Current reasons for domesticating bison include its importance in Americana symbolism, competition, the search for a better ecological animal, and to develop a healthier meat option. All of these reasons rely on the availability of bison, and, due to the development and division of the land in the United States, bison have become available only under human control.

Bison behavior is also relevant to defining domestication. Claims that bison are wild animals are supported by evidence that they have displayed human-directed violence. However, records have shown that ranchers find that bison have become more docile and tame over time. Possible reasons for this change in behavior include: selective breeding, learned behavior passed from cows to calves, and toleration of human presence due to fencing practices. This study also looks into the bison’s capability of breeding bison in confined environments and their acceptance of humans, all of which are characteristics of domestication.

**WHAT CONSTITUTES DOMESTICATION?**

“All these definitions and individual ways of understanding the process of domestication are only prerequisites of understanding its entirety. But in the end only an overall view provides a really profound understanding of life and organisms.”

- Helmut Hemmer

Domestication is a continuous process; therefore, it is difficult to locate a starting point. When do we begin to call an animal domesticated? What are the prerequisites for that label? The following are a few of the leading theories on the subject in an
attempt to construct an emerging concept of what constitutes domestication. The majority of the theorists who study domestication agree, at the very least, that it is both a cultural and a biological process. Domestication must then be examined using a multi-disciplinary approach: socially, behaviorally and morphologically. The cultural process begins when animals are incorporated into the social structure of a human community and become objects of ownership, inheritance, purchase and exchange. The morphological changes that occur in domesticated animals come second to this integration with human control. Richard Bulliet claims that keeping a small number of animals in confined environments while not letting them breed with the wild counterpart, “in combination with a constant and disturbing presence,” would eventually be enough to lead to “domestic tameness.” More specifically, Bulliet acknowledges that the wild instincts of “excitability, wariness, combativeness and flight from predators” will be exchanged for tame traits of “docility, acceptance of human presence, tolerance of saddling and harnessing, and acquiescence in being herded, milked, sheared, and slaughtered.” In support of this theory, Helmut Hemmer suggests that, “the central point for understanding the phenomenon of the ‘domestic animal’ lies in the structure of its behavior, especially in the underlying changes from the wild condition.” It is also important to note that, when animals are bred in captivity, breeders artificially select for traits that are valued by humans rather than those that would be naturally selected for in the wild.

The following is a working definition of the notion of domestication as a compilation of the aforementioned definitions: Domestication is a continuum that begins with a human’s decision—a cultural decision—to confine an animal in a space with constant human intervention. In addition the animal must have potential for living and reproducing for many generations. As a result, the evolution of the population is more strongly influenced by artificial selection in confinement than by the principle of natural selection. Results will first be seen culturally and behaviorally, then morphological and genetic changes, all of which will continue to evolve.

One factor which makes defining domestication a complex task is that morphological changes that are used to identify domestication in mammals often do not show up for hundreds, sometimes even thousands of years after the cultural changes that induced domestication have become habitual. As Zeder shows, in “Documenting Domestication,” when sex-specific harvest profiles were constructed of bone assemblages of goats in Iraq and Iran, herd management of goats (Capra aegagrus) could be detected over a thousand years before the appearance of any morphological markers of domestication for the species. The majority of excavated bones came from adult females of reproductive age and young male goats, providing evidence for herd management, whereas wild hunting populations would have differed in composition based on gender and age. This provides evidence of herd management. In light of these findings, Jonsson claims that using morphological traits to define an animal as domesticated is too narrow—it refrains from introducing the full history of evolution and the human societies that coevolved. The biological (morphological) changes that would define a bison as domesticated have not occurred and may not occur anytime soon. The progress of human cultural changes and the behavioral changes that they cause in bison, if sustained, have the potential to lead bison down the trajectory of becoming biologically domesticated.
ON THE RANCH

“Euro-American agriculturalists carved up the land while changing the biota, which ultimately prohibited any possible resurgence of free-ranging bison herds reminiscent of those in the preceding millennia.”

- Ken Zontek

Motivation is necessary for human cultures to confine an animal. Five main motivations for raising bison have emerged from discussions with the ranchers: symbolism, competition, desire for a better ecological animal, economics, and the search for a meat option healthier than beef. The symbol of the ‘buffalo’ appears in a variety of places; from buffalo nickels to school mascots to state seals and flags.11 In The Buffalo Book, Dary attributes various symbolic meanings to the ‘buffalo’ that include a nostalgic reminder of a vanished time in the West prior to Euro-American civilization and a sign of strength and endurance, but the animal also symbolizes “man’s ignorance of conservation.” Notions of both ‘status’ and ‘exhibition’ vary from ranch to ranch. At two of the farms, Alta Vista and Sayersbrook, the ranchers openly display their taxidermic bulls to visitors, typically their largest prized bull. Oak Creek, a recently-founded ranch, which had not mounted an animal yet, has plans to mount and stuff one of their older prized bulls. All four farms make their bison livestock available to the for public for viewing, often with detailed tours that include feeding the bison treats in order to have the animals come close to people. Three of the ranches also have gift shops.

Ranchers also wanted to discuss their involvement in competitions. Most farms focus on raising either meat-producing animals or breeding animals, both of which have competitive potential. The rancher in Beech Hill Farms, for example, prefers breeding animals to meat-producing ones because he likes the process of breeding, which includes, for instance, selecting for prize-winning traits to win agricultural competitions. Alta Vista and Oak Creek ranches seemed more concerned with sharing the bison with visitors by allowing access to the herds for observation. The ranchers of both Alta Vista and Oak Creek ranches related stories about how they tamed bison calves using bottle feeding. These bottle-fed calves are more accessible to visitors and are treated by the ranchers more as pets and companions than as livestock. On Alta Vista Ranch, the ranchers raised a male buffalo, Louie, in order to protect his life because the bulls “tossed him around” upon his birth. Louie would not have survived the aggression from the other bulls, so when the ranchers recognized that his mother was not protecting him, they took him away from the herd and bottle-fed him. Louie became very attached to the rancher who harnessed him and let him wander in the house. Sadly, Louie died later from an illness, which may explain why the bulls attacked him initially.

Oak Creek Ranch owns a bottle-fed calf named Tootsie who is currently a teenager—approximately one and a half years old. When Tootsie was young, she was driven around in a car and shown off at bison and family functions. These days Tootsie continues to show her affection for the rancher by staying at her side in the fields.
Although Tootsie lives with the herd, she has never been fully integrated. Future research could be directed towards recording whether Tootsie becomes a mother, and if so, how she would raise her young. At Oak Creek Ranch, the ranchers often refer to one of their two herds of bison as “extended family” (the other herd is physically distant from the house and is kept for more practical purposes). Interestingly, some of the photographs taken on that farm looked more like “family portraits” to the head rancher than just images of bison.

These bottle-fed calves fulfill roles that domesticated animals often do—those of companion and status symbol.4 The ranchers at Oak Creek and Alta Vista claim that many of the decisions they make are in keeping with what the bison would choose naturally. Yet, the decision to bottle-feed these calves is based entirely on human motivations.

Ecological solidity, health and economics are also motivations to raise bison. It was abundantly clear that ranchers at all four farms were opposed to raising cattle. It has been proven that bison are better adapted to the ecology of the western grasslands because of their uniquely evolved digestive systems; therefore, they have the ability to eat a wider range of grasses than cattle.2 Moreover, bison meat has lower cholesterol and is much leaner than beef (even more so if the bison are grass-finished).12 These make bison farming a lucrative business.

Whereas Sayersbrook and Beech Hill ranches grain-feed their bison in addition to grass, Oak Creek and Alta Vista only grass-feed their bison with hay supplements during the winter or droughts. The ranchers at the latter believe that grass-feeding is more natural and healthier for the animals and for consumers of bison meat. Although there is some conflict within the agricultural community concerning this subject, many still seem to agree that bison meat is healthier than beef.

The ranchers are also greatly concerned, from both ecological and economic perspectives, with how feasible it is to raise bison on the land they own. The Oak Creek ranch recommends that new ranchers buy bison most native to their area when starting a herd because native bison are already adapted to the local environment. This prevents sowing unnecessary vegetation and allows the rancher to raise an animal that will be generally faster and easier to raise on the land available. The rancher from Beech Hill Farm, who raises bison on land that was not part of the bison’s natural habitat, spends time and money buying specialized products and sowing additional grasses. Despite these efforts, he claims that he still fares well economically. The reason is simple: the bison is a good and valuable product. Furthermore, he believes in the ecological benefits of raising bison, especially as a lucrative alternative to raising beef.

Another factor necessary for domestication pertains to the behavioral characteristics of the animal. This concept may seem paradoxical because, while there are certain characteristics an animal may possess—such as low stress levels and high fertility rates—that would lead to its becoming domesticated, those traits can be manipulated and heightened through artificial selection. Thus, it becomes difficult to determine how pronounced those characteristics must be in order to facilitate domestication.

Some ranchers consider the bison an undomesticated mammal because of their behavioral unpredictability; they can become violent without much forewarning. When the ranchers were asked if they had observed their bison becoming tamer, and whether the tamer ones were breeding more docile young, three of the ranchers
answered with a fairly strong ‘yes’. The rancher from Sayersbrook replied, ‘My suspicion would be that that would be true. But I don’t know that it is a fact. Because the bison that are “tamer” will come up closer to the wagon, the younger ones will then, too. Just by seeing what mom does they will, too. But I don’t know that as a fact.” At Beech Hill ranch, one of the ranchers also believes that the calves pick up the temperament of the adult bison through the mother’s teachings, which is why she believes their whole herd is calm. At Oak Creek, the rancher claims there is a lot of learned behavior in the herd that comes mostly from the mothers but also from herself. She reaffirms that the mild behavior is learned and not inherited. Because of the strong influence bison cows have over the whole herd, when she chooses animals to keep for breeding purposes, she strongly considers their dispositions. She removes cows with bad dispositions, believing that the herd would make the same choice, if possible.

However, the Alta Vista rancher answered ‘no’ when asked if he was able breed a tamer temperament into future generations of bison. Coincidentally, this is also the ranch found to have the least artificial selection and human intervention, which may coincide with the rancher’s inability to breed more docile bison. The rancher continued his discussion by explaining that, when the ranch did have wagon tours, the bison would take food out of the visitor’s hand. He claims the bison “respect him, but that they have little patience.” Early in his career, he was injured by a cow that came up behind him as he was shaking grain into a trough and slammed him against the trough. Another time, he was injured when he wanted to touch “the kinky hair on the bison’s forehead” and was then gored on his arm by its horn. As the Beech Hill rancher claims, based on conversations he has had with other bison ranchers, there seems to have been an increase in bison-related injuries during the last year. The ranchers joked that, “We have become a little complacent and put our guard down.” Despite these cases of behavioral unpredictability that led to human injury, it must not be assumed that the increase in injuries are necessarily due to an increase in bison aggressiveness but rather due to the increased trust of the rancher towards seemingly more docile bison.

Based on interviews with the ranchers, this research elucidates the evident growing tameness that is being passed to bison offspring through learned behavior, mostly influenced by the cows. Additionally, the ranchers have said they artificially select for less aggressive animals to raise on their farms. At Beech Hill, one of the ranchers said that while she believed it was possible that some aggressiveness in confined bison would be taken out because of ranchers’ selectiveness, she also questioned whether bison are naturally predisposed to aggressiveness, or whether this trait comes from the human environment they are being placed within.

Human intervention—that is, a constant human presence that attempts to lower levels of stress—seemed to be the most prevalent factor in producing docility in the animals. On two of the farms, the herd was observed to run toward the rancher in order to receive treats; at the other two farms there was no opportunity to observe this behavior. Additionally, at Oak Creek, the rancher and visitors ride in the fields on all-terrain vehicles alongside the bison. The bison are completely used to this practice despite the noise, smell, and intrusion. As far as visitor density, the Beech Hill farm told me they receive 10,000 visitors a year, sometimes one hundred a day. All the ranches have tightly closed-in fences to train the bison to become used to certain pens
or to move through one pasture to another. This process is often used to separate the young from their mothers into two separate herds in two separate pastures. Fencing in bison is a technique, which if used, greatly disrupts the natural herd composition. The pens are also used to later capture the animal for transportation, health inquiries, etc. All these practices cause bison to adapt more docile behavior.

CONCLUSIONS

If one looks at the process of domesticating mammals from an archeological perspective, it would appear that bison are domesticated. As Zeder explains, when archaeologists analyze whether animal remains are domesticated or wild, they look for “sudden changes in the abundance of animals, their appearance outside their presumed geographical range, changes in human settlement patterns, the presence of corrals or other traces of animals in settlements (manure or hoof prints) or artifacts related to the exploitation of domestic animals (bits or milk churns).” When utilizing this method of identifying for cultural changes in environment, all four bison ranches in this study would be considered to be on the continuum of domestication. Additionally, behavioral changes that made the bison more docile and more meat-producing were evident. Overall, the conscious and unconscious decisions made by participating ranchers of small bison herds in this study lead to the aforementioned definition of domestication. However, the degree of domestication varies from ranch to ranch. As Jared Diamond suggests, the domestication of a new large mammal critically depends on the economic value given to it. The future of the industry’s demand for bison is key to the process of bison becoming domesticated. Despite the fact that bison populations in the United States are on the rise and that some observers, such as Pickering from Bison World, claim that there are a variety of people interested in raising bison from “current livestock producers, tired of cycles and unstable prices, to non-agricultural people, tired of the rat race of downtown cities,” a few of the ranches visited in this study were concerned about the outlook of the industry. Currently, there seems to be potential for economic gain in bison ranching, but will these motivations continue to attract ranchers and, furthermore, will these motivations continue to grow? The Beech Hill rancher professed:

There is a crisis that is coming in our business. The buffalo has always been on a treadmill; it is like feast or famine. It has leveled out somewhat, but now you have a bunch of people my age who want to retire. We have the production side, we are creating the consumer, but I think in the upcoming years we will be short on ranchers so it is going to be very difficult to continue supplying the demand.

The motivation to raise bison because it is a symbol of a ‘wild’ animal—having the strength and endurance to survive harsh environments—from pre-civilized days was found to be a contradictory concept. At Sayersbrook, the symbolism of bison having ‘wildness’ seems to be a motive for domestication. The very first words the rancher spoke in the formal interview, clearly, and loudly were, “The bison is a wild animal!” And, yet, his farm is one that could be considered further along the road of domestci-
cation than others. Will the waxing of the bison as a domesticated animal become paralleled by a waning motivation to raise bison on ranches? Only time will tell if bison will remain on this trajectory.

*At their moment of action, the shifts of the bison are hardly perceptible, but over time, the movements will quantify and become.*

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**Notes**

The design of efficient photovoltaic devices (ie. solar energy cells) requires the ability to optimize and accurately and effectively calculate the quantum yield of excitons-free electrons generated by excitation radiation. Semiconductor quantum-wire structures offer the advantage of large absorption probabilities that efficiently generate charges from light, and also the dimensionality to transport and collect the charges. To optimize their utility, the photoluminescence of various quantum-wire structures are characterized and analyzed with particular focus on the infrared region of the electromagnetic spectrum. In order to do this, a new spectrometer was constructed that will enable sensitive measurements in the infrared. The experimental design was divided into two parts: (i) basic photo-induced fluorescence, and (ii) the chopper and lock-in amplifier system, necessary to elevate the signal-to-noise ratio of the normally weaker spectra of interest.

**ABSTRACT**

**FACULTY MENTOR: RICHARD A. LOOMIS, PH.D., ASSOCIATE PROFESSOR OF CHEMISTRY**

Dr. Loomis’ research is focused on the detailed interrogation and manipulation of reaction dynamics and energy transfer at the molecular and atomic level. Current projects include 1) the categorization of quantum confinement effects in semiconductor nanostructures and the development of novel photovoltaic materials; 2) the spectroscopic characterization of bimolecular interactions using clusters to access specific orientations; and 3) coherent control of chemical dynamics using ultrafast lasers and the manipulation of quantum interference effects.

**ACKNOWLEDGEMENTS**

I would like to thank all of the physical chemistry professors that I have had during my four years at Washington University. Their passion in this field helped me gain a strong interest in chemistry, one which I certainly didn’t have coming out of high school. I’d especially like to thank Professor Loomis who served as professor, advisor, and mentor to me during my four years. I’d also like to thank Jessica Hoy, who is jointly responsible for the research presented in this paper. Lastly, I’d like to thank the Office of Undergraduate Research and Sigma Xi for providing me with this research opportunity.

**KEY TERMS**

- Photovoltaic Devices
- Photoluminescence Spectra
- Chopper/Lock-in Detection
- Signal-to-Noise Minimization

**Peer Editor:**

James Benjamin Kugler: a junior, majoring in Biomedical Engineering
BACKGROUND

Photoluminescence (PL) measurements are very common in physical chemistry and are acquired by exciting a sample with light in the visible, ultraviolet, or infrared wavelength regions and recording the intensity of emitted radiation as a function of wavelength. The energy of emitted photons directly corresponds to the transitions between energy levels of the atoms, molecules, or materials in a sample, thus providing information on both the energy levels and transitional probabilities of these atoms or molecules. Furthermore, PL experiments can be used to test or validate quantum-mechanical calculations.

The samples of interest were various quantum wires composed of II-VI semiconductors. Quantum wires possess quantum-confinement characteristics in which the band-gap energies are tunable with the size (diameter) of the wires. Band gap energies correspond to the lowest energy electronic transition—from the highest energy level of the valence band to the lowest energy level of the conduction band; the band structure of crystalline materials can be modeled quantum mechanically using periodic potential energy surfaces. The tunability of quantum wires is appealing for future incorporation into photovoltaic devices, and is thus an important property to investigate.

MATERIALS AND METHODS

Basic PL experiments rely on a common set of procedures: a light source emits light, the bandwidth of excitation energy is modulated by either a band pass filter or a monochromator, the light is focused on the sample, emitted light is focused onto another monochromator at 90° from the axis of excitation, the light exiting the second monochromator is focused onto a detector and the current output of a detector goes into a preamplifier, which then goes into an analog-to-digital converter and is recorded by a computer. The second monochromator must be computer guided, as its job is to scan a wavelength range at a particular rate. It does this by rotating the angle of a grating, thus changing the part of the diffraction pattern that hits the exit slit of the monochromator and impinges on to the detector. Computer software must either be obtained or written for the purpose of synchronizing the two basic tasks of scanning over a wavelength range, and recording PL intensities at each increment.

Although the preceding explanation of the basic set-up gives insight into the experimental techniques and procedures used in fluorescence measurements, it does little to describe signal-to-noise concerns and the manipulation of such electronic signals. If the amount of fluorescence is too low, the current that the detector generates will be small and thus drowned out by inherent noise in the electronics. A real-world analogy of this is listening to music on a headset in a noisy room. If the volume on the headset is too low, the music will be drowned out by the noise in the room. If there is no way to turn the volume up (small signal), then the only way to hear the music better is to somehow block out the ambient noise. This is what is meant by improving the signal-to-noise ratio.

The amount of white noise (voltage fluctuations that are independent of and present over all frequencies) from an amplifier is proportional to the square root of
the frequency bandwidth over which detection occurs\(^7\). Passing this signal through a band pass filter (a circuit that limits the range of AC voltage frequencies) helps to reduce the noise, but does not necessarily result in a sufficient reduction. An example given in the Stanford Research Systems Lock-In Amplifier handbook details this fact. A very good band pass filter might have a 100 Hz bandwidth. A good low-noise amplifier might have about 5 nV/(Hz)\(^{1/2}\) of input noise. A PL signal might generate a 10 nV signal at its maximum emission. These parameters lead to a maximum signal to noise of 10nV/((100\(^{1/2}\))* (5nV))=0.2.\(^2\) For comparison, the standard for acceptable signal to noise is greater than or equal to 2. Hence, normal PL techniques will not work for such a low PL signal, and a lock-in amplifier system might be a good alternative.

A. Chopper & Lock-in Amplifier Set-up

The purpose of the chopper and lock-in-amplifier is to modulate a signal at a particular frequency, and then measure only the electronic signals at this particular frequency. This minimizes all noise that occurs at frequencies other than the chosen frequency of the signal. The chopper is responsible for creating a signal at a particular frequency. A light source, in our case either a continuous wave laser or a 250W lamp, is focused on the rotating chopper wheel, which spins at the speed required to generate an excitation light source that is modulated at a particular frequency. The wheel has slits in it, and so the light continuously alternates between being blocked, and shining through one of the slits, creating an on/off binary-type signal of the desired frequency. This light is then used to excite the sample, and thus the PL signal becomes coupled to the same frequency.

There are two important inputs to the lock-in amplifier: (1) the input signal comes in from the detector, and can either be a voltage or current signal (in our case, current), and (2) the reference input comes from the chopper, which indicates to the lock-in what frequency the signal is being modulated to. The reference input signal goes into a phase-locked loop, which generates a sine wave of the same frequency as the reference input.

The exact processes that take place to improve signal-to-noise best explain the function of the lock-in amplifier. Because the PL signal is periodic, it can be expressed as a Fourier series. This series contains a sine wave with the same frequency as the excitation light source, and may contain any harmonics of the sine wave. The input signal is multiplied by the signal generated by the phase-locked loop (reference signal). Recall that the input signal not only contains the fluorescence signal of interest, but also contains all the noise picked up through the detector, pre-amplifier, BNC cables, and any other electronic devices.

The time-dependent reference signal is of the form \[ V_0 \sin(\omega t + \theta) \] where ‘\(\omega\)’ is the frequency and ‘\(\theta\)’ is the phase shift. The PL signal is the Fourier series consisting of the sum of terms \[ V_n \sin(\omega_n t + \theta_n) \], where ‘\(n\)’ denotes the harmonic and “\(V_n\)” is the Fourier coefficient. Multiplying the \(n\)th harmonic by the reference signal, generates a new signal \[ V_n V_0 \sin(\omega t + \theta) \sin(\omega_n t + \theta_n) \]. Using the trigonometric identity \[ \cos(a \pm b) = \cos(a) \cos(b) \mp \sin(a) \sin(b) \], one finds that the signal is equivalent to \[ 0.5 V_n V_0 \cos((\omega - \omega_n) t + (\theta - \theta_n)) - 0.5 V_n V_0 \cos((\omega + \omega_n) t + (\theta + \theta_n)) \]. It is important to consider the circumstance in which \(\omega = \omega_n\). In this instance, a DC signal of \(0.5 V_n V_0 \cos(\theta - \theta_n)\) is created if the quantity \(\theta - \theta_n\) is time invariant.
This realization highlights the importance of the phase-locked loop that was mentioned before. The phase-locked loop achieves \(\theta - \theta_n\) time invariance by locking to the phase shift of the reference signal and creating a new signal with a completely time-independent phase shift. To isolate the DC signal from the noise signals, all signal components are passed through a low-pass filter (the digital equivalent of a resistor and capacitor in series). The low-pass filter only allows for DC signals, and AC signals with periods much greater than the time constant of the filter to be left untouched. All signals with periods much less than the time constant of the filter will be averaged out due to the relatively long decay of the RC circuit, and thus will not be expressed as noise.

All noise components and all harmonics of the PL signal that differ in frequency from the reference signal are not converted to a DC signal and are therefore ideally filtered out with the low-pass filter. If there is a noise component with a frequency very close to the reference signal, the product of the two will result in a very-low frequency signal that will transmit through the low-pass filter untouched. However, Stanford Research Systems Lock-In Amplifier handbook estimates that an effective bandwidth as narrow as 0.01 Hz can be achieved by multiplying the signal by the reference input and sending the resulting signal through a low-pass filter. Taking the same parameters as before (10 nV maximum signal input and 5 nV/(Hz)^{1/2} noise) the signal to noise is improved to \(10\text{nV}/[(5\text{nV}/\text{Hz}^{1/2})*(0.01\text{Hz}^{1/2})]=20\) an increase of two orders of magnitude.

Looking back at the PL signal of interest (DC signal) one realizes that the magnitude of this signal is dependent upon the difference in phase shifts between the two signals being multiplied. The maximum DC signal is achieved when \(\cos(\theta - \theta_n)=1\), or when \(\theta=\theta_n\). However, this ideal situation is intrinsically unattainable since the reference signal is at a maximum when the excitation light is incident on a slit, whereas the PL signal grows after a short time interval during which the sample has not been fully excited. In order to obtain the maximum signal the magnitude must be independent of phase. This is achieved by utilizing a second phase-locked loop in which the reference is phase shifted by 90° and then multiplied by the input signal. Taking the square root of the sum of the squares of the two outputs gives 
\[
\left[(0.5V_nV_0\cos(\theta-\theta_n))^2+(0.5V_nV_0\sin(\theta-\theta_n))^2\right]^{1/2}=0.5V_nV_0.
\]
This is how the lock-in creates a DC signal independent of phase.

**B. Software Components**
Lab View, a symbolic programming language developed by National Instruments, was implemented to communicate with and control the various instruments, and to collect the digital voltage measurements. Data acquisition was achieved by creating a simple computer program that strung together multiple VIs (Virtual Instruments) to ultimately output a PL spectrum.

**RESULTS**
The first test of the experimental design utilized a Rhodamine in methanol solution, which had a relatively large quantum yield, and thus a large and easily observable PL signal. This solution was excited with a 543 nm cw laser. The dispersion for the
The monochromator (Acton SP-2150) was 5 nm/mm using a diffraction grating with 1200 grooves/mm. The slit on the monochromator was set at .5mm, resulting in a resolution of .5mm*5nm/mm=2.5nm. The data shown in Figure 1 reflects a fluorescence peak around 585 nm. The acquisition of such a spectrum reflects the successful coordination of data sampling and wavelength selection by the monochromator. This is one criterion necessary for a successful fluorescence experimental set-up.

![Fluorescence spectra of Rhodamine solution](image)

**Figure 1.**

A rhodamine in methanol solution was excited with cw laser at 543 nm. PMT was biased at approximately -300 volts.

The other criterion necessary for a successful set-up is the improvement of signal-to-noise using the lock-in amplifier compared to data collected without the lock-in. Figure 2 indicates that this criterion has been successfully met, by contrasting the spectra of a neon lamp obtained using the two different methods. For this experiment, the photomultiplier (PMT) power supply was set at -521 volts, the slits on the monochromator were closed to 0.05 mm, five data points were collected and averaged at each wavelength increment, and a 0.4 optical density neutral density filter was placed directly in front of the entrance slit to the monochromator to block much of the incident light (to avoid over-saturating the PMT). The spectrum shown in Figure 2(a) was collected by monitoring the direct output from the PMT using the data acquisition channels in the PCI A/D (analog-to-digital converter) card. In other words, there was no signal processing. Then, to obtain the spectrum shown in Figures 2(b) and 2(c), the chopper was placed between the neon lamp and the slit, and the signal from the PMT was sent to the lock-in along with the reference signal from the chopper.
CONCLUSION

It is evident that the signal-to-noise level was dramatically improved by introducing the chopper and lock-in amplifier to the fluorimeter set-up. While the baseline in Figure 2(a) is masked by noise, the baseline in Figure 2(b) is completely noise-free—so much so that it was magnified and shown in Figure 2(c). Although Figure 2(c) is the baseline of 2(b) magnified by 1000x, it still clearly shows the fine structure of the spectrum essentially noise free. The calculated signal-to-noise of this spectrum using the lock-in was approximately 30,000 for an arbitrary peak, compared to approximately 5 for the largest peak in the spectrum obtained without a lock-in amplifier.

Such a dramatic improvement in signal-to-noise enables future attempts to accurately characterize PL in the less-accessible infrared region of the electromagnetic spectrum, which is of interest with the II-VI semiconductor quantum-wire structures.

NOTES

Inward rectifying potassium (Kir) channels are of particular interest because of their involvement with insulin regulation in pancreatic beta cells as well as their involvement in shortening action potentials in multiple tissues and organs, including the heart and the nervous system. The bacterial inward rectifier, KirBac1.1, has significant primary sequence similarities to those of the eukaryotic Kirs. These experiments deal with mutant forms of KirBac1.1 in order to understand the structural basis of channel opening and closing. Methods include the reconstitution of purified proteins into liposomes. Column chromatography is used to establish a potassium gradient (high intracellular and a low extracellular) and rubidium uptake is used as a surrogate for potassium flux in order to measure channel activity. The slide helix, a domain of KirBac1.1, has been implicated as playing a key role in gating of the channel. We are exploring the mechanistic properties of Wild Type (WT) KirBac1.1 and mutants with altered slide helix residues and in particular their sensitivity to protons, and PIP2, a phospholipid. We show that W60C and WT have similar sensitivities to inhibition by protons. However, W60C is less inhibited by 0.1% PIP2 concentration than is WT. Mutant W60C is located at the C-terminus of the slide helix. It is concluded that mutant W60C has a decreased sensitivity to PIP2. Experiments are ongoing to determine the effects of other mutations in the slide helix region of KirBac1.1 on the activity of the channel in general and sensitivity to PIP2 concentration in particular.
Intrinsic daily changes in behavior, such as locomotor activity, gastric secretion and sleep-wake cycles are called circadian rhythms. The suprachiasmatic nucleus (SCN) is considered to be the master circadian pacemaker in mammals. The SCN is comprised of approximately 20,000 neurons per bilateral nuclei. It is not known if some, none, or all SCN neurons function as circadian pacemakers. The hypothesis that circadian pacemakers comprise a chemically-identifiable population of SCN neurons was tested in this investigation.

To study the cell-autonomous pacemaking of individual neurons, plated SCN cells were plated at low density (<150 cells/mm²). It was found that glial-conditioned medium improved markers for cell health in these low-density (LD) cultures, such as the number of process-bearing neurons in a culture over a week in vitro. Bioluminescence in individual SCN cells harvested from PERIOD2::LUCIFERASE transgenic mice was then monitored. About 10-15% of Per2-expressing neurons generated self-sustained circadian rhythms, 20% of cells showed no rhythms in Per2 and the remaining cells either did not express Per2-driven bioluminescence or could not be tracked for the six days of recording.

These cells were then monitored according to their neuropeptide expression using immunocytochemistry and fluorescence microscopy for arginine-vasopressin (AVP) and vasoactive intestinal polypeptide (VIP), two neuropeptides which identify approximately 20% and 10% of mouse SCN neurons, respectively. Of the rhythmic cells, 21% expressed AVP, 8% expressed VIP, and the remainder were unlabeled. Surprisingly, of the arrhythmic cells, 14% expressed AVP and 18% expressed VIP. It is concluded that AVP- and VIP- neurons are heterogeneous in their ability to sustain daily rhythms when isolated and that only a small subset of SCN neurons are self-sustained circadian pacemakers.
Recent discoveries of circadian gene expression in many mammalian cell types have prompted speculation that every cell is capable of intrinsic daily timekeeping. Little is known, however, about the role of circadian transcription in physiology and behavior. For example, the main olfactory bulb (OB) shows daily rhythms in gene expression in vivo and in vitro, in the absence of cues from the environment or from the master circadian pacemaker in the suprachiasmatic nucleus (SCN) of the hypothalamus. This study aims to determine a function for the circadian clock in the OB.

We hypothesized that the circadian clock in the OB modulates olfactory sensitivity with time of day. We have developed a novel method to test whether mice show daily rhythms in their olfactory threshold. We designed and built an olfactometer which provides a water reward to condition mice to indicate whether they smelled an odor (e.g. vanilla diluted in deionized water delivered in vapor phase at a rate of 2 ml/min). Mice are trained to indicate the presence or absence of an odor by poking their nose in one of two detector ports. A computer logs the percentage of correct choices made by the mouse, the latency to respond, and the percentage of missed trials for each odor concentration and the time of day when tested. Preliminary results indicate that mice can acquire this task after approximately three to five ten-minute sessions. The olfactometer should provide a high-throughput method for testing the role of specific genes and cells in determining olfactory threshold as a function of time of day.
After Radical Reconstruction in the United States, sexualized violence was perpetrated against black women under the guise of a racial/gender rhetoric that white men were supposed to be ardent protectors of white womanhood. The justification for lynching and other sexual attacks were frequently derived from the myth that savage black rapists were robbing white men of their sexual property. While lynching is traditionally viewed as a crime between men, shifting the focus to the study of women reveals the complicated interplay of ideas about gender, race, and sex in the post-Reconstruction United States. Black women served as proxies for absent husbands or relatives who were accused of crimes or who challenged the political or economic place that black men were expected to happily assume. In actuality, however, most of the attacks during this time period were not perpetrated as the result of crimes that had anything to do with black-on-white rape or even consensual sex. The graphically violent and sexual nature of these lynchings that lacked probable cause prove that the underlying motivations for lynching were based more on gender and race issues than on the actual presence or supposition of interracial sex. The inaccuracy of the assumption that women were merely pawns in this culture of racially-motivated violence is further worn away by looking closely at the roles that white women played in perpetrating or encouraging this type of violence against other women. In particular, white women asserted their own agency in this paradigm by determining the extralegal punishments for crimes allegedly perpetrated against them. The motivations of these individual actors during this period, in which gender and race categories were in such a state of flux, depict a larger narrative of the dual oppression faced by black women as they attempted to assert their political, social, and economic citizenship.
Syphilis Epidemic Exposed: Perspectives of Health Practitioners, MSM Patients and Community-based Organizations in St. Louis

Mentor: Bradley Stoner

Syphilis is an infectious disease caused by the bacteria, *Treponema pallidum*. Despite available and accessible cures, syphilis has reemerged as a serious epidemic. The situation in the United States is reflected in St. Louis, where rates of primary and secondary syphilis increased substantially after a decline in the 1990s. Men who have sex with men (MSM) and African-Americans are often accounted for in the rise in syphilis incidences. To further explore the issue in St. Louis, one-on-one, open-ended, anonymous interviews were conducted with five health practitioners who treated syphilis, four MSM patients who have received clinical treatment for syphilis in the past five years, and four community-based health organizations involved in syphilis testing and prevention. Interviews focused on health care providers’ and patients’ experiences with syphilis and clinical care, as well as issues faced during the treatment. Interviews also centered on the role of health agencies in promoting syphilis prevention and clinical care, and problems encountered in their campaigns. Results showed that despite successful treatment, several clinical barriers prevented long-term behavioral interventions. Some patients felt stigmatized by their health practitioners. Communication barriers were found between health practitioners and patients, due to racial and ethnic disparity, and practitioner’s self-perception of not knowing their patients well enough. Some health practitioners were reluctant to offer sex counseling to their patients, partly due to their impression that patients were promiscuous and unresponsive to change. Health practitioners and patients also had different constructions of safe sex practices. Community-based organizations viewed their campaigns as successful and well-received in the community but encountered funding problems. Findings point to a distinct gap between health care providers and patients that has adversely affected syphilis treatment. Community-based health agencies can bridge the gap between the two disparate groups. Thus, their roles in the community should be further expanded and supported.
It is a widely accepted idea that among the benefits of female education, one of the most important will be a decline in fertility, or the number of children delivered. However, the quality of that education is a variable that has never been formally studied. Two schools in Kalleda Village, India, offer very different educational experiences. One is a well-funded institution run by a non-governmental organization, and the other is a typical government-run school with problem of funding and over-crowding. Due to admissions policies students at both schools are equally intelligent and come from the same demographic background. This study is the first year of a multi-year longitudinal study that will track the same students and the effect of the quality of education on fertility rates.

180 students were interviewed for this study, 90 from each school. An equal number of boys and girls were interviewed from each of the 8th, 9th, and 10th grade classes. While this is a longitudinal study and the actual effects on fertility are still to be determined, there were some immediate differences in the student populations. The students from the non-governmental organization-run school wanted fewer children in general. Students from the government school preferred female children, probably due to new government educational programs teaching the value of daughters, whereas students from the non-governmental school wanted a more equal distribution, though boys were more likely to want sons and girls were more likely to want daughters. A majority of students at both schools worried about paying for the dowry if they were to have a daughter. These general trends indicate that the quality of education does indeed affect some aspects of fertility, though successive yearly interviews of these same students through their reproductive years will provide more conclusive answers.
Toward a Better Understanding of...

Civil Participation and Voluntary Multiculturalism at the American Church in Paris

Jacqueline Dodd

Mentor: John Bowen

A case study was conducted on the American Church in Paris (ACP), an interdenominational Protestant, multicultural, Anglophone church with a mission to welcome foreigners visiting and living in Paris. The study investigated the role of American Protestant civic culture in the immigrant experience. Six weeks were spent frequenting the sanctuary and community center, attending Sunday services, fellowship gatherings, church-wide special events, and non-church activities. The fellowship activities varied in population and purpose, from African and Filipino Fellowships to youth ministries. Examples of church-wide special events include a multicultural fashion show, a one hundred fiftieth anniversary play about ACP history, and a bateau mouche ride down the Seine. Printed and online information on non-church groups who rented space throughout the week were collected and the researcher attended meetings and activities such as a film group, a French-English conversation hour, and aerobics. By attending both church and non-church events, and by participating in the Sunday service and coffee hour, the researcher became acquainted with the social networks housed and provided by the church. Observing how the networks intersected (who participated in which events, who were church members, and where each heard about the event) showed how the various networks related to the church as their host, and to Paris as their locale. Special note was taken of how these dynamics were reflected in the pastors’ sermons. In preaching to the entire church body, the pastors pulled ACP’s diverse activities into a cohesive identity under God which interpreted and guided the members’ experiences. It is concluded that the pastors’ interpretations of divinity illustrated how religion can provide a safe space for multiplicity in members and activities. The ACP may not make foreigners Parisian, but it allows them to celebrate cultural differences as diversity, instead of fearing them as a social barriers.
Quarks in their most familiar form are confined in protons and neutrons that make up standard nuclear matter. However, it has been suggested that this configuration of quarks (most commonly associated with atomic nuclei) is metastable and that a fully stable state exists composed of up, down, and strange quarks, forming exotic nuclei known as “strangelets.” A larger strangelet cannot maintain an outer electron shell and, in order to assure bulk neutrality, allows some electrons to exist inside the quark matter. One possible instance of strangelets would be in strange stars. One version of a strange star surface is a gradual growth of quark density through a mixed phase of vacuum and unpaired quark matter. At the outermost edge there would be pure vacuum followed by nuggets of quark matter, which would increase in density until they become rods and finally slabs of quark matter. These transition layers are described by one-, two-, and three-dimensional strangelet structures, respectively. The potential for strangelets as components of a strange star crust, comprised of a mixed phase of vacuum and quark matter at a range of values for surface tension and external pressure, was examined. Both larger surface tensions and larger pressures were found to serve to disrupt heterogeneous behavior, thus indicating a critical surface tension and a critical external pressure above which a strange star surface is unable to splinter into strangelets. Multiple techniques were utilized to solve the Poisson equation to find that two-dimensional behavior, should it exist, would only occur for extremely low surface tension and high pressure, while one-dimensional behavior will never establish a stable state for any surface tension.
In this study, the insight of patients into their own disorders as well as their delusions were assessed using two semi-structured scales: (1) the Scale to assess Unawareness of Mental Disorder and (2) a local scale of insight which is comprised of 9 questions, each graded on scale of 0 to 2, that are then added for a total point of complete insight. An interview to assess conviction about, perspective on and emotional commitment to delusions was also administered. The subjects studied were 44 male patients, ages over 18, under treatment in closed and open male-only psychiatric wards of the Bakirkoy Psychiatric Hospital, in Istanbul, Turkey. Patients were assessed twice; once at their admittance to the hospital and once as their treatments were completed. The mental disorders treated for were schizophrenia, schizoaffective, bipolar, major depression, and psychosis NOS. Some patients also had comorbid axis II disorders of Paranoid Personality.

This definitive as well as correlational research gathered a pool of empirical data. Analysis looked at correlations between diagnosis, insight into disorder, number of times of hospitalization and the current day of hospitalization. Studying these variables provided information on what kind of delusional disorders allow the gain of insight with an acute treatment of major mental disorders. The results also allow for examination of patients with the same disorder as well as with different disorders and how early in the treatment patients gain insight.
Conformational Changes in LRRK2 or Its Mutants Are Associated with Aggregation in a Parkinson's Disease Model System

Mark Fahey

Mentor: Karen O'Malley

Parkinson's disease (PD) is the second most common neurodegenerative disease, characterized clinically by rigidity, bradykinesia, tremors, and postural instability. Recently, mutations in the LRRK2 gene have been identified as a major cause of familial PD. Some of these mutations increase LRRK2 protein aggregation and are associated with increased cellular toxicity. In other neurodegenerative disorders, protein cleavage often occurs before aggregation. Because LRRK2 is an extremely large protein, we hypothesized that it too undergoes cleavage producing a misfolded protein with a higher aggregation propensity. To test our hypothesis, we transfected SH-SY5Y cells with N-terminal-fluorescently tagged wild type or G2019S mutant LRRK2 constructs, allowed aggregates to develop and then stained cells using an anti-C-terminal antibody. Cells were imaged by confocal microscopy and then analyzed to determine the degree of co-localization of the N-terminal GFP tag (green) and the C-terminal cy3 epitope (red). Co-localized tags indicated that the protein had not been cleaved whereas tags that were not co-localized suggested that either cleavage had taken place or that the protein was altered such that this epitope was no longer recognized. Results indicated that 75% of the red and green tags in wild type LRRK2 aggregates and about 90% in the G2019S mutant aggregates were not co-localized. These data suggest that LRRK2 is being cleaved or conformationally altered in the process of aggregate formation and that the mutant protein exacerbates this response. These findings may serve as the basis for future screens looking for molecules that prevent aggregation formation.
Most receptors are thought to function only when inserted into the plasma membrane where they receive extracellular signals that are transmitted into the cell. When not at the plasma membrane, many receptors are on vesicles waiting to go to the cell surface or having just come off the membrane to be down regulated, degraded, or recycled. These intracellular receptors are considered “spare” receptors and in the past were not thought to signal from within the cell. Research has found that the metabotropic glutamate receptor 5 (mGlu5) is located at the inner nuclear membrane of neurons where it can send signals to the nucleus.

mGlu5 is a G-protein coupled receptor (GPCR) that is coupled to Gq/11 leading to phosphoinositide signaling and release of calcium from intracellular stores. Calcium is an important second messenger within the cell that regulates many cellular activities including gene transcription. It has been shown that activated mGlu5 can lead to large changes in calcium levels within the nucleus itself. Research currently seeks to understand how these changes lead to the activation of different genes.

In addition to asking how mGlu5 molecules send signals in the nucleus, another major question is how mGlu5 is being inserted into the inner nuclear membrane. Many proteins destined for the nucleus have a nuclear localization signal (NLS) that allows certain carrier proteins to take them through the nuclear pore complex. In contrast, mGlu5 must reach its destination through a side channel located in this complex. A few studies suggest that the proteins that go around instead of through the nuclear pore complex also have an NLS. This may also be true for mGlu5. Since NLS's are often composed of basic amino acids, the sequence of lysine-arginine-arginine (KRR) in the C-terminus was of great interest. The lab then proceeded to mutate KRR to three glutamine (Q) residues. This was then transfected into HEK 293 cells, stained and viewed in confocal microscopy. The protein was still found to have some co-localization to the nuclear membrane. After this, the KRR sequence was deleted from the protein. This protein was again transfected, stained and viewed in confocal microscopy and found to co-localize to the nuclear membrane.

Following these results, it has been concluded that KRR is most likely not sufficient for NLS, for it still occurred after its mutation and deletion. There are a few other basic amino acids nearby, meaning that the NLS for mGlu5 might be bipartite, meaning that the amino acids causing nuclear insertion are not all in tandem. Other sequences will be deleted around KRR in order to determine each of their relevancies for nuclear localization in future experiments along with an in-depth look into the relevance of other basic amino acids nearby.
The Women’s Institute for Secondary Education and Research (WISER), which seeks to rectify the large gender differential in educational outcomes in Muhuru Bay, Kenya, a small fishing village on the shore of Lake Victoria, was created in the summer of 2006. This research investigates barriers to girls’ education and ways in which the WISER curriculum could address these obstacles. The majority of the research took place through the assessment of Camp WISER, an academic enrichment program designed to introduce 30 freshmen and sophomores at Muhuru Bay’s secondary school to topics not normally taught in the Kenyan curriculum.

The study assessed the knowledge base and provided a profile of secondary school age boys and girls in Muhuru Bay in regards to health, gender, and leadership options in their lives. The assessment was done through Camp WISER workshops entitled Adolescent Health, Gender and Everyday Life, and Leadership. Workshops were analyzed and used in combination with a pre/post test measure developed to gather information about participants and the WISER program. Camp WISER deviated from standard Kenyan teaching style, and thus the assessment measure had to be in keeping with the more open and qualitative approach. The survey asked students to rate their confidence, willingness, frequency of experience and awareness of different topics related to course work on a 1-10 scale. A statistically significant improvement on all questions asked in the workshops was observed, and students verbally acknowledged their increased understanding of the Camp WISER coursework. The plan to further gender sensitization, increase health knowledge, and generally provide empowering leadership information not only serves to benefit Camp WISER participants and the future school, but is also in line with the community’s development plans and those of the Kenyan government.
This research explores the history of critiques of the industrial food regime in the mid-twentieth century. By examining a sampling of works by Helen and Scott Nearing, J. I. Rodale, Frances M. Lappé, E. F. Schumacher, and Wendell Berry we see that these critiques have traditionally evoked social-ethical dynamics to challenge industrial food production. In other words, these critiques are not merely concerned with the method of food production, per se, they also express concern for the social dynamics engendered by industrial agriculture. Moreover, these critiques illustrate the diversity of approaches each author took while challenging the industrial food regime along social-ethical lines. For example, the Nearings believed that, whereas industrial production devalued food and people and facilitated dependency and exploitation, the ideal of self-sufficiency could be employed to facilitate a new social order; Rodale believed that industrial agriculture was counter to nature and killed our soil, thus jeopardizing our civilization; Lappé believed that empowered consumers, through embracing their consumption choices as ethical decisions, could engender a new allocation of the earth’s produce; Schumacher believed that the materialist metaphysics of industry and economics—which claimed to be metaphysically neutral—introduced a violent metaphysics into agriculture and society; and, Berry believed that the loss and denial of “connections” was degrading and destroying our society. Finally, the social-ethical nature of these critiques is especially significant when we consider the current expression of opposition to industrial agriculture. We might ask if the opposition embodied by organic agriculture, for example, challenges industrial agriculture in the same way.
Endocytosis is a complex process in which cells take up nutrients from the extracellular compartment. Less well understood is the role of endocytosis in signal transduction. The fate of an internalized receptor is determined in part by a series of GTP binding proteins called Rabs. Rabs act as molecular switches that are turned on with approaching vesicular traffic and turned off after the traffic has been dispatched to its proper target. Rab5 regulates early endocytic trafficking and is encoded in the genome by three different genes that are translated into three nearly identical proteins: Rab5a, Rab5b and Rab5c. The specificity of Rab5 phosphorylation is dependent on the extreme N and C terminal amino acids. To determine whether N or C terminal amino acids are important for phosphorylation, a series of Rab5a-Rab5b chimeras were made and tested.

To prepare Rab5 chimeras as indicated below, restriction sites were identified in each of the two Rab5 isoforms to be examined—Rab5a and Rab5b, at the appropriate locations. This permitted the preparation of appropriate fragments (carboxy terminus, amino terminus). These fragments were cleaned and combined to form four working recombinant proteins with varying termini (5a C-terminus + 5b; 5a N-terminus + 5b; 5b C-terminus + 5a; 5b N-terminus + 5a). All four chimeras were successfully produced and the presence of translated protein from the transcription of these chimeras was confirmed.

In future experiments, the chimeras may all allow the determination of specificity and better elucidate understanding of endocytic trafficking. These chimeras could be used to uncover how endocytic interactions occur. Further, data collected from these experiments can be utilized to come up with novel ways to manipulate endocytic trafficking and opens the possibility for more research into possible therapeutic uses.
Toward a Better Understanding of...

**Between Domestication and Wildness**

*Sylvia Hardy*

*Mentor: Richard Krueger*

The shift from hunting wild bison to raising confined bison for food production occurred rather rapidly in North America. As the bison transitioned from roaming North American landscape to the fenced farms and parks of our contemporary society, they have become exposed to new environments that are predominantly under human control and not always located in their natural habitat. Currently, private ranchers own the majority of bison while smaller numbers are living on public land and Native American reservations. This study examines whether the choices private bison ranchers make have an effect on the confined bison’s trajectory of becoming more domesticated or remaining wild. Contemporary material that was collected during the research was interpreted with an eye to the existing archaeological and biological literature and data on the process of domestication in mammals and on the bison’s recorded past. The research consists of a series of surveys on privately owned bison farms in Maine, Massachusetts and Missouri. Formal interviews were conducted with the private herd ranchers, but understanding was also gained from many casual discussions held during stays on their ranches.

Examination of bison behavior, their interaction with the ranchers and their environment was made through direct observation and photography. As opposed to the typical documentary style, the photographs taken intend to capture the unique sense of time and place of these particular confined bison. The portfolio focuses on human-bison interactions and the complexity of trying to place the bison in a contemporary visual reality.

Ultimately, the study sought to understand the parameters that constitute domestication and whether these bison fulfill such criteria. Bison on private ranches are in a continuum of becoming domesticated. However, since ranchers make diverse (and at times drastically different) decisions in the amount and type of human interaction, diet, artificial selection by controlled breeding, the social structure of the herds, etc., it is apparent that the confined bison are at different degrees in the domesticating process. It is contented that the majority of these actions are taken to intentionally create a more docile and meat-producing bison.
South Africa is a country still struggling with an ugly history of institutionalized racial apartheid. While the formal apartheid ended in 1994 with the implementation of free elections for all citizens, the aftereffects of the segregated system are felt to this day. The documentary undertaken in this work explores the current state of South Africa politically, economically, and socially. The focus of the project was on the attitudes and emotions of the youth in modern South Africa, since they truly are the future of the country. The role that education is playing in these people’s lives and how education can be used as a vessel for social change is of particular interest.

Much has changed politically in South Africa since 1994, but social change is a much slower process. While certainly some significant strides have been made, economic disparities remain immense in much of the country and often coincide with racial identities. Schools that serve primarily non-whites are more often under-funded and under-staffed than are white schools. For many students from the townships that surround the cities, education is a struggle and schools are often inadequate and unsafe. Unless drastic changes occur rather quickly, South Africa will likely continue to struggle in the aftermath of its segregated past. But there is hope. The youth of South Africa believe in themselves and their ability to achieve in the face of adversity. Many are realistic about the obstacles that await them yet have plans and dreams for their futures. Time will tell whether or not South Africa can truly move forward from its racialized past to a future that is more welcoming and more inclusive of all people within society.
It has been suggested in retrospective studies that chemotherapy may provide protection to pituitary tumors from radiation based on endocrine control. Some hospitals, such as the Mayo clinic, have already decided to withhold chemotherapy before administering a regimen of radiation. This study looks at the radioprotective effect of bromocriptine on both secreting and non-secreting pituitary adenoma cells. One cell line, WU351, was an aggressive prolactin secreting highly functional pituitary adenoma, as confirmed by measured prolactin levels of the patient and in vitro media prolactin measurements of more than 600ng/mL. The other cell line, WU118, was a non-functional pituitary adenoma. All tumor cells were obtained through transphenoidal surgery at Barnes-Jewish Hospital. Cells were initially grown and passed in Falcon® primary tissue cell flasks. The actual experiment was done in vitro on individual Corning® 50mm dishes. All cells were at low passage level (less than 6 passages) and grown to about 100,000 viable cells per dish as determined by Trypan Blue Exclusion before variants were introduced. Contrary to expectations, those cells receiving both bromocriptine treatment and radiation treatment (7 Gy of gamma X-Rays) had fewer viable cells over a period of 10 days than those receiving either bromocriptine or radiation only. The experiment was repeated to verify results. None of the cells receiving both treatments did markedly better than those receiving only one treatment in either experiment in either cell line. Bromocriptine has rarely shown any effect on nonfunctional pituitary tumors clinically. However, the non-functioning WU118 consistently grew more slowly when exposed to media with 50 micromolar bromocriptine. These results suggest that bromocriptine does not provide any substantial radioprotective effect, at least certainly in vitro.
Medicine and The Metaverse
Mark Kizelshtein

Mentor: John Bowen

Medicine and The Metaverse is an interdisciplinary project exploring the therapeutic impact of social virtual reality on convalescent, chronically ill and preventive care patients. 3D Massively Multi-user Virtual Environments (MMVEs) are ushering in a new era of immersive collaboration that increasingly augments the economic and social life of physical world communities. The study seeks to understand the current and near-future impact of this technology as its adoption by patients and caregivers becomes more widespread and to evaluate the goals motivating the design of therapeutic and educational spaces in MMVEs. Using Second Life, today’s largest user generated virtual world, as the primary case study, the variety of healthcare oriented “sites” within Second Life will be analyzed and patients, organizers, and physicians will be interviewed. The study will also be supplemented with interviews from medical professionals who have yet to embrace this technology. Second Life currently has a user base of nine million people, with approximately 40,000 people online at a time. Various healthcare organizations have working “presences” and are operating with patients in Second Life.
Wavelets are functions that can be used to decompose signals into various frequency components at an appropriate resolution for a range of spatial scales. Edges can be defined as sharp changes of the intensity in a signal. Applications of edge detection technology can be found in many fields, including medical imaging. The objective of this project was to explore the latest generation of wavelets in order to create improved edge detectors.

Toward this end, several known signal-processing methods were studied and applied. These included methods based on well-known Fourier transform and wavelet transforms in both one and two dimensions. Theoretical results concerning edge detection in one dimension were reviewed and the corresponding algorithms were implemented. Furthermore, tests were run on images by applying one-dimensional decompositions in both the horizontal and vertical directions independently. These results were compared to edge detection schemes based on gradient methods, which capture sharp changes in intensity.

It is well known that one-dimensional wavelet techniques are suboptimal in the representation of images. Recently a new generation of intrinsically two-dimensional wavelets, e.g. shearlets, has been introduced to alleviate these deficiencies. In this project, new edge detection methods were developed based on the shearlet transform. As a refinement of these methods, subdomain decomposition was introduced to preserve less dominant edges. Furthermore, several basic post-processing schemes were used to provide more distinct edges. All of the above methods were applied to both artificially generated and natural images. In order to measure the accuracy of the various methods, the Hausdorff distance between the actual and approximate edges of artificial images was computed. Through this analysis, it was concluded that edge detection methods based on shearlets were at least as accurate as popular methods, such as Canny and Sobel, when applied to artificial images.
Toward a Better Understanding of...

**Alzheimer’s Disease:**

**Generation of Amyloid-beta**

*Michelle Mo*

Mentor: Gunnar Gouras

Amyloid-beta (Aβ) is a peptide largely responsible for the amyloid plaques that form in the brains of Alzheimer’s disease patients. Initially part of the amyloid precursor protein (APP), Aβ is formed when APP is cleaved sequentially by β- and γ-secretases. Aβ has been described to localize in different organelles (endoplasmic reticulum, trans-Golgi network, endosomes, plasma membrane, and mitochondria), although the predominant view within the field is that the exact location of Aβ generation remains unclear. An increase in the concentration of a specific type of Aβ, Aβ42, has been linked to familial and sporadic Alzheimer’s disease. In particular Aβ42 is more hydrophobic in nature than another common type of Aβ, Aβ40, as it easily accumulates and leads to the formation of amyloidogenic deposits. Hence an understanding of where Aβ42 is generated will give much needed insight into the process involved in amyloid plaque formation.

Because Aβ42 is a small peptide located in the middle of the APP gene, distinguishing Aβ42 from its larger counterpart, APP, has proven especially difficult. Common tags such as green fluorescent protein (GFP) cannot be used because Aβ is unable to accommodate them. To address this, a construct was generated using a tetracysteine tag inserted into a region designed potentially redundant for Aβ function given the normal generation of Aβ 1-40/42 and Aβ 11-40/42. The tetracysteine tag can then react with biarsenical reagents such as FlAsH and ReAsH, a conformational change of the tetracysteine region occurs, and emission of fluorescence is produced. Consequently, localization of Aβ and APP can be seen. Moreover, to accurately monitor cleavage of APP into Aβ and other soluble peptides, two additional constructs were created with the tetracysteine tag as well as GFP type tags in the N and/or C terminus of APP. Using both live cell imaging and fluorescent microscopy, the movement of Aβ throughout a cell can be tracked and the site where Aβ is generated and transported in a neuron relative to APP can be determined.

In order to better understand the process of Aβ generation, an alternative method analogous to Kaether’s et al. was developed. Instead of specifically following the Aβ peptide and the APP molecule, one can instead follow the steps of APP cleavage in neurons. Using a γ-secretase inhibitor and subcellular markers, blockage of the C-terminal fragment of APP can be observed and the location of Aβ formation can be deduced. Knowledge of where Aβ is generated will allow for future developments of therapeutic agents that target the disease.
**Addition of N-acetyllactosamine Characterizes the Differential Glycosylation of the Urea Transporter UT-A1**

*Benjamin Nanes*

Mentors: Dr. Janet Klein and Dr. Jeff Sands

Urea transporters play an important role in the maintenance of an osmotic gradient in the kidney medulla and are essential for normal urine concentration. Previous studies have shown that expression of the urea transporter UT-A1 in the inner medullary collecting duct (IMCD) is increased in some conditions, such as diabetes mellitus, where urine concentrating ability is impaired. UT-A1 is expressed in two glycosylated forms, 117kDa and 98kDa. The 117kDa form is expressed primarily in IMCD cells of the kidney inner medulla (IM) tip, while the 98kDa form is expressed in the IM base as well. In diabetic rats, the relative abundance of the 117kDa form is increased and its expression spreads to the IM base, suggesting that the differential glycosylation may have a functional role in the response to impaired urine concentrating ability. Glycosidase and lectin analyses were used to characterize the differential glycosylation.

A common modification of N-glycans is the addition of poly-N-acetyllactosamine chains (Gal-β4-GlcNAc-β3)n. These chains are cleaved by endo-β-galactosidase, which specifically targets β-1, 4-GlcNAc linkages. In addition, *Lycopersicon esculentum* lectin (LEA) binds to N-acetyllactosamine chains of three or more units. Treatment of immunoprecipitated UT-A1 from rat kidney IM with endo-β-galactosidase followed by Western analysis revealed the disappearance of the usual 117kDa band, while the 98kDa band remained present. In addition, new lower and higher molecular weight bands appeared following the endo-β-galactosidase digestion. The lower band appeared significantly below the 88kDa band that resulted from PNGaseF treatment, which removes all N-glycosylation. The lower band also appeared following sequential treatment with endo-β-galactosidase and PNGaseF. Blots of rat kidney medulla cell lysate probed with horseradish peroxidase conjugated LEA showed several discrete bands. However, LEA did not appear to bind to immunoprecipitated UT-A1, though this may have been due to low abundance of UT-A1 in the samples. Similar results for each of the experiments above were obtained from diabetic rats, with the relative abundance of the 117kDa form, as well as the overall expression of UT-A1, increased. These results suggest that the addition of N-acetyllactosamine units to UT-A1 is partly responsible for the two different glycosylated forms of the protein. Further study is needed to determine the location of these additions and the precise role they play in the regulation of UT-A1.
The island of Hispaniola has been shaped by geologic and climatic cycles. These cycles have had a drastic impact on the terrestrial species of the island. The rising of sea levels brought on by the glacial periods during the Pleistocene inundated a large section of the island, forcing animal populations to relocate into refugia to ensure survival. Populations of *Leiocephalus schreibersii*, the curly-tailed lizard, have not been exempt from dealing with these conditions.

The population located on the southern coast of the island near the village of Las Salinas seems to have been isolated by geologic and climactic factors. These lizards are morphologically distinct and are present at only one locality. Because this population, along with the others, is in a disjunct distribution, hypotheses can be tested about how the population has been shaped over time. We tested two hypotheses: first, we expect to find detectable divergence between the population at Las Salinas and all other among *L. schreibersii* populations; second, we would expect genetic divergence among the remaining populations across the central mountain range of the island. These hypotheses were tested using molecular population-genetic techniques.

Thirty individuals from seventeen populations of *L. schreibersii* were sampled from throughout their range in the Dominican Republic. Genetic data were collected for three loci: ND2, alpla-tropomyosin intron 5, and rhodopsin intron 3. The sequence data were analyzed using PAUP*, MCMCcoal, and DNASP to derive phylogenetic trees and estimates of population-genetic variation and divergence.

We found that the populations of *L. schreibersii* across the island are split geographically into three major clades, and that the Las Salinas population is the sister lineage to the combined northern and central clades. We also determined, through statistical analysis, that the separation between northern and central populations coincides with an interglacial period and, in addition, that the central population has undergone a recent geographic expansion in size. Recession of the inundated region likely opened new geographic areas for colonization, thereby explaining the recent population growth.
Intelligent systems for on-road navigation have become increasingly important areas of research in the scientific community. Many government agencies and companies have recently shown an interest in developing autonomous vehicles capable of both on-road and off-road driving. Locating and identifying traffic signals is a crucial aspect of the vision system of a successful intelligent on-road vehicle. The goal of our work is to find traffic lights in a given scene and to identify their color. This work could also be used for sign and signal identification in manufacturing robotics and other applications.

The traffic light perception system we have developed consists of three phases – color classification, tracking, and shape matching. Color classification was tested using a variety of color spaces (RGB, HSI, and L*a*b) and classification methods (Gaussian classification, color ratio, and thresholding). Tracking methods including consistency testing and Lucas-Kanade tracking were tested. Shape matching was tested using a disk-shaped, center surround template and a Canny edge detection method utilizing a gray scale template. Our goal was to test different methods for accomplishing the three phases and to combine the most effective algorithms to create a robust system. The algorithms were all implemented using MATLAB.
Quantum Efficiency of VERITAS Photomultiplier Tubes and Optical Properties of Epitaxially Grown Semiconductor Samples

Aubrey Scott

Mentor: James Buckley

The success of any experiment depends upon the ability of the researchers to accurately collect the desired data. For this reason it is essential to know the efficiencies of the instruments used. One important piece of equipment for many experiments is the photomultiplier tube, used to detect photons of light. The following is a description of a method and system used to test photomultiplier tubes (PMT) for use in the Very Energetic Radiation Imaging Telescope Array System (VERITAS). There have been reports that the PMTs chosen for the system have inconsistent quantum efficiencies from tube to tube. Using a UV arc lamp and a monochromator to generate a specific wavelength of light, the quantum efficiencies of a sample of PMTs will be plotted to test their consistency. The graphs do indeed show a broad range of quantum efficiencies between the PMTs tested, with peak values of 15-25% depending on which PMT is being tested. The second section of this work describes how the PMT testing system will be implemented in the testing of semiconductor samples grown using a molecular beam epitaxy (MBE) machine. In the future we hope to use epitaxially grown semiconductors to construct a light detector with higher quantum efficiency in the UV range. Such detectors would yield more accurate data for gamma ray detection systems like VERITAS. If such detectors are built they will be tested in the same way as the PMTs.
How does economic growth influence ideologies? Previous literature has studied the effects economic growth has on individual religions but fails to simultaneously consider multiple religions. Only when considering multiple religions can trends in beliefs be truly studied – some beliefs may become popular while others may lose support in reaction to the same event. A statistical study comparing membership in various religions over time can display trends in beliefs relating to economic growth. The data in this study consists of religious membership in the most popular religions in the United States during recent decades and measures of economic growth.

This research finds that different religions respond very similarly to changes in the economy in regard to relative growth. The general trend observed implies that people are not changing their religious beliefs with economic changes, however, people are responding to lower relative economic growth by reducing religious affiliations at similar rates. Political models are used to provide additional evidence to support this finding. These model political elections as a function of various economic factors over time, and likewise find that political beliefs are not influenced by these factors.
Haba na Haba is a theatre group that uses drama, dance, and music to address the most pressing issues in the slums of Nairobi, Kenya. This research revealed the stunning capacity of performing arts to relay essential messages in the African context. Condensed urban centers with thousands of idle youth provide ideal venues for staging plays addressing issues of HIV/AIDS, drug abuse, prostitution, and violence. A musician simply begins playing drums and hundreds gather in mere minutes. Energetic traditional dances and songs, combined with eye-catching acrobatics, keep the audience’s attention as the excitement of the spectacle draws a bigger crowd. Haba na Haba rarely plays to audiences of fewer than eight hundred people.

Once the dancers and acrobats have finished their show, the actors perform skits specifically created to have an educative impact on the crowd. Nearly all of the spectators interviewed, from football players to parents to jobless youth, mentioned a character in the play and how they do not want to end up like him or her. They explain that, unlike pamphlets or lectures, theatre conveys lessons which stay in their memories. In areas where illiteracy abounds and a small percentage of the population has access to common forms of media, drama becomes a crucial tool for relaying messages and mobilizing the community to regain agency and improve their lives.

Existing education programs in East Africa should seriously consider integrating drama and performance into their presentations. From an anthropological perspective, the history of theatrical techniques used for communication in the traditional African framework makes it the perfect medium by which to educate people on the most important issues facing the continent today.
The authors and editors of the Spring 2008 WUURD wish to acknowledge the contributions of the following members of the Peer Review Board

Morgan Grossman-McKee
James Benjamin Kugler
Olga Lozovskaya
Shweta Murthi
Cassie Sadinski
Lisa Sudmeier
The logo for the Office of Undergraduate Research, on the front cover of this publication, consists of an “impossible triangle” within a starburst. To some, the triangle evokes the challenge of puzzles to be solved or the eternal research question “How does that work?” To others, the triangle represents the Greek letter ∆, the mathematical symbol for change.

WUURD, the Washington University Undergraduate Research Digest, is published by the Office of Undergraduate Research once a semester each academic year.

How to contact us:
Office of Undergraduate Research
100 Umrath
Campus Box 1026
Phone: (314) 935-7342
Fax: (314) 935-4384
E-mail: research@artsci.wustl.edu
Web: http://ur.wustl.edu

Henry Biggs
Director of Undergraduate Research and
Associate Dean in the College of Arts & Sciences
hbiggs@wustl.edu

Joy Zalis Kiefer
Undergraduate Research Coordinator, Co-editor
Assistant Dean in the College of Arts & Sciences
jkiefer@artsci.wustl.edu

Kristin G. Sobotka
Editor
ksobotka@artsci.wustl.edu

Emily Beck
ebeck@wustl.edu

Tim Bono
tjbono@wustl.edu

Issues of the print version may be obtained at the Office of Undergraduate Research in 100 Umrath Hall or the College of Arts & Sciences Office in Brookings Hall.

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The Office of Undergraduate Research is funded by the College of Arts & Sciences.
Feature Articles

Immigration and Education: Windows into National Identity in Madrid and Barcelona  Matt Adler and Ben Kastan

Beyond Culture: Successes and Failures of Multiculturalism at the American Church in Paris  Jacqueline Dodd

Between Domestication and Wildness: A Study of North American Bison bison on Contemporary Private Herd Ranches in Maine, Massachusetts and Missouri  Sylvia Hardy

Construction of an IR/Visible Fluorimeter with Chopper/Lock-in Amplifier Detection  Jesse G. McDaniel

Summaries of Student Work