

The cover features a high-angle photograph of the University of Michigan campus under a dramatic, cloudy sky. The central focus is a large, modern brick building with a curved facade. To the left, a historic stone building with a prominent tower is visible. The foreground shows a paved plaza with a small green lawn and several people walking. The sky is filled with large, white and grey clouds against a deep blue background.

University of Michigan Undergraduate Research Journal
Issue 9, Spring 2012

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Letter From the Editors

Dear Readers,

On behalf of the entire editorial team, we are proud to present the Fall 2012 issue of the University of Michigan Undergraduate Research Journal (UMURJ). As the only student-run organization whose mission is to promote undergraduate inquiry in all academic fields, we continue to showcase the dynamic nature of undergraduate research on campus in our ninth edition of the journal.

Our publication illustrates the depth and breadth of research conducted by University of Michigan undergraduates in a variety of ways. Full-length research papers, typically written by upperclass students, represent scholarly projects that often are the culmination of a student's undergraduate research experience. Our recently-introduced abstract competition allows students of all levels – from novice to experienced researchers – to offer a snapshot of their work to the campus community. As you read through the selections offered in this edition, you will find that University of Michigan undergraduates are probing questions in topics ranging from public health to computer science, in each case displaying extraordinary inquisitiveness, curiosity, creativity, and passion for their intellectual pursuits. Our editorial team, a multidisciplinary cohort composed of undergraduate students in all fields of study, has thoroughly enjoyed working with each of our authors over the past few months in creating this year's edition of UMURJ.

One of UMURJ's core missions, promoting undergraduates' intellectual and personal growth through independent research endeavors, could not be realized without the generous support of our campus sponsors, the Undergraduate Research Opportunities Program (UROP), the Women in Science and Engineering (WISE) program, and the Office of the Vice President for Research (OVPR). We would also like to thank the faculty reviewers who dedicated their energies toward helping our undergraduate authors put forth the highest quality work possible.

We hope you will find the articles presented in this issue of UMURJ to be thought-provoking and insightful, fascinating and inspiring. If you are interested in learning more about UMURJ, please visit our website at umurj.org, where you will find electronic copies of past editions. The aim of advancing undergraduate research requires a coordinated team effort, and we encourage you to contact us through our website if you are interested in working with UMURJ in any capacity.

Sincerely,

William Hockeimer and Connie Shi

**Cover Photo Courtesy of Lily Zhang*



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Blood Banks in Kumasi, Ghana: Social Barriers Preventing Volunteer Blood Donations

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Aims/Objectives: To explore the attitudes and beliefs toward voluntary blood donation within a Ghanaian Christian community as a first step in developing a sustainable blood supply.

Background: The shortage of donated blood available for emergency transfusions in the developing world is a critical issue that can significantly affect the prognosis and recovery of hemorrhage patients. In the case of some local hospitals in Kumasi, Ghana, although the proper technology is in place to sustain an adequate blood bank, there have been periods of donated blood shortages.

Materials and Methods: Members of Faith Gospel Church, Kumasi, Ghana, participated in a pilot case study. Study participants completed written surveys, based on the Theory of Planned Behavior model, which explored their attitudes and beliefs toward voluntary blood donation.

Results: A total of 50 church members participated in the survey. While 94% expressed the importance of voluntary blood donation and thought it was a good idea, 62% articulated some sort of health concern as a barrier.

Conclusions: The study revealed that religious, cultural, or tribal beliefs were not a major factor in this sample deciding to volunteer to donate blood. Health concerns were the largest issue that needs to be addressed when developing blood drives for a sustainable blood bank supply in the future.

Introduction

The fifth United Nations Millennium Development Goal is focused on reducing the maternal mortality ratio by 75% between 1990 and 2015 and achieving universal access to reproductive health care by 2015 (UN Development Group, 2010). The leading cause of maternal mortality is obstetric hemorrhage, accounting for up to 44% of deaths in some areas, 26% of which can be attributed to the lack of blood units available for emergency transfusions (Bates, 2008). In 2008, the worldwide deficit of blood units needed for transfusion was estimated at 40 million. Up to 80% of patients who require a blood transfusion in sub-Saharan Africa cannot receive one without providing their own donor in the form of a family member (Bates, 2008). If a family member is not available or the patient requires additional transfusions, he or she may not receive the necessary blood. This complicates the efforts of clinicians in resource-limited hospitals to save women suffering from postpartum hemorrhage or ruptured ectopic pregnancy, which is the largest contributor to maternal mortality occurring during the first trimester of pregnancy (Tenore, 2000). One step to prevent these deaths is having available donated blood for transfusion.

Although storing donated blood is not an option in much of sub-Saharan Africa, Komfo Anokye Teaching Hospital (KATH) in Kumasi, Ghana, Africa, has the necessary facilities. In the developing world, 50% of blood donations are either direct—e.g., from a family member—or paid for, which is the situation that often occurs

at KATH (Al-Drees, 2008). KATH has developed a blood bank in its new Accident and Emergency Center that is comparable to those existing in the United States. However, even though all the proper technology is in place to sustain an adequate blood bank, there are periods of time where shortages in donated blood supply occur. The periodical shortages of donated blood impede the daily work of many hospital staff and medical administrators at KATH and can result in the unnecessary death of their patients. They often must scramble to secure the proper blood type for donation or find enough family members to donate what blood is needed for the patient.

Previous research conducted in Saudi Arabia has shown that perceived risk of contracting HIV, preference of direct donations from relatives, lack of knowledge that a blood bank is in need of blood, and mistrust of modern medicine and hospitals all contribute to a population not donating a sufficient amount of blood (Al-Drees, 2008). Additional belief barriers may include the perception that the procedure is painful or could make the donor weak, as well as a fear of needles or becoming anemic. Logistical barriers, such as the effort it takes to go to the location and perform the act of donating blood, also have been shown to be impediments in other locations (Zago, Freitas de Silveira, & Dumith, 2010). Sometimes, the simplest barrier may be that an individual has never been approached about donating blood and therefore doesn't know how to go about the act itself, which can be a critical dynamic (Al-Drees, 2008).

The goal of this study was to investigate the social, cultural, personal, and knowledge barriers that prevent citizens from donating blood at the modern and capable blood bank at KATH. Using a series of semi-structured and culturally sensitive surveys, the thoughts, attitudes, knowledge and beliefs about blood donation among members in a Christian Ghanaian community were explored. This design allowed us to identify what community members perceive to be the reason that people might or might not donate blood. We used the results of the surveys to design a sustainable strategy between the church study population and KATH in an effort to increase voluntary blood donation and to replicate the process with other local churches in order to maintain a sufficient supply of blood to treat patients.

Study Design and Methods

Study Participants

Fifty Faith Gospel Church youth group members at two separate branches of Faith Gospel Church in Kumasi volunteered to enroll in the survey study during June 2011 after being recruited by a committee created by the church to oversee the research process. Informed consent was obtained from all participants. Youth Group members targeted for this study ranged between 17 to 25 years of age. To test the theory that religious beliefs are one of the hypothesized factors in donating blood, we ensured that participants were from a Ghanaian Christian community. Local Kumasi blood banks might be interested in targeting Christian churches and communities for blood-donation programs because Christianity composes 69% of the population in Ghana ("The World Fact," 2011). No identifying information or characteristics were recorded in the survey about the individual participants. The University of Michigan's Health Sciences and Behavioral Sciences Institutional Review Board in Ann Arbor, Michigan, United States, exempted this study from any further approval. There was no review board for the area of study in Kumasi, but the local Faith Gospel Church leadership approved and monitored the completion of the research.

Survey Investigations

The consent form of the survey was read aloud in English and then signed by each participant before completing the written survey. All study participants were fluent in English. Each participant completed the survey individually and privately and then returned the survey to the administrator within 30 minutes in the same location where the survey was distributed. As an incentive, once participants returned the survey, they were entered into a raffle for University of Michigan apparel. After all participants at the site were finished with their surveys, numbers were drawn and prizes were distributed. If translation was needed for any part of the survey, a translator for the local language, Twi, was provided.

Statistical Methods

The survey questionnaire used was based on the Theory of Planned Behavior model and a previous survey developed by University Putra Malaysia. This methodology was used to assess the variables of attitudes toward the behavior, subjective norm (social pressure to perform behavior), assessed knowledge, past behavior,

and self-efficacy (the belief that one is capable of successfully performing task) of the participants toward blood donation (Jalalian et al, 2010).

Because this was a pilot study, descriptive quantitative and qualitative analyses were performed on the study data. Means and percentages of the survey questions were summarized and reported. The first section of the survey questions explored intention, attitude, subjective norm, and self-efficacy. The wording of the questions explored positive versus negative, general versus specific, and worthwhile versus waste-of-time approaches.

Themes were extracted from the participants' responses during the qualitative analysis of the open-ended questions. This section of the survey considered the assessed knowledge, normative beliefs, and behavioral beliefs of the participants regarding donating blood. Participants answered open-ended questions investigating their beliefs concerning the advantages and disadvantages of volunteering to donate blood, in addition to explaining which trusted people or organizations they thought would approve or disapprove of them doing so.

Results

Survey Results

The responses to the closed-ended questions in the survey (yes/no; selecting from several specified choices) show a clear understanding that blood donation is important (Table 1). The participants also indicated a strong aspiration to meet the desires and expectations of the church, family and friends (Table 2).

On the open-ended questions, when asked about the perceived advantages for donating blood, the most common response was "donating blood saves lives," with a 90% consensus among participants. All other advantages expressed were no greater than 2%. The recurring perceived disadvantages were weight loss (12%), anemia (10%), weakness (22%), death (8%), or disease (16%), such as HIV. Sixty-two percent of participants articulated some sort of health concern in the disadvantages section. Only 2% of participants stated that blood donation was against their religious beliefs. When asked who would approve of the participant donating blood, 36% indicated members of Faith Gospel Church or other Christians, and almost the same number indicated family members or friends. In contrast, 24% said that a family member or friend would disapprove, and 18% replied that a Christianity sect important to them would disapprove. The only other form of perceived disapproval offered was from the participant's physician (4%).

Interview Data

Some study participants believed that their health-care providers would not approve of them donating blood, and we hypothesize that many of these providers may have concerns because they aren't aware of the high level of sanitation at KATH and/or because they know that the patient isn't healthy enough to donate blood.

Table 1. Results from the survey section in which participants selected multiple answers exhibiting their direct attitude toward donating blood and their indirect attitude as a function of behavioral beliefs and outcome evaluations.

Statement	Percent agreeing with the statement
Overall, donating blood is a good idea	94
Overall, donating blood is pleasant	4
Overall, donating blood is the wrong thing to do	2
Overall, donating blood is unnecessary	2
If you donate blood, you will save a patient's life	96
If you donate blood, you will be doing something beneficial for yourself	4
If you donate blood, you will become anemic	2
If you donate blood, you will feel that you're doing something harmful to yourself	2
Doing something to save a patient's life is desirable to you	86
Doing something beneficial to yourself is desirable to you	14
Becoming anemic is desirable to you	4
Losing weight is desirable to you	2

Table 2. Results from yes/no survey section, which further examined the issues in terms of direct and indirect measures of subjective norm, self-efficacy, intention, and past behavior.

Statement	Percent agreeing with the statement
Doing what your church wants is important to you	91
Your church would want you to donate blood	86
You would donate blood if your church wanted you to	78
You think you would be able to donate blood if asked to do so	78
You are expected to donate blood	76
People who are important to you want you to donate blood	64
It would be easy for you to donate blood	58
You think you would be too weak to donate blood	50
You think you don't have enough blood to donate blood	48
You don't want to donate blood because you're afraid of needles	42
You feel under social pressure to donate blood	38
You have donated blood before	22
People who are important to you think you should not donate blood	18
Your church would disapprove of donating blood	6

The head of KATH's Child Health Directorate has declared that the shortage of blood is one of the major causes of maternal and infant mortality in hospitals and that the shortage also results in palpitations, poor memory, poor cognitive development, heart failure, and other health-related diseases among patients. He also stressed the need for school leaders to organize counseling services for students, teaching the importance of blood in health care ("Educational Institutions Urged," 2011).

The medical director of KATH further clarified, stating that intermittent blood shortages at the hospital's blood bank have been one of the hindrances of health-care delivery at the hospital ("Educational Institutions Urged," 2011). A constant—not intermittent—supply of donated blood is essential to maintain the needs of patients and health-care providers at a health facility the size of KATH. The head of KATH's Hematology Department has said that Ghana's national health insurance scheme, which requires hospitals to prescribe blood, puts additional pressure on the blood bank, thus requiring an intensive campaign to try to ensure a regular supply at the blood bank ("Educational Institutions Urged," 2011).

It can be theorized from the high concentration of Christians in Ghana that the second-largest gathering place in Kumasi, after educational institutions, are churches and other religious sites. The head of KATH's Hematology Department has suggested that blood-drive workshops need to be extended to still more organizations, such as businesses and the media, as a means of creat-

ing even greater awareness and encouraging voluntary donation ("Educational Institutions Urged," 2011). The blood-drive teams at KATH are working diligently to provide enough blood for the patients in need, but more education and more cooperation from schools, religious institutions, and all citizens of Ghana are vital.

Discussion

It is apparent from the survey results that the social and belief barriers preventing Kumasi citizens from donating blood is associated less with religious and tribal beliefs and more with (often erroneously) presumed medical and health concerns residents may ascribe to blood donation. Some of these health concerns, however, are valid, likely resulting from negative stereotypes concerning the sanitation of health-care facilities and of the medical equipment in economically developing countries. For the purposes of this study, it is important to note that the Accident and Emergency Hospital at KATH, which houses the hospital's blood bank, is held to the same, high sanitation standards of hospitals in the economically developed countries, such as the United States.

The lack of education and knowledge of facts about sanitary blood donation, as described in the data, is another key stumbling block. To counteract these beliefs, it is essential for the leadership in the communities that could be targeted for blood drives to endorse the act of volunteering to donate blood and to collaborate with health-care workers to educate the population. Another

health-related concern is some local residents' fears of learning their HIV status during the mandated pre-screening process.

The possibility of increased blood donation in Kumasi, Ghana, looks promising. It is apparent that citizens and church members realize the importance of volunteering to donate blood and understand that it saves patients' lives. Barriers may continue to exist concerning family members and friends not approving of blood donation, but increased education about health and safety concerns may prove effective.

Although this study was focused on a particular setting in Kumasi, Ghana, donated-blood supply shortages occur in health-care facilities in both economically developing and developed countries all around the world. Religious institutions can be a reliable target for blood drives because of their strong beliefs concerning morals, helping their fellow human, and the sacred gift of life. It is important for health-care institutions to reach out and collaborate with the leadership of religious communities, encouraging them to endorse the practice of safely volunteering to donate blood when possible. Religious leaders can address the spiritual and moral aspects of donating blood. Health-care providers can address the health concerns through presentations and question-and-answer sessions and by discussing the fears of becoming weak, anemic, or ill, losing weight, or dying. Unlike the Ghanaian Christian church that volunteered to participate in this study, some religious institutions, tribes, or cultures still may firmly oppose the practice of donating blood, and that belief must be recognized and respected.

Acknowledgments

The authors wish to thank Charles Okrah, Edmund Quainoo, Bernard Obeng, Gabriel Fofie, Millicent Amankwah, Prince Owusu Kyenkyehene, and the rest of the Faith Gospel Church community for their full support in implementing this research. They also extend their appreciation to A.T. Odoi and the rest of the Obstetrics and Gynecology Department at KATH for their collaboration and support throughout the research process the past few years. The research of Kathleen Sienko and Global Health Design Specialization of the University of Michigan's Department of Mechanical Engineering should also be acknowledged for inspiring this research effort. This study was supported by grants from the Center for Global Health and the Department of Sociology at the University of Michigan.

Alexander Harrington and Sarah Rominski designed the research study. Alexander Harrington and Michael Jacobson performed the research. Alexander Harrington and Rajesh Balkrishnan analyzed the data. Alexander Harrington authored the paper, which was edited by Rajesh Balkrishnan and Diane Benson Harrington.

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The Association between Hometowns and Joining Clubs in College

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Introduction

According to the 2000 United States Department of Transportation Census Statistics, seventy-nine percent of Americans live in urban areas or clusters, compared to the twenty-one percent who live in rural areas (2000). Some homogenous rural communities are spread across several miles, whereas other heterogeneous communities burgeon with new immigrants living in crowded cities. With that in mind, how does growing up in these distinct living conditions shape people? How does one's environment influence the decisions he or she makes in the future? More specifically, does rural versus urban living influence college students' participation in clubs and organizations during their undergraduate experience? Perhaps where a student grew up could be a variable in determining the nature of his or her involvement in school.

Previous research has focused on similar topics, including how urban and rural living conditions differ in terms of the social networks formed in these communities, as well as the independent or interdependent disposition of community members (Hofferth and Iceland 1998; Yoshihisa et al. 2004). In their meta-analysis of social capital in both urban and rural communities, Hofferth and Iceland (1998) point out that the heterogeneity of cities could increase individuals' awareness of other social groups, and perhaps encourage them to immerse themselves in a more diverse environment when they come to college. In addition, it is understood that residents of rural communities have stronger social networks with their kin, whereas urbanites may have weaker social ties, but are more likely to have ties with people outside of their family or friend group (Hofferth and Iceland 1998).

Aside from the family, the community is the primary location for social contact, and thus plays a role in developing concepts of association with others and individual expression (Wilkinson 1972, as cited in Summers, 1986). With that said, variances in the structure and characteristics of a community, such as size and ethnic and religious diversity, can influence individuals in different ways. To examine this idea, a psychology experiment by Kashima et al. (2004), identified the impact of different-sized cities on a person's development of individual, relational, and collective selves. Findings showed that rural individuals tend to be more interdependent and collectivist whereas urban individuals tend to be more individualistic (Kashima et al. 2004). Consequently, urban students' ability to form weaker ties can allow them to participate in many distinct organizations on campus, as they more regularly branch

out to new people. In another study, researchers found that social networks are stronger and smaller among family versus friends, and more educationally, religiously, and racially similar in rural communities as compared to those in urban communities (Beggs, Haines, and Hurlbert 1996). If these trends pervade the college environment, then perhaps rural students will join fewer clubs or join clubs with friends in order to maintain a small social network.

Researcher Alexander Astin highlights that participating in collegiate clubs is one of the most beneficial social outlets for students (1993). Indeed, spending time with peers in clubs and organizations allows students the opportunity to strengthen their personal development and learning skills, thereby encouraging them to be productive and sociable. Distinctions between interdependence and independence may expose the motivations behind individuals' desires (or lack thereof) to join certain types of clubs. In addition, social networks can also play an important role in creating certain peer groups. For these reasons, it is worth examining the motivations for joining clubs to see if there is an environmental basis for participation.

This research intends to shed light on the demographics of the students involved in organizations on the University of Michigan campus and the reasons behind their choices to join. Furthermore, this study examines the correlation between students' previous living environments and their involvement in clubs around campus. Knowing this information can enlighten the college community and student affairs provosts to create programs to get more students involved in clubs, regardless of their backgrounds.

Based on previous research on hometowns, social networks, and participation in collegiate clubs, I predicted that students who were raised in an urban environment would be more likely to join clubs and organizations in college. Urban students may be more individualistic and thus will want to branch out and meet people from many different groups, rather than limiting themselves to familiar faces. Along these lines, since the University of Michigan is a state university, with around 65% of the students coming from the state of Michigan, the majority of students go to school with students from their town or high school (Lichterman 2010). Thus, it is likely that students raised in the rural areas of Michigan brought their social networks from home to the university, so they do not need to branch out as extensively to make a new peer group through clubs. I predicted that rural students will participate in fewer clubs and will be more likely to join clubs with friends, or to join clubs that

are familiar to them, such as those that existed in their high school.

This study also looked at gender differences in the number of clubs joined and whether participants joined clubs with or without friends. The literature on club participation suggests that participation in clubs may be influenced by the gender of the student, where women are more likely to join clubs than men (Astin 1993). Therefore, I predicted that at the University of Michigan, women would join a greater number of clubs than men.

This study also assessed the role of extraversion and introversion, as these characteristics may be another reason why students do or do not choose to join clubs in college. Extraverts are not only more social, but may seek out environments that breed sociability. In this manner, extraverts may want to make more friends by joining clubs, whereas introverts may not have the same desire to be social in an extracurricular setting.

Methods

Participants

There were 29 participants in total, 38% male (n=11) and 62% female (n=18). 55% (n=16) of the participants were from a city (population of 50,000 +) whereas 45% (n=13) of the participants were from a rural small town (population of less than 10,000). All 29 participants were undergraduates at the University of Michigan, and range from first year to fourth year students. Participants were excluded if they were not from the United States and if they were not an undergraduate student. Also, if during their lifetimes, participants moved to a hometown of a different size or type (i.e. rural to urban, or vice versa), they were excluded from the data.

Measures

Participants were asked to report their gender, age, year in school, nationality, type of hometown (urban, suburban, or rural) where they grew up, whether they seek out opportunities to make new friends, and if they prefer to hang out with new or old friends.

To assess the strength of participants' social network in terms of their weak and strong social ties, participants were asked if they felt closer to family or friends. To measure club participation, participants were asked whether they joined clubs on campus, and if so, how many they have joined. In addition, participants were also asked about the types of clubs joined and if they are new or similar to those in high school. Extraversion and introversion is measured by participants' self-reported rating of agreeability, and whether they seek out opportunities to make new friends or if they socialize with their existing group of friends.

Procedure

Participants were selected by utilizing a convenience and non-probability stratified sample. I sent out the survey to several club list serves and to many friends who may not be involved in clubs, and I also posted a link to the survey onto Facebook in the hopes that both involved and uninvolved students came across the link. Thus, the population consisted of all undergraduate students at the University of Michigan, using a cross-sectional study for the analysis. Additionally, both purposive as well as snowball samples were employed, as I asked friends to send the link to their social networks, so the survey snowballed to other groups on campus. I wanted to compare subgroups (urban vs. rural students) in the population, so using a stratified sample best helped achieve this target group.

Results

Sub-Analysis 1

The literature revealed that because of weaker but more abundant social ties, students from urban communities may be more likely to participate in clubs than those students with a rural background, who have stronger, but fewer, social ties (Kashima et al. 2004). The data supports this hypothesis, to some extent. Seventy-one percent (n=10) of urban students participated in three or more clubs, compared to 23% (n=3) of rural students. In contrast, 46%

Table 1. Distribution Between Number of Clubs Joined in College with a Student's Hometown and Gender

Hometown		Number of clubs joined					Total
		1	2	3	4	5+	
Urban	Male	25% (n=1)	0% (n=0)	25% (n=1)	50% (n=2)	0% (n=0)	n=4
	Female	10% (n=1)	20% (n=2)	50% (n=5)	0% (n=0)	20% (n=2)	n=10
Rural/ Small Town	Male	57% (n=4)	43% (n=3)	0% (n=0)	0% (n=0)	0% (n=0)	n=7
	Female	33.3% (n=2)	17% (n=1)	17% (n=1)	33.3% (n=2)	0% (n=0)	n=6
Total		n=8	n=6	n=7	n=4	n=2	n=27

Source: Hometown and Clubs Survey, Qualtrics

(n=6) of rural students participated in only one club, which differed from the 14% (n=2) for urban students. These results indicate that the participants from an urban hometown participated in a greater number of clubs than the participants from rural hometowns, and thus there is an association between the size of a student’s hometown and the number of clubs in which they participate.

Table 1 displays the relationship between hometown, number of clubs joined, and gender. Due to the literature on women’s increased sociability and city dwellers’ increased social networks, I expected that urban females would participate in the most clubs, and rural or small town males would participate in the fewest number of clubs (Astin 1993; Beggs, Haines, and Hulbert 1996). Indeed, the survey results supported this hypothesis. 100% (n=7) of men from small towns only participated in 1-2 clubs and no males from a small town or rural area participated in more than 2 clubs. In contrast, 20% (n=2) of females from urban hometowns participated in 5 or more clubs, providing support for my first hypothesis that females and students raised in urban areas are more likely to join a greater number of clubs. Furthermore, a higher proportion of females (62.5%) participate in 3 or more clubs compared to their male counterparts (27%), regardless of their hometown. On the other hand, males (73%) were more likely to join 1-2 clubs compared to females (37.5%).

Sub-Analysis 2

This analysis focuses on the second hypothesis, which looks at the relationship between rural students’ social ties and if they joined familiar clubs with friends. I also examined the effects of gender. Of the 27 participants, 56% (n=15) of participants clas-

sified themselves as having high sociability. With that said, 40% (n=6) of the “highly sociable” respondents still chose to join familiar clubs with friends, compared to the 20% (n=3) who chose to join unfamiliar clubs without their friends. The “low sociability” respondents were equally distributed (33.3%) amongst every category except joining familiar clubs without friends. These results indicate that there is not a strong relationship (if any) between one’s sociability and the types of clubs one joins. However, this association should be further researched using a larger sample and more accurate measures of sociability.

Results in Table 3 show that men are more than four times as likely (27% compared to 6%) to join unfamiliar clubs without friends than females. In contrast, 44% (n=7) of women choose to join familiar clubs with friends compared to only 9% (n=1) of men. Furthermore, 50% of women (n=8) join unfamiliar clubs with friends compared to 55% of men (n=6). These results support the notion that females like to be with their friends more, regardless if they were existing friends, whereas men are more likely to join clubs without friends.

A three-way table examined the relationship between joining certain clubs, types of sociability, and gender. I had originally predicted that females would be more interested in branching out and making new friends. 100% (n=9) of highly sociable women indicated that they would join familiar clubs with friends, compared to 33% (n=2) of highly sociable men. In actuality, 94% (n=15) of the 16 responses for females reported joining familiar clubs with friends. Along these lines, 64% (n=7) of the 11 men fell under this category as well. However, 50% (n=3) of males with high sociabil-

Table 2. Distribution Between Rural Student’s Participation in Familiar Clubs with Friends and Types of Sociability

Sociability	Types of clubs joined				Total
	Familiar clubs with friends	Familiar clubs without friends	Unfamiliar clubs with friends	Unfamiliar clubs without friends	
High Sociability	40% (n=6)	7% (n=1)	33% (n=5)	20% (n=3)	n=15
Medium Sociability	11% (n=1)	0% (n=0)	89% (n=8)	0% (n=0)	n=9
Low Sociability	33.3% (n=1)	0% (n=0)	33.3% (n=1)	33.3% (n=1)	n=3
Total	n=8	n=1	n=14	n=4	

Source: Hometown and Clubs Survey, Qualtrics

Table 3. Distribution Between Rural Students’ Participation in Familiar Clubs with Friends and Gender

Gender	Type of Clubs Joined				Total
	Familiar clubs with friends	Familiar clubs without friends	Unfamiliar clubs with friends	Unfamiliar clubs without friends	
Male	9% (n=1)	9% (n=1)	55% (n=6)	27% (n=3)	n=11
Female	44% (n=7)	0% (n=0)	50% (n=8)	6% (n=1)	n=16
Total	n=8	n=1	n=14	n=4	n=27

Source: Hometown and Clubs Survey, Qualtrics

ity were willing to join familiar clubs without friends, compared to 0% of females surveyed. These results show that both genders prefer to join familiar clubs with friends, yet males tend to be more willing to branch out and join clubs without friends compared to women. This finding did not support my hypothesis, which predicted that females, on the basis of being more social, would join any type of club, regardless of their friends' actions.

Conclusion

The results discussed above indicated that urban students are in fact more likely to join clubs on campus than rural students. In addition, females from both types of hometowns joined more clubs than their male counterparts. Even though results showed that females are more sociable, sociability minimally impacted results, as males were four times more likely to join unfamiliar clubs than females.

This study differs from previous work, mainly on the basis that no one has investigated the link between where one grew up and clubs joined in college. The biggest limitation in the study was the small number of participants. The results therefore are not generalizable to the University of Michigan undergraduate population, or to rural and urban residents across America. However, despite the small sample size, the data obtained is fairly evenly distributed between the number of participants from urban and rural hometowns, which adds validity to the results.

In addition, it is important that future research in this same area defines the variable of hometown more specifically so that there is no confusion over what constitutes the suburbs, city, or a small/rural town. Many participants inaccurately categorized their hometown in this study, which is why there is a sparse sample size. Another study limitation is that there was selection bias because the sample was taken solely from University of Michigan students. Because of the competitive campus environment at UM, students may participate in clubs because they are pressured to fit in or need to bolster up their resumes, not because their hometown environments shaped them to join certain types of clubs.

In addition to the surveys, this study would also benefit from collecting data through open-ended interviews. Such interviews would provide a more thorough analysis of students' motivations for joining clubs, the extent of their involvement in these clubs, and how they select which clubs to join. Additionally, an interview would clarify the social network question on the survey to elicit a more specific response, which would provide a richer analysis on the second hypothesis, which links sociability to types of clubs joined.

My research has shown that, in this sample, the type of setting – rural, or urban – where someone grew up does have a correlation to both the number and types of clubs joined in college. Implications of this knowledge can help student affairs directors in numerous ways. Most importantly, they can better understand reasons for student involvement, and either increase funding for clubs that are

more active, or create more incentives for people to join clubs in the first place. For example, if students received credit for clubs joined, perhaps students would be more motivated to put their free time into a productive activity instead of into potentially harmful ones. In a broader sense, the results have helped to shed light on the behavioral pattern of urban and rural students, which may or may not stay with them in their post-college years. Better understanding people's motives and behaviors in college could enable researchers to potentially predict behavioral patterns in the future.

With that said, future directions could include a longitudinal study to see where active club members get jobs and pursue their professional career. It would be interesting to see if there is a correlation between the number or types of clubs joined and success in the job market or even marriage. If researchers had the answers to these questions then perhaps it would provide students with enough motivation to join clubs in their undergraduate career.

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HIV and Hepatitis C Co-infection: Trends and Changing Treatment

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Advisor: Tim Lane MD | Doctor of Infectious Disease at Moses Cone Hospital in Greensboro, NC

Two of the greatest challenges in health care are the chronic infections with hepatitis C virus (HCV) and human immunodeficiency virus (HIV). They are currently the most prevalent blood-borne chronic viral infections in the United States and worldwide, and both carry high mortality and morbidity rates if left untreated. In recent years there have been tremendous advances in the treatment and management of both viruses individually. However, co-infection with HIV/HCV generally leads to a more complicated disease course: it reduces the effectiveness of treatment because HIV tends to accelerate the progression of HCV and decreases the patient's susceptibility to the current HCV standard therapy of interferon and ribavirin. Currently, little data exists describing the population co-infected with HIV/HCV. But with the recent approval of two new oral drugs by the FDA for the treatment of hepatitis C and the promise of more to follow, understanding the population dynamics of HIC/HCV co-infected individuals has become much more important for future treatment. Using the patient information collected by Mr. Charles Hansen, Dr. Timothy Lane and their partners at the Regional Center for Infectious Disease in Greensboro, North Carolina, where over a thousand HIV-infected patients receive care yearly, we were able to analyze the cohort of HIV infected patients who are co-infected with HCV. This co-infected cohort is approximately 10% of the total who are HIV-infected. It is our hope that these data will better the understanding of HIV/HCV co-infection and improve the standard of therapy.

Introduction

HIV is the retrovirus responsible for causing Acquired Immuno-deficiency Syndrome (AIDS), a progressive failure of the human immune system resulting from HIV virus infection and destruction of vital immune system cells. HIV alone is one of the most destructive pandemics in human history, with the World Health Organization (WHO) estimating that over 25 million people have succumbed to AIDS between 1981, the year of its first recognition, through 2011 (7). At the end of 2010, it was estimated that 34 million people worldwide are living with the disease, with a disproportionate number living in sub-Saharan Africa (7). That number continues to rise as the disease continues to spread at a rate estimated to be around 2.6 million new infections a year (5). Fortunately, treatments are available; for instance, the effectiveness of highly active antiretroviral therapy (HAART) improves the life expectancy of persons already infected.

HCV infection is even more widespread with an estimated 130-170 million people infected worldwide and an estimated 3 million new infections per year (6). With 4.1 million infected in the United States alone, HCV has become the leading cause for liver transplantation in the U.S. and is on track to surpass alcoholic liver disease as the leading cause of liver-related death (1). There are six known genotypes of HCV, distinguished from each other based on the composition of virus RNA. Genotype 1 is the most common in North America and also the most difficult to treat

with the current interferon therapy (1). In addition to infection by genotype 1 HCV, other diagnostic factors that negatively affect responsiveness to interferon-based therapy include old age, African American ethnicity, an IL28B TT haplotype of the human interferon gene, alcohol consumption, advanced liver fibrosis, and HIV co-infection due to the resulting low CD4 lymphocyte counts. Fortunately, unlike the hepatitis B virus and HIV, which can build up reservoirs of their genetic code within the host's genome, HCV does not integrate its genetic material into the host's. Without these dormant stores of genetic code, which are difficult, if not impossible, to eradicate, it is possible to attain permanent sustained virologic response (SVR) for most HCV infected patients if successful combinative therapies could be developed. SVR is defined as long term suppression of viral RNA below detectable levels. It is anticipated that a SVR of a year or longer will portend a probable cure, but it is relatively early in the era of antiviral treatment of HCV.

Co-infection with HCV and HIV presents a greater challenge to treat than either of the two infections individually. It is estimated that 4 to 5 million people worldwide are suffering from a chronic infection of the two viruses. Co-infection is characterized by increased rates of disease progression and decreased responsiveness to standard therapy. In a recent review published in the Journal of the American Medical Association, only about 30% of patients with HIV/HCV co-infection receiving pegylated interferon (peginterferon) and ribavirin treatment developed an SVR

(1). In comparison, approximately 55% of patients with only HCV infection developed SVR after receiving the same treatment (1). Besides being more resistant to treatment, HIV/HCV co-infection is associated with accelerated development of fibrosis, cirrhosis, end-stage liver disease, and hepatocellular carcinoma. This acceleration could be due to the problematic reactive oxygen species or oxidants that are produced by the very active infections of HIV and HCV, resulting from the lower CD4 counts and other immunosuppressing effects associated with the course of HIV infection. Additionally, co-infection treatment is further hampered by complications from ribavirin and HIV anti-retroviral agents. Fortunately, HCV infection does not seem to alter the course of HIV infection and progression to AIDS. A 2002 study showed HCV infection does not significantly alter the risk of death, development of AIDS, or a positive response to HIV antiviral treatment (4).

The current standard of treatment for chronic HCV infection is a 48-week regimen of peginterferon with ribavirin. The treatment subjects the patient to an unpleasant experience due to the side effects of interferon, including flu-like symptoms and depression, and suffers from only a 40-50% chance of success in achieving an SVR (2).

Two new drugs, telaprevir (Incivek) and boceprevir (Victrelis), have shown tremendous improvement in the percentage of patients who achieved an SVR compared to those who only received standard therapy with peginterferon and ribavirin. Both drugs are nonstructural 3/4A serine protease inhibitors that target multiple steps of the HCV life cycle. In a recent double-blind randomized trial, telaprevir plus standard therapy showed an 83% SVR (2). A similar trial of boceprevir showed an SVR of 68% (3). With both drugs showing significant improvement over the current standard of therapy, it is likely that they will become part of a new standard regimen. It will thus be important to identify and understand the populations that are co-infected and to anticipate challenges in delivering such improved therapies.

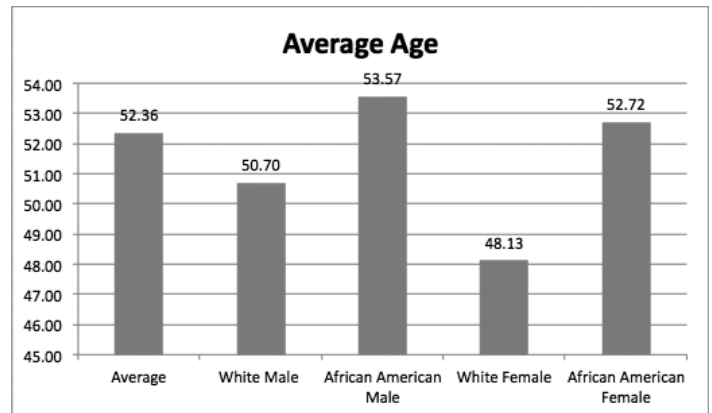
Results

Extensive data on patients co-infected with HCV and HIV has been collected from the medical records of patients receiving treatment at the Regional Center for Infectious Disease (RCID) in Greensboro, North Carolina. Over a thousand patients receive HIV treatment currently at the RCID, and approximately 10% of the patients are co-infected with HCV. The age, years since HIV diagnosis, HCV/HIV viral loads, and CD4 count are analyzed and subdivided according to gender and ethnicity to provide a better description of the co-infected population.

The co-infected sample comprises of 49 African American males (44%), 15 white males (14%), 37 African American females (34%) and 9 white females (8%). The data indicates a higher co-infection rate in African Americans regardless of gender, which is consistent with studies in other locales and is supported by large population surveys, such as the U.S. National Health and Nutrition Assessment.

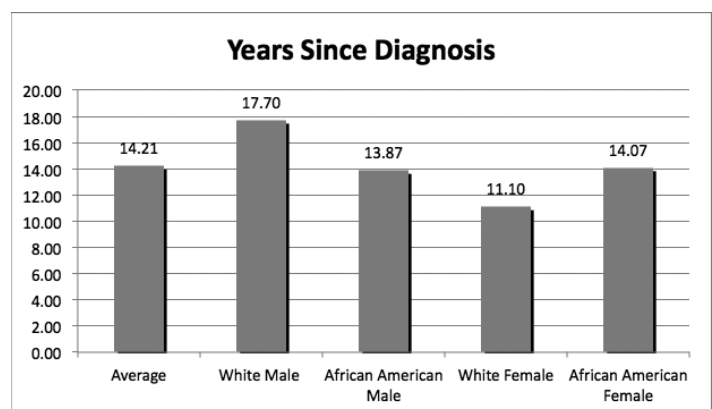
The average age of the entire group was 51.7 years with a standard deviation of +2.42 years. Both African American males and females tend to be a few years older than their white counterparts, though this slight difference is not significant.

Figure 1: Average age of co-infected patients. $p = 0.896$ by Chi-square with 3 degrees of freedom.



Also remarkable is the consistency in the years since diagnosis. In the co-infected sample, an average of 14.21 years has passed since the original HCV diagnosis. The standard deviation here is +2.71 years, slightly larger than the average age standard deviation. Again there is slight difference between African Americans and whites, with white males being diagnosed about 3 years before African American males and white females about 3 years after African American females. This difference, however, is not significant.

Figure 2: Average years since HCV diagnosis. $p = 0.671$ by Chi-square with 3 degrees of freedom.

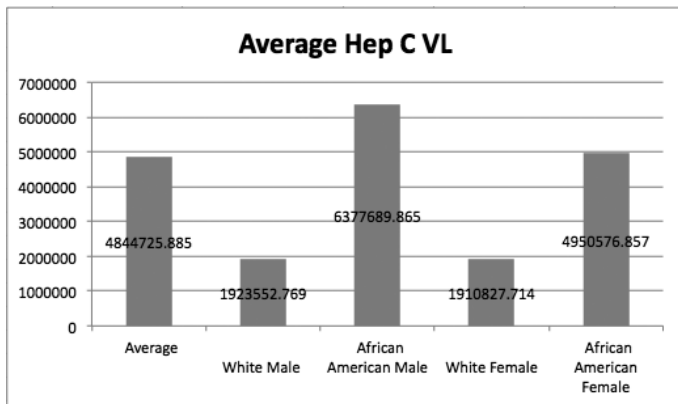


Taken together, the data suggests that this sample of co-infected patients is very homogenous. As a group, the majority was born sometime in the late 1950s and early 1960s and was likely exposed to the high-risk practices that occurred in the 1970s and 1980s.

Blood transfusion histories were not available in the co-infected cohort and would be another possible source of HCV infection since HCV testing of donated blood did not begin until approximately 1990. With the development of HCV screening, the majority was diagnosed in the mid to late 1990s and only very few (10 patients of the 117 in this sample group) have received any treatment for HCV, mainly because of cost and fear of side-effects. These HCV infections have clearly been present for some time but now there is cause for some optimism for those with HCV. If one patient were to have a positive response to the new therapies and achieve an HCV SVR, then the remaining and relatively homogeneous population would also be good candidates for treatment.

A few notable differences do arise when comparing the latest average HCV/HIV viral loads and average CD4 counts between ethnicities and genders. White males and females have the lowest (1.9 million IU/mL) hepatitis C viral loads based on testing done an average of 4.4 years ago. They are followed by those of African American females (5 million IU/mL), while African American males have the highest average viral load (6.3 million IU/mL). This further suggests that African American ethnicity is a negative prognostic factor for hepatitis C virus and may partially explain the 10%-15% lower SVR rates to the new HCV antivirals compared to the response in white populations.

Figure 3: Average hepatitis C viral load in IU/mL



HIV viral loads and CD4 counts taken an average of 0.4 years ago show that white males have an average viral load of 803 copies of HIV RNA /mL, with 67% having undetectable (<48 copies of RNA/mL) levels of the virus in their blood, and an average CD4 count of 558/ml. 68% of African American females in the co-infected sample have undetectable HIV RNA levels and an average CD4 count of 504/ml. 49% of African American males in the co-infected sample have undetectable viral loads and an average CD4 count of 443/ml. Finally, only 33% of white females in the co-infected sample display undetectable HIV viral loads and an average CD4 count of 466/ml.

Overall, it appears that white males tend to have overall better control of their HIV infection in terms of lower HIV viral loads

and higher CD4 counts. Breaking the trend seen in HCV viral loads, African American females appear to be the second healthiest subgroup followed by African American males. White females seem to have the least control of their HIV infections. These differences among the subgroups could be attributed to a wide variety of factors, including difference in treatment history, social issues, economic status, accessibility of care, and differences in ethnicity. Though these are interesting trends, their usefulness in determining who will benefit from the new HCV treatment is limited as the teleprevir and boceprevir studies were not conducted with HIV co-infected person. Until studies are done analyzing HCV treatment response with regard to HIV progression, this data can only offer a unique demographic breakdown of the co-infected population.

Figure 4: Average HIV viral load in copies/mL

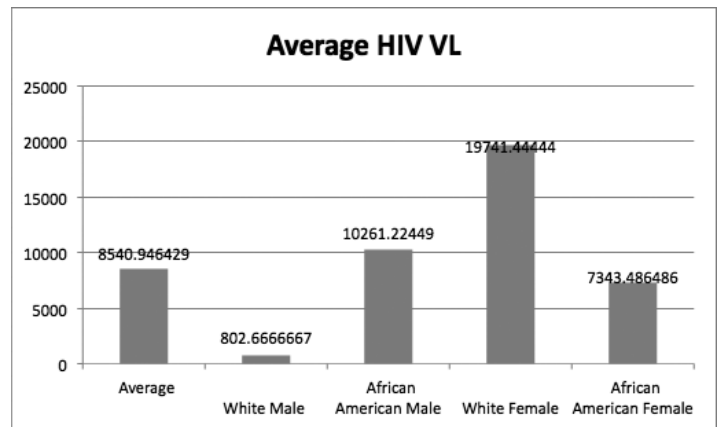
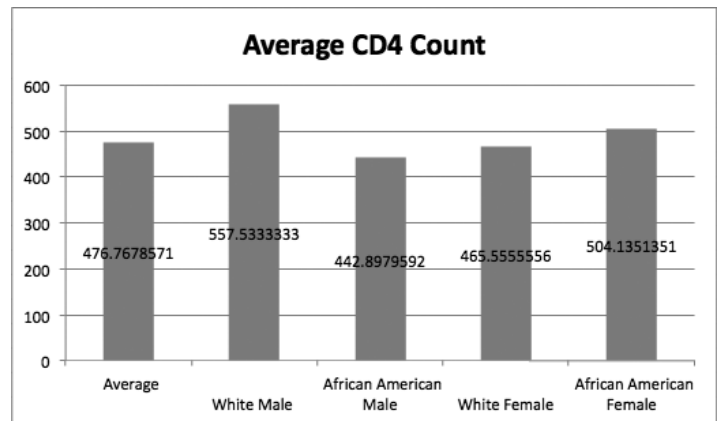


Figure 5: Average CD4 count in cells/mL



Conclusion

Analyzing patient statistics can offer a wealth of information by illuminating trends in disease progression. Physicians can use these patterns to tailor individual treatment based on group factors that prove to be beneficial or detrimental to treatment success. In the cohort of co-infected HIV and HCV patients studied

here, it was determined that the group was remarkably similar in age and the number of years since HCV diagnosis. This suggests that if one patient were to have a positive response to the new treatment, the remaining patients are likely to as well. If the homogeneity of HIV/HCV co-infection were to extend beyond the sample studied here, patients around the globe might have equally high chances of success.

In the next few years, telaprevir and boceprevir will likely become part of the standard of treatment for chronic HCV. Both are expensive drugs: \$55,500 for 12 weeks and \$28,500 for 24 weeks, respectively. With one in four patients in this population without any type of health insurance, it is crucial that populations who will potentially benefit from these treatments be identified and access to treatment be provided. Through improvements in medicine and further research in HCV and its co-infection with HIV, it may be possible to obtain sustained virologic responses in a much larger proportion of patients. Additionally, because humans are the only known natural hosts for HCV, it is theoretically possible with improving treatments for HCV to be eradicated from the global population.

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Efficient Belief Propagation in Depth Finding

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One of the greatest abilities of the human eye is its capacity to perceive depth, an essential skill that allows us to perform fundamental tasks, such as avoiding obstacles and retrieving objects, as well as complicated tasks, such as driving a car. As advancements in the field of robotics allow robots to successfully perform these aforementioned tasks, the need for simulated depth perception, ideally in an efficient manner, continues to grow. With the specific application of creating an efficient depth finding algorithm for robots with simple binocular cameras, various optimizations, introduced by Pedro Felzenszwalb of the University of Chicago, were applied to a naïve belief propagation algorithm to achieve more efficient belief propagation in depth finding. This paper provides an overview of the naïve belief propagation algorithm, the algorithm optimizations, and experimental results and analysis on the impact of these optimizations on algorithm performance.

I. Naïve Belief Propagation Algorithm

The general approach to accurately approximating a disparity depth map from two frame images is loopy belief propagation, a method that assigns each pixel in the disparity depth map to a value, which corresponds to the depth of the pixel in the two-frame images. Each pixel has an energy, consisting of a fixed data cost based on the pixel's value assignment and discontinuity cost, which depends on the value assignments to the pixel's neighboring pixels [4]. During an iteration, each pixel sends a message to each of its neighbors with an information vector containing the cost the neighbor will incur based on every possible value assignment to the pixel currently sending the message [2]. The algorithm loops through every possible pixel value assignment in order to find the value assignment that minimizes the energy of each pixel, based on the messages received from its neighbors. Over each successive iteration, the pixels receive discontinuity cost information from more distant pixels and are reassigned accordingly, decreasing the total energy of the graph from the previous iteration [2]. When run over many iterations, the naïve belief propagation algorithm's total energy converges, producing a reasonably accurate disparity depth map approximation.

II. Felzenszwalb's Optimized Belief Propagation Algorithm

The Felzenszwalb algorithm uses three optimization techniques, including fast message updates, grid graph, and multi-grid, on the naïve belief propagation algorithm in its belief propagation approach.

A. Optimization 1: Fast Message Updates

The fast message updates technique computes message updates in linear time by expressing these updates as min convolutions [2]. Instead of computing the optimal value assignment of the current

pixels with the optimal value assignment of each neighboring pixel together, the optimal value assignment of the neighboring pixels can be computed independently of the current pixel's values. The algorithm needs only to iterate over the possible pixel values for each neighboring pixel twice; thus, message updates can be computed in linear, in contrast to the standard quadratic, time.

B. Optimization 2: Grid Graph

The grid graph technique computes messages in linear time by passing messages to every other pixel on even iterations and vice versa on odd iterations. This technique eliminates the need to store messages from the previous iteration for calculating and updating current messages.

C. Optimization 3: Multi-Grid

The multi-grid technique involves running the belief propagation algorithm in a coarse-to-fine manner, which increases the efficiency of passing messages over long-range distances by building a data pyramid of message updates [2]. At the highest level of the data pyramid, the algorithm runs in a coarse manner and passes messages over a large number of iterations. Running in a progressively finer manner, the number of message-passing iterations is reduced at each successive level. The Felzenszwalb algorithm is approximately the application of these techniques to the naïve belief propagation algorithm.

III. Algorithm Efficiency Experiments

In order to compare and evaluate the efficiency and accuracy of these algorithms, the naïve belief propagation algorithm and the Felzenszwalb optimized belief propagation algorithm were used to generate disparity depth maps of two-frame images from the Middlebury Stereo Datasets [1]. Both the naïve and optimized

algorithms were implemented in Java for the experiments. The comparison data consists of the runtime and total energy for each algorithm recorded over a range of belief propagation iterations values. Because all of the algorithms attempt to minimize the overall graph energy, an algorithm that minimizes its total energy over less iteration is considered more efficient than an algorithm whose total energy reduces more slowly. Furthermore, as the correct disparity depth map is reached, the total energy of the graph will converge to approximately its minimum value. Naturally, an algorithm whose total energy converges over less iteration is preferred.

A. Resulting Disparity Depth Map Images

Figure 1: Disparity Depth Map resulting from naïve belief propagation algorithm for 5000 iterations



Figure 2: Disparity Depth Map resulting from naïve belief propagation algorithm with Felzenszwalboptimizations for 5000 iterations



Figure 3: Disparity Depth Map resulting from Felzenszwalb belief propagation algorithm with 5000 iterations



B. Algorithm Performance Graphs

Figure 4: Iterations vs. Performance of the naïve belief propagation algorithm, the naïve belief propagation algorithm with Felzenszwalb optimizations, and the Felzenszwalb belief propagation algorithm.

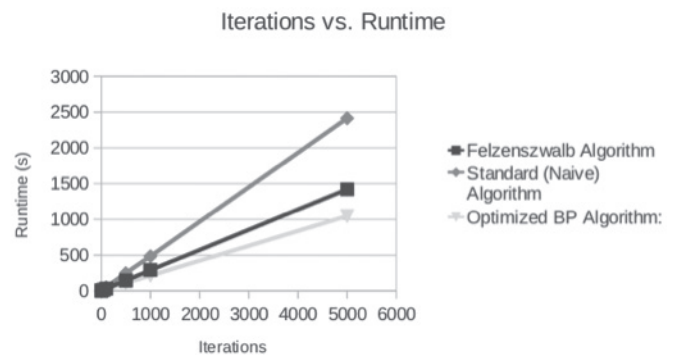
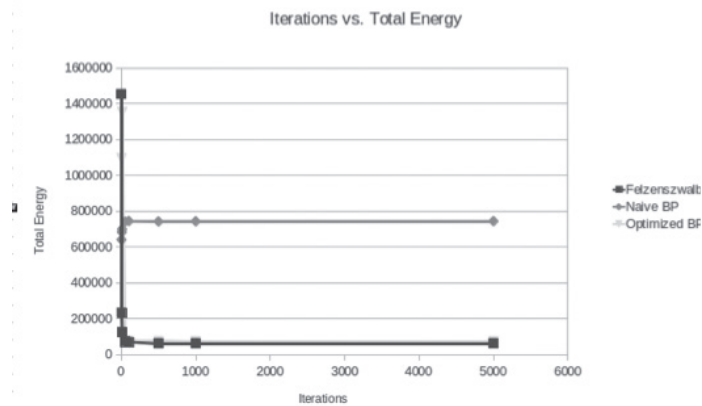


Figure 5: Iterations vs. Total Energy of the naïve belief propagation algorithm, the naïve belief propagation algorithm with Felzenszwalb optimizations, and the Felzenszwalb belief propagation algorithm.



From the data, it can be observed that the Felzenszwalb algorithm converges more quickly and has a shorter runtime than the naïve belief propagation algorithm. Furthermore, the Felzenszwalb algorithm and naïve belief propagation incorporating the Felzenszwalb optimization techniques have roughly the same runtime and convergence time; thus, by applying these optimization techniques to a naïve belief propagation algorithm, the Felzenszwalb algorithm's performance can be achieved.

IV. Conclusions

Based on the comparisons of the Felzenszwalb algorithm and the naïve belief propagation algorithm using the criteria of belief propagation iterations versus runtime and belief propagation iterations versus total graph energy, it can be reasonably confirmed that the Felzenszwalb optimizations increase both the runtime and accuracy of the belief propagation algorithm over a fixed iteration period. Furthermore, as the Java implementation of the Felzenszwalb algorithm and the naïve belief propagation algorithm incorporating the Felzenszwalb optimization techniques have reasonably close accuracy and runtime performances, it can be confirmed that Felzenszwalb's proposed techniques improve the runtime and accuracy of naïve belief propagation algorithms. Future optimizations to be explored include implementing the Felzenszwalb optimized belief propagation algorithm with parallelization.

Efficient computer vision techniques have strong applications in robotics. This belief propagation algorithm is efficient enough to run on even a small processor with little memory, allowing simple, inexpensive robots to calculate consistent depth information with comparable accuracy to their more expensive robot counterparts. Inexpensive robots with increased capability make robotics research more accessible, thus enabling the field to continue growing and improving.

V. Acknowledgements

Particular thanks to Johannes Strom for meeting with me on a weekly basis to help with the implementation and debugging of these algorithms and to Dr. Edwin Olson for overseeing the project.

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How to Get Involved in Research

Types

Science

*Chemical, Medical,
Psychological*

Humanities

History, Languages

Engineering

*Material Science,
Civil Electrical*

Social Sciences

Economics, Political

To get Started

- Ask your professors about their exciting research
- Search department websites for PIs in your field of interest
- Search Student Employment Website
- Join or visit the UROP office to streamline the whole process
- Steps for getting an interview:
 - Identify a research project
 - Due diligence: background research and network
 - Send email cover letter and attach a resume

Looking Ahead

- Summer Opportunities:
 - Summer Research Opportunity Program (SROP)
 - Research Experience for Undergraduates (REU)
 - Social Sciences & Humanities Summer Fellowship Programs
 - Summer Biomedical and Life Sciences
 - Professors seek research assistants year round

Benefits of Research

- Contributes to the advancement of human knowledge
- Builds a unique set of hard skills and hands on experience
- Helps identify your academic and career interests
- Prepares you for graduate opportunities
- Provides a steady income or academic credit

Apis mellifera: The Domestication and Spread of European Honey Bees for Agriculture in North America

Ella Weber | Department of Archaeology

Throughout history, honey bees have benefited man both for food and their ability to increase crop yield via pollination. This paper will discuss the complex manner in which beekeeping became a part of societies across the globe, and how individuals have altered the natural evolution of honey bees by manipulating location, hive building, and tendency to swarm. Additionally, it will address the recent issue of colony collapse disorder, and the ways in which human disruption of *Apis mellifera* is leading to mass colony death, which is adversely affecting the agricultural community that has become so dependent on their pollination practices.

Introduction

Roughly 10,000 years ago, receding glaciers and the development of a more stable climate on Earth helped shape the emergence of agriculture-based societies out of communities previously focused on nomadic hunting and gathering practices (Wenke et al. 2007). Social insects, however, had already been collaborating long before humans were even around. Roughly 100 million years ago during the Cretaceous period, angiosperms, or flowering plants, became the dominant foliage type on Earth (Crane 1999). Because many of these plants require intra-species pollination, scientists hypothesize that the emergence of angiosperms is directly correlated to the evolution of honey-storing insects. According to the fossil record, existence of some of the oldest flowering plants requiring insect pollination coincided with the earliest evidence of social bees (Crane 1999).

While *Aculeate Hymenoptera*, honey-storing insects primarily pertaining to bees, existed before the dominance of angiosperms, they were primarily solitary and lived in single units. Anatomical comparisons of prehistoric insects point toward social bees evolving from wasps, slowly adapting to a diet of nectar and pollen rather than preying on other insects (Winston 1987). This change is distinctly marked by the development of pollen carrying appendages, most notably the development of plumose hairs and broadened hind legs that increased their ability to gather and transport pollen back to the nest (Winston 1987). Although researchers cannot be certain when the shift to hive behavior began, the oldest evidence points to the subfamily Miliponinae, a type of stingless bee found exclusively in tropical regions (Crane 1999). Earliest fossils indicate a tendency toward highly social behavior dating to around 80 million years ago, displaying physical characteristics of modern bees (Crane 1999). Roughly 35 million years after the evolution of Miliponinae, the first organized honeybees (*Apis*) began to populate areas with moderate climates and high angiosperm densities (Crane 1999).

Among the genus *Apis*, evolutionary divergences occurred to create the large variety of honey bee species found in the present day. The first of these branches led to *Apis dorsata* and *A. florea*, both of which built rudimentary single-comb nests, often open and poorly protected from predators (Crane 1999). Despite their ineffective building strategy, these were the only two species directly related to modern honeybee, and they existed on the Earth for over 30 million years. Eventually, a more organized method of nest building evolved, leading to the emergence of *A. cerana* and the species most commonly found in Europe and North America, *A. mellifera*. Forming advanced cavity-nesting spaces containing multiple parallel combs, these species initially managed to spread locally because of their unique ability to survive cold winters by forming clusters within their hive (Crane 1999).

Scientists speculate that the spread of honey bees prior to extensive human involvement can most likely be attributed to climate changes during the Pleistocene. During the ice age, glacial formations caused the sea level to fall, often creating land bridges that allowed honey bees to travel between continents in the northern hemisphere. As global temperatures began to rise roughly 10,000 years ago, bridges were submerged and islands formed, leading to divergent evolution and a wide distribution of honey bees (Crane 1999). The recent finding of Hymenoptera fossils in Nevada point to some evidence that early honeybees may have traveled across Beringia, the land bridge thought to connect modern-day Russia to Alaska (Engel et al. 2009). According to this theory, honey bees expanded into western North America from Asia, where they were most likely confined to a small, ecologically supportive environment (Engel et al. 2009). When temperatures increased, fauna and habitat changed drastically, causing the extinction of *Apis* in the New World until they were reintroduced by European settlers in 1622 (Engel et al. 2009). Although the evidence supporting this is limited, similarities between this and the introduction of ginkgo trees and horses to North America increase the validity of this claim.

Early Domestication

Despite arguments over the introduction of honey bees to North America, scientists do agree that the domestication of *A. mellifera* began much earlier, most likely somewhere in Egypt, although the earliest representations of bees are illustrated in rock art in southern France and northern Spain (Crane 1999). The earliest record of man eating honey can be dated to roughly 3 million years ago, with extensive exploitation of honey bees dating around 10,000 years ago (Crane 1984). Societies originally scavenged for honey in trees and along rocky overhangs where bees often built hives; however, as populations became larger and more sedentary, the demand for honey outgrew its natural availability (Harissis et al. 2009). Honey was used not only as a food source but also as a part of religious rituals and as a medicinal ingredient, which meant that it needed to be readily accessible for collection. The practice of controlled honey production was also not confined to a single area. Tomb paintings in Egypt display beekeeping, and evidence has been found dating as early as the Minoan Civilization indicating large beekeeping practices and extensive honey trade (Engel et al. 2009). Further evidence exists in Jewish laws dating around 597 B.C., in which questions are raised about collecting honey on the Sabbath and how close hives should be in relation to people's homes (Engel et al. 2009). These populations all sought a similar approach to attracting honey bees by housing collected combs in wooden boxes or cylinders made of clay or mud (Engel et al. 2009). By creating these artificial homes, ancient civilizations began the earliest and most crude methods of beekeeping. They laid the groundwork not only for a honey market trade, but also the encouragement for later civilizations to perfect beekeeping methods. Simultaneously, these practices altered the evolution of honey bees and increased the importance of honey bees in an agricultural society.

As honey bee domestication spread into Europe, selective pressures from beekeepers drastically changed the development of the once uniform species. These differences primarily stemmed from specific characteristics desired by beekeepers. Generally, this list is confined to six main factors: colony survival during dearth periods, colony survival when honey flow is poor, resistance to disease, maximum amount of honey storage, tendency to sting, and ease of pacification by smoke (Crane 1999). While these characteristics benefitted honey-gatherers, they also acted to remove some natural defenses of bees, detracting from their ability to survive without human interference. Differences in selection arose depending on the degree of desirability in each location. For example, in African societies, honey-hunters were in direct competition with native animals, and therefore bees that showed increased aggression to deter such competitors were selected (Crane 1999). In areas with a more temperate climate, beekeepers were often less concerned with temperament and focused more on selecting bees that could survive cold winter periods (Crane 1999). Additionally, the removal of honey bees from the tropical regions of Africa into the temperate zones of Europe most likely affected natural selection of bees. Bees more suitable for changing temperatures would

have shown greater fitness in Europe, whereas bees more capable of migration and surviving drought, heat, and excessive rain would have been artificially selected for in tropical regions.

Increasing Alterations and Domestication

A. mellifera is the only species of honey bee native to Europe, and has been the focus of most beekeepers since the time of the Roman Empire. Early European beekeepers focused primarily on ease of access, evolving from large clay hives in Greece to coiled wicker skeps in Romania and Great Britain that were sealed with mud or cow dung to create a more weather-tight hive (Crane 1984). These advances in the stability of honey bee hives increased the longevity of colonies beyond that of wild bees while simultaneously increasing the ease of collection for beekeepers. European beekeepers also affected the natural spread of honey bees by altering their swarming habits. Honeybees generally swarm due to a food shortage, preparing to relocate to an area with higher flower density. To minimize colony loss, beekeepers in Greece and England would often use wine, flute music, and a great number of other tactics to direct bees into a new, local hive and maintain their population (Harissis et al. 2009). This promoted the cultivation of *A. mellifera* with a low tendency to swarm, which is a deviation from the lifestyle of wild bees. Although this was not problematic at the time, recent researchers speculate that removing this characteristic from modern bees is increasing their exposure to disease.

In 1622, honey-deprived British colonists brought the first *A. mellifera* with them to North America, where the Native American population dubbed them "the white man's fly," and used them to mark the westward expansion of the new settlers (Engel et al. 2009). Although controlled mating between races of bees has occurred since their introduction and selective pressures have been applied by queen breeders, *A. mellifera* is one of the best studied domesticated bees because the European racial lines have been fairly well maintained (Winston 1987). Honey bees in the colonies were originally confined to wild hives in hollow trees, with a 1641 court case in Massachusetts providing the first documented practice of controlled bee keeping in the colonies. Honey hunting – that is, following a bee back to its hive or opportunistic honey gathering – remained the most popular way of obtaining honey up until the end of the 18th century, one of the reasons honey bees in North America relate closely to their English ancestors, whereas English honey bees differ greatly from their African relations. This can also be attributed to the fact that many North American beekeepers selected for color and striping, characteristics that have been shown to have no impact on honey production or any other behavioral traits (Crane 1999).

Advances in the domestication of honey bees in the United States at the turn of the 19th century can largely be attributed to coincidence. The accidental introduction of the greater wax moth destroyed roughly 80% of all domesticated hives within two years, leading beekeepers to experiment with hive design (Crane 1999). Creating an artificial hive with a sloped bottom to discharge the

moth larvae, beekeepers increased the fitness of their more docile, weather resistant, domesticated bees, while wild honey bees continued to see substantial hive collapse. The further development of moveable-comb hives encouraged honey bees to change their normal comb building patterns to make them easily extractable from the hive, incorporated gradually by mimicking the natural spacing of wild bee combs (Crane 1999). This revolutionized beekeeping possibilities, making it more profitable for a beekeeper to operate a large number of hives, eventually leading to the large-scale hive management seen in the United States today (Crane 1999).

Large-Scale Agricultural Use and Economic Importance

Since the creation of improved hives, beekeepers in North America have been altering the natural practices of *A. mellifera* to better suit both honey production and crop pollination. For instance, modern colonies have become increasingly resistant to cold winters as farmers now either ship hives to warmer areas in the off-season or wrap hives in insulating material (Crane 1999). This has changed honey bees' tendency to swarm and nest in natural cavities in the wild. Queen excluders have also been used to increase the productivity of honey bees. These hive additions feature a hole just big enough for drones to fit through, allowing hives to include more than one queen as well as directing where combs can be built, forcing bees to use space more efficiently, and thus creating a higher yield than wild bees (Crane 1999). Controlled mating has also been used to direct the evolution of North American honey bees. Early beekeepers attempted to isolate queens with those working drones they found to be more desirable, and artificial insemination has been attempted since 1790 (Crane 1999). While beekeepers were not always selecting for characteristics conducive to productivity, this nonetheless altered the natural evolution of *A. mellifera* in the United States.

In recent decades, crop pollination has replaced the importance of hive maintenance for honey production. Originally used in New Jersey for apple pollination in 1909, this practice has expanded to roughly 2.9 million colonies transported for agricultural purposes annually (Morse et al. 2000). Coupled with increased resistance to cold weather, farmers around the United States have created a complex system of shipping bees in accordance to crop season which has led to a wider variety of angiosperms selected for pollination by bee colonies. In one of her presentations, entomologist Julianna Tuell described how bees on the east coast, where they pollinate orange trees in Florida, are shipped to mid-range states for squash pollination, and finally sent north to Maine during the blueberry bloom before repeating the cycle. While wild bees would normally only visit plants in a specific climate region, this new practice has radically altered the preferences and uses of domesticated *A. mellifera*. This high use of honey bees for pollination has also led to increased dependency by farmers, which could have devastating results if bee colonies continue to decline.

Negative Influences of Domestication

Recently, rapid decline has been noted in colony numbers,

which is widely attributed to the stress that forced migration is placing on colonies due to poor nutrition and increased exposure to diseases and harmful pesticides, according to Tuell (2011). These factors, among others, are thought to be the leading causes of colony collapse disorder, an affliction scientists know little about that causes the sudden death of entire hives. Researchers and farmers alike are concerned that this marks the beginning of a severe decline and loss of progress in agricultural honey bee use. Many researchers are afraid that a large amount of blame for colony collapse disorder is actually due to pesticides sprayed on hives to kill pests. These have been proposed as compromising honey bees' immune systems and leading to the evolution of pesticide resistant pests (VanEngelsdorp et al. 2008). In this way, attempts of domesticating honey bees further has actually proved to be a step backwards, creating hives that are less beneficial to agriculturalists with lower individual fitness. Additionally, the recently introduced varroa mite can destroy entire colonies and is expensive to eradicate (Morse et al. 2000). Similar to the wax moth crisis, farmers' methods of treatment have varied effects on their colonies, altering natural defenses that may arise and increasing the spread of bees that have been selected for by infestation resistance.

Conclusion

Since their development into social communities thousands of years ago, honey bees have made a long voyage between continents, cultures, and human exploitation. While early civilizations interacted with bee colonies out of reverence and convenience, beekeeping has since grown into a full-scale occupation for many. Initial modifications to hives for ease of honey collection evolved into safeguards against disease, and sexual selection reshaped the natural evolution of *A. mellifera*. All these disruptions in the normal patterns of honey bees led to a more-or-less accidental development of workers more suitable for human use, creating the domesticated honey bee present in North America today. Farmers benefit from the transportation of colonies reared to pollinate a wide variety of angiosperms, and the bees themselves benefit from safe hive locations and a guaranteed food source. Although domestication efforts have recently been suspected of having a negative impact on *A. mellifera*, pollination remains an integral part of agriculture in the United States, and the evolution of this species will undoubtedly continue to be marked by human interference as long as humans and bees remain interdependent.

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Abstract Competition

Every year, hundreds of undergraduate students make leaps and bounds in independent research - a small sample of which is published in this journal. However, these full articles are the product of multiple years of work, and we at UMURJ feel that younger students should also have an opportunity showcase their work-in-progress; the second annual Abstract Competition is just that. In these abstracts are potential advances in technology and insights into culture, the future headlines of tomorrow's papers and the next generation of Michigan research. We hope that you find them as perceptive and thought-provoking as we have.

***Proteus mirabilis* Growth and Swarming Behavior on Minimal Medium**

Samantha M. Antczak

Advisor: Harry L. T. Mobley, PhD

Catheter-associated urinary tract infection (CaUTI) is the most common hospital-acquired infection. *Proteus mirabilis*, a Gram-negative, dimorphic bacterial species, is one of the main causes of CaUTI. This bacterium possesses the ability to differentiate into elongated cells with thousands of flagella, allowing the bacterium to swarm across catheters. In a lab setting the same swarming behavior occurs on LB agar with 100 mM NaCl, but not on minimal medium. However, we have found that adding combinations of glutamine, arginine, histidine, ornithine and malate promote swarming on minimal media. Our hypothesis is that these factors induce swarming by increasing growth rate.

To test this hypothesis, we analyzed growth in minimal media with the mentioned factors in comparison to plain media. Using the BioScreen automated growth curve system, we measured the optical density of minimal media containing *P. mirabilis* from overnight cultures and 10 mM of each trigger. We found that glutamine increased growth rate; malate decreased growth rate; and arginine, histidine and ornithine did not affect growth rate.

We next tested combinations of these factors to determine if swarming is correlated to increased growth. Of the 43 conditions which promoted swarming, 13 also promoted increased growth rate. Therefore, increased growth occurred in only 30% of the conditions in which swarming was also induced, meaning that swarming can occur without growth increasing. However, since 13 of the 17 conditions which promoted increased growth rate also promoted swarming, there is a significant chance that swarming will occur whenever growth rate increases. Additionally, different carbon and nitrogen sources and iron amounts were found to affect both growth rate and swarming. Specifically, iron, urea as a nitrogen source and glycerol as a carbon source allowed for increased growth and swarming. In conclusion, while certain combinations of triggers induce both growth and swarming, other factors and conditions are also involved in inducing such behaviors. Because swarming behavior allows *P. mirabilis* to colonize in the urinary tract, understanding how factors induce swarming will allow for better CaUTI treatment options. As a result, future work will focus on determining how these conditions promote swarming independent of growth rate.

Lipooligosaccharide Structures and Serum Resistance of *Haemophilus Influenzae* Causing Otitis Media

Deborah Daniel

Advisor: Kirk McCrea, PhD

The *Haemophilus influenzae* bacterium exists ubiquitously in throats and nasal passages. The bacteria causes ear infections in many children, but it leaves most adults healthy. However, the bacterium in elderly or smoking adults predisposes them to infections such as COPD and pneumonia. This project is looking at the differences between strains in their serum resistance, which is the ability to resist complement-mediated killing. We hypothesize that serum resistance correlates with certain lipooligosaccharide (LOS) structures on the bacterial surface. This will be tested by looking for statistical differences of serum killing among strains with predicted structures. There are two of six major LOS configurations that are predicted to be more prevalent among disease than non-disease isolates. Our current data indicates that strains vary widely in their serum resistance, some being completely sensitive or resistant to the dilution of human serum that we are using. All strains will be tested prior to making statistical inferences between resistance and predicted LOS structural configurations. Results obtained from these studies will be used toward the development of an LOS vaccine capable of eliminating diseases caused by *Haemophilus influenzae*.

Supermassive Black Holes in Barred Galaxies

Samsul Hoque

Most galaxies have a supermassive black hole in their centers. For most of these galaxies, the mass of the black hole (MBH) is tightly correlated with the velocity dispersion (σ , i.e. the standard deviation of the velocities of stars) in the central region of the galaxy. This important correlation is referred to as the “MBH- σ ” (M-sigma relation). However, the M-sigma relationship does not seem to hold for barred galaxies. Barred galaxies appear to have velocity dispersion (σ) values higher than expected for their black hole masses. The purpose of this research project is to better understand why the relationship between the mass of a supermassive black hole and the velocity dispersion of its host galaxy breaks down for barred galaxies.

According to a recent paper by Hartmann et al. (2012 in preparation), bar formation in a galaxy has various effects on the bulge velocity dispersion of a galaxy. In addition, a bar can affect the central mass density and anisotropy of the velocity distribution (i.e. how much the velocity distribution changes with direction within the galaxy). However, this paper studied simulations which did not actually include the gravitational effects of a central supermassive black hole. In my project we analyze a series of simulations which do include a supermassive black hole and study the simultaneous effects of both the changing bar and the growth of the black hole.

My specific task in this project is to use IDL to analyze data from the simulations. My first job was to plot the positions of particles from two different simulations, each with nearly 40 thousand particles. Next I made plots of the density as a function of radius, rotation curves, and the velocity dispersion for both sets of data. After completing the velocity dispersion, I moved on to analyze eight simulations generated by Dr. Juntai Shen (Shanghai Observatory). The difference between the Hartman simulations and the simulations that I worked on is that 1) they either already had a stable bar or have never formed one and 2) they had a black hole slowly growing in the center. These simulations will not only enable us to gain a deeper understanding of the effect of a black hole on the dynamics of stars within close proximity, but they will also help us understand the roles that black holes play in the evolution of galaxies.

Competitive Adsorption of Methane and Carbon Dioxide on MOF Adsorbents

Zachery Gizicki, Trinh Tran, Christian Lastoskie

There is a growing acceptance of the need for humanity to utilize energy resources in an environmentally sustainable manner. One of the biggest challenges confronting our society is how to meet future energy needs while reducing CO₂ emissions, which are a major component of the greenhouse gases that are responsible for global warming. The Lastoskie laboratory is addressing this issue by investigating the possible use of metal-organic framework (MOF) adsorbents to separate carbon dioxide from combustion gases. MOFs are porous materials that consist of metal ions connected to one another by organic linkers in a three-dimensional configuration. Our research group is assessing the effectiveness of two particular MOF adsorbents synthesized in our laboratory, ELM-11 and ELM-12, to separate carbon dioxide from gas mixtures. We are measuring isotherms – graphs showing the relationship between pressure and adsorption – for CO₂ on volumetric adsorption instruments over a range of temperatures from 25 to 75 °C, conditions under which carbon capture might be carried out at major CO₂ emission sources like coal-fired power plants. Our laboratory is also investigating the adsorption of methane, the principal component of natural gas, on these materials. By finding an efficient way to separate CO₂ from combustion gases and from the shale gases produced during hydraulic fracturing operations we will be one step closer to finding an economically viable way to reduce CO₂ emissions and improve our nation's energy sustainability.

Respiratory Scores in Children with Bronchiolitis

Blake Sanford

Advisor: Marisa Louie M.D.

Bronchiolitis is a viral infection of the lower airways and is the most common reason for the hospitalization of infants. Currently, several numeric scoring systems exist to aid in the clinical management of these patients. Three commonly used scoring systems are the Wang Bronchiolitis Score, the Modified Cincinnati Score and the Respiratory Distress Assessment Index (RDAI) Score. It is not known whether any score can assist in admission versus discharge decisions, nor has the inter-rater reliability been described or compared.

The goal of this study is to identify an accurate and reliable scoring system for the evaluation of pediatric bronchiolitis. We believe that one of three commonly used scoring systems for bronchiolitis, or a combination of elements from these three, best correlates with admission and discharge decisions and will be reliable across different providers. We prospectively enroll patients between the ages of 0-24 months who have been diagnosed with bronchiolitis in the Emergency Department or inpatient setting of Mott Children's Hospital. We then evaluate each patient daily according to the protocols of each of three commonly used scoring systems and compare these scores to patient disposition at the end of each day. Additionally, inter-rater reliability is determined via the simultaneous evaluation of a subgroup of subjects.

Subject enrollment is ongoing. We expect to conclude that one of the scoring system, or parts of different systems, best correlates with discharge from the hospital and has the highest level of inter-rater reliability. This system will be the optimal current scoring system for bronchiolitis. We intend to incorporate this system into the UMHS Clinical Practice Guideline for Bronchiolitis, which we plan to publish on the Agency for Healthcare Research and Quality's National Guideline Clearinghouse website.

Gender Perceptions in Mathematics

Alexandra Tourek

Advisor: Dr. Anjel Vahraton

Many US researchers have found alarming rates of girls' disassociation with mathematics compared to boys along with the persistence of the pervasive stereotype that "math is for boys."¹ Researchers at the University of Washington go on to say this is even before actual gender performance differences begin to appear in mathematical subjects. Gender plays a strong role in shaping collective attitudes towards the abilities of women in mathematics, leading to inequalities in opportunities for women to enter and sustain positions within mathematics. About 27% of the University of Michigan's undergraduate math program is female². Tenured staff in the Science, Technology, Engineering and Mathematics (STEM) fields at the University is only around 23% women³. These trends are consistent throughout many US institutions despite the growing acknowledgement of gender disparity and institutional shifts towards promoting diversity through minority outreach programs.

My objectives for this project are to (1) begin the analysis of the gendered culture of mathematics, (2) develop a strong basis for understanding how the roles of women and minorities in mathematics are socially constructed and (3) understand the implications of gender disparities in mathematics as well as how to begin to combat deeply engrained inequalities.

I aim to address the three points above through a review of the literature on how gendered perceptions affect mathematical achievement and the self-perception of it, feminist interventions in the math classroom and other strategies for change. I will also implement a survey to test my two main research questions: How do the perceptions of math differ between genders? Do these perceptions have predictive power regarding students' success in mathematics?

¹ PSYPost. "Gender stereotypes about math develop as early as second grade." <http://www.psypost.org/2011/03/gender-stereotypes-develop-second-grade-4665> March 14, 2011.

² Grapevine, Rebecca. "Solving the Gender Equation." Michigan Daily. 20 February 2007. <http://www.lsa.umich.edu/psych/news/department/news/?id=195>

³ Advance: University of Michigan. "Institutional Indicators of Diversity for Faculty at the University of Michigan: AY2010." September 2010. <http://www.advance.rackham.umich.edu/AY2010IndicatorReport-Public.pdf>

