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THE UNIVERSITY OF MICHIGAN UNDERGRADUATE RESEARCH FORUM

Dear Readers,

I would like to welcome you to the third issue of the University of Michigan Undergraduate Research Forum. The Forum is a cross-disciplinary undergraduate research journal, which we have created with the goal of showcasing the wide range of student research activities on all three of the University of Michigan campuses. It is the goal of the Forum to join various local symposia, poster sessions, lecture series, and conferences in making research more accessible to undergraduates. We intend the Forum to act neither as the sole outlet for experienced student researchers nor as a gateway for newcomers; rather, we encourage both to publish in the Forum so that we may bring all undergraduates together.

Through the past four years, the Forum has flourished with submissions from student researchers, and applications from students interested in firmly rooting this tradition. We have made several positive adjustments to our infrastructure since the unveiling of our previous issue. In particular, we have expanded our journal to include the University of Michigan - Flint and Dearborn campuses to add intellectual diversity to the publication. We feel that the only true way to display the strength of undergraduate research at the University of Michigan is to consider all of the campuses of the University.

Our adjustments are not limited only to submissions. We now enjoy funds to hold an annual banquet to celebrate the accomplishments of the student researchers and the Forum Board. Furthermore, we look forward to publishing a second issue in April of 2006, and establishing a strong tradition on this campus. Lastly, we have reached out to other organizations in our push to encourage academic exploration on campus. We have enjoyed the support of such organizations as the "Biotechnology Education on Campus Organization" and "Mars Rover Team" throughout our publication process.

The production of this issue was invigorating for our editorial board and staff, as it required great coordination to ensure successful continuity in the production of our journal. It has been a pleasure working with an experienced editorial board and eager staff, who have been involved in all aspects of the journal, from reviewing and copyediting submissions to publicizing and reviewing applications for Forum staff and editorial board positions. I encourage all undergraduates who are interested, no matter your field of study, to apply for a position on the journal staff. As seniors graduate, this organization relies on an entering class of aspiring academics.

Lastly, I would like to emphasize the diversity of articles which can be found in this issue. Our journal covers such issues as evolution, inorganic chemistry, education, psychology, and international health. We are excited to work with the LS&A Themed Semester Committee focusing on evolution. With that, I invite you to enjoy the Forum and encourage you to actively participate in the creation of our journal. Thank you.

Sincerely,

Shailesh Agarwal
Editor-in-Chief
University of Michigan Undergraduate Research Forum

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Evolution: A Fundamental Theory for a Complete Science Education

BY *EMILY KENNY*

The Debate

In classrooms and courtrooms across the country, the teaching of Darwin's theory of evolution has been continually debated. Since Darwin published *The Origin of Species* in 1859, biological evolution has been challenged and resisted outside the scientific community. It has been largely creationists and, more recently, proponents of Intelligent Design who have been opposed to the theories of evolution (including natural selection). Unfortunately, most opponents of evolutionary theory lack a complete understanding of the boundaries of the theory as it applies to the scientific world; removing the topic from the public school classroom would compromise the comprehensive science education of our youth and perpetuate the misunderstandings that form the basis of the controversy. Furthermore, the argument that students need to be exposed to "all current theories" of the origins of life is inherently flawed, as the only scientifically accepted theory is Darwin's theory of evolution, and any theories including a creator or "intelligent designer" lie outside the realm of science.

Education

Legal conflicts regarding the teaching of evolution have recently popped up in states across the United States. In 2004, Ohio mandated plans encouraging teachers to offer aspects of Intelligent Design and definitions of the terms 'theory' and 'evolution' differing from the generally accepted definitions held by the scientific community.[1] Georgia and Alabama have placed disclaimers on all biology textbooks, stating "evolution is a theory, not a fact, regarding the origin of living things. This material should be approached with an open mind, studied carefully, and critically considered."[2] The local courts have ruled this label to be unconstitutional, but the decision is currently being appealed. Students in Dover County, Pennsylvania are required to learn Intelligent Design alongside evolution in their high school biology classes.[3] In a small southwestern Michigan village, two teachers quietly taught Intelligent Design, against state policy, in their science classes for two years, until a parent filed a complaint last fall.[4]

All of these events have attracted controversy, but perhaps the most famous event occurred in Kansas. The debate began in 1998, when the Kansas State Board of Education asked a committee of scientists and science teachers to revise the science standards for a statewide examination. The committee presented its standards, which included natural selection and Darwinian evolution; however, another board member presented a different set of standards written by Missouri creationists. When it was time to vote on the new standards, the Board demanded that the committee re-write some of the passages, glossing over most topics dealing with evolution, including "macroevolution," continental drift, the age of the earth, and the Big Bang. They also changed the definition of science from "the human activity of seeking natural explanations for what we observe in the world around us" to seeking "logical explanations," and changed the definition of a scientific theory from "a well-substantiated explanation" to just "an explanation." These changes allowed for science instruction compatible with creationism. Eventually, in 2001, these new standards were overturned, but after recent elections, the standards are under review for a second time.[5]

HIV and Natural Selection

Evolution is an essential concept to master for those interested in pursuing a science career. However, the topic also is important for non-scientists. When a doctor prescribes antibiotics to a patient, the patient is instructed to take them for the full course of the medicine, even if symptoms disappear. When people do

not finish these antibiotics, they contribute to the problem of antibiotic-resistant bacteria. It is important that people understand why they need to finish the prescription, and the health consequences when they fail to comply. One of the biggest health problems facing the world today is antibiotic-resistant Tuberculosis, caused by a failure to administer treatment properly.[5] Another important everyday application of evolution is in the understanding and treating of the AIDS virus. AIDS is one of the fastest evolving organisms on the planet, and it mutates so quickly that nearly every person who is infected has a unique strain of the virus.[5] This makes AIDS especially dangerous and hard to treat. A broad overview of evolutionary concepts is important for people who have AIDS or who are at risk for AIDS so that they can understand the nature of this disease.

High School Perspective

Within the history of science, the theory of evolution is one of the most simple and beautiful concepts of the last two centuries. It is also one of the most well supported and well-documented theories of science.[6] However, in a survey of high school-aged teens, only 37% thought evolution was "a scientific theory well supported by evidence." The same survey found that the percentage of adults who believed that same statement increased with education, the highest being adults with a postgraduate education (65% believe).[7] Even more surprising, these numbers have hardly changed in the last two decades. When including the same polls conducted in 1982, 1993, 1997, and 1999, at least 44% of the population has always supported the idea that God created humans, with no evolutionary influence.[6] This lack of support for evolution is due, in large part, to ignorance or misunderstanding of the scientific theory.

Evidence for Evolution

Evolution happens; this is a biological fact. Changes happen within populations over time; bacteria become resistant to certain toxins, birds' beaks differentiate to suit available food sources, etc. The theory behind evolution rests in the mechanism of the process, known as natural selection. It is based on three observable premises: all organisms produce more offspring than can survive, each individual in a species is unique (genetic variation), and some individuals are more suited to a changing environment than others are.[5] The theory of natural selection says that random genetic variation will sometimes produce certain traits (in size, shape, color, song, strength, etc.) that are more suited to a particular environment than others.

These advantageous and heritable traits increase the chances that the individual will survive long enough to reproduce and will have more offspring that survive to reproduce than other members of that species. Consequently, through many generations, the frequency of a desirable and heritable trait increases, and the species changes from what it once was. Changes within a species as well as the formation of new species occur by the same process, the only difference being the amount of time involved. Comparative anatomy, fossil evidence, comparative genetics, and numerous experiments performed on bacteria, guppies, birds, mice, plants, and other organisms, can provide evidence for evolution. As recently stated in *National Geographic*, "The evidence for evolution is overwhelming."[6]

Just a Theory?

In the vernacular, the term theory is often used to mean a rough guess or dreamy speculation. But in science, the term has a very specific definition: it is "an overarching set of proposals about some aspect of the universe whose explanation fits its evidence."[5] Theories need to be well documented, and most theories in a context outside the community of science are considered fact. Examples include: Newton's Theory of Gravitational Motion, Einstein's Relativity Theory, Copernicus' Theory that the Earth orbits the sun, and the existence of atoms and electrons, Atomic Theory. When someone calls evolution "just a theory," he or she is also calling these other examples merely theory. In the language of science, "theory" is a very substantial claim. Theories cannot be tested directly, but rather through experiments with falsifiable hypotheses - testable predictions about the specific application of a theory.[5] When a hypothesis generated by a theory

is found to be true, then theories are verified. Founded theories lead to new scientific discoveries and deeper truths about reality. Evolution is a fundamental theory of science; because of this, it is essential that it be included in a basic science course. Removing evolution from a biology curriculum would be like ignoring the force of gravity in a physics course.

Intelligent Design

Intelligent Design, however, does not stand the tests of science. It does not ask falsifiable questions, nor is it supported by scientific evidence. Proponents of Intelligent Design do not even agree on a unified proposal. What they agree on, however, is the need to find flaws in evolutionary theory. The main argument of Intelligent Design is that molecular life is "irreducibly complex" and, as such, could not be created by a mindless process such as evolution; rather, life could only be formed by a designer (the nature of the designer is left out of the theory).[8] This principle alone contradicts Darwin, who meant to show how amazingly complex features could be randomly selected with no end goal in mind. But Intelligent Design does not flatly reject evolution. Rather, it sidesteps the issue.

The main attack on evolution by Intelligent Design leaders is made by Michael Behe, a biochemist. He claims that there are molecules in living organisms that are irreducibly complex; in other words, if any structure of the cell is removed, the cell cannot function. Behe uses a classic evolutionary example—the eye. He believes that cells have come together independently to form the eye, but that the cells were already fully formed and did not evolve once they were together.[5] They could not have evolved, because all the parts are essential. Some intelligent power must have designed the cells. However, Behe's speculation can be proven wrong in the laboratory. Proteins in the cell often have similar structures and genes that code for them, and similar proteins with small variations can be seen in similar animals.

Another of Behe's examples is the "irreducible complexity" of blood clotting, where if one factor is removed clotting is blocked and the organism will bleed to death. Comparative anatomy shows that not all animals have the same clotting functions. Some animals, like starfish, do not have any clotting factors. Biologists have concluded that when mutations in proteins or other molecules occur, they usually perform other functions initially, but gradually become important and irreplaceable in a process. When Behe was confronted with this evidence, he admitted that he did not mean to say irreducibly complex systems could not evolve gradually. "I quite agree that my argument against Darwinism does not add up to a logical proof."[8]

Micro v. Macro

If one believes Behe's arguments, there is room for the position that people evolved from monkeys. Other variations on Intelligent Design exist. One school of thought accepts what they term "microevolution," or genetic changes within existing species, but refutes "macroevolution," or genetic changes that lead to speciation. However, as mentioned previously, in Darwinian theory, there is no such distinction. The two are part of the same process, the only difference being time. By accepting one, they automatically accept the other, whether or not they mean to.[1] Proponents of Intelligent Design often claim that fossil intermediates, like cow-whales or dinosaur-birds are never seen. However, these claims are made in ignorance of the fossil record. *Archaeopteryx* is a fossil who was found with half-dinosaur traits and half-modern bird traits. Several species of whales with some form of hind legs have been discovered, including *Dorudon*, the most whale-like with a detached pelvis.[6]

The appeal of Intelligent Design is that it seems like a reasonable compromise between science and religion. As such, it is an attractive idea for many people, but it is bad science. It can be argued that Intelligent Design is disguised creationism, which was banned by the courts in 1968 from being taught in public schools on the premise that it forces a religion on students.[5] Among scientists, who should be responsible for designing a science curriculum, there is no debate on the theory of evolution versus "other alternatives".

Intelligent Design is not a science and is not accepted by the scientific community. As such, it should not be included in a scientific curriculum.

Philosophy of Science

From another perspective, although Intelligent Design is not science, it does not mean asking such questions as "Why are we here?", "What is our purpose?", or "Is there a higher being?" is futile. However, such questions are outside the realm of science. The purpose of science is to explain processes that are observed in the natural world; questions about the supernatural are, by definition, above the laws of nature, hence beyond the scope of science. As Carl Zimmer explains in his textbook on evolution, "the scientific method does not claim that events can have only natural causes but that the only causes that we can fully understand scientifically are natural ones."[5] Religion and evolution are not mutually exclusive ideas; they merely belong to separate disciplines. Creationists and Intelligent Design supporters claim that evolution is propelled by atheists and is really a religious cult taught to innocent school children. What they fail to realize is that evolutionary scientists represent a variety of religious beliefs. While some scientists are atheists, many, including Darwin himself, are Christian, Jewish, or follow other religions. Of the five most influential evolutionary biologists of the last century, only one was an atheist. It is possible for scientists to agree on a scientific mechanism, even if they come from entirely different theological backgrounds.

Conclusion

At a time when ignorance of evolution has led politicians to try to alter textbooks and even change the definitions of science, it is important to educate the public on the simple, lucid scientific truth. After all, the aim of the public school system science curriculum is to teach science.[9] People may come to their own conclusions on spiritual origins, but they need to be informed of real science, as well as the limited scope of science. Instead of placing labels on textbooks warning of "holes" in evolutionary theory, maybe a more accurate label would read, "While well-tested theories like evolution and the Big Bang have provided remarkable new insights and predictions about nature, questions of purpose that may underlie these discoveries are outside the scope of science, and scientists themselves have many different views in this regard."[10]

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Dr. Andrew J. Haig
International Disability: A Growing Epidemic

INTERVIEW BY *ADIL KHAN*

This past summer Adil Khan, who is majoring in Biopsychology and Cognitive Sciences, studied as a research assistant at the University of Michigan's Spine Program. Mr. Khan was offered this opportunity through the Summer Clinical Research Apprenticeship Program (SCRAP) of the University of Michigan Medical School. Dr. Andrew Haig, a prominent physician in the field of Physical Medicine and Rehabilitation, mentored Adil through his experience.

Adil worked with Dr. Haig in the on-going development of LIFE (Language Independent Functional Evaluation), a computerized tool used to assess disabilities in developing countries. Together, they developed the LIFE tool and assessed its validity compared to published industry standards (Barthel Index, circa 1965). They developed the evaluative tool to address the needs of developing countries and ensure its marketability. By means of LIFE, Dr. Haig's team sought to measure the rates of disability and to develop a model for implementation of rehabilitation infrastructures in developing countries.

Adil took the opportunity to interview Dr. Haig and gain an in-depth understanding of disability with a global perspective.

Adil: What is the clinical definition of disability?

Dr. Haig: A disability is the inability to do an activity that the average person is capable of. Disability is not a good term, because everyone has certain strengths and weaknesses and these are not the same for anyone. Professional athletes can have a disability and still perform above average activities. Rehabilitation medicine's job is to optimize a patient's ability to do daily activities that are specific to his or her lifestyle.

A: What can cause disability?

H: There are many different ways a person can become disabled, but frequently it is the result of spinal cord injuries, strokes, congenital defects, neurological problems, amputations and even arthritis.

A: Among these, which do you deal with often?

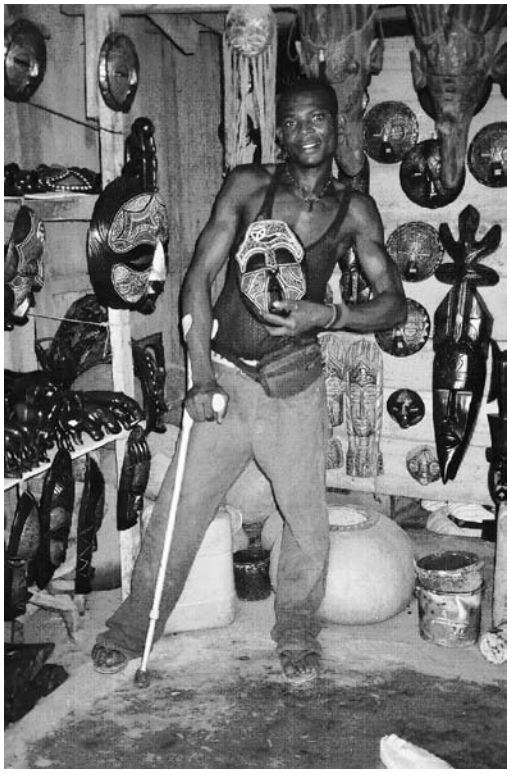
H: In my clinical practice, I mainly deal with spinal cord disorders and diagnose nerve disorders causing disability.

A: How do we evaluate disability?

H: There are two different ways; First, as a doctor we ask the patient questions about what the patient wants to do and match that with what they are physically capable of doing. This complex process involves treating the patient with a team of experts to determine how he or she will be able to accomplish their desired tasks. The team varies but often includes other doctors, physical therapists, occupational therapists, psychologists, exercise specialists, orthotists and even speech therapists. Secondly, from a public health standpoint,

disability is measured by means of a set of standardized scales and questionnaires designed to evaluate mass populations. The problem with this method is that it only measures general abilities and ignores activities important to the individual.

A: Why is international disability a problem?
H: People all over the world have disabilities, but in developing countries, a higher percentage of the population has some type of disability. There are little to no rehabilitation infrastructures to treat people with disabilities. People always think about popular diseases like AIDS, because in terms of mortality, it is devastating, but from a public health perspective, dying is relatively inexpensive. The real cost occurs when living people are unable to support themselves and fulfill their life roles due to a disability. This is a more significant problem in developing countries, which have little funds to disperse for health care and rely on support from other world agencies. While both [AIDS and disabilities] are huge problems, diseases like AIDS get disproportionate attention as compared with international disability.



A: Approximately how many people are affected by disability worldwide?
H: A good approximation would be about 10% of the world's population. Only a few percent of these get adequate rehabilitation for their affliction.

A: What is being done to combat this?
H: Right now, almost nothing. The tsunami of 2005 and the disaster in New Orleans [Hurricane Katrina] all are huge recent crises. However, a strategic plan for the rehabilitation of those affected has never been brought up as an integral part of recovery from these disasters. This is because the majority of the agencies involved are interested in heroic actions and immediate results.

A: Where are your interests focused in internationally?
H: My interests are in changing rehabilitations efforts all over the world, but strategically, I must first develop some models for other countries and agencies to follow. Half of my time is used in organizing efforts, ideas and experts to develop a practical model to be implemented and the other half is working with doctors in Ghana to develop their first national rehabilitation hospital, and collaborating with a NGO [Non-Governmental Organization] to build a rehabilitation center in Pune, India.

A: How did you get started with this type of work?
H: The first step was my training to become a doctor in medical school and completing a three-year residency in Physical Medicine and Rehabilitation. After some years in a private practice, I joined the University of Michigan faculty to combine research with my clinical work. A couple of years back, I spent a year overseas looking at the needs for rehabilitation and ways that people become successful leaders. Most Americans think that we can help by just showing up some place and volunteering, but that never works for a long-term solution. The only way to sustain an international rehabilitation program is to have people in all countries be experts in their field, and having the backing of competent leaders who understand the specific needs of their country. In Ghana for example, there is not a single doctor trained to understand strokes and disability, so there is a definite lack of expertise across the world.

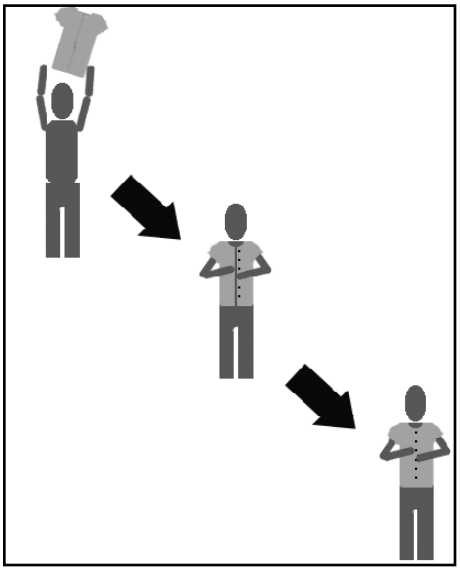
A: What can students do to help out with this cause?
H: Two things, first is to advocate awareness for rehabilitation. This can be done by anyone, from an English major writing a piece on international rehabilitation, to an engineer using universal design to provide accessibility for people of all abilities, to people involved in policy assuring that policies do not assume that everyone is able bodied. Lastly, we recently started an organization of Rehabilitation Doctors International and we are looking for any way people can help us with fundraising for our endeavors.

A: Are there specific areas in the world especially affected by disability?
H: Yes, almost all of sub-Saharan Africa has a huge disproportionate amount of disability and almost a complete absence of rehabilitation. Many war torn countries around the world have many landmine victims without an infrastructure for rehabilitation.

A: What is LIFE?
H: Life stands for Language Independent Functional Evaluation. This is basically a non-verbal animated version of the Barthel Index, a standard scale used to measure disability. It was developed this summer by a team of doctors, medical students and undergraduate students. Since the invention of written word, we have looked at measurements as responses to written questionnaires, and this does not address language and literacy concerns. Function is a motion and language is unnecessary as a method to convey motion. Computer technology allows others to visualize the basic movements we want to convey and allows us to bypass using a language for communication.

A: What are some of the goals LIFE set out to accomplish?
H: We would like to establish a tool to measure disability without bias or prejudice towards certain levels of education or language. When we give countries a tool to measure disability, and they discover that it is indeed a problem, then they are less likely to ignore the personal and economic impact of disability.

A: Are there similar technologies out there?
H: I have seen nothing similar to this; it has never been done before.



A: Where do you see international disability in 10 years? Is it a good or bad forecast? Why?
H: It is a great forecast. My colleagues and I are teaching doctors around the world to be experts and leaders and [we] will begin to teach politicians and companies about the seriousness of disability. These people will in turn teach citizens of their country that dealing with people with disabilities is cost effective.

A: Do you think this problem is being addressed thoroughly in today's medical society?
H: It is absolutely being ignored, most of the doctors in the world were trained that their only job was to treat diseases, not to optimize [bodily] function. So they feel that they are off the hook when they have prescribed all their drugs. Today, in most countries, disabilities are seen as a death sentence. There is no future for that person to live. We need to change that.

A: What can be done to increase awareness of this growing problem?
H: Most importantly is that people who have disabilities themselves must be very open and vocal to the world about their disabilities and their accomplishments. In much of the world, being disabled is considered taboo and people are often shunned in their communities. Doctors who are trained with a proper rehabilitation infrastructure need to organize and do some strategic planning as to how to deal with this problem.

A: Do you have any inspirations that led you to work on international disability?
H: Two instances come to mind. My wife is a speech pathologist and after coming back from her work in Haiti, she was very angry and frustrated with the amount of untreated disabilities there. Knowing that there was hope for them but hearing about their desperate situations led me to think outside of our country in terms of my profession. Another instance is when my brother, who is a world-class athlete and a wheelchair user, came back from working with the Dalai Lama in India with brilliant ideas about how to change problems afflicting the world.

A: Do you have any personal anecdotes or stories that are relevant, that you would like to share?
H: There is the true story of Emmanuel Yeboah, who is a national hero in Ghana because he rode across the country in a bicycle even though he is a leg amputee. He is giving a voice to all the disabled people of Ghana and giving them hope. They are making a movie about his life and Oprah Winfrey is helping him build a national rehabilitation infrastructure in Ghana.

Acknowledgements
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Staff at Spine Program

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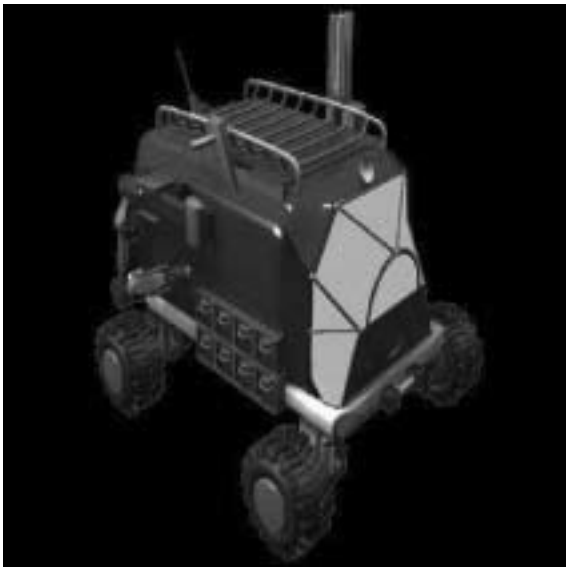
The Michigan Mars Rover Team

BY *MATTHEW VAN KIRK*

Since NASA unveiled its Vision for Space Exploration in February 2004, research into planetary technologies for use on the Moon and Mars has become increasingly popular. Surface vehicle technology, from robotic exploration rovers to crew transport and construction vehicles, is particularly important to NASA's plan. Engineers are already working on designs that will be used on missions 20 years from now. One group already contributing to the engineering effort, which will eventually send humans to Mars, is the University of Michigan Mars Rover Team.

The Michigan Mars Rover Team was created in March 2000 with two goals: to design, build, and test prototypes of a pressurized rover for human missions to Mars and to inspire and educate students about space and Mars exploration. Since its creation, the team has been led by and composed of students at the University of Michigan. Most team members are undergraduates in the school of engineering, and all volunteer their time to work on the project.



Formation of the Mars Rover Team occurred after a group of students submitted an entry to a pressurized rover design competition sponsored by the Mars Society. With its design, the Michigan team won the competition, which received entries from across the country, and won the chance to build a prototype Mars rover.

Initial Mars Rover Concept

Construction of the team's rover prototype began with several mock-ups. Using simple cardboard, paper and plywood, the team was able to make several design decisions and changes. Following the mock-ups, the Mars Rover Team began work on its first full-scale, operational prototype rover, Everest. This vehicle was based on an FMTV (Family of Medium Tactical Vehicles) flatbed cargo truck, donated by the U.S. Army - TACOM. The team removed the flatbed of the truck and added a living cabin onto the frame rails. Since construction began, Everest has gone through several iterations of interior design, increasing in fidelity each time.

After construction of Everest was completed in the summer of 2003, the vehicle was shipped to the Mars Desert Research Station (MDRS) in Utah where it was used in the world's first prototype rover testing. Everest enabled the crew at MDRS to test mission scenarios, exploration strategies, and equipment options during long distance exploration missions. While at MDRS, Everest was able to support three crew members for full-simulation missions of up to 500 miles round-trip.

Everest Rover at MDRS

With the lessons learned researching and building Everest, the Mars Rover Team submitted two papers to the American Astronautical Society for publication in 2003. One paper related to Everest and the design and construction of analog rover prototypes. The second was based on the team's theoretical research into

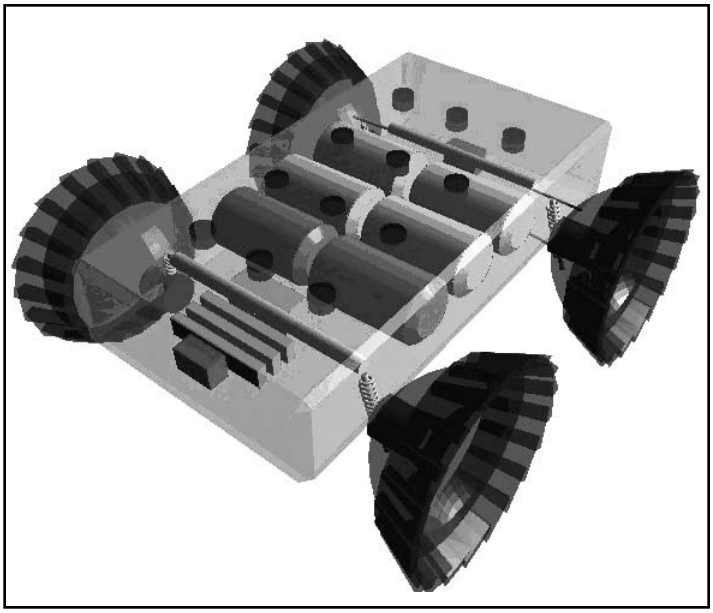
power systems of pressurized Mars rovers. Both of the papers can be found on the team's web site.

In addition to construction and testing using Everest, the Mars Rover Team has also continued theoretical research into future planetary vehicles. In recent semesters, students have worked to design specific rover subsystems such as airlocks, sample collection and storage systems, and fuel tanks. From these semester projects, the Mars Rover Team submitted a white paper to NASA in 2004 titled "Surface Mobility Technology Development: Pressurized Mars Rovers." In the paper, the team highlighted its research and proposed directions for future research of different rover components such as power, mobility, and thermal regulation systems. The white paper is also available on the team's web site.

Most recently, the Mars Rover Team began work on a concept called the "Universal Chassis" for modular ground vehicles. This concept uses a modular approach to simplify the design and production of planetary vehicles. Each vehicle needed for a Lunar or Martian mission would be based on a particular class of chassis, which would provide the power, structural support, mobility, and computing systems for the vehicle. The chassis would support payload modules specific to a vehicle's desired task. For example, the same large chassis would support a pressurized living module for crew exploration missions or a construction module with a crane or backhoe.

Universal Chassis Concept

To develop this concept, the Mars Rover Team identified the different vehicles and capabilities that will be required for surface exploration of the Moon and Mars. Team members then classified these vehicles into three categories (small, medium, and large) based on their total mass and energy requirements. A complete definition of modularity and the Universal Chassis concept followed, from which the team identified six technologies that will be necessary for the concept to be successfully implemented. Each of the six technologies, interfaces, mobility systems, electronic drive control, hub motors, computing and autonomous navigation, and fuel cells, is currently under development in the automotive industry. The team concluded that these emerging technologies could be applied to planetary vehicles to reduce the cost of surface mobility for planetary missions.



After researching and developing the Universal Chassis concept during the Fall 2004 and Winter 2005 semesters, the team presented its designs in May 2005 at the Revolutionary Aerospace System Concepts - Academic Linkage (RASC-AL) forum sponsored by NASA. The concept won a prestigious second place among more than 20 other undergraduate teams at the RASC-AL forum. The report and appendices from RASC-AL are available on the team's web site.

The Team

Currently, the Mars Rover Team continues to work on the Universal Chassis project in hopes of developing more detailed designs. This semester, team members are researching the mobility of vehicles based on the Universal Chassis in much greater detail to confirm the concept's usefulness. The primary goal of this research is to create high-fidelity computer models of the Universal Chassis with several different suspension and wheel options. The models will be analyzed for a variety of mobility characteristics such as maximum slope of climb and descent and radius of turn. In addition, the computer models will help enable analysis of weight and load distribution requirements and susceptibility to damage. Based on these analyses, team members will determine the optimum configurations for Universal Chassis vehicles. Along with mobility, the team continues to research the interfaces between chassis and payloads. Based on factors such as simplicity of connection, susceptibility to dust and temperature damage, and reliability, the team will choose the best system for connecting modules to the Universal Chassis. Because of these current projects, the Mars Rover Team will develop a more detailed Universal Chassis design and plan of operation.

The Michigan Mars Rover Team also remains committed to its goal of inspiring and educating students about space and Mars exploration. The Everest rover has now become a teaching vehicle rather than a research vehicle. Team representatives have been on hand with Everest at numerous science events at the University of Michigan, including the Sally Ride Festival and Great Space Adventures sponsored by the Michigan Space Grant Consortium. The Mars Rover Team has also taken Everest to many local schools to generate excitement about space exploration. This year, the team is sponsoring its second rover design contest for Michigan high school students to inspire the next generation of engineers.

If you would like more information about the Michigan Mars Rover Team or its research, please visit the team's website (www.umrover.org) or e-mail rover@umich.edu.

Team Members at RASC-AL Forum. From Left to Right: Frant Sobolic, Christine Kryscio, Matthew Van Kirk, Eric Nytko, Ilya Wagner, Chad Rowland.

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Stepping Away from Evolution: A Study of Heterosexual and Homosexual Mate Preferences and their Link to Society

BY *JULIA HEMING, DORY GANNES, AND CAROLYN NISHON*

Abstract

This study examined the mate preferences of both heterosexual and homosexual males and females to extend previous research, which focused on heterosexual populations, to homosexual populations. The study showed strong support for a model that states that humans prefer evolutionarily relevant mate characteristics in amounts relative to their own personal perceived endowment of the same attributes. By questioning 449 heterosexual and homosexual residents of Ann Arbor, Michigan on their own attributes and the attributes of a potential mate, the study found that both populations supported the "likes attract" model. This provides evidence that regardless of sexual preference, individuals living in the same society follow similar human mate choice models.

Introduction

Biologists and psychologists have examined human mate choice using evolutionary theory and the process of natural selection. Since mate choice affects the genes passed on to future generations, characteristics used in mate choice indicate an evolutionary advantage. However, the evolutionary approach does not seem readily applicable to homosexual relationships. With heterosexual couples, children are the product of both partners' genetic makeup, whereas with homosexual couples, children's genes can be derived from only one partner. Thus, the child of a homosexual couple would not receive the "evolutionary advantage" of mate choice.

Increasing discussion on the lesbian, gay, bisexual, and transgender community has generated questions about the effect of human mate preferences. It is therefore necessary to investigate the similarities and differences between heterosexual and homosexual mate preferences in order to understand the implications of preferences that do not directly affect the process of natural selection. One of the earliest and most influential papers on mate preferences in general was written by Robert L. Trivers.[1] While Trivers addressed the mate preferences of any sexually reproducing species, his ideas are nevertheless useful in assessing the history of human mate preference models. Trivers' study promoted the theory of parental investment – the idea that the biological manner in which both males and females contribute to the reproductive process affects their choice of mate.

Trivers wrote that as females have a limited number of eggs that they can produce, their primary concern is to gain resources for those eggs and future offspring. In contrast, males can fertilize many eggs because of the rapid production of sperm. As a result, Trivers found that males' major concern was gaining access to the maximum number of eggs possible. These differences in reproductive potential lead to differences in parental investment, which in turn lead to a different set of preferred traits for each gender. The study found that "males tend to be limited by their access to fertile females while females are limited to the resources that they need to nourish their offspring."[1] As a result, females generally look for traits such as wealth, status, and family commitment – indicators of their mate's willingness to provide resources for their future offspring. On the other hand, the study found that males prefer aspects such as health, physical

attractiveness, fertility, and sexual fidelity – factors that would affect the male's reproductive success.

To further develop Trivers' model, Alan Feingold wrote that while women can give birth to only a certain number of children, men can inseminate as many women as they choose, with little time investment relative to women.[2] This may suggest something about the intentions of heterosexual males when seeking a mate: do heterosexual males find it less important to be faithful to their mates because they do not have to invest as much time? We may question whether, simply due to biological reasons, men are more likely to have casual relations with many women instead of having an exclusive relationship.[3] Homosexual couples, on the other hand, cannot combine their genes to create offspring using current reproductive technologies. Do homosexuals prioritize fidelity differently than heterosexuals?

Heterosexual Mate Preferences

Following Trivers, other studies have shown the importance of self-perception in determining heterosexual mate preferences. David Waynforth and R.I.M. Dunbar's study examined the "Lonely Hearts" columns – classified ads seeking partners – of four United States newspapers to see what kind of preferences the heterosexuals showed.[4] The study found these newspaper advertisements to be the most telling, as they showed the people's ideal choice, whereas actual relationships could involve a great deal of compromised preferences. The study compared the advertisers' descriptions of themselves with their preferences in mates. The basis of the hypothesis was that the more a subject has to offer, the more he or she can demand in a mate. Waynforth and Dunbar's study supplied a multitude of hypotheses about the preferences of older men, younger women, and financially independent men and women – groups that society perceived as having the most to offer mates. The most interesting finding, however, was that mate preferences were conditional – as women age, their reproductive potential declines, and they demand less in their mates. However, as men age and become more stable in wealth and status, they demand more in their mates. These conditional preferences showed that self-perception is a key factor in heterosexual mate choice.

Anthony C. Little's study on mate choice also indicated a correlation between self-perceptions and specific mate preferences.[5] The study required female subjects to rate themselves on physical attractiveness and then construct the ideal male face for a mate using computer programs. Inherent in this study was the assumption that the females tested were heterosexual. The study found that the self-rated physically attractive females found males with masculine and symmetrical faces to be attractive in a long-term relationship. Little's study suggests that symmetrical and masculine faces are indicators of useful evolutionary genes. Other studies have suggested that facial symmetry shows an ability to resist disease while masculinity of a male's facial structure is indicative of male virility. That self-perceived attractive females showed preferences for these characteristics speaks for the conditionality of mate preference among heterosexual females.

Likes Attract Model

Building upon this research, Peter Buston and Stephen Emlen's study on mate preferences placed all heterosexual preferences within one model.[6] Seeing that preferences were conditional, the study found that mate choice follows a "likes attract" model. This meant that heterosexual males and females found specific traits attractive if they felt that they were themselves well endowed with those traits. The study looked at evolutionarily relevant categories such as physical appearance, wealth and status, family commitment, and sexual fidelity. Buston and Emlen found that participants who rated themselves highly in one of the categories also had a high preference for a high rating in that same category for a potential mate. Elizabeth Epstein and Ruth Guttman also found evidence for similar mate preference models by contending that heterosexuals do indeed seek those who have similar characteristics such as intelligence levels, attractiveness, personality (extroverted/introverted), and socio-cultural status.[7]

Social Forces

With evidence pointing towards the importance of self-perception in mate preferences, one must examine the source of these self-assessments. Several studies have found that the culture in which we live shapes our self-perception and the context in which we place ourselves. A study by Jonathon D. Brown *et al.* placed subjects in various social environments and asked them to rate themselves on physical attractiveness. The findings suggested that individuals changed their self-concept based on the people surrounding them. The results showed that the social forces present in the subjects' environments and the effects of Western culture and society contributed to the molding of the self-concept both positively and negatively.[8] This research leads us to predict similarities in self-perceptions, and therefore mate preferences, of both heterosexuals and homosexuals, as both live in one society.

Homosexual Mate Preferences

While many of these studies have supplied information on heterosexual mate preferences, it is difficult to know if we can apply these ideas to homosexual preferences. Pamela C. Regan's study on the mate preferences of male and female homosexuals provides a background on which to build.[9] Approaching the field from a psychological perspective, Regan found that homosexual males and females differentiated between preferences based on whether they were looking for a short-term sexual partner or a long-term romantic partner. When a group of 80 homosexual males and females were asked about their preferences on the physical, emotional, and social fitness of their mates, their answers varied based on the type of relationship for which they were searching. Physical fitness was preferred in a short-term sexual partner, while the other preferences were looked for in a long-term romantic partner. While this is interesting and provides insight into the mate preferences of homosexuals in general, what is perhaps most useful are the similarities between the findings of this study and that done on heterosexuals.[10] This implies that the mate preferences of homosexuals and those of heterosexuals have the potential to follow the same models.

Additionally, there has been some research done regarding the preferences for attractiveness of heterosexual and homosexual males and females. In one study by Zebulon A. Silverthorne and Vernon L. Quinsey involving homosexual and heterosexual males and females, results showed that there were "different age and sex facial preferences among the four sex-orientation groups and differences in the response to facial pictures of different ages within each of the sex-orientation groups."[11] With this in mind, our study aims to replicate the findings of Buston and Emlen, seen as the most recent research on heterosexual preferences, and to extend the research to homosexual males and females. By looking at the same evolutionarily relevant categories – physical appearance, wealth and status, family commitment, and sexual fidelity – this study discusses the possibility that heterosexuals and homosexuals living in one society follow the same mate preference model.

Methods

We distributed surveys on mate preference and self-perception to both heterosexuals and homosexuals within the University of Michigan campus in Ann Arbor, Michigan. Four-hundred-fifty-two individuals completed the two-part questionnaire. Questionnaires from three individuals were not included in analyses because these individuals failed to complete the self-perception questions. Ninety-five percent of the respondents were in the 17-25 age bracket and five percent were in the 26-50 age bracket.

Surveys were distributed randomly in the center of the University's campus on three separate days. We collected additional surveys by soliciting participants of various campus organizations and attending local campus events. Participants were asked to indicate their age, gender and sexual preference. The questionnaire contained two sections: one on mate preference and the other on self-perception. The mate preference section consisted of twenty questions, each highlighting a different attribute. The twenty attributes were derived from four evolutionarily relevant categories; the categories were wealth and status, family commitment, physical appearance, and sexual fidelity. The respondent was asked to rate the importance of each attribute in a potential partner using a nine point scale (one = not at all important, nine = extremely important.) Each category was represented by five questions spread out within

the mate preference section of the survey. In the section on self-perception, the questionnaire listed twelve attributes, with three from each evolutionary category. Here the respondents rated themselves as potential partners on the same nine point scale (one = low, nine = high.) To analyze the participant's responses we calculated mean scores for overall mate preference (based on 20 items) and the overall self-perception sections (based on 12 items). We also calculated mean scores for each evolutionarily relevant category for mate preference and self-perception sections.

Group	Sample size	F statistic	df	P value	R^2	Regression type
Male heterosexuals	171	20.83	170	<0.0001	0.198	linear
Male homosexuals	35	19.87	34	<0.0001	0.375	linear
Male bisexuals	10	51.72	9	<0.0001	0.866	linear
Female heterosexuals	189	109.45	188	<0.0001	0.369	linear
Female homosexuals	23	14.58	22	<0.0001	0.593	second order polynomial
Female bisexuals	21	1.63	20	0.217	0.079	linear

Table 1: Summary table of regressions of overall mate preference score on overall self-perception score for each gender and sexual orientation group.

We analyzed the data using linear and second order polynomial regression analyses; separate analyses were performed for each gender and sexual orientation combination. We tested the hypothesis that the self-perceptions of both heterosexuals and homosexuals would be the basis of the mate preferences of these same individuals. The two different mechanisms we looked at were the "reproductive potentials attract" model and the "likes attract" model. The "reproductive potentials attract" model hypothesizes that one is attracted to a mate that has a similar reproductive potential. Past studies of heterosexuals have indicated that a woman who has a fecundity of "X" degree is attracted to a man with comparable wealth of "X" degree. For example, women who perceive themselves to be on the higher end of the spectrum in terms of physical appearance and sexual fidelity will emphasize the importance of wealth and status and family commitment in a potential long-term male partner. Similarly, men who think that they are on the higher end of the spectrum in terms of wealth and status and family commitment put higher emphasis on physical appearance and sexual fidelity in a long term female partner.

Self-preference scores	Wealth & status	Family commitment	Physical appearance	Sexual fidelity
Wealth & status	6.06	26.51	18.63	0.916
	0.0149	**<0.0001**	**<0.0001**	0.339
	0.034	0.136	0.099	0.005
	0.186	0.368	0.315	0.073
Family commitment	2.02	94.64	4.01	7.38
	0.156	**<0.0001**	0.047	**0.007**
	0.011	0.359	0.023	0.042
	0.109	0.599	0.152	0.205
Physical appearance	3.52	10.38	50.44	3.24
	0.062	**0.0015**	**<0.0001**	0.074
	0.02	0.057	0.229	0.019
	0.143	0.241	0.479	0.137
Sexual fidelity	0.817	41.69	0.036	8.24
	0.367	**<0.0001**	0.85	**0.005**
	0.005	0.198	0.0002	0.046
	0.069	0.445	0.015	0.216

Table 2: Summary of outcome of linear regressions between categorical self-perception scores and mate-preference scores for all combinations of relevant categories for heterosexual males; light shading indicates predicted associations of "reproductive potentials attract" model while the dark gray shading along diagonal indicates predicted associations of "likes attract" model.

Results

Both male and female respondents who rated themselves highly were more selective in their mate preferences. For both sexes, there was a significant relationship between overall self-perception score and overall mate-preference score. When we analyzed the data by gender and sexual orientation, there were significant relationships between self-perception scores and mate-preference scores for all groups except bisexual women, who were not analyzed further (Table 1). Below, we examine the data further by assessing whether the "reproductive potentials attract" or the "likes attract" model provides a better fit.

If the "reproductive potentials attract" model fits the data, we would expect a significant relationship between the male self-perception score in the wealth and status category and the mate preference score in the physical appearance and sexual fidelity categories. We found that there was a significant relationship between male wealth and status and female physical appearance but not female sexual fidelity (Table 2). In contrast, the "likes attract" model would predict relationships between self-perception scores and mate preference scores in all four evolutionarily relevant categories and that is what we see. Moreover, the R^2 values (which explain how much of the variation in the data is explained by that factor) are higher for the "likes attract" model (Table 2). Thus far, our results match those of Buston and Emlen's study of a college age population in Ithaca, NY.[6] The results for homosexual males matched those for heterosexual males, with the "likes attract" model fitting the data better (Table 3). For bisexual males, there was no support for the "reproductive potentials attract" model but there was support for the "likes attract" model for three out of the four categories (Table 4). There was, however, no relationship between self-perception score on physical appearance and mate-preference score on physical appearance.

Self-preference scores	Wealth & status	Family commitment	Physical appearance	Sexual fidelity
Wealth & status	13.03	5.89	11.94	0.495
	0.001	0.021	**0.001**	0.486
	0.283	0.152	0.266	0.014
	0.532	0.389	0.516	0.122
Family commitment	3.053	45.74	1.41	5.72
	0.089	**<0.001**	0.243	0.023
	0.084	0.568	0.012	0.148
	0.291	0.762	0.203	0.384
Physical appearance	8.13	0.317	16.608	0.17
	0.008	0.577	**0.0003**	0.683
	0.173	0.009	0.335	0.005
	0.445	0.098	0.579	0.072
Sexual fidelity	1.93	0.604	0.003	9.46
	0.175	0.443	0.957	**0.004**
	0.055	0.018	-0.03	0.199
	-0.235	0.134	-0.009	0.472

Table 3: Summary of outcome of linear regressions between categorical self-perception scores and mate-preference scores for all combinations of relevant categories for homosexual males.

When we consider female heterosexuals, we find support for both the "reproductive potentials attract" and the "likes attract" models, however the "likes attract" model explains more of the variation in the data (see higher R^2 values, Table 5). This is in line with Buston and Emlen's study of undergraduates at Cornell University.[6] The data from homosexual females is strikingly different – there is no support for the "reproductive potentials attract" model and the "likes attract" model does not fit the data that well either (Table 6). There are strong relationships between self-perception scores and mate preference scores on family commitment and physical appearance (explaining 67% and 53% of the variation, respectively), but not on the other two evolutionarily relevant categories.

Discussion

Throughout our study of heterosexual and homosexual males and females, we looked for evidence to support previously discussed models. The "reproductive potentials attract" model and the "likes attract" model, discussed

by Buston and Emlen in previous studies, lay out patterns of similarities between individuals' self-perception and their perceptions of potential long term mates. In extending the population studies to include homosexuals, results showed strong support for the "likes attract" model. The "likes attract" model indicates that an individual finds characteristics to be important in a potential mate if he or she perceives himself or herself to be well endowed with those characteristics. Our study found the most evidence to support this model.

The idea of self-perception in mate choice is not a new topic of discussion. Wayneforth and Dunbar found that self-perception was important by examining "Lonely Hearts" advertisements and finding that the more a subject perceives that he or she has to offer, the more he or she can demand in a mate. Little's study furthered this idea of self-perception by finding that women who found themselves to be sexually attractive held preferences for men with purported useful genes. Buston and Emlen found the most evidence for the "likes attract" model and thereby added to the scientific evaluation of self-perception in mate choice. In extending this research to the homosexual community we found support to suggest a correlation between the mate preferences of the five gender and sexual orientation groups. Brown's study stated that individuals living within one society would form similar self-conceptions. Our study was designed to find support for either the "likes attract" or "reproductive potentials attract" models for both the heterosexual and homosexual populations.

Self-preference scores	Wealth & status	Family commitment	Physical appearance	Sexual fidelity
Wealth & status	11.903	3.51	1.93	3.13
	0.0087	0.098	0.202	0.115
	0.598	0.304	0.195	0.281
	0.773	0.552	0.441	0.53
Family commitment	0.397	32.97	0.982	5.63
	0.546	**0.0004**	0.351	0.045
	0.047	0.805	0.109	0.413
	0.217	0.897	-0.331	0.643
Physical appearance	2.36	0.966	2.771	0.75
	0.161	0.354	0.135	0.412
	0.23	-0.003	0.257	0.086
	0.479	0.328	0.507	0.293
Sexual fidelity	1.53	13.22	0.299	30.73
	0.251	**0.007**	0.6	**0.0005**
	0.161	0.623	0.036	0.793
	0.401	0.789	-0.19	0.891

Table 4: Summary of outcome of linear regressions between categorical self-perception scores and mate-preference scores for all combinations of relevant categories for bisexual males.

Similar to Buston and Emlen's study, our results showed some evidence to support the "reproductive potentials attract" model. If the male heterosexual population were to follow this model, the individuals would show similar numbers within their self-perceptions of wealth and status and the importance rating of physical appearance and sexual fidelity in a potential mate. While the statistical analysis showed support for the physical appearance category, this did not hold true for the sexual fidelity category. Male homosexuals had similar results - physical appearance fit the "reproductive potentials attract" model, but there were conflicting results for the sexual fidelity category.

Though female heterosexuals showed the strongest support for the "likes attract" model, there was still evidence to support the "reproductive potentials attract" model. Under this model, females who rated themselves highly in the physical appearance category would be expected to similarly rank their potential mates highly in the wealth and status and family commitment categories. Our data supported this hypothesis in addition to supporting the "likes attract" model. Female homosexuals did not fit the "reproductive potentials attract" model.

All gender and sexual orientation combinations showed at least partial support for the "likes attract" model. When we consider heterosexual males, the only evolutionary category that did not provide strong support for the "likes

Self-preference scores	Wealth & status	Family commitment	Physical appearance	Sexual fidelity
Wealth & status	41.12	21.76	43.67	18.35
	<0.0001	**<0.0001**	**<0.0001**	**<0.0001**
	0.201	0.104	0.185	0.089
	0.449	0.323	0.435	0.299
Family commitment	9.85	186.38	6.38	9.63
	0.002	**<0.0001**	0.012	**0.002**
	0.05	0.499	0.033	0.049
	0.224	0.707	0.182	0.221
Physical appearance	43.33	20.33	80.71	16.382
	<0.0001	**<0.0001**	**<0.0001**	**<0.0001**
	0.188	0.098	0.301	0.081
	0.434	0.313	0.549	0.284
Sexual fidelity	1.41	8.56	0.145	22.44
	0.236	**0.004**	0.703	**<0.0001**
	0.007	0.045	0.0007	0.107
	0.087	0.209	-0.028	0.327

Table 5: Summary of outcome of linear regressions between categorical self- perception scores and mate-preference scores for all combinations of relevant categories for heterosexual females.

attract" model was the wealth and status category. Heterosexual males seemed to follow societal norms in their ratings regarding wealth and status. Although they gave themselves a high rating in the category, they gave their partners a low rating. This supports the notion that men are traditionally responsible for wealth and status. However, all other categories support the "likes attract" model.

With homosexual males, the results consistently followed the "likes attract" model. Support for this model indicates similarities between the heterosexual and homosexual populations coexisting in the same society. Strong evidence supporting the "likes attract" model within the wealth and status category of the homosexual population may indicate a relationship in which one partner is not heavily dependent on the other; we did not see this in the heterosexual male population.

Our results showed strong evidence for the "likes attract" model with the female heterosexual population as well. These results concur with Buston and Emlen's studies of the heterosexual women.[6] Homosexual females did not specifically coincide with one of the two models; however, there was stronger support for the "likes attract" model. Why are there strong relationships between self-perception scores and mate preference scores on family commitment and physical appearance but not on the other two evolutionarily relevant categories? This is a topic for future study.

This study moves away from the "reproductive potentials attract" model and towards the "likes attract" model. This movement is important because it illustrates a shift in mate preference models. Past studies have focused on the perspective that humans were most concerned about maximizing their reproductive success, and therefore, placed the most importance on seeking characteristics in a potential mate that may not have been the most compatible for their personal relationship with each other. Buston and Emlen's formulation of the "likes attract" model modified this view by stating that reproductive success would be maximized not by picking partners with the highest reproductive potential but by picking compatible partners and thus creating a stable relationship that would maximize the number of offspring.

In Western society today, cultural evolution, rather than biological evolution, may be influencing mate choice as people are placing more value on the stability of the pair bond itself instead of on the success of future generations. We can see this in both the heterosexual and the homosexual populations, where partners are making the decision to adopt a child and forego the opportunity to pass on their own genes or choosing not to have children at all. Now that the focus of partners is shifting over to interpersonal relationships, natural selection against individuals who cannot procreate is no longer a limiting factor. The results of this study show that increased emphasis is on seeking

compatibility with a potential mate.

The goal of this study was to look at a population that was not homogenous and included a more representative sample of sexual orientations within our society. Evolutionarily speaking, the homosexual population is unique because mates cannot both contribute genetically to their offspring. This concept leads us to question whether this population has the same mating preferences as the heterosexual population that is ruled by the desire to pass on the most evolutionarily advantageous traits. The support for the "likes attract" model within the homosexual male population speaks for the argument that sexual preferences run along societal lines. Even within the female homosexual population (the category that showed the least support for the "likes attract" model), we still found that the "likes attract" model is applicable to a certain degree. From this, we can acknowledge that members of our society assess themselves and their potential mates in similar ways regardless of sexual orientation.

Self-preference scores	Wealth & status	Family commitment	Physical appearance	Sexual fidelity
Wealth & status	0.008	6.46	2.93	0.263
	0.93	0.02	0.104	0.61
	0.0004	0.264	0.14	0.014
	0.021	0.514	0.374	0.12
Family commitment	0.062	37	3.22	0.165
	0.806	**<0.0001**	0.089	0.698
	0.003	0.673	0.152	0.009
	0.059	0.82	0.39	-0.095
Physical appearance	3.89	5.84	20.06	0.053
	0.064	0.027	**0.0003**	0.821
	0.18	0.25	0.527	0.003
	0.422	0.495	0.726	0.054
Sexual fidelity	0.167	1.51	0.733	2.71
	0.687	0.235	0.403	0.117
	0.009	0.077	0.039	0.13
	0.96	0.278	0.198	0.362

Table 6: Summary table of outcome of linear regressions between categorical self-perception scores and mate-preference scores for all combinations of relevant categories for homosexual females.

Although this study replicates many of the procedural methods used in Buston and Emlen's research, certain limitations may have hindered our results. While distributing surveys in the center of the University, researchers "recruited" random participants by asking for their participation in our study. It is possible that those who chose to go forth and fill out the questionnaire differed in personality from those who refused, which would result in a confounding factor. Furthermore, in order to obtain a greater homosexual and bisexual response, researchers recruited participants at a gay pride rally where individuals were celebrating their sexuality *en masse*, singing, yelling, and uniting. A multitude of studies have indicated that individuals oppressed through race, gender, sexuality etc. do indeed display lower levels of self-esteem and an increased likelihood for depression. An environment such as the rally may have temporarily heightened self-perception responses, again confounding the data. Another possible shortcoming of the study is the potential lack of a correlation between what an individual lists as his or her preferences and the way he or she actually chooses a mate in reality. Though this is primarily a study on mate preferences and not on mating patterns, this limitation could affect some of the conclusions.

Our results lead to interesting speculations regarding mate preferences and societal influence. If performed again, it would be ideal to obtain greater sample populations of homosexual and bisexual participants in order to have a more accurate representation of all sexual orientations. The next step for further research would be to discern why our results generally followed the "likes attract" model and research which prevalent factors in society are responsible for shaping our thoughts and perceptions regardless of sexual orientation. Though we may speculate

about this, extensive research would have to be done in order to provide concrete support. In order to grasp fully how Western civilization influences its inhabitants, the study would be replicated not only in our society but also in other cultures as well, thereby providing a multicultural framework for researchers and readers alike.

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Theoretical Investigations on Adsorption of NO on Copper Exchanged Zeolites (Cu-ZSM-5)

BY *GEORGE SCHOENDORFF*

Abstract

Adsorption of NO on copper exchanged ZSM-5 is investigated using *ab initio* methods. Cluster models, ranging from 1T to 5T (T is silicon or aluminum), are used to represent the structure of zeolites. Equilibrium structures are calculated at the HF and DFT theory levels. Relative energies among different adsorption complexes are calculated.

Introduction

"Acid rain" (or so-called acid deposition) is a broad term used to describe both wet and dry ways that acid falls out of the atmosphere. Acid rain has received worldwide attention during the past thirty years since it deteriorates our vulnerable environment and leads to serious health problems.[1-4] Wet deposition refers to acidic rain, fog, and snow. Dry deposition refers to acidic gases absorbing on surfaces and particles settling out. The direct effect of acid deposition is to harm the natural environment, including plants, aquifers, and aquatic organisms. Another important effect, but frequently ignored by many people, results from chemical reactions with existing minerals in the soil to generate soluble toxic metal ions, which eventually enter our bodies *via* foods and/or drinking water. Accumulation of such toxic metals can lead to serious health problems.[1-3]

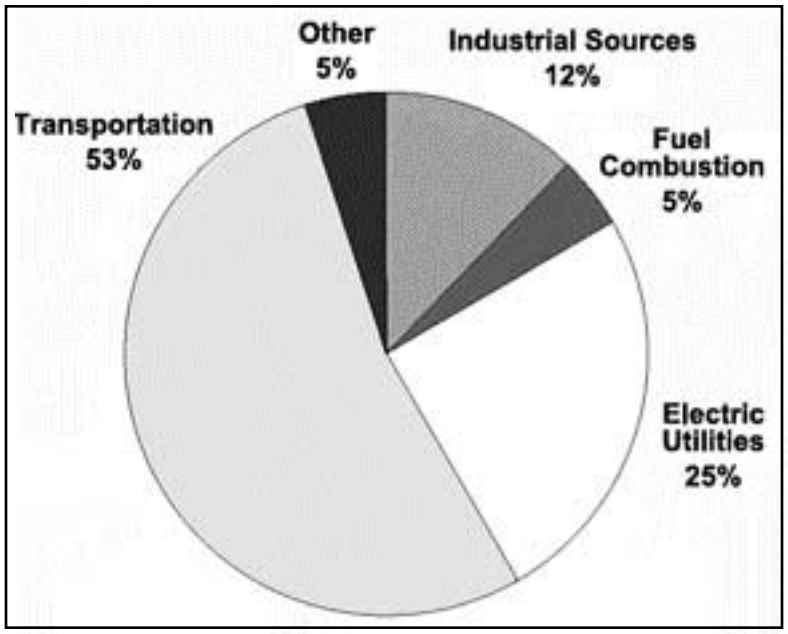


Figure 1: NOx emissions from the United States in 1998.[1]

Tremendous efforts, including labor and money, have been spent in controlling acid rain. However, it is neither an easy task nor a short-term fight. NOx, a mixture of NO and NO_2, is one major contributor to acid rain[1-4] and is emitted primarily in exhaust fumes from millions of automobiles.[2] In 1998, this accounted for 53% of NOx emissions in the United States (Figure 1). In 2000, the total emissions of NOx in the United States was 5.11 million tons.[1] It is of interest and importance, therefore, to develop a powerful catalyst to selectively reduce NOx and eventually to reduce the damage caused to humans and environments.[5-8]

Zeolites are crystalline materials consisting of a large number of tetrahedral TO_4 units (T: primarily silicon with a small portion of aluminum) (Figure 2) connected to each other *via* oxygen to form three-dimensional cavities and channels (Figure 3). The crystalline framework supplies a high internal surface area and active sites, which make zeolites good adsorbents and catalysts.[9-11] Over the past decade, the medium-

pore ZSM-5 zeolite has attracted a lot of attention. Because of small pore size and its uniform distribution, the internal surface developed by the porous channels is much larger than the external surface. The higher ratio of internal to external surface area (about 4:1) leads to its higher activity and selectivity.[12,13]

Due to the existence of the aluminum in the TO_4 unit, oxygen atoms adjacent to the aluminum show the partial negative charges, which can be balanced by external cations. Copper exchanged ZSM-5 (Cu-ZSM-5), a new derivative of ZSM-5, is the most active catalyst for the direct decomposition of NOx to date.[14,15] Cu-ZSM-5 has adsorption properties similar to ZSM-5.[12] The ratio of internal surface area to external surface area is even larger than that of ZSM-5. The study of pore size distribution demonstrates that Cu-ZSM-5 represents a well-defined distribution with main micropore size at 0.7 nm with a limit of 2 nm. Experimental studies have shown that

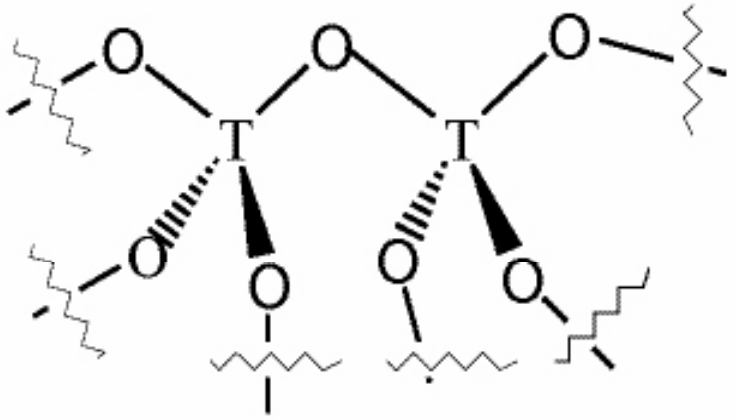
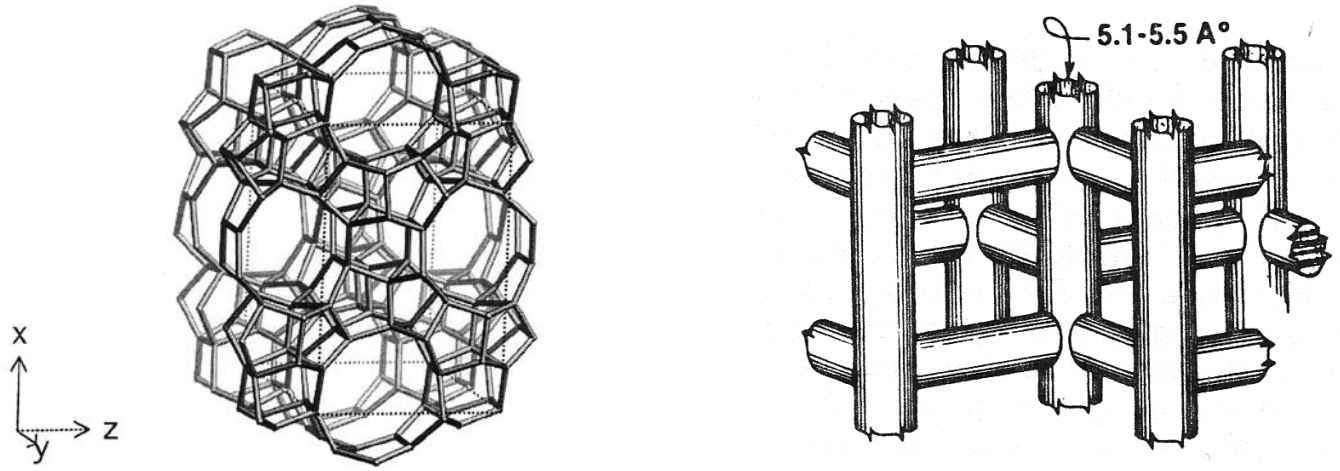


Figure 2: The tetrahedral TO4 unit in zeolites.



Framework View **3D View**

Figure 3: The structure of zeolite (MFI type).[12,13]

Cu-ZSM-5, rather than ZSM-5 or naked copper cation, exhibits high activity in decomposing NOx into N_2 and O_2, major components of the air.[16,17] However, the detailed adsorption-decomposition reaction mechanisms remain unknown from the experimental investigations.

The computational tool is an alternative and/or support to the experimental research, but theoretical studies (*ab initio* calculations) of bulky zeolites are limited by computer resources. With the recent development in theoretical methods, two affordable approximations, the cluster model and the embedded cluster model, can be used to represent the interaction between adsorbed molecules (adsorbate) and zeolite fragments, as well as between zeolite fragments and the whole framework.[18-23]

The mechanism of adsorption-decomposition of NO on Cu-ZSM-5 is complicated and involves many steps.[24] This study focused only on the adsorption of NO on Cu-ZSM-5, the first step in the adsorption-decomposition process. Only chemically bonded adsorption complexes may be stable enough to allow subsequent decomposition reactions. There are three possible structures of the NO-Cu-ZSM-5 adsorption complex. *Ab initio* calculations of the structure of these complexes were performed to determine possible adsorption complexes and energy barriers.

Approaches

Cluster model was used in this project to simulate the zeolite structures. Zeolite is treated as a very small neutral cluster cut out of the bulky crystal structure. Hydrogen atoms terminate the resulting dangling bonds at the boundary.[20] Since the cluster model takes only a very small part of the zeolite structure, two important deficiencies of cluster models exist.[29] First, the cluster model is different from the zeolite structure because atoms near the cluster boundary, arbitrarily terminated by H, are in different electronic environments. The second is potential deficiency. A potential is generated from the long-range electrostatic forces between the cluster model and the zeolite framework, which is missing in cluster calculations.

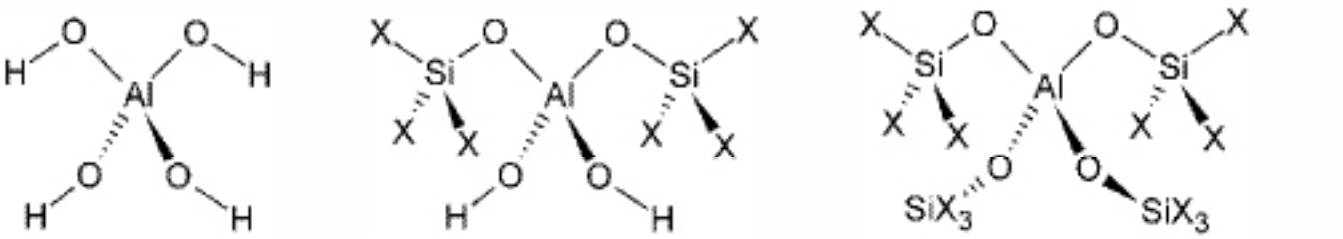


Figure 4: The cluster models (X = H or OH).

Results obtained from cluster model investigation may give us a chance to examine the usage of embedded cluster model. A recently developed embedded cluster model method can be used to avoid/alleviate aforementioned problems without significantly increasing the computational costs.[30-32]

Computational Details

Full optimizations of cluster models, from 1T to 5T models (Figure 4), were performed at the Hartree Fock (HF)25 and then the Density Functional Theory (DFT)27 levels with the 6-31G(d) basis set using the *ab initio* suite of GAMESS package.[28] Additionally, MacMolPlt, a 3D visualization package, was used to view the optimized geometries.[33] All calculations were performed on a Mac Power G5 cluster.

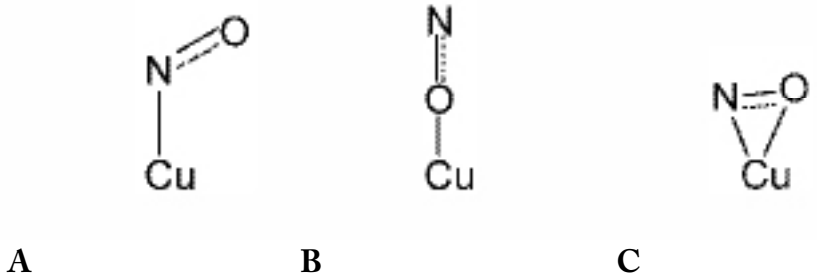


Figure 5: Three possible NO-Cu adsorption complexes.

Results

There are three possible ways for NO to adsorb on Cu-ZSM-5 (Figure 5). The first possibility is the formation of a bond between Cu and N to give the Cu-N-O adsorption complex (A). Alternatively, a bond between Cu and O could form, yielding the Cu-O-N adsorption complex (B). The remaining possibility is for Cu to bond to both N and O to make a Cu-N-O ring structure (C). Geometries optimized at the HF level and at the DFT level are listed in Table 1 and 2, respectively. Due to the substitution of Si by Al in the zeolite framework, oxygen

atoms next to Al are partially negatively charged. As a result, Cu cations are bound to balance this negative charge. Since NO is a polar molecule and the dipole moment points to N from O, different binding type should affect bonding in NO, even the relative stabilities of different adsorption complexes.

Complex A must have a shorter Cu-O bond length than B because the partially negative charges on O in B are shared between Cu and N. As a result, the N-O bond strength is decreased. Complex C will show the longest N-O distance because Cu forms bonds to both N and O. Because both N and O share Cu, it is expected that Cu-N bond is weaker than that in complex A but Cu-O bond is stronger than that in complex B. Both HF and DFT results show the same tendency. At the DFT level, molecular NO was calculated to have a bond length of 1.1589 Å. DFT results in Table 2 show that N-O length in structure A is the closest to that of molecular NO while that in structure C is about 0.08 – 0.09 Å longer.

From Table 1 and 2, it is also found that, with the increase in cluster size, geometrical parameters of cluster framework (*e.g.* Cu-Al distance) may change drastically. A similar observation is found when a different terminal group is used. Compared with the change inside of the zeolite framework, changes in bonding between zeolite and adsorbate are smaller (usually less than 0.02 Å) but not neglected.

HF shows that the optimized geometries have C2V or CS symmetry since the dihedral angle OCuNO is always zero. Compared with DFT results, HF can predict the conformations of B and C qualitatively correct, though HF always overestimates the bond lengths. However, the A complex displays a quite different dihedral angle near 90˚ in HF and DFT studies: in small clusters, DFT results support an out-of-plane structure with the C1 symmetry. With the increasing size of the cluster model, such stable structures vanish. It may suggest that in this study both the cluster size and electron correlation could be important factors. The CuNO angle in the A complex also varies between the HF and DFT geometries.

The HF geometries always predict a 180˚ bond angle. Once again, this is due to the symmetry of the optimized HF geometries. The CuNO bond angle in the DFT structures is near 150˚. This 150˚ bond angle occurs with the

	1T			3T-H			3T-OH			5T-H		
Adsorption type	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Distance (Å)												
Al-Cu	2.8477	2.8289	2.8443	2.7950	2.7836	2.7832	2.8441	2.8393	2.8282	2.7851	2.7702	2.7755
Cu-N	1.8957		1.9299	1.9272		1.9972	1.9444		2.0660	1.9387		2.0237
Cu-O		2.0886	1.9337		2.1009	1.9800		2.0978	2.0197		2.1052	1.9978
N-O	1.1205	1.1287	1.1651	1.1188	1.1293	1.1548	1.1180	1.1288	1.1480	1.1184	1.1294	1.1516
Bond angle (degrees)												
Cu-N-O	180.0		72.6	180.0		72.4	180.0		71.5	180.0		72.1
Cu-O-N		180.0	72.3		180.0	73.9		180.0	75.9		180.0	74.6
O-Cu-N	141.0		118.9	139.7		119.1	140.7		120.6	139.7		119.5
O-Cu-O		140.7	127.7		139.6	125.9		140.6	127.2		139.4	126.0
Dihedral angle (degrees)												
O-Cu-N-O	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 1: Distances and bond angles calculated at the HF level with the 6-31G(d) basis set.

90˚ dihedral angle in these structures. However, this bond angle becomes 180˚ when the dihedral angle is 0.0˚ in the larger clusters. The variations of the CuNO angle and the dihedral angle in the DFT structures always occur together. Therefore, when C2V or CS is broken in the small DFT clusters, it is because O from NO lies roughly 30˚ outside the CS plane.

The relative energies of the adsorption complexes at the HF level show little variation among the 1T and 3T clusters (Table 3). The calculated energies at the HF level indicate that adsorption type A is the most stable and, therefore

	1T			3T-H			3T-OH			5T-H		
Adsorption type	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Distance (Å)												
Al-Cu	2.7793	2.8323	2.7706	2.7898	2.7763	2.7706	2.8186	2.8082	2.8010	2.8011	2.7571	2.7585
Cu-N	1.7191		1.8351	1.7241		1.8351	1.7095		1.8395	1.7237		1.8364
Cu-O		1.7589	1.8625		1.7667	1.8625		1.7683	1.8629		1.7694	1.8648
N-O	1.1777	1.1880	1.2421	1.1759	1.1862	1.2421	1.1723	1.1839	1.2397	1.1707	1.1854	1.2410
Bond angle (degrees)												
Cu-N-O	149.8		71.9	149.2		71.6	180.0		71.5	180.0		71.7
Cu-O-N		180.0	68.6		180.0	69.2		180.0	69.4		180.0	69.2
O-Cu-N	123.5		114.9	139.0		115.5	139.6		116.0	139.5		114.5
O-Cu-O		140.3	126.2		138.8	122.3		139.4	123.0		138.6	123.2
Dihedral angle (degrees)												
O-Cu-N-O	88.5	0.0	0.0	93.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2: Distances and bond angles calculated at the DFT level with the 6-31G(d) basis set.

Adsorption Type	1T	3T –H	3T –OH	5T –H
HF//HF				
A	0.0	0.0	0.0	0.0
B	5.52	4.27	3.94	3.86
C	4.56	6.34	7.99	6.77
DFT//DFT				
A	0.0	0.0	0.0	4.45
B	28.49	24.89	25.06	19.46
C	6.55	4.89	4.96	0.0

Table 3: Relative energies (kcal/mol) calculated using 6-31G(d) basis set.

the most likely adsorption type. The B and C types are relatively closer in energy. DFT energies, however, differ significantly from the HF energies. The 1T and 3T clusters still indicated type A as the most stable complex and B is significantly higher in energy than C. The substantial differences in energies at the DFT level demonstrate the importance of electron correlation in these calculations. Given the DFT energies, type B is clearly the least stable of the adsorption complexes. The cluster size also contributes to the difference in the DFT calculations. 1T and 3T cluster models indicate that the A type is the most stable, followed by the B type. When the cluster is enlarged to 5T, though, the C type is the most stable followed by the A type.

Discussion

The most obvious conclusion from this data is that the cluster size has a significant impact on the energies of the complexes as well as on the geometries. If only small clusters are used, then the A type adsorption complex would appear to be the most stable. However, framework effects from the larger 5T zeolite cluster seem to increase the stability of the C type adsorption complex. DFT data from the 5T (-H terminated) cluster model indicate that type C is in fact the favored adsorption mechanism, contrary to the established trend from smaller clusters. Type C, with its longer N-O bond length, would be better able to dissociate NO into N and O ions or radicals.

In addition to the effects of the cluster size, the level of theory (DFT *vs*. HF) also impacts the results. Electron correlation from the DFT calculations contributes to a large increase in the relative energy of the B complex. From HF energies alone, it is not clear whether type B or type C is the most stable. DFT results, however, show a clear difference in energy between these two adsorption complexes. Type B, then, is clearly the least stable complex. Type C, on the other hand, appears to be the most stable given a large cluster size.

The results in Table 3 also indicate a difference between –H termination and –OH termination. Though two clusters may have the same number of tetrahedral units, the type of termination used still impacts the results. Changing the cluster from –H terminated to –OH terminated can greatly change the electron distribution in the zeolite framework and, further, change the binding of the absorbate.

With only one type of cluster contradicting the stability of the A type mechanism, it is unclear whether this result is an anomaly. Therefore, it is necessary to obtain DFT results for other large clusters – namely the 5T –OH terminated and 10T clusters. If type C is the most stable complex in these larger clusters, then it will be clear that small clusters give qualitatively incorrect results.

Acid rain is a serious problem that affects everyone. It can cause aesthetic damage to paints and other coatings. More importantly, it affects the environment by acidifying soils and aquifers. Changes in pH are harmful to aquatic animals by interfering with biological processes and reducing the amount of available calcium carbonate for shells. In addition, acid in the soil can react with metals bound up in minerals and cause them to be released into drinking water. Many of these metals are toxic to humans and other animals. Additionally, many acidic gases -- in particular nitrogen oxides -- are greenhouse gases. Although the amount of these emissions is small compared to the production of CO_2, they still contribute to climate change. Acidic gases are produced through both natural means such as volcanism as well as through the burning of fossil fuels.

Any technology that reduces the production of acidic gases will greatly benefit people and the environment. This includes alternative energy sources such as solar or wind power, alternative fuels such as hydrogen or biofuels, or catalysts that reduce acidic gases to harmless molecules. So far, copper exchanged zeolite is one of the most promising catalysts that shows stronger catalytic capability over NO from small-scale experimental studies. However, before it is used on a large scale, it is necessary to understand how and why it works and whether it can be improved. If the reaction mechanism for the reduction of NO on zeolite is understood, it may be possible to design better catalysts that work in a wider range of circumstances.

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Interpersonal Problems and the Therapeutic Alliance in Psychodynamic Psychotherapy

BY *ASHLEY JAKSA*

Abstract

One facet of alliance formation between client and therapist that has not seen much attention is the client's interpersonal problems. This study's goal was to further this research using the Inventory of Interpersonal Problems, the Combined Alliance Scale, and the Newthal metrics to measure interpersonal problems, client rated alliance, and therapist rated alliance, respectively. Results showed that therapists reported better alliance with female patients with relatively more concerns in the Exploitable and Overly Nurturant domain and worse alliance with those with more concerns relating to the Vindictive domain. For males, an overall level of interpersonal distress was negatively correlated with Confident Collaboration and Goal Task agreement.

Introduction

The topic of the therapeutic alliance is an influential issue within the clinical psychology field. Edward Bordin developed a comprehensive account of the alliance, which he defined as having two main components: the alliance is a mutual agreement between client and therapist regarding the goals and tasks of therapy, and further, it is a bond involving confidence and trust.[1] The alliance is an interpersonal relationship between the therapist and the client as well as a reflection of the client's relationship with others. Therefore, the study of how the clients' interpersonal problems affect the alliance is important for the exploration of the alliance.

An important tool for measuring the effect of interpersonal problems on the alliance is the Inventory of Interpersonal Problems (IIP), which is a measure used to describe a person's impaired interactions with others. The majority of studies that have investigated the Inventory of Interpersonal Problems and the alliance have associated client IIP scores with client-rated alliance, but have not examined therapist ratings of the alliance.[2-4] One of these, by Paivio and Bahr, examined the relationship between interpersonal problems and the alliance using a relatively small sample of 33 clients receiving short-term experimental therapy.[2] They concluded that IIP octant scores of Vindictive and Exploitable were predictive of a poor alliance as rated by clients. Furthermore, Mary Gibbons *et al.* used a larger sample of 201 participants to study client ratings of the alliance and IIP scores, and found that the Domineering, Vindictive, Cold, and Socially Avoidant octants correlate negatively with the alliance.[3] Both of these studies used a relatively small sample size, which may not give a clear view of the overall trends within the data.

This study replicated and extended Gibbons *et al.* by using a larger sample of participants and including the rating of the alliance by therapists as well as by clients. Therapists' perspectives of the alliance differ from those of their clients, which is important to note because the therapists' views of the alliance "can affect their conduct of treatment."[5] One study even found that the most stable ratings of the alliance are from therapist-based measures.[6] These studies highlight the importance of using therapists' ratings to study the alliance.

In the present study, we hypothesized that therapist ratings and client ratings of the alliance would be similar. For effective therapy, the client and therapist have to agree to work together on the goals they set

and must trust each other to reach these goals; thus, their perspective of the alliance should reflect these shared qualities. Like previous studies, this study expected to find that clients with more concern in the Overly Nurturant and Submissive areas would form stronger alliances, while clients with more concern about being Domineering, Vindictive, and Cold would form weaker alliances.

Methods

Participants

This study used 291 participants receiving psychodynamic psychotherapy from the University of Michigan Psychological Clinic. Of the 291 participants, 68.4% were female and 31.6% were male. Each client completed both the Inventory of Interpersonal Problems and the Combined Alliance Scale (CAS) while in therapy, while their therapist completed the Newthal.

Measures

The IIP is a 64-item self-report "used to identify dysfunctional patterns in a person's interpersonal interactions."[7] The IIP identifies a person's overall level of interpersonal difficulty as well as a person's most severe interpersonal difficulty. The questions are organized into eight subsets, called octants, (Domineering, Intrusive, Overly Nurturant, Exploitable, Nonassertive, Socially Avoidant, Cold, and Vindictive) which describe the spectrum of interpersonal problems a client can have.

The Combined Alliance Scale is a measure of alliance. This self-report questionnaire contains 25 items with five subscales: Confident Collaboration, Goal-Task Agreement, Bond, Idealized Relationship and Dedicated Patient. The Confident Collaboration subscale measures how confident the client is that the work that he or she does in therapy is a collaborative effort between him or her and the therapist. Goal-Task Agreement is the sense of clarity and agreement between clients and therapists on goals, tasks and duties. Bond measures how close the client feels with the therapist and the degree to which the client is open to expressing feelings. The aspect of the scale that asks clients if they tend to express negative feelings toward therapists is measured by the Idealized Relationship scale, while the Dedicated Patient scale measures how well clients are willing to face the difficult tasks of therapy.

The Newthal measures a therapist's view of the alliance. It is a 30-item self-report questionnaire created from the factor analysis of the therapist version of the WAI-T and the CALPAS-T reported by Hatcher.[8] The Newthal has six subscales: Therapist Confidence, Goal-Task Disagreement, Bond, Confident Collaboration, Shared Goals, and Patient Commitment. In addition to the subscales on the CAS, the Newthal has a rating of the therapist's confidence in the client; a rating of the disagreement between the therapist and the client on goals and tasks; a rating on the degree to which the therapist believes that he or she shares the same goals as the client in regards to treatment goals; and finally, a therapist rating of to what extent the client is committed to the goals of therapy.

Results

To analyze the relationship between client and therapist ratings of the alliance and the client IIP scores, we conducted bivariate correlations. We adjusted for overall level of distress by ipsitizing the IIP scores. This ipsitization focused our data on how much a particular item on the IIP is the focal point of the person's concern, removing how distressed the person was. This allowed us to determine which octant is the client's primary concern without taking into account the overall distress they feel in interpersonal situations. Previous studies have also taken related steps to control for distress levels in IIP scores.[2,3] Partial correlations to control for session count revealed no significant differences with the correlations that did not control for session count. Therefore, clients that have had more sessions with their therapist are no different in our correlations from clients that have had fewer sessions.

Our results (Table 1) revealed that there was a positive overall total therapist rated alliance with women who have more concerns in the Exploitable octant (r =.26) and the Overly Nurturant octant (r =.22), but that there was an overall negative correlation with females who expressed more concerns in the Vindictive octant (r = -.26). Within

the overall therapist rated alliance, males showed no significant correlations (Table 1). The lack of many significant male correlations is of particular interest and will be examined in more detail shortly. Similarly, there were no significant correlations between the CAS and the octants of the IIP for either males or females. Furthermore, Table

	Domineering	Intrusive	Overly Nurturant	Exploitable	Nonassertive	Socially Avoidant	Cold	Vindictive
EWTHAL								
Female n=199	-.10	.11	.22*	.26*	.07	-.11	-.20	-.26*
Male n=92	-.02	-.12	.12	.22	.22	-.25	-.07	-.06
AS								
Female	-.06	.01	-.03	.03	.02	-.07	.10	.01
Male	-.01	.07	-.04	-.03	.09	-.05	-.02	-.03

Table 1: Overall mean alliance correlations from both therapists (Newthal) and clients (CAS) correlated with the IIP octants; the Newthal and CAS column is further broken down into female and male groups.
**** Correlation is significant at the .01 level (2-tailed)**
*** Correlation is significant at the .05 level (2-tailed)**

2 shows the mean IIP score correlated with each subscale of the CAS. This table shows that the mean IIP correlated negatively with each subscale of the CAS for the female group (r = -.31, -.23, -.21, -.37, and -.41) and with the Confident Collaboration (r =-.23) and Goal-Task Agreement (r = -.38) subscales for the male group.

	Confident Collaboration	Goal Task Agreement	Bond	Idealized Relationship	Dedicated Patient
IIP Mean					
Females n=199	-.31**	-.23**	-.21**	-.37**	-.41**
Males n=92	-.23*	-.38**	-.12	-.10	-.13

Table 2: IIP mean correlated with each of the 5 subscales of the patient rated CAS. The IIP mean column is further broken down into female and male groups.

Discussion

Our patient rated alliance results did not show any similar correlations to what we expected. The lack of significant patient rated data is unexplained by our data. However, in accordance with our predictions and similar to previous client rated research, our therapist rated data concluded that females with relatively more concerns of being exploitable and/or overly nurturant form stronger alliances with their therapists. Furthermore, females who are concerned with anger and irritability are more likely to form weaker alliances with their therapists. The male group did not reveal any significant data for these correlations. As Gibbons[3] reported, the overall level of interpersonal distress had a negative affect on alliance for all female rated CAS subscales and only the Confident Collaboration and Goal-Task Agreement subscales for males. This result suggests that clients view the alliances as being weak when they feel more interpersonal distress. In contrast to the client rated CAS, the therapist rated Newthal did not show any significant correlations. This leads us to suspect that the level of distress only affects the client's view of the alliance, but not the therapist's view.

Within our correlations, there is a distinct difference between scores of female and male clients. While female client correlations show many significant findings, there is a lack of significant findings within the male group. One reason for the insignificant male correlations could be the low number of males that participated in the study (N=92). It appears that some of the male correlations are close in pattern to the significant female correlations, but the findings are lost due to the low number of males. Finally, our study did not take into account the gender of the therapist, which might also account for some of the gender difference that our correlations showed.

We have no explanation for the lack of correlation between CAS and IIP scores along with the gender difference and feel that these issues warrant further study. Using a larger number of male clients and taking into account the gender of the therapist might shed some light on these unresolved issues. In addition, the need to replicate and further prove our therapist rated alliance data would give solid clinical application to our findings. Our data shows a possibility that therapists will be able to explain why some people are more likely to form positive alliances while others are not. The ability to identify clients' tendencies in interpersonal relationships could lead to a better plan to change their behavior.

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Why Are There Fewer African American Men in College Than African American Women?

BY *ZACHARY ANDERSON*

Introduction

The right to equal education has always been a critical issue in the African American community. However, although the number of African Americans seeking to obtain higher levels of education has risen in the past several decades, African American men are lagging behind African American women, whose number is increasing on college campuses while the number of African American men is decreasing (Figure 1).

Between 1984 and 1994, African American women had an enrollment rate that was 24% higher than that of their male counterparts. Moreover, between 1977 and 1994, the number of bachelor's degrees awarded to African American women increased by 55.4% (from 33,489-52,179) versus only 19.6% for African American men (from 25,147-30,086).[1] This presents serious problems for the African American community. The lack of African American men with college degrees can lead to instability in the African American community and hinders African Americans from closing the economic gap between African Americans and Caucasians. Despite progress made during the civil rights movements in creating an educational system to provide equal opportunities for all Americans, there are still major obstacles that are preventing African American men from pursuing higher levels of education.

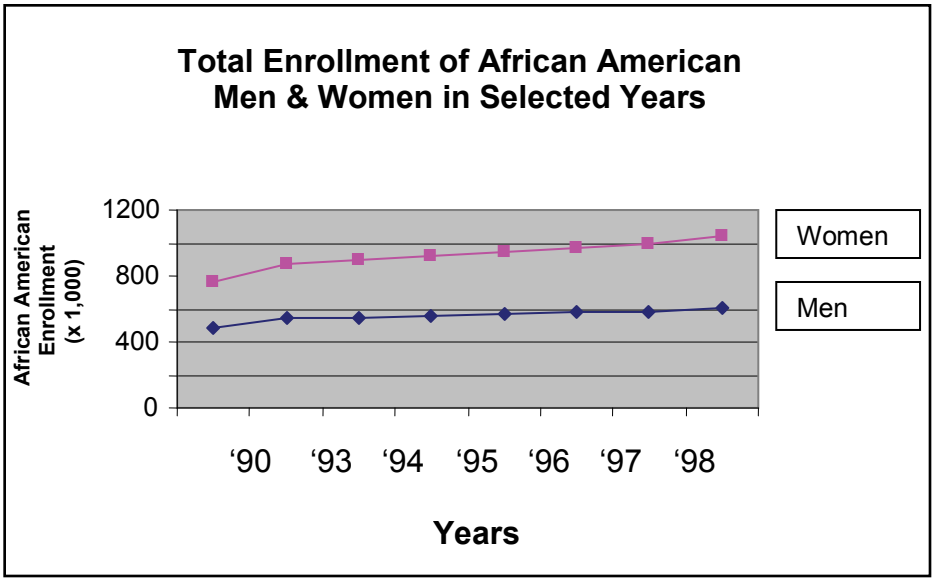

Figure 1[16]

Role Models & Academic Success

African American men are not sufficiently encouraged to achieve in school. The low expectations that teachers, parents, and authority figures have for African American men is one obstacle that hinders African American men from attending institutions of higher education.[2] Communities, teachers, and schools are not investing enough time and effort in preparing African American men for college. Teachers are praising boys less frequently and criticizing them more.[3] Additionally, cultural differences can create misunderstandings between students and teachers. Because of these cultural differences, a teacher may misdiagnose a student as having a learning disability and subsequently place him or her in remedial classes, which will stifle his or her academic success.[2-4] Thus, schools are creating environments that no longer nurture young African American men, but hinder them.[5-7]

It should be noted that such repressive forces as family disruption, chaotic schools, drug abuse, crime, violence, premature parenthood, and lack of role models affect all people who live in inner cities, regardless of race and gender. However, African American men appear to be far more vulnerable to these forces.[8] The low expectations that teacher often have for African American boys could foster an anti-achievement attitude and a lack of respect for school, which makes gang participation an appealing alternative to school.

African American men lack role models in both home and school environments to encourage them to succeed academically.[1,2,4] The lack of African American male role models at home and at school leaves many young African American men with a limited idea of what success means. The media portrays a stereotype of a successful African American man by highlighting the images of successful African American men such as athletes, musicians, actors, comedians, and other African American men in professions that require little or no formal education.[9,10] These images lead young African American boys to associate wealth, prestige, and success as achievable without academic success. The problem with this way of thinking is that it fosters the idea that African American men can only be successful in fields that do not require formal education.[8,11]

Acting White & Stereotype Threats

An African American child who does well in school may be accused of "acting white." Some researchers theorize that African American children discourage academic success or the idea of "acting white."[10,11] However, the "acting white" theory does not hold to be true, as there is no evidence of underperformance attributable to beliefs that working hard would betray group identity or would be considered "acting white."[12] There is evidence of stereotype threat wherein minority students disengaged from schoolwork for fear of living up to expectations of failure.[13]

Academic & Financial Constraints

The lack of academically qualified African American men could be used to explain why there are so few African American men in college. Research indicates that African American women have had consistently higher rates of high school completion than their African American male peers. However, although many African American men drop out of high school, the gap in high

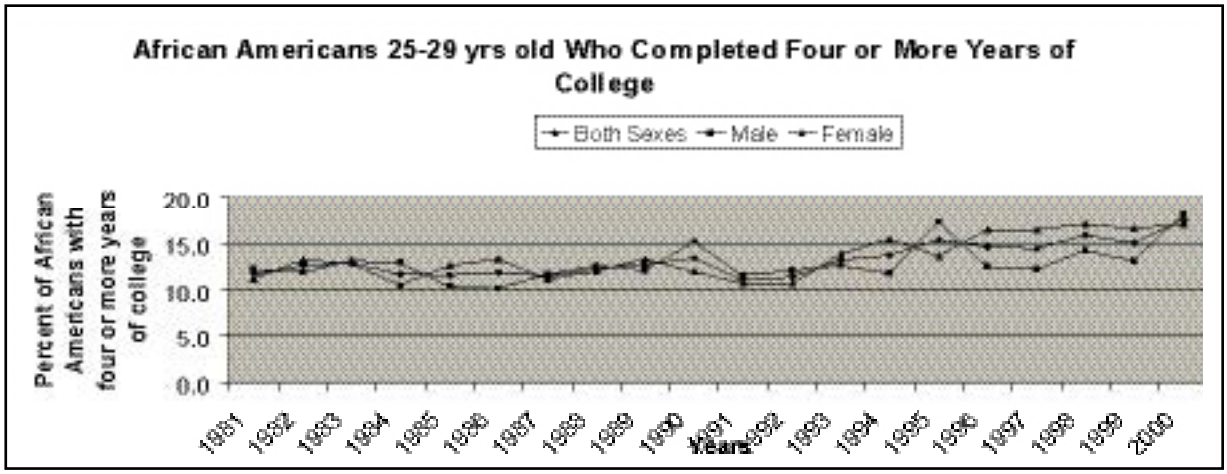

Figure 2[16]

school completion rates is getting smaller and the number of male dropouts is not significant enough to explain the growing gender gap in higher education.[14]

Those African American men who do graduate from high school may not have had a proper preparation for college. Often the schools that serve urban communities lack the resources to prepare their students adequately. Thus, African Americans often are not academically prepared for college.[1,2] This problem affects both African American men and women. However, young African American women seem to have an academic edge over their male peers. Young women, regardless of race, tend to have higher grade point averages and are more likely to take

AP classes.[7,15] Because young women are taking more AP courses than young men, young women are being better prepared for college than young men.

Another factor affecting the discrepancy is that African American men do not always have the necessary resources to pursue higher education. The rising costs of attending college along with increasingly constrained amounts of financial assistance available from federal, state, and local sources may impede the entry of African Americans, and possibly the entry of African American men in particular, into postsecondary institutions. African American men receive little financial aid compared to African American women. One of the reasons that African American women are more likely to receive financial aid is that they are more likely than their male counterparts to declare themselves financially independent and responsible for dependants. This is because more African American women than men comprise the 24-years old and over student population.[14]

Alternatives to Higher Education

If African American men are not in college, where are they? One of the most common answers is prison. In fact, only 1/3 of the African American male population between ages 20-29 is in jail or on probation/parole.[14] There are college-aged African American men in jail, but not every African American man who is not attending a university is in prison. Furthermore, there are high numbers of both African American men and women in jail, so the incarceration rates do not explain the gender gap in higher education.

Another answer to this question is that African American men are choosing an alternative to college such as the military. In the past 15 years, there has been a decline in the number of total Americans on active duty and there has been a stagnation of growth in the representation of African American men in the armed forces.[14] African American men do enlist in the military, but the number of African American men in the military does not sufficiently explain the lack of African American men in college.

Another factor is that some African American men are choosing not to attend college and instead, to enter the workforce directly after high school, because they do not feel that a college degree will provide them with better job opportunities. This is because African American men are aware of the perceived racism and discrimination that occurs in the workplace and this knowledge deters them from deciding to go to college.[10,11] They assume that it would be pointless to go to college since they could suffer from discrimination and not get hired or promoted due to racist and discriminatory policies. African American men are aware that Caucasians might perceive African American women as less threatening. Some Caucasians may feel that an African American man would increase the level of competition for jobs at the higher levels within the workplace, but that an African American woman would not want to advance to higher levels. Some African American men believe that because African American women are a double minority an employer will choose an African American woman to get the "twofer," and thereby meet racial and gender hiring quotas.[8,10]

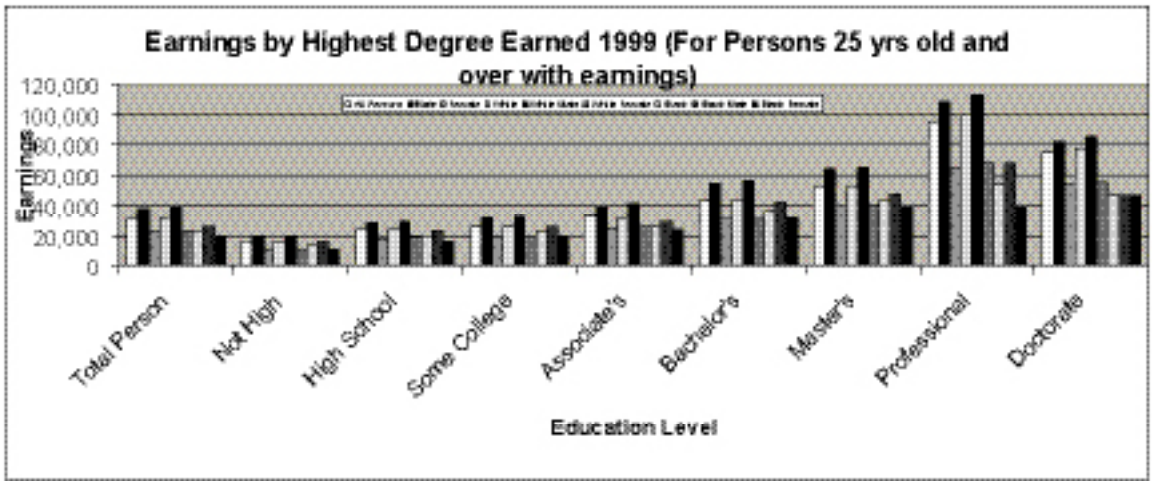

Figure 3[17]

Therefore, while African American men are entering the workforce, they are doing this because they feel that a college degree would not make a difference in the type of job or salary that they are able to obtain, nor would it change the level of advancement that they can achieve within their place of business.[10,11]

Conclusion

Young African American men might drop out of school and/or disengage from work due to fear of stereotype threats and they are often not academically prepared for college. Some African American men cannot afford to pay for college. Perceptions of racism in the labor force can cause African American men to decide not to continue their education since they feel it would not be beneficial.

The gender gap in higher education has an indirect effect on the African American household. Marriages between spouses with significantly different levels of education may be more prone to divorce and spousal abuse than marriages in which the spouses have similar education.[4] The gender gap has a direct effect on African American wealth. Many African American men are earning less than their Caucasian counterparts due to the lack of education that they have (Figure 3). The income gap between African American and Caucasian women is not as great as the gap between African American and Caucasian men; however, the overall gap between African American wealth and Caucasian wealth is tremendous.

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Crohn's Disease: An Evolutionary History

BY *THOMAS MICHNIACKI*

Introduction

Crohn's disease is classified as an Inflammatory Bowel Disease. The disease is capable of causing severe inflammation in any portion of an individual's gastrointestinal tract and is often chronic in nature. The symptoms of Crohn's disease arise due to complex interactions between genes, the environment, and the patient's immune system. An initial trigger in the patient's gastrointestinal mucosa begins the complex process of inflammation involved in Crohn's disease.

Once the activation of immunity has begun, the body fails in its attempts to control the immune response and excessive inflammation occurs. This exacerbated inflammation is due to excess Th1 cytokine production and often inadequate Th2 cytokine creation. Th1 and Th2 cells are two types of lymphocyte subpopulations that secrete proteins (*e.g.* cytokines) that help regulate immune responses.

Having disproportionate levels of Th1 and Th2 cytokines is especially debilitating because Th1 cytokines are the driving force in fighting infections in the mucosa membrane. Without enough Th2 cytokines (the inhibitory cytokines) to inform the Th1 cytokines to cease attacking, excess inflammation and severe damage occur.[1] This imbalance of Th1 and Th2 cytokine production has led many to believe that Crohn's disease is an autoimmune disease. An autoimmune disease is characterized by the targeted destruction of self-tissue by the immune system.[2]

The complexities of Crohn's disease lie within the affected individual's genes. Multiple gene mutations (potentially more than 8) cause the many mechanisms present in Crohn's disease.[3] Abnormalities arising on the NOD2, Vitamin D receptor, and Th-2 cytokine production genes may hold the key to unraveling the complexities of this disorder.[4] These complex mutations could potentially interact with environmental factors to create toleration or possibly even selection for the genes that cause vulnerability to Crohn's disease.

Environmental Influence

The evolutionary history of Crohn's disease begins in Africa with a few chance gene mutations. The first important mutations arise on the NOD2 (CARD 15) gene and genes involving Th1 and Th2 cytokine creation.[3] The NOD2 gene is similar to a gene that creates bacteria resistant proteins in plants.[4] With the development of the NOD2 mutation, those carrying the alteration now have an increased vulnerability to contracting a bacterial infection in their gastrointestinal mucosa. However, the excess inflammation that is characteristic of Crohn's disease may not arise in individuals that carry the genetic material alterations because of factors present in the African environment. Helminthic worms and parasites are rampant in the environment and individuals are prone to contracting them.[5] In individuals that have the NOD2 mutation, the contraction of the Helminthic worms may have beneficial aspects.

Studies have shown that infection with Helminthic worms may lead to elevation of the Th2 cytokine levels in patients.[5] An elevation of Th2 cytokines would potentially offset the harmful qualities of having excess Th1 cytokines that continually attack an area of the gastrointestinal tract. An individual could potentially carry some of the genetic mutations that lead to Crohn's disease but not show the damaging excess inflammation of the disease because the Helminthic worms that lie within the patient's body balance out the individual's immune response. This is a beautiful example of pathogens interacting with the body's own

defenses. Parasites may modify the bodily defense system of individuals afflicted with Crohn's disease and thus cause the genetic mutations that lead to Crohn's disease to be tolerated in an early evolutionary environment with a plentiful supply of Helminthic worms. This hypothesis may prove to be falsified with further research into the potential benefits of Helminthic worms and other parasites but the potential of having no selection for or against the mutations because no Crohn's phenotype is manifested in this early environment is fascinating.

Early human evolutionary history took place in surroundings similar to the tropics of today. A great deal of sunlight (and thus Vitamin D) is present in both the tropics of today and the early evolutionary environment of humans. Interestingly, Crohn's disease is very uncommon in the tropics today.[6] Vitamin D may hold the key to the toleration of gene mutations found in individuals with Crohn's disease in the tropics of today and in mankind's early African setting. A large amount of research has been conducted on the effects of the Vitamin D hormone, 1,25-dihydroxy vitamin D3, and its possible benefits on autoimmune diseases. Through this, it has been found that the Vitamin D hormone decreases the Th1-driven immune response in autoimmune diseases.[2] This decrease of Th1 cytokines ceases inflammation in those afflicted with Crohn's disease. It would therefore be logical to believe that an environment with a large amount of sunlight and Vitamin D could potentially be beneficial to an individual with the gene mutations characteristic of those with Crohn's disease.

Genetic Mutation

An interesting gene mutation carried by those suffering from Crohn's disease is an alteration involving a Vitamin D receptor.[4] This may make an individual carrying the mutations require greater amounts of Vitamin D for optimal health.[2] Imagine an individual in our evolutionary past with the Vitamin D receptor gene alterations. The only possible way for the harmful inflammatory effects of Crohn's disease not to be seen in this individual would be if he or she were relegated to an environment with a large amount of Vitamin D.

This is what could have potentially occurred in Africa. The individual acquired the plentiful mutations of Crohn's disease but the harmful inflammatory effects of the disease were not present because the individual obtained a large amount of Vitamin D that suppressed overactive Th1 cytokine production. The potentially harmful genes found in those with Crohn's disease may have been tolerated in this Vitamin D abundant environment.

Selection

An alternative hypothesis to explain the success of the Crohn's disease phenotype is that it was selected for because it conferred greater reproductive success. As stated above, research has shown that a Vitamin D hormone may decrease the levels of Th1 cytokines in the body.[2] Since Th1 cytokines are vitally important for fighting infection, a substantial decrease in the number of Th1 cytokines, due to the Vitamin D hormone, could possibly have negative effects on any individuals exposed to large amounts of Vitamin D.[7]

It is therefore plausible to believe that Crohn's disease and its elevated Th1 levels may have been selected for to increase the ability of individuals in high Vitamin D concentrated areas to fight infection. An optimal Th1 cytokine level may have been reached in this highly concentrated Vitamin D environment with the acquisition of Crohn's disease. Crohn's disease mainly affects individuals during the prime years of reproductive success.[8] This fact makes the idea of Crohn's disease selection for fighting off infection and in return increasing reproductive success somewhat logical. Selection would not occur on the Crohn's disease phenotype if it did not benefit or hinder the reproductive success of the individual during these prime reproductive years. Selection occurs for reproductive success and Crohn's disease may have been selected for to increase an individual's ability to fight infection and thus be more efficient at passing on his or her genes.

An individual may face an interesting tradeoff during the selection of Crohn's disease. The symptoms of Crohn's disease are usually less than beneficial, but in the right environment (one filled with large amounts of Vitamin D and Helminthic worms) the symptoms may not be as severe and Crohn's disease may be a tradeoff selected to fight

infection. The odds of dying from a mild form of Crohn's disease could potentially be far less than the odds of dying from contracting a deadly infection. This could be regarded as a tradeoff for reproductive success. The idea of Crohn's disease protecting against infection and increasing reproductive success could potentially mean that many more individuals contain the genetic mutations of Crohn's disease than were once thought. If sufficient numbers of the mutations found in Crohn's disease are not found in many diverse human populations, my hypothesis may be incorrect. New research into the potential benefits of Crohn's and the prevalence of gene mutations in the population must be performed.

The genetic mutations of Crohn's disease may have been prevalent in our early evolutionary surroundings (Africa) and eventually through migration moved to an entirely new environment (Europe). Europe is an environment without the abundant Vitamin D or Helminthic worms of Africa. This new novel environment of Europe has the potential to negatively affect those that carry the Crohn's disease genes.

Changing Environment

The new environment of Europe offers far less sunlight than the African environment. This characteristic property of Europe is most likely beneficial to many with genes lacking the mutation because they are exposed to far less sun and thus less deadly melanoma but individuals carrying the Crohn's disease mutations are negatively affected by the decrease in sunlight exposure. Crohn's disease patients are already at a selective disadvantage because their bodies make an excess amount of Th1 cytokines, which can destroy their own tissues, but now their potentially negative genotype is exacerbated in these new surroundings by a lack of Vitamin D, which could decrease their Th1 levels.[2] Crohn's genes were interacting with a novel environment and this contact potentially killed many individuals who held the mutated genes.

Centuries ago, through the implication of improved living conditions, hygiene began to improve in the European continent. This fact appears to have been positive for the general population but not for the percentage of the population that harbored the Crohn's disease gene mutations. This increased cleanliness further reduced the number of Helminthic worms and other parasites that Crohn's patients were exposed to. Without the large amounts of Helminthic worms in their environment, individuals with Crohn's disease no longer received the benefits of an elevated Th2 cytokine count.[5] Their additional Th1 cytokines were then free to destroy their gastrointestinal tract through excess inflammation.

Socioeconomic levels for individuals also seemed to play a role in the rise of Crohn's disease in Europe and eventually America. The richer an individual becomes and the more hygienic his or her living conditions become, the greater the opportunity to contract Crohn's disease.[6] A clear social stratification has begun to emerge within Europe and the United States. The poor are now far less likely to contract Crohn's disease, and the rich are becoming ill with excess inflammation.[6]

The new European and American environment once again began to shape the phenotype of Crohn's individuals when, about 6000 years ago, dairying was initiated. Lactase persistence began to be selected for with the expansion of pastoralist activities. Lactose digestion capacity (LDC) was beginning to become prevalent in northern Europe and North America. In current times, LDC is very uncommon in Africa and Asia.[9] This pattern of LDC positively correlates to the pattern of prevalence of Crohn's disease in these continents. Crohn's disease is very rare in Africa and Asia.[6] This fact leads many to believe that the key antigen that may interact with the NOD2 mutation in Crohn's patients and trigger a negative inflammatory process by the immune system is located in milk.[10]

Antigen Studies

The most sited antigen in studies involving Crohn's patients is *Mycobacterium avium Paratuberculosis* (MAP). This bacterium causes a disease similar to Crohn's in sheep and has been found in a high percentage of individuals infected with Crohn's disease.[11] Through co-evolution, the pathogen appears to have evolved to survive the pas-

teurization of milk.[10] An ability of the pathogen to evolve much faster than individuals with Crohn's disease, gives the pathogen a clear advantage. The ability to survive the high temperature of pasteurization potentially means the bacterium could now be transmitted in our novel environment through milk, cheese, or yogurt.[12]

In viewing the symptoms of Crohn's disease one observes that diarrhea is prevalent in the manifestations of the disease.[1] The existence of diarrhea as a Crohn's disease symptom could be viewed in two ways. Diarrhea could be an evolved defense to expel MAP from the body or it may be present due to manipulation of the host by the bacteria to form an efficient way of transportation for the pathogen. Interestingly, individuals infected with Crohn's disease also experience the symptom of deficiency of iron.[1] It may appear that the low iron count of Crohn's patients is harmful to the patient and is a negative effect of the disease manifestation but this may not be so. Insufficient iron may be present in Crohn's individuals because iron is needed by bacteria to grow and multiply.[13] By the body decreasing the amount of available iron in its tissues, it may in fact be creating an environment less than suitable for a multiplying pathogen. Two perceived negative symptoms of Crohn's disease can now be explained as defense mechanisms in the presence of the MAP bacterium.

With the discovery of *Mycobacterium avium Paratuberculosis,* the evolutionary constraint of breastfeeding in mammals now presents a problem for individuals that carry the Crohn's disease genes. Research has shown that breast milk can transmit MAP.[10] It has also been observed that breastfeeding is correlated with higher instances of Crohn's disease.[14] This circumstance creates an interesting tradeoff and constraint for those who could potentially be vulnerable to contracting Crohn's disease. Breastfeeding has many positive benefits to the immune system and other functions of the body but if breastfeeding passes on a bacterium that may trigger a severe inflammatory response by the immune system, then the negative aspects of breastfeeding may outweigh its positive aspects.

The evidence that MAP causes the trigger that initiates the excess inflammatory response of Crohn's disease is controversial because recovering the bacterium from samples and individuals involves many complex chemical processes.[12] This fact makes the research of this pathogen's relevance in the pathogenesis of Crohn's disease arduous and inconclusive. Better techniques for the recovery of the bacteria are needed but the relation between *Mycobacterium avium Paratuberculosis,* the evolution of lactose digestion, the use of milk, and Crohn's disease is undoubtedly interesting.

Relationship with HIV

The fascinating aspects of the evolutionary history of Crohn's disease continue when one investigates the effect HIV has on individuals affected by Crohn's disease. When an individual contracts HIV, his or her Crohn's disease mysteriously goes into remission.[15] This phenomenon is most likely due to that fact that HIV causes a decrease in the patient's immune system response. Without the excessive immune response and inflammatory processes, Crohn's disease is nothing more than unexpressed genetic mutations. The relationship of Crohn's disease to HIV offers an interesting but unlikely tradeoff. Although acquiring HIV stymies the symptoms of Crohn's disease, it is much more in the individual's benefit to show the effects of Crohn's disease rather than HIV. HIV is much more deadly than Crohn's disease and this fact makes this tradeoff improbable. The relationship between HIV and Crohn's disease is remarkable. It proves the complexities of the interactions between genetic mutations, environment, and the immune system in creating a very severe disease.

Conclusion

The hypotheses presented throughout this paper must be thoroughly tested. The research into Crohn's disease must now include the prevalence of the Crohn's genetic mutations in the general population. A better understanding of their prevalence would create improved insight into their potential toleration in an early evolutionary environment. More research must be performed on how Vitamin D and its specific hormone, 1,25-dihydroxy vitamin D3, affect the immune system in not only individuals suffering from Crohn's disease but in every individual. A clear understanding of the immunity of the body and its correlation to Crohn's disease is crucial since the Th1 and Th2

cytokine imbalance is imperative in the manifestation of the disease. Finally, studies into the effects of antibiotics and drugs specifically targeting *Mycobacterium avium Paratuberculosis* must be performed. The idea of bacterium or pathogens causing Crohn's disease is controversial and studies into antibiotics would be greatly advantageous. The evolutionary history of Crohn's disease is multifaceted and fascinating. It involves potential toleration of gene mutations due to an early environment that leveled out the Th1 and Th2 cytokines through Helminthic worms and sunlight.

The journey continues into a new environment, Europe, where the gene mutations were no longer tolerated and became hazardous. The negative aspects of the genes may have multiplied when they experienced gene flow into new cultures that exposed the genes to a new bacterium presented in milk. A new exposure to bacterium creates unforeseen defense mechanisms and co-evolution between host and pathogen. Now in a new novel environment the complex nature of Crohn's disease is shown through the constraint and tradeoffs of breastfeeding, the interesting effects of AIDS on Crohn's disease, and social stratification of the disorder. The journey of Crohn's disease through our history has been extraordinary and deadly. A better understanding of the past and present mechanisms of Crohn's disease may have the potential to save lives.

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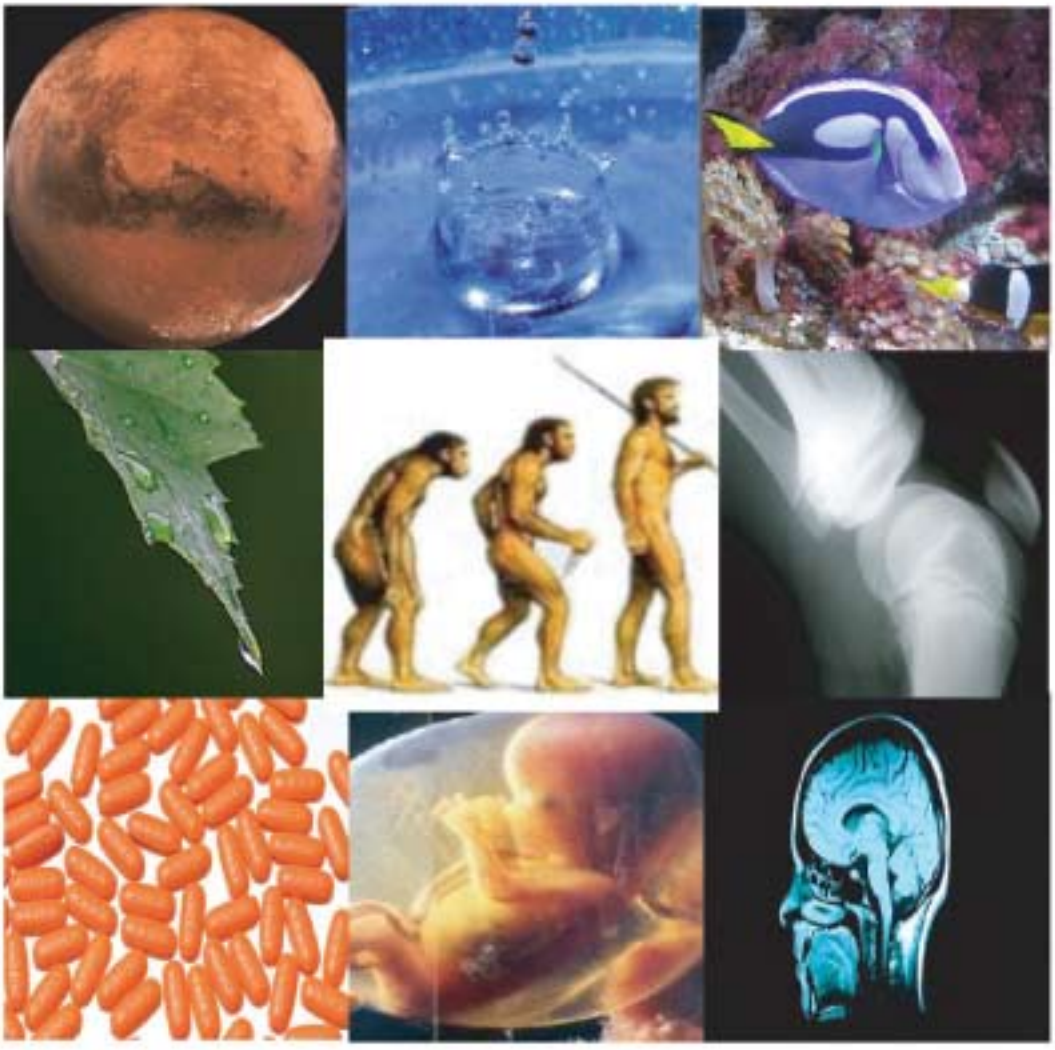

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