

ReCUR

Red Cedar Undergraduate Research

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About ReCUR

ReCUR is a bi-annual publication of the Michigan State University Honors College that highlights the diversity and quality of our students' research and creative endeavors. Each May issue of ReCUR accepts submissions from Honors College Students. Each December issue accepts submissions from participants in University-wide research and creative arts forums. In addition to providing students an outlet for publication of their work, ReCUR offers students an opportunity to learn about publication in a scholarly journal from multiple viewpoints: as a submitter, a member of the student editorial board or editorial staff.

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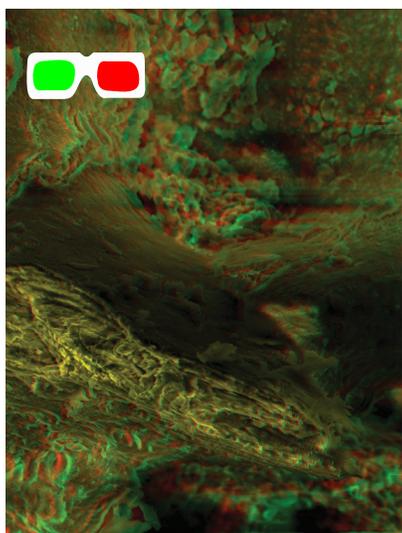
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About the front cover

The image on the front cover is a 3-dimensional scanning electron micrograph of mouse cortical bone taken at 200X magnification with the JEOL 6400V Scanning Electron Microscope (SEM). The mouse bone was dehydrated by soaking in 25, 50, 75 and 95% ethanol for one hour successively, and three repeated soakings for one hour in 100% ethanol. The bone sample was further dried to the critical point with carbon dioxide and mounted on an aluminum stub with adhesive carbon tape. The sample surface was made conductive by coating with a 21 nm thick film of gold. The image was produced by superimposing two images upon each other, taken at 0°

and 3° tilt. The imaging software package, analySIS Scandium (Olympus) produced the combination image and adjusted the color of each initial image to produce the 3-dimensional effect. Although the image is rendered well in print, it is even more striking when viewed in its electronic format (recur.msu.edu). This image was submitted by Craig Pearson, a first year Biochemistry and Molecular Biology and Honors College student. Craig captured the image while working in collaboration with Materials Science and Engineering graduate students Yutian Shu and Sara Loganbach as part of his Professorial Assistantship.

Letter from the Associate Provost and Dean of Undergraduate Studies



Undergraduate education instills in the learner the ability to think critically about the multiple dimensions of complex global problems and stimulates the desire to seek new understandings and apply these for the benefit of society.

At MSU, this occurs in a learning environment where

curricular and co-curricular experiences promote active student engagement and are grounded in clearly articulated learning outcomes. Learning at MSU allows students to see the connections that link seemingly diverse and disparate areas of knowledge and therefore provides a strong foundation for future learning.

As you think about the ideal of undergraduate education and Michigan State University's goals for student learning, the Red Cedar Undergraduate Research (ReCUR) journal exemplifies all that is best. Reading the cumulative work in even one volume of ReCUR will impress on you the dedication, talent, knowledge, and abilities of MSU students

who are preparing to be the leaders and change agents of the future. Importantly, you can also appreciate the commitment of faculty and graduate students who are transforming the lives of not only the students selected to publish their work, but the thousands of other students who are changing MSU and the world through the application and dissemination of knowledge.

My congratulations to the students selected to publish their work in ReCUR and my special thanks to the dedicated editorial board who faced the challenge of selecting the few among many whose outstanding work is featured in this edition. ReCUR is evidence that undergraduate education is achieving the goal of instilling in students the importance of creating and disseminating knowledge that enhances the lives of individuals and societies.

Sincerely,

Douglas W. Estry, Ph.D.

Associate Provost for Undergraduate Education
and Dean of Undergraduate Studies

Red Cedar River in Winter



Associate Provost Estry Photo © 2010 MSU Board of Trustees;
Red Cedar River Photo © 2008 MSU Board of Trustees.

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An interview with Drs. Stephen Lacy and Scott Michaelsen, Faculty Advisors to ReCUR



Dr. Stephen Lacy



Dr. Scott Michaelsen

ReCUR: What do you do at ReCUR, and what credentials do you bring to the assignment?

Stephen Lacy: As faculty advisers, we have a variety of tasks. We evaluate submissions, work with staff members, and help establish policy. My most notable credential for this position is that I volunteered! Beyond that, I have experience as a journalist, photographer and social science researcher. I also have served as a newspaper and academic journal editor, the latter as co-editor of the *Journal of Media Economics*. I've published four books, and my textbook, *The Media In Your Life: An Introduction to Mass Communication*, is now in its fourth edition.

Scott Michaelsen: For the last ten years I have been co-editing a University-owned journal, *CR: The New Centennial Review*, and for my editing work I earned the Phoenix Award for Significant Editorial Achievement from the international Council of Editors of Learned Journals. I try to bring all of the tools I have used in that assignment to the editorial table at ReCUR. Given that ReCUR started from scratch, I've tried to provide practical advice on everything from design to marketing, and from faculty review of submissions to copy-editing and printing. I think we're all very proud that the first issue of ReCUR looks splendid and reads even better!

ReCUR: What were your own experiences trying to get published as a young writer and thinker?

Stephen Lacy: My first few efforts to have my research accepted for conference presentations were not pretty. I think I had three papers rejected before one was ac-

cepted. But I learned from those efforts. Each time, the research got better. As athletic coaches say, we play like we practice.

Scott Michaelsen: I knew that I wanted to write and be published somewhere around the time I was ten. From then on, writing became a part of my daily life. My first published work was journalistic, and written during the time I served as the Rock Editor of the *Harvard Crimson* in 1980-81. From there, I took a Master's Degree in Journalism at Northwestern, and began writing for many magazines in the 1980s—most significantly at the *Chicago Reader*. That work led to the publication of two non-fiction, book-length studies published in 1986 and 1989 at Random House, and finally a crack at graduate school in English. Just like anyone else, I took some hard knocks along the way: I've had many rejections, but many successes. Writing and publishing early in life gave me thick skin, and the fearlessness to write about the world in ways that seemed important to me.

ReCUR: What value does ReCUR have for the University, the Honors College, and MSU students?

Stephen Lacy: ReCUR serves Honors College students in a variety of ways. In addition to providing an outlet for their research and creative work, the review process helps to improve the quality of their work. ReCUR allows the staff to learn about the scholarly publishing process. Beyond its value to students, it provides a way for Honors College alumni to stay in touch with what students are doing.

Scott Michaelsen: Education necessarily involves writing, in all fields. I am of the opinion that writing should be mandatory across the curriculum, rather than restricted to writing classes. Without the ability to use language in sophisticated ways in order to communicate with others, a college education is of limited value. The students who are submitting work to ReCUR recognize this fact, and are excited by entering a process in which they are subjected to the rigors of the various disciplines. If we do our job right, these students will stand a better chance of making a mark in their future professions. ♡

MSU Debate Team: 2010 National Debate Tournament Champions

Katelin McArdle | Department of Professional Writing



The 2009-2010 Debate Team: Pictured in the back row are Biza Repko (alumna), Jeremy Hammond (Assistant Coach), Greta Stahl (Director of Debate), Tom Gliniecki, Katie Klante, Gus Eyzaguirre, Will Repko (Head Coach), Sam Shore, David Strauss (Assistant Coach), and Cat Duffy. Pictured in the front row are Carly Wunderlich, Eric Lanning and Josh Miller.

Achieving a national debate tournament championship is an ambitious goal coveted by dedicated teams at schools across the nation. Achieving three national championships in a relatively short time span is an especially remarkable feat that has been accomplished by Michigan State University in 2004, 2006 and 2010.

The MSU Debate team travelled to the University of California at Berkeley in March 2010 to bring home their most recent national title at the 64th annual National Debate Tournament (NDT). The topic for last season's series of debates was, "The United States government should substantially reduce the size of its nuclear

weapons arsenal, and/or substantially reduce and restrict the role and/or missions of its nuclear weapons arsenal." Only the top 78 two-person teams in the nation qualified for the tournament. These teams, hailing from many of the 286 colleges and universities that participate in the NDT, qualified to compete based upon their performances at tournaments around the country. MSU had two teams qualify for this esteemed competition: Carly Wunderlich and Eric Lanning, and Sam Shore and Tom Gliniecki. On their way to winning the NDT, Carly and Eric defeated several teams, including the team from Emory University (top nationally-ranked team prior to the NDT) in the octo-semifinals and the

team from Northwestern University (second-highest nationally ranked team) in the finals.

A combination of commitment, enthusiasm and teamwork helped the MSU teams advance to the NDT. Competing against schools like Northwestern, Emory and Harvard Universities throughout the debate season, MSU proved itself to be a strong opponent. Prior to winning the NDT, Carly and Eric had also earned first place at the October 2009 Henry Clay debates at the University of Kentucky, had advanced to the final round of the Harvard University tournament in the last week of October and had finished third in the coaches' panel voting for the regular season leading up to the NDT. Sam and Tom qualified for the NDT based upon their strong performance at the district qualifying tournament at Northwestern University.

Being a member of the debate team at any level of competition is a significant commitment, requiring hours of time spent researching and practicing. Debate topics in years past have encompassed a wide range of issues, from international relations to energy policies. The topic for the 2010-2011 season is immigration law reform.

Greta Stahl, the current Director of Debate at MSU and a 2004 NDT champion provided her insights about the role research plays in debate. "Students have to investigate the in-depth pros and cons of each sub-issue of the topic and have to cite their sources during debate rounds. (Something like immigration reform covers quite a lot of ground!) Since students debate both sides of the topic at every tournament, they have to know the issue inside and out. The process is not totally different from academic research, though more emphasis is placed on recent literature in debate, as each side wants to be able to say they have the most up-to-date information. Over the last few years, the availability of information on the Internet—ranging from academic publications, to government sources, to a huge array of news sources—has meant that students have access to more information than ever."

Carly Wunderlich, one of the 2010 NDT Champions, and Tom Gliniecki, a current MSU Debate team member and a 2009-2010 NDT qualifier, also provided their perspectives on the time they have spent as members of the Debate team. Carly graduated from MSU in 2010 with a BA in Chemistry, and is currently the Assistant Debate Coach at



Carly Wunderlich and Eric Gliniecki pose with the trophy after winning the 2010 National Debate Tournament Championship.

Gonzaga University in Spokane, Washington. Tom is an International Relations and Western European Studies student planning to graduate in Spring 2011.

How did you become involved in the MSU Debate Team?

Carly: I heard about the MSU Debate Team because I went to the summer debate camp that the team runs, the Spartan Debate Institute. My instructors at the camp were both Will {Will Repko, current head coach for the MSU Debate Team} and Greta, and I really enjoyed my time there. They convinced me that MSU and MSU Debate were good fits for me.

Tom: My debate coach at Okemos High School debated for MSU when he was in college, and convinced me to attend the Spartan Debate Institute. I had the opportunity to learn from the coaches of the MSU Debate Team, who at that point had just won the national championship in 2004. It was such a great experience that I returned for the next two years, winning the camp tournament before my senior year of high school. After working with them over the years, I knew I wanted my college debate experience to be with the debate staff at Michigan State.

Can you describe the research involved with

debate-how does it relate to other courses/fields?

Carly: Debate is a research-intensive activity. We typically spend more time than a full time job researching in a typical week and since we debate on the same topic for the entire academic year the research is simultaneously in-depth and broad. I've debated on topics about the Supreme Court, the Middle East, ocean policy and nuclear weapons (just to name a few). The topics about foreign policy had obvious cross-applications for some of the International Relations classes I took at MSU. For example, I took the International Relations senior seminar about Russia with Dean Garnett and I wrote my final paper about the intersection of U.S. nuclear policy and Russian nuclear policy.

Tom: The research involved with debate is extremely intensive- every year, a different broad controversy is chosen for the topic; this year we're debating about immigration, last year about nuclear weapons policy, the year before that agriculture. Obviously, there is an extremely wide array of things to say about the specifics of something like immigration policy, and we need to be prepared to talk about all of those contingencies. During the year, we might spend as many as five or six hours every day doing research and giving practice speeches to prepare for tournaments.

A lot of MSU's debaters are in James Madison College, so usually there is an intersection between what we're learning about in our classes and the public policy controversies we talk about in debate. For example, last year I took a course on Russian foreign policy which by necessity entailed looking at the how the nuclear weapons posture of the United States influenced Russian decision making; a very large portion of the debate topic. Even outside of those direct intersections, the research skills we get from all of the work we put into debate definitely help with research papers we're assigned in our classes, since we're used to putting in a degree of effort more on par with a graduate thesis on a regular basis.

Why is debate at the collegiate level a valuable experience?

Carly: Debate for me has been something more challenging and rewarding than any other single experience. I met my best friends and had a lot of fun channeling my competitive side, but it's more than just a game. I learned how to research, commit myself to

something, work really hard for a single goal, and work as a team. I know it sounds really cheesy but college debate (specifically the MSU coaching staff) taught me to believe in myself; it taught me that if I worked really hard for something I could do anything.

Tom: There are so many positive aspects of involvement with debate that it's hard to list them all: academically, the research and critical thinking skills developed in debate have been extremely valuable to me. Outside of that, debating has given me the opportunity to travel all over the country and meet with the smartest students with similar interests from other universities. I've formed some of my deepest and most lasting friendships through debate, and I can think of no other activity that could match all of the social and academic benefits afforded by it.

How did you go about advancing to the NDT championship round?

Carly: In short, winning the national championship was entirely the result of great coaching and a great team. We all put in long hours and made a lot of sacrifices in order to do it. There were times that both Eric and I wanted to give up or weren't sure that we could do it. In those times we relied heavily on the coaches and the rest of the team. There were days I didn't want to get up and go to the Debate office but someone was always there to encourage me and I know it was the same for Eric.

What is the most challenging aspect of debate?

Carly: For me, the hardest part of debate is its subjectivity. You can work really hard for a single match-up and the judge can vote for the other team even though you thought you won. You have to be able to let the losses you don't think you deserve go. It's also what makes it so hard to put yourself on the line. It was possible that we were sure we'd won the national championship, but didn't actually win because the judges didn't agree. There's a lot of uncertainty and things that are out of your control. I think that this is the most challenging aspect of debate.

Tom: Competing against the most talented teams in the country—students from schools like Northwestern, Harvard or Berkeley—is obviously extremely difficult, but we do love a challenge. Knowing that our work is going to be tested by such a high caliber of op-

ponents is what makes us strive to improve, and that process can help us even if we lose some of those debates (but it also makes it all the better when we win!).

What has been a highlight of your career with the debate team?

Carly: I'm sure it's cliché but, for the rest of my life, I will never forget the moment that they announced we were the national champions. It was the culmination of eight years of my life ending just the way I'd hoped and dreamed. It doesn't get any better than that. I honestly looked at Eric and said "I can't believe this is my life right now." There were challenges to overcome and people who discouraged me along the way but having a core group of people who supported me and taught me to believe in myself has meant everything to me.

Tom: Obviously, it was great to be a part of the squad that won the national championship last year. Eric and Carly might have been the ones doing the actual debating in the final round, but everyone had put in a ton of their best work throughout the whole year to make that possible.

Can you recall a favorite memory or aspect of being on the team?

Carly: This is a really difficult question. There are so many little moments spent traveling or working in the debate office that made my experience really amazing. I'll share a memory that I think epitomizes why the team component of MSU Debate is so invaluable:

Eric and I were invited to debate at the Kentucky Round Robin {a small invitation tournament for the top nine teams in the country held prior to the Henry Clay debates}. We did (by Eric and my standards) terribly... {winning only} three of eight debates and {losing} to teams that we {should have defeated}. There was only a one-day break between that tournament and the {Henry Clay} tournament...The morning of our day off, Will called a meeting with Eric, Dave, Greta and me. {Will} let us vent and complain but he wouldn't let us get too down on ourselves. All the coaches told us that it was only a small set back and that they believed we could still do really well...We eventually went on to win the {Henry Clay} tournament after beating most of the teams who'd defeated us at the Round Robin earlier that week. The team and the coaches encouraged and supported us even when we weren't sure we could do it. It was the turning point of our entire year

and it could have easily been something we wouldn't have come back from without unbelievable coaching and support from the team.

Tom: One of my favorite moments happened while I was actually still in high school. MSU hosted a high school tournament in December during my senior year, and Dave Strauss, an assistant debate coach at MSU, approached me to say that some of the research I had done at the summer camp earlier in the year turned into a really large portion of MSU's strategies for that year's college topic (and eventually even some other schools started using it). As a high school student, it was awesome to know that something I had done was being used by one of the best college debate programs—and it taught me that everyone could play an important role as I went through the years as a younger member of the team.

What are some of your future goals/plans?

Carly: I'm not certain what my ultimate goal or plan is but I think I want to work towards being the director of a debate team in the short term.

Tom: Right now, I'm planning to go to graduate school, and hopefully to be an assistant debate coach at whatever grad school I end up attending.

What would you recommend to students interested in becoming involved in debate?

Carly: For anyone interested in debating the best advice I ever got was to just try it. I wasn't sure I even wanted to do it in high school or college but it was definitely worth trying to see if I enjoyed it. It's a lot of work, but it's also really rewarding, and people learn that if they just give it a try.

Tom: It's pretty difficult to go straight into the highest levels of competition in college without having had debate experience in high school—though it isn't unprecedented. The MSU debate team does some outreach activities with groups like 4-H {with which} less experienced people could {participate}. Our director would certainly be willing to answer any questions interested students might have about participation in debate activities.🍀

For more information about MSU Debate, please see debate.msu.edu.

Highlights of the Undergraduate Literature

MSU undergraduates have their work published in a wide range of scholarly journals. Below are summaries of previously published work completed by several 2010 UURAF participants.

Developing Thermal and Chemical Signatures of Building Materials

Cory Kramer worked as part of a research group led by Associate Professor Ruby Ghosh to develop a system to characterize the chemical and thermal properties of materials as they begin to burn. As a proof-of-concept of the system that they developed, they measured the thermal and chemical properties of poly(methylmethacrylate), a transparent plastic. Their goal is to use the system that they developed to build a library of thermal and chemical properties of building materials, which, when combined with remote sensing technology for gases and temperature fluctuations caused by combustion, might allow first responders to characterize what types of materials may be burning within an enclosed space. This knowledge would then enable first responders to better combat the fire prior to complete engulfment of the building.

Ghosh, R., Loloee, R., Wichman, I., and Kramer, C., Thermal and Chemical Identification of Materials Prior to Combustion, *IEEE Sensors* 25-28, 774-776, 2009.

Identification of a Potentially Novel Class of Fatty Acid Desaturases

Arthur Monoli worked as part of a research group led by Professor Christoph Benning to identify and characterize a novel fatty acid desaturase, FAD4, in *Arabidopsis thaliana*. Fatty acid desaturases are enzymes that facilitate double bond formation in fatty acids, creating monosaturated, unsaturated and poly-unsaturated fatty acids from saturated and unsaturated fatty acids. Based upon their analyses, they concluded that FAD4 is likely part of a novel class of fatty-acid desaturases with widespread distribution in many organisms, including plants, animals and humans.

Gao, J., Ajjawi, I., Manoli, A., Sawin, A., et al., FATTY ACID DESATURASE4 of *Arabidopsis* Encodes a Protein Distinct from Characterized Fatty Acid Desaturases, *The Plant Journal* 60, 832-839, 2009.

Synthesis and Characterization of a Novel Coordination Polymer Solid

Amy Pochodylo worked with Professor Robert LaDuca to synthesize and characterize zinc isophthalate coordination polymers containing bis(3-pyridylmethyl)piperazine. They created and characterized two novel polymers, $\{[\text{Zn}(\text{ip})(\text{H}3\text{-bpmp})]\text{ClO}_4 \cdot 4\text{H}_2\text{O}\}_n$ and $\{[\text{Zn}_2(\text{NO}_2\text{ip})_3(\text{H}_23\text{-bpmp})(\text{H}_2\text{O})_5] \cdot 3\text{H}_2\text{O}\}_n$. They found that the first compound forms a “parallel interpenetrated layer topology” whereas the presence of the nitro group in the second compound results in a polymer with a more “chain-like topology.” In addition, molecular orbital transitions caused the compounds to luminesce. Like other coordination polymer solids, these compounds may have applications in industrial processes.

Pochodylo, A., and LaDuca, R., Substituent Dependent Dimensionality in Luminescent Zinc Isophthalate Coordination Polymers Containing Bis(3-pyridylmethyl)piperazine, *Zeitschrift für anorganische und allgemeine Chemie* 636, 2568-2573, 2010.

Detecting Pathogens Using Barcoded DNA Sensors

Michael Huarng worked as part of a research group led by Associate Professor Evangelyn Alocilja to develop new sensors to detect disease-causing bacteria, including *Bacillus anthracis* (cause of Anthrax) and *Salmonella enteritidis* (a common cause of food-poisoning). Their system affixes specific DNA probes to different types of nanoparticles, which are modified to attach heavy metal ions through barcoded DNA. When pathogen DNA is present, heavy metal ions are released and detected electrochemically. Their work may lead to development of miniaturized and integrated micro-systems that can better function as portable testing devices in clinical settings.

Zheng, D., Huarng, M. and Alocilja, E., A Multiplex Nanoparticle-Based Bio-Barcoded DNA Sensor for the Simultaneous Detection of Multiple Pathogens, *Biosensors and Bioelectronics* 26, 1736-1742, 2010.

(Continued on page 39)

The Elusive Significance of the Fart in Chaucer's *Summoner's Tale*

Mark Kelly | Department of History

Abstract

Geoffrey Chaucer's *Summoner's Tale* has traditionally been considered a simple fabliau—puerile, crude, and ultimately bereft of any greater significance. However, over the last fifty years scholars have begun to see the tale's crude nature as rife with greater symbolic significance; some interpreting the flatulence of the central character to be a Christian allegory for the biblical Pentecost, while others painting it as an allusion to the growing power of medieval reason and science. My interpretation of the tale synthesizes these two schools of thought, envisioning flatulence as an allegory for the subtle changes in the intellectual environment of Chaucer's time: the religious authority of the friar being undermined by the reasoned explanations of the logic-laden squire and the hitherto supernatural phenomenon of the fart, seemingly inexplicable, being reduced to human control and comprehension.

Paper

Traditionally, the *Summoner's Tale* has been dismissed as a simple and crude fabliau, deriving its humor from scatological imagery of the meanest and commonest sort.¹ However, since 1971, when Alan Levitan published his seminal essay "The Parody of Pentecost in Chaucer's *Summoner's Tale*," commentators have broadened their interpretations of the tale, in particular by developing a sophisticated understanding of the tale's use of flatulence as an allusion to the biblical Pentecost.² Over the past 40 years, these scholars have both deepened and augmented Levitan's argument, while also offering new interpretations of flatulence's role in the tale, most notably as an allusion to the growing rational science of the day, specifically the medieval "science of winds."³ The tale, then, despite its underlying—indeed, essential—prurience, has been launched into contemporary thematic debates over Chaucer's work and imbued with a significance and relevance unforeseeable fifty years ago.

In order to better understand the role of flatulence in the tale, a short summary is necessary. The story begins with Friar John entering the home of the invalid Thomas, ostensibly to pray for Thomas's return to health but in reality to beg for alms. The friar pursues his goal of material enrichment through a longwinded and hypocritical diatribe about the virtues of the abstemious lifestyle against the vice of anger. This sermon's argument centers around the conceit of auctoritee, the idea that the friar, as an educated and ascetic cleric, has greater access to knowledge and divine truth—as seen through his ability to "glose" the text of the bible—than a layman like Thomas. During the sermon, the friar blithely ignores Thomas's growing ire and concludes his speech with a plea for a monetary donation (1920). Thomas agrees that he will indeed donate a gift, hidden suspiciously "bynethe [his] buttock," to the friar's monastery, but only on the condition that gift be distributed evenly amongst all the friars. Friar John, with gluttonous zeal, accepts the condition and eagerly "gropes" between Thomas's buttocks only to receive a fart of thunderous power and sound (2141-42). Insulted and embarrassed, the friar runs to the local lord, demanding that Thomas be punished for his insolence and blasphemy. The lord, however, takes no interest in such banalities, finding himself more intrigued by the intellectual question of how to divide a fart evenly among twelve friars. The lord's squire wittily solves this problem by proposing that, on a windless day, Thomas be placed atop a twelve-spoked wagon wheel and the nose of each friar be placed on each spoke—an arrangement guaranteeing, with Euclidean perfection, an equitable distribution of flatulence.

The fart forms the center of the tale and, consequently, over the past forty years, two schools of interpretation that appear superficially irreconcilable have evolved to explain its significance. Levitan began the debate by arguing that flatulence alludes to religious mystery, interpreting the image of the twelve friars surrounding the wagon wheel to receive Thomas' "wind" as a satiric parallel to medieval images of the biblical

Pentecost, where the twelve disciples in a circle receive the divine wind of the Holy Spirit—in some pictures, each receiving their own specific and equal share. Alternatively, as Timothy O'Brien and Phillip Pulsiano have claimed, the tale references nascent medieval scientific inquiry, specifically the “science of winds,” a discipline replete with its own set of images depicting the twelve divided winds flowing outward like spokes on a wheel. However, both of these arguments share a similar flaw in that they search for symbolic parallels exterior to the tale, while ignoring the symbolism internal to the tale. Both arguments presume that flatulence only has meaning when linked to specific external situations—e.g., when used as an analogue to divine wind—while investing it with no inherent meaning of its own. This may be due to common preconceptions of farting as a lowbrow comedic tool, a rather facile and thoughtless way of engendering laughter.

However, when explored at a deeper level this assumption must be discarded because the humor of farting derives from a far more profound consciousness about the human condition. Flatulence is both necessary, natural, and, most importantly, uncontrollable. It symbolizes the inability of the mind to control the body and the consequent inevitability of human imperfection, for the inner stench of mankind always seeps out. Therefore, farts, when considered with the seriousness they deserve, represent the absence of human control or will and also the innate sinfulness of human nature. The religious and allegorical significance of the fart derives from the recognition of human weakness in the face of natural forces: the fart represents something transcendent over and higher than the human will. However, Chaucer complicates this spiritual significance of flatulence by subverting it into both an allegory for, and mockery of, the emergent reason-based scientific movement that sought to rationalize medieval society. Farts, though symbolic of a spiritually driven age where uncontrollable natural phenomena dominate a humanity limited by its gassy sinfulness, become circumscribed by the imposition of the squire's logical system of order, demonstrating how an uncontrollable and natural faith might someday become controlled by humanist reason. And yet, while such a transition would seem to validate the epistemology of science, Chaucer, with characteristic moderation, questions this search for truth as well, reminding us that the entire debate centers quite literally around hot air.

The poet, then, utilizes the imagery of flatulence to frame and explicate a debate between the purveyors of two types of truth-knowing, the auctoritee-driven clergy and the experience-driven rationalists, to mock these two epistemologies' pretensions to exclusive knowledge and, ultimately, to express his own belief in anti-intellectual pragmatism.

At the start of the tale, farting is associated with the supernatural and demonic. During a short and comic prologue, the Summoner describes how when friars die they are sent to Hell, where they are stored in Satan's anus, freed only when the devil “drives” them from his “ers” like bees from a hive (1685-1700). This association with the supernatural and satanic resonates throughout the first portion of the tale, where flatulence functions as a metaphor for the mysterious or inexplicable aspects of the temporal world, the seeming supernatural in mundane existence. This is not particularly surprising because, as Karl Wentersdorf notes, flatulence has often held a prophylactic role in European religion, including the “bizarre belief, not uncommon in the medieval and Renaissance periods that an effective way to drive off the devil in time of temptation...was to turn one's back on the tempter (devil or human) and either break wind or defecate.”⁴ Flatulence and defecation thus have a two-fold symbolic significance: they can embody defilement and corruption or they can represent spiritual cleansing and protection. The scene in the prologue therefore carries a much deeper symbolic significance than might first be imagined and draws upon a far richer variety of cultural associations with breaking wind. Because farting dispels supernatural malevolence, it becomes a liminal agent between the supernatural and the natural, the demonic and the mundane.

Flatulence is not the only thing raised above human understanding in the *Summoner's Tale*. Friar John makes the case that only certain humans have the ability to understand and communicate with the divine. This sacerdotal attitude, though undoubtedly insincere in the friar's case, acts as a parallel to flatulence. Religious knowledge and education, as embodied by the friar, and flatulence, as presented in the prologue, share a common opacity: they cannot be understood by the common human. This is a recurrent social theme of the Middle Ages, where knowledge's scarcity led to a simplified societal hierarchy: there were those with access to divine consciousness, able to see and understand the world, and those who

suffered the burden of spiritual ignorance, forced to accept the teachings of the higher order. Friar John attempts to perpetuate this dichotomized social system when he lectures Thomas by emphasizing the special privileges and powers that his order gives him. To understand the meaning of the Bible “is hard to yow” he explains to Thomas, and thus requires the “glosinge” of clergymen (1791, 1793). This, of course, stems from the friar’s supposedly more ascetic lifestyle, which, in its stripped-down purity, allows him greater access to the divine realm. His closer communion to God, closer than any “burel folk” could hope to attain, gives him power (1872).

However, while the friar forthrightly asserts an epistemology of privilege, the belief that access to truth comes from one’s position in the social hierarchy, Chaucer undermines this presentation by cleverly illustrating the friar’s hypocrisy during his long-winded sermon. The sermon’s hypocrisy, of course, stems from the friar’s motive: he preaches on the morally cleansing effects of material deficiency while begging for more money from Thomas—he extols the salutary effect of poverty even as he seeks his own wealth. In asserting his greater access to truth, the friar really demonstrates his greater sinfulness and distance from divine understanding. Consequently, while the friar attempts to ground his claims to higher socio-religious position upon his ability to gloss and to fast, his obvious behavioral inadequacies in both categories call into question his claimed auctoritee, a fact emphasized by Thomas’s fart, which exposes the friar’s worldly and spiritual impotence.

Though oppressed by his lack of auctoritee and social position, Thomas asserts his agency. Formerly a believer in the Church’s power to alleviate his suffering, Thomas became a skeptic through his own empirical experience of the clergy’s inability to cure his physical ailments. When he farts into Friar John’s hand—co-opting the fart and controlling it, subjecting it to his own desires—he acts with the express purpose of embarrassing the authority figure of the friar, the man with auctoritee. With this action, Thomas has diminished the uncontrollability of the fart and the authority of the friar: both are no longer incomprehensible—occupying some ineffable higher plane beyond the grasp of normal humans—but have been demystified, reduced by human control and skepticism. By removing the fart from the realm of the supernatural and inexplicable and employing it as a

tool for his own mundane purposes, Thomas denies the legitimacy of ecclesiastical claims to divinely granted authority. Through flatulence, he exercises a crude sort of subaltern protest.

This overtly physical, but implicitly intellectual, aggression causes the friar a great deal of anxiety. The friar “up stirte as doth a wood leoun,” loudly decrying Thomas, threatening that “thou shalt abyge this fart” (2152-55). He runs to the local lord where he first describes his “despyt” (2176), then claims that Thomas “blasphemed hath our covent” (2183), because he has “charged [the friar] to parte that wol not departed be” (2213-14). This line of wild declamations and threats compellingly describes the intricacies of Friar John’s logical universe: as his outrage continues, his anxiety at the abstract principles embodied in Thomas’s actions intensify while his more personal ire at the invalid’s “despyt” diminishes. As he presents his case to the lord, the friar becomes increasingly aware of the danger that flatulence in human control signifies. Thomas becomes more than just an “olde cherl with lokkes hore” (2182): he is a “blasphemour” (2213). Significantly, Thomas’s blasphemy derives not from any specific breaking of the law or act of heresy, but rather from the friar’s interpretation of Thomas’s request as a violation of natural law. To split a fart evenly is an impossible task, and it is to this aspect of Thomas’s challenge that the friar reacts most strongly. This subversion of flatulence, this threat of making the impossible possible, profoundly vexes the friar because it intrudes into “divine privitee”—it represents a worldview that supports human inquiry into Godly power and grace, dismissing the priestly auctoritee, which the friar himself has proven to be both morally and epistemologically bankrupt.

The lord, however, ignores both the friar’s superficial anger and deeper ideological qualms, vindicating a more scientific interpretation of the world through his fascination with the intellectual questions embedded in Thomas’s strange request. He reframes the initial challenge posed by the grumpy invalid into a formal inquiry—collecting the various “blasphemies” into a coherent questioning of nature: how might a gaseous substances be equally divided? The lord takes no interest in the theological threats raised by the friar, being consumed only by his esoteric interest in the mysteries of the natural world. This sentiment provides the first unambiguous instance in the tale where religion is placed in opposition to science and reason.

Key to this conflict is the nature of the fart. The lord wants to understand the nature of flatulence both qualitatively and quantitatively—he wants to know its “soun or savour” (2266), to explain its “rumblinge” and “reverberacioun” (2233-34)—yet he concludes that this understanding is beyond man’s capabilities, that “ther is no man can demen” (2236) the inner workings of the fart. Farting, therefore, becomes the crux—for the lord, the underlying import of flatulence is its usefulness as a test of liminality, dividing the world into a natural sphere comprehensible through reason and “ars-metryke” and a supernatural plane of knowledge, unreachable to humanity.

This inquisitive scientific interest in the properties of wind and gas is reflected in the rest of Chaucer’s work; Chaucer alludes with surprising depth and regularity to the numerous classifications of wind present in medieval society, especially in his “Treatise on an Astrolabe.”⁵ When the squire solves the seemingly impossible questions posed by the lord, his solution reflects Chaucer’s own intellectual research and knowledge, lending the ridiculous series of events an air of plausibility, sensibility and rationality. The squire utilizes the language of academia throughout the proposal—“preve,” “demonstratif,” etc.—and the logic of classical geometry—“Jankin spak in this matere as wel as Euclide or Ptholomee” (2288-89). More fundamentally, the squire uses an epistemology based upon empirical evidence or experience—the results of his experiment will be “seen,” verified by the senses—in contrast to the friar, who simply asserts his own truth, relying solely upon auctoritee. The solution therefore evolves from a logic-based understanding of the world: the squire imposes the cartwheel upon the gas, defining its limits with rigorous certainty. Symbolically, the squire’s solution takes the image of the fart given at the beginning of the tale and completely subverts it. The explosive fart from the “develes ers” (1694) that sent the friars flying through hell, the rectal symbolism of spiritual imprisonment, has been converted into the fart of the cartwheel, itself now imprisoned by human logic. Formerly representative of divine control over all events—the higher powers that dominated human lives—flatulence now becomes symbolic of the power of human reason to control and understand the world.

However, the academic discussion at the heart of the squire’s solution contains satire as well as science. Certainly the entire basis of this discussion is ludi-

crous. The lord, by transforming the theological question of the friar into an essentially logical or scientific question, lessens the influence of the friar’s religious authority but he simultaneously degrades scientific learning. That is, while the theme of flagrant anti-fraternalism in the tale is overt, the mockery of those who claim to have scientific knowledge shares thematic prominence. As W. G. East argued forty years ago, the third fragment of the *Canterbury Tales*—consisting of the *Wife of Bath’s Tale*, the *Summoner’s Tale*, and the *Friar’s Tale*—is a commentary on the conflicting epistemologies of auctoritee and experience.⁶ The *Summoner’s Tale*, as the final tale in this series, offers the definitive answer to this debate, mocking anyone who presumes superior access to truth: the friar, who should be learned, manages to gloss entirely over all of the meaningful parts of the scripture—his auctoritee is fraudulent, and his mere existence calls into question the entire legitimacy of sacerdotal claims to higher truth—while the lord, whom one might expect the tale to support, abstracts the real problem of the fart into an irrelevant intellectual quibble. The lord is not interested in the friar’s hypocrisy nor is he bothered by Thomas’s obvious affront to the social hierarchies and paradigms in place, for the intellectual debate captures his full attention. Yet, the logical puzzle of the lord’s question and the reasoned solution that the squire provides are logical and reasoned only as much as they are distinct and detached from the world. In a sense, the friar is the only reasonable actor in this scene for he is the only character whose mind is grounded in reality, the actual social situation and is not distracted by some abstruse seeking of truth.

Furthermore, Chaucer’s use of academic language and imagery, while invoking the developing science of the day, a slowly bifurcating and increasingly distinct movement from religiously-based knowledge, only serves to describe the various movements of a fart, a natural phenomenon for which qualitative analysis might be more appropriate than quantitative. What the squire’s “ars-metryke” (2222) and “preve” (2272) misses is that the purpose of Thomas’s fart was not to incite theological uncertainties or scientific inquiries, but rather to exhibit the old man’s disgust for the friar—the squire fails to comprehend the fundamental message of the fart. In this context, the solution represents not intellectual profundity but a sort of comic wit; “the squire does not explain the significance of the fart,” claims James Andreas, “he simply ‘tops Thomas’s topper.’”⁷ Overall, then, Chaucer

mocks both experience and auctoritee, seeing neither as definitive methods for garnering the truth.

If Chaucer seeks to satirize those who claim to have truth in the *Summoner's Tale*, is he proposing merely a negativist argument—striking down the types of intellectuals he sees as fraudulent and presumptuous pedants—or does he have his own positive view of what creates truth, what empowers real authority and what constitutes real experience? Gregory Heyworth argues that Chaucer uses vulgarity—in the form of anality and the inarticulate, but powerfully evocative, language of the body—to express his preference for a more simple, common, or vernacular form of truth-telling.⁸ This theme, that knowledge belongs to the thoughtful regardless of social or economic position, that intellectual privilege is no match for folk wisdom, runs throughout the poet's work. To Chaucer, truth is truth regardless of its language or its speaker—indeed, there is no certain way to truth, because it can be attained through many “divers pathes.” This perspective is particularly powerful in the context of Chaucer's decision to write in the vernacular instead of languages artificially elevated by intellectual tradition: he disenfranchises both religious and scientific scholars from their linguistic privileges, claiming instead that truth is the right of the intelligent and the pragmatic, regardless of their intellectual prestige and position.

Ultimately, the *Summoner's Tale* explores two different methods of knowing—the epistemologies of religion and science, auctoritee and experience—and finds both insufficient. As a cursory review of recent literary criticism on the *Summoner's Tale* will demonstrate, the story is ideally suited towards the layering of meanings so prominent in our postmodern age, where every narrative can be picked apart into its most intricate, minuscule, and all-too-often meaningless parts.⁹ But that of course is the point—the tale's humor derives from the manner in which Chaucer manages to construct layers of arguments and significances that are, ultimately, just hot air, a reeking fart. The enormous contrast between the grave articulacy of the discourses—theological, social, and intellectual—that surround the fart and the obvious (and ludicrous) inarticulacy of the fart itself provide the humor of the story. And in that utterly inarticulate blast of air and stench, Chaucer argues against articulacy and the inherent falseness of scholarly privilege—with all of its baggage of class separation and distinction—

arguing essentially for anti-intellectualism, a negation of the search for knowledge. In the end, the *Summoner's Tale*, because it derides so much of everything—the corrupt friar, the bitter old man, the apathetic lord and the overly intellectual squire—shows itself to be a deep and disturbing commentary on the intellectual trends of Chaucer's world: the religious authorities break their promise of trust to their congregations, the scientists argue on a high metaphysical plane departed from the realities of the world and the only real, definite and meaningful act comes in the form of a fart. The *Summoner's Tale* may be one extended fart joke; but it is a fart joke with meaning. 🍌

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Endnotes

1. Szittyta, P., The Friar as False Apostle: Antifraternal Exegesis and the *Summoner's Tale*, *Studies in Philology* 71, 19, 1974.; Kittredge, G., *Chaucer and his Poetry*, Harvard University Press, Cambridge, MA, 192, 1915.
2. Levitan, A., The Parody of Pentecost in Chaucer's *Summoner's Tale*, *University of Toronto Quarterly* 40, 236-46, 1971.; Olson, G., The End of the *Summoner's Tale* and the Uses of Pentecost, *Studies in the Age of Chaucer* 21, 209-246, 1999.
3. Pulsiano, P., The Twelve-Spoked Wheel of the *Summoner's Tale*, *The Chaucer Review* 29, 388, 1995.; O'Brien, T., “Ars-Metrik”: Science, Satire, and Chaucer's *Summoner*, *Mosaic* 23, 1-22, 1990.
4. Wentersdorf, K., The Motif of Exorcism in the *Summoner's Tale*, *Studies in Short Fiction* 17, 250-51, 1980.
5. Pulsiano, P., The Twelve-Spoked Wheel of the *Summoner's Tale*, *The Chaucer Review* 29, 382-89, 1995.
6. East, W.G., By Preeve Which that is Demonstratif, *Chaucer Review* 12, 78-82, 1977.
7. Andreas, J., “Newe Science” from “Olde Bokes”:

A Bakhtinian Approach to the *Summoner's Tale*, *The Chaucer Review* 25, 146, 1990.

8. Heyworth, G., Ineloquent Ends: Simplicitas, Proctolalia, and the Profane Vernacular in the *Miller's Tale*, *Speculum* 84, 2009.

9. See, for example: Beechy, T., Devil take the Hindmost: Chaucer, John Gay, and the Pecuniary Anus, *The Chaucer Review* 41, 71-86, 2006.; Cox, C., 'Grope Wel Bihynde': The Subversive Erotics of Chaucer's Summoner, *Exemplaria* 7, 145-178, 1995.; Travis, P., Thirteen Ways of Listening to a Fart: Noise in Chaucer's *Summoner's Tale*, *Exemplaria* 16, 323-48, 2004.

References

Andreas, J., "Newe Science" from "Olde Bokes": A Bakhtinian Approach to the *Summoner's Tale*, *The Chaucer Review* 25, 138-151, 1990.

Beechy, T., Devil take the Hindmost: Chaucer, John Gay, and the Pecuniary Anus, *The Chaucer Review* 41, 71-86, 2006.

Clark, R., Doubting Thomas in Chaucer's *Summoner's Tale*, *Chaucer Review* 11, 164-178, 1976.

Cox, C., "Grope Wel Bihynde": The Subversive Erotics of Chaucer's Summoner, *Exemplaria* 7, 145-178, 1995.

East, W.G., By Preeve Which that is Demonstratif, *Chaucer Review* 12, 78-82, 1977.

Hasenfratz, R., The Science of Flatulence: Possible Sources for the *Summoner's Tale*, *The Chaucer Review* 30, 241-61, 1996.

Kittredge, G., *Chaucer and his Poetry*, Harvard University Press, Cambridge, MA, 1915.

Lancashire, I., Moses, Elijah and the Back Parts of God: Satiric Scatology in Chaucer's *Summoner's Tale*, *Mosaic* 14, 17-30, 1981.

Levitan, A., The Parody of Pentecost in Chaucer's *Summoner's Tale*, *University of Toronto Quarterly* 40, 236-46, 1971.

O'Brien, T., "Ars-Metrik": Science, Satire, and Chaucer's Summoner, *Mosaic* 23, 1-22, 1990.

Olson, G., Measuring the Immeasurable: Farting,

Geometry, and Theology in the *Summoner's Tale*, *The Chaucer Review* 43, 414-427, 2009.

Olson, G., The End of the *Summoner's Tale* and the Uses of Pentecost, *Studies in the Age of Chaucer* 21, 209-246, 1999.

Pulsiano, P., The Twelve-Spoked Wheel of the *Summoner's Tale*, *The Chaucer Review* 29, 382-89, 1995.

Travis, P., Thirteen Ways of Listening to a Fart: Noise in Chaucer's *Summoner's Tale*, *Exemplaria* 16, 323-48, 2004.

Wentersdorf, K. The Motif of Exorcism in the *Summoner's Tale*, *Studies in Short Fiction* 17, 250-51, 1980.

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Incorporating the MBTI® into Tutor Training Increases Client Satisfaction with the Writing Center

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Abstract

The Myers-Briggs Type Indicator (MBTI®) is a personality type test that yields one of 16 possible four-letter types; each type describes an individual's behavioral tendencies in a wide variety of situations, including writing and tutoring. This study explored the effects on client satisfaction of training MSU Writing Center consultants in the MBTI® and how it correlates with writing and tutoring processes. Data on overall satisfaction with Writing Center (WC) sessions was collected via a questionnaire administered to first time clients of consultant participants. Consultants then attended a 2-hr training session, including analysis of MBTI® types and techniques for adapting tutoring approach to individual clients. After training, client satisfaction with sessions was assessed again, and data from clients seen before the training was compared to data from clients seen after; a significant improvement in overall satisfaction was found.

Introduction

The Myers-Briggs Type Indicator (MBTI®) is a personality type test that identifies an individual's preference on four dichotomies: extraversion-intraversion (E-I), sensing-intuition (S-N), thinking-feeling (T-F), and judging-perceiving (J-P). The test is based upon Carl Jung's Psychological Types (1923), a theory later modified by Isabel Myers (1962), and yields 16 possible four-letter types, individualized by complex interactions between dimensions.

Jung's theory of psychological types is based on the classification of behaviors into three dichotomies (Jung 1923). The first, extraversion-intraversion, identifies where individuals obtain and direct their

energy; extraverts obtain/direct energy toward the outer world of people and things, while intraverts obtain/direct energy toward the inner world of thoughts and ideas. The second, sensing-intuition, identifies how an individual perceives information; sensing perceivers focus on details and information taken in by the senses, whereas intuitive perceivers focus on the big picture, or the patterns and possibilities presented by that information. The third, thinking-feeling, identifies how individuals process information and make decisions; thinking judges base decisions on objective analysis, while feeling judges base decisions on what they value (Jung 1923).

Myers (1962) added the fourth dimension, judging-perceiving, to identify how people structure their lives. Perceiving types approach the world using their perception function (S or N), preferring to keep their options open and resisting decision making in favor of continuing to take in new information. In contrast, judging types approach the world using their judgment function (T or F) and prefer making decisions and sticking to them. Thus, the MBTI® developed by Myers (1962) identifies where an individual's behaviors fall on these four dimensions.

In any given situation, individuals tend to exhibit behaviors characteristic of the pole they prefer on each dimension (as identified by their type), and thus develop skills associated with that pole. Although people are most comfortable displaying behaviors in line with their type, all individuals are capable of behaving in accordance with the opposite preferences. The process of gaining skills associated with the opposite preferences is known as type development. Myers (1980) believed type development was a healthy supplement to the development of personality, but this development requires that individuals first know their type because it requires conscious

expression of the opposite behaviors.

Particular MBTI® type preferences have been shown to correlate with many behaviors, including choice of major (McPherson 2007), smoking (O'Toole 2001), writing (Jensen 1984) and tutoring (Thompson 1994). Specifically, research has demonstrated that MBTI® type relates to an individual's writing process.¹ For example, extraverted writers talk about their paper topic, thriving on feedback from others, whereas introverted writers think through their topic individually and are more sensitive to criticism because of personal connections to their writing (Jensen 1984). MBTI® type also relates to primary strengths and weaknesses in writing. Thinking types focus on the logical force of their argument rather than how their audience will respond; their primary strength, then, lies in how they support their argument but lack of audience awareness may cause them to skip important transitions and/or clarifications. In contrast, feeling writers' strength lies in their ability to anticipate readers' responses, while their weakness lies in choosing arguments they value, ignoring those that are objectively stronger (Jensen 1984).

Effective writing requires the application of tendencies associated with all types (i.e., type development). Jensen and DiTiberio (1984) argue that type development is critical when revising writing. They advocate the use of preferred writing processes in the early stages and the opposite during later stages. Students have many resources available when developing writing, including professors' comments, peer review and the writing center (WC). Writing centers offer a place for students to (voluntarily) engage in collaboration with peers trained in tutoring the writing process (Harris 1986). If the goal of using this resource is to develop writing skills, clients benefit most when they receive instruction that helps them engage in type development when writing.

At the MSU WC, undergraduate consultants are trained in a required semester-long class during which they are introduced to various approaches to helping clients improve their writing. Graduate consultants are assumed to have already obtained equivalent training and/or experience. Because individuals display unique writing processes, adherence to a particular tutoring approach is likely to help some students, but consultants must adjust their ap-

proach to address the specific needs of each client. Personality type theory offers important insights as to how to accomplish this and avoid unsuccessful sessions. For example, extraverted consultants are blunt with their suggestions because they prefer that as writers (Thompson 1994). Because introverted clients are more sensitive to criticism, they may become upset or defensive in response to blunt suggestions and may stop listening to the consultant's feedback or may not return for help with a future assignment.

Cooper and Miller (1991) found a significant correlation between teaching- and learning-style congruencies and student evaluations of the instructor and course at its completion. Students who come into the WC because they want to improve their writing, therefore, will presumably be the most satisfied if consultants address their individual needs. From the authors' personal experiences, most students come to the WC during the later stages of writing. (These observations were confirmed with clients' questionnaire responses.) Thus, it is necessary for consultants to be able to help clients engage in type development as writers because the revision stages require the use of the tendencies opposite of their preferred MBTI® type (Jensen 1984). Additionally, in order to adapt their tutoring approach on an individual basis, consultants must engage in type development as tutors.

While a few researchers have investigated how the MBTI® is associated with writing processes and consultants' preferred tutoring approach in the WC context (Jensen 1984; Thompson 1994), none have quantitatively measured the effect that incorporating personality into tutor training has on client satisfaction. This study tested the hypothesis that if consultants were trained in how MBTI® type preferences influence writing and tutoring processes, client satisfaction would increase as a result of consultants' increased ability to individualize their approach and thus address clients' specific needs.

Methods

Participants: Consultants

Thirty consultants employed at the MSU WC participated in this study. This sample included both graduate and undergraduate consultants of varying experience levels. The study was presented as an

opportunity to engage in professional development and participation was voluntary.

Participants: Clients

All first-time clients of participating consultants were asked to fill out a questionnaire immediately following the session to ensure that consultants were not adjusting their approach and/or working well with that client because of familiarity. This decision will be expanded on in the discussion section.

A pilot study assessed the possible confounding effects of clients' experience with the WC, writing level, assignment and native language. Students from a WRA class, the introductory freshman writing course at MSU, served as one sample of client participants for which all of these variables were controlled. A randomly selected group of clients served as the comparison sample. Since no differences were found between these two groups, data was collected from clients under the assumption that these variables were not significantly skewing the results. Additionally, the WRA students were required to come into the WC by their professor; thus, this initial comparison served to aid in generalizability to all students, not just those who come into the WC voluntarily.

Consultants were instructed to offer the questionnaire to all first-time clients and then to leave so they were not present while the client was responding. One group of clients was sampled before consultants were trained in MBTI® types (n=86), and another group was sampled after training (n=38) to measure the effect of the training session on client satisfaction. Each consultant was assigned a number that was written at the top of each questionnaire distributed so they could be identified as pre- or post-training while maintaining anonymity.

Data were not gathered from randomly assigned groups because the purpose of this study was to improve the normal functioning of the WC at MSU. Thus, it was necessary to select participants in a way that maintained the philosophy of the WC which is based on providing students with a voluntary resource that encourages collaboration in a non-threatening, non-discriminatory atmosphere (Law 1997). Also, the only research currently published on the MBTI® and its implications for

tutor training is based primarily upon case studies (Thompson 1994). Although random sampling would have enabled more control over possible confounding effects and increased ability to identify a causative relationship between the training session and client satisfaction, the goal of this study was to expand Thompson's results and quantify them for the purpose of generalization to all writing centers.

Further, while the samples consisted of different clients, the consultants were the same across groups, and client satisfaction was measured to assess the effect of the training on consultants' approach and the success of that approach during their first meeting with a new client. It was necessary to sample different clients before and after consultant training because of the possible confounding effects of familiarity. Additionally, consultants asked all new clients to fill out a questionnaire and informed them that participation was voluntary, resulting in different numbers of clients who agreed to fill out the questionnaire in the two groups. It is also possible that the reduction in participation seen between the groups that completed questionnaires resulted from overall decreased usage and/or a decrease in first time users of the center across the academic year that occurred between training sessions (documented usage trends (not shown)).

Measures

Data were collected using a questionnaire developed by the researcher (see Appendix, which is available online at recur.msu.edu/archive.html), which was designed to measure overall client satisfaction by assessing clients' reactions to specific behaviors expressed by the consultant. The questions were based on the observations presented by Thompson (1994) concerning the habitual behaviors of consultants associated with each of the eight possible MBTI® preferences. For example, the statement "I wish the consultant had focused more on adding to the paper rather than polishing it" refers to the judging-perceiving dimension: judging tutors tend to view the paper as a finished piece in need of polishing. Eighteen questions consisted of a statement (e.g., "The consultant effectively helped me anticipate readers' reaction to my ideas/word choice.") to which clients were asked to respond on a 10-point Likert-type scale (1 = strongly disagree to 10 = strongly agree).

Of the scaled questions, seven were negatively scored (e.g., “The consultant jumped right into the session before getting a good idea of what I wanted to work on”) to identify clients displaying an acquiescence response style (i.e., the tendency to respond with agreement regardless of the content of the question (Weijters 2010)). Data were excluded if this was the case. In addition, seven open-ended questions (see Appendix) were included to validate the scaled question responses. To verify the effects demonstrated, follow-up interviews with consultants were conducted a few months after they completed the training to assess whether they believed the training impacted their tutoring.

Training Session

Consultant participants attended one 2-hr training session in groups of two to three. They were instructed to take the MBTI® Form Q online before their scheduled time and were given their results at the beginning of the session to help them understand their own tutoring approach and to compare their type with other consultants. They were then walked through the writing preferences associated with each type, as previously published (Jensen 1984). Following this discussion, consultants were given writing samples and were asked to identify the author’s type based on characteristics of the writing (e.g., extent to which the author seemed aware of their audience). Next, MBTI® type influences on tutoring approaches were presented. The best approach to aiding these clients/authors based on their identified type (each of them also took the MBTI®) was discussed, and consultants were asked to reflect on how this differed from their preferred approach. Finally, techniques for individualizing tutoring approach based on client type (as identified using their writing) were presented and discussed (e.g., if client was identified as a thinking type, one could focus more on helping them increase audience awareness).

Statistical Analysis

Clients’ satisfaction, as measured with their responses to the scaled questions, was analyzed in two ways. First, the average total score, calculated for each client by averaging the scores for each of the 18 questions, was compared (pre- and post-consultant training). This was taken to be an objective measure of satisfaction because it reflected clients’

responses to the actual approach taken by consultants. Second, the average score on question 18 (Q18: “Overall, I was 100% satisfied with my writing center session.”) was compared across groups. This rating was taken to represent a subjective measure of satisfaction because it simply asked clients to specify how happy they were with the session without taking into account any specific behaviors exhibited by the consultant. Both comparisons were completed using independent samples t-tests; an increased score on both measures, which reflected consultants’ ability to individualize their approach (i.e., change their behavior during the session to focus on what the client most needed) was expected.

Results

Since the questionnaire was developed for the purpose of this study, reliability and validity analyses were conducted. First, a pilot questionnaire was administered and revised based on respondent feedback concerning the clarity of questions and the usefulness of open-ended responses (e.g., “What did you want to work on? Did you accomplish your goals?” was expanded; see Q1 in Appendix). Once the questions were finalized, inter-item correlations were analyzed to verify internal consistency reliability, yielding a Cronbach’s alpha of 0.92 for the 18 scaled questions. The validity of the measure was checked by comparing the answers provided for the open-ended questions to the scores on the scaled questions. Analysis revealed high correlations between these two question types, suggesting that the questionnaire had sufficient construct validity. Thus, the statistical tests were conducted under the assumption that the questionnaire was a valid, reliable measure of client satisfaction.

Client satisfaction before consultants were trained (pre) was compared to after (post). This comparison was run on two values: the total score (TS) and Q18 in isolation. In the pre-training group, the mean total score was 6.81 (standard deviation (SD)=1.498) and the mean score on Q18 was 7.44 (SD=1.926), and these scores increased to 8.20 (SD=1.379) and 8.95 (SD=1.012), respectively, in the post test (Table 1). Independent samples t-tests were conducted to determine whether these differences were significant. Results indicated that the training significantly improved client satisfaction on both of these measures (TS: $t_{122}=4.897$, $p<0.000001$; Q18: $t_{122}=4.543$,

Table 1. Results of independent samples t-tests comparing pre- and post-consultant training data

	Mean (Pre)	Mean (Post)	Degrees of Freedom	t-statistic	Significance
TS ¹	6.8088 (SD=1.498)	8.2047 (SD=1.379)	122	4.897	p<0.00001
Q18 ²	7.4419 (SD=1.925)	8.9474 (SD=1.012)	122	4.543	p<0.00001

p<0.00001; see Table 1).

Interestingly, one of the most salient differences between groups was the range of scores on Q18. Because the sample included both undergraduate and graduate consultants of varying experience levels and personality types to begin with, the scores on Q18 for the pre-training group ranged from 1 (lowest possible satisfaction) to 10 (highest possible satisfaction), as expected (Figure 1). The post-training responses to this question, on the other hand, ranged from 7 to 10 (Figure 2). These results suggest that the training served to lessen the difference across consultants, as well as between sessions for each consultant, and decreased the likelihood of unsuccessful sessions.

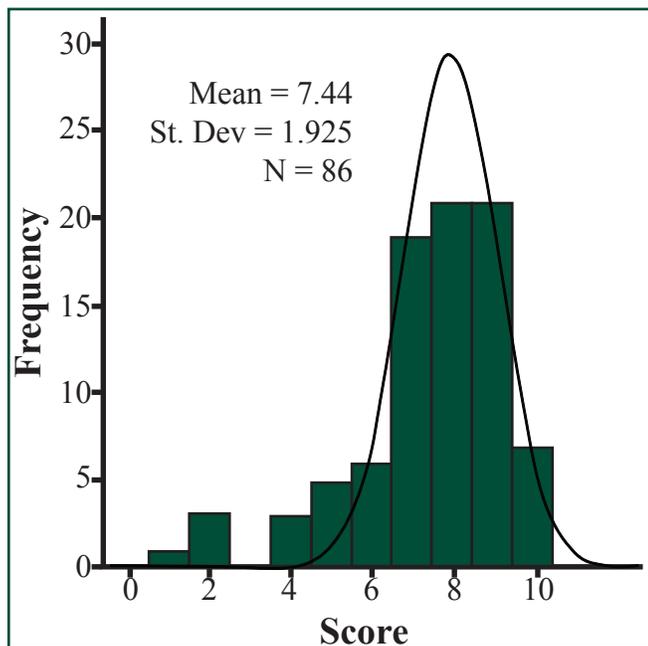


Figure 1. Distribution of scores on Question 18 prior to consultants' participation in training

In follow-up interviews, consultants indicated that they believed the training had influenced their tutoring, and that they had used what they learned to target clients' specific needs in subsequent sessions. Consultants also indicated that the training

had helped them understand why clients behaved in particular ways (e.g., why some clients became very defensive in response to their suggestions), which allowed them to ease the tension before it became a problem (i.e., resulted in a totally unsuccessful session).

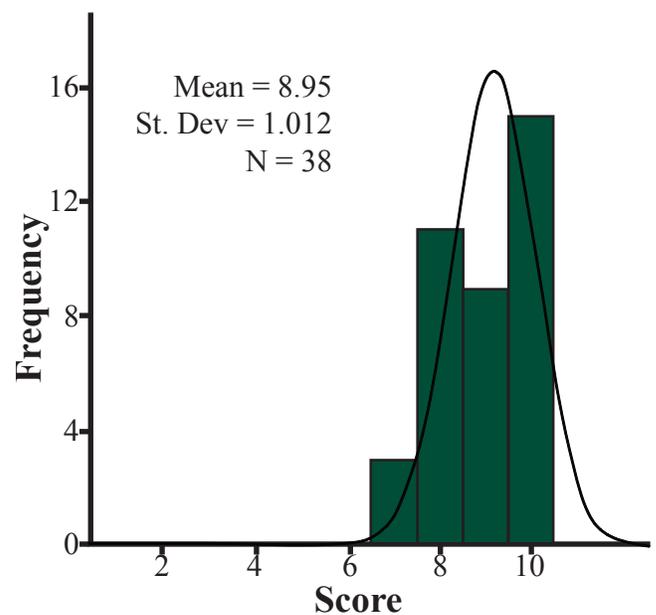


Figure 2. Distribution of scores on Question 18 following consultants' participation in training

Discussion

The goal of the MSU WC is to help students become better writers by engaging them in collaboration about their writing process and offering suggestions for how to improve its effectiveness. The success with which consultants achieve this goal determines clients' satisfaction with their sessions and necessarily depends on the consultants' abilities to accurately identify and address the needs of the client in question. To best aid every client, and thus maximize satisfaction with the WC, consultants need to be able to adapt their tutoring approach on an individual basis. This study hypothesized that if consultants were trained in the differential effects of the

various MBTI® type preferences on writing and tutoring processes, client satisfaction would increase as a result of consultants' increased ability to individualize their approach and thus address clients' specific needs.

The scores on the client satisfaction questionnaire significantly improved (both total score and Q18) in the post-training group compared to the pre-training group (Table 1; Figures 1 and 2). Based on these results, we conclude that the training session helped consultants individualize their tutoring approach. In follow-up interviews, consultants indicated that they had applied what they learned in the training to later sessions and that they approached these sessions differently than they would have had they not been through the training.

Cooper and Miller (1991) used the MBTI® to measure learning- and teaching-style incongruencies (e.g., teachers using an intuitive teaching-style while students preferred a sensing learning-style) and found correlations between the level of learning and teaching-style congruency and both academic performance and student evaluations of the instructor and the course as a whole. These results suggest that students are most satisfied when their needs are being targeted by a particular teaching-style, which supports the findings of this study as well as the original predictions that adherence to a particular approach will be helpful for some clients, but not all. Thus, if consultants are able to adjust their approach to meet the individual needs of their clients, the students will leave satisfied with their sessions because they will have learned how to improve their writing from a perspective congruent with their learning style.

Further, the scores on Q18 ("Overall, I was 100% satisfied with my writing center session.") ranged from 1 to 10 in the pre-training group (Figure 1), but only 7 to 10 in the post-training group (Figure 2). Based on these results, we propose that consultant experience level, which most likely played a role in setting the range of the pre-training scores, mattered less in determining client satisfaction after the training session. If the effects of personality type are taught to consultants early (i.e., during their original training), they will be more equipped to help clients become better writers from the start. Additionally, some MBTI® types contribute to problematic sessions. For example, introverted clients, who are more personally connected to their writing because it

is heavily based on introspection, may cry or become defensive in response to their extraverted consultant being too blunt with comments. Even the most experienced consultants have had their share of these sessions. Incorporating personality type theory into tutor training may help prevent, or at least notably lessen the occurrence of, these sessions altogether because consultants will begin tutoring with an understanding of the personality type differences that complicate tutoring sessions.

Before the MBTI® training session, consultants with more experience may have been better at avoiding unsuccessful sessions because of the general sense of familiarity with the WC and the typical clients encountered. However, this experience does not necessarily ensure success with all clients. In addition, this generalized familiarity builds over a long period of time, and some consultants never develop it fully. Training in personality types, on the other hand, did make a difference for all consultants, as evidenced by the lack of the bottom six satisfaction scores (1-6 on Q 18) from the post-training questionnaires.

Similarly, repeat clients (i.e., those that schedule weekly appointments with the same consultant) establish a rapport with the consultant, making their sessions more and more productive as time goes on. This familiarity results from their getting to know each other. The consultant implicitly picks up on the client's personality (and vice versa) and begins to understand the client's writing process, which makes the sessions more successful because the consultant knows what to address to achieve the goal of helping the client improve his or her writing. Incorporating personality type theory into tutor training will help consultants establish a similar familiarity with their clients the first time they meet.

The method employed in this study leaves open the possibility that the effect demonstrated can be attributed to alternative explanations. For example, the increase in satisfaction could have resulted from consultants improving as a function of time (and thus their increased experience as consultants) rather than as a result of the training session itself. However, this is unlikely for two reasons. First, the consultants who participated were of varying experience levels at the start of the study and their improvement as a result of time would not explain the decrease in the range of scores obtained on the post-training questionnaires as compared to the

pre-training questionnaires (3 points, as compared to 9). Further, the time between the pre-training and post-training questionnaire administration, which averaged a few days, was not large enough to induce any significant differences in experience level.

It is also possible that the difference in satisfaction resulted from pre-existing differences in the personality types of the clients who provided the data. This possibility was measured with an additional set of questions at the end of the questionnaire that were included to assess clients' preferred writing processes. The questions were constructed using previously reported writing tendencies associated with each of the possible MBTI® types (Jensen 1984; Thompson 1994) and clients were instructed to choose the statement that most often described their writing process. The responses to these questions revealed no patterns in the MBTI® preferences of clients who utilize the WC; thus, the effect cannot be attributed to pre-existing differences in personality across groups.

One possible direction for future research would be to investigate further the effects of this training on consultants' satisfaction with their experiences at the WC. When sessions are highly successful, it is more satisfying for the consultant (at least in the authors' experiences). Follow-up interviews were conducted in an attempt to validate the current results, but more insight may come from focusing a study on this aspect. Further, identification of the specific aspects of the training session that improved consultants' effectiveness would help to generalize the results and allow for development of a standard protocol for tutor training programs that could be introduced and applied across all writing centers. This, in turn, will improve the overall effectiveness of tutor training and, therefore, of writing centers.

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Endnotes

1. As used here and throughout, the "writing process" refers to a collection of processes, applied individually or in concert at any point from the start of a project until its completion.

References

Cooper, S., and Miller, J., MBTI® Learning-style Teaching-style Discongruencies, *Educational and Psychological Measurement* 51, 699-706, 1991.

Harris, M., *Teaching One-To-One: The Writing Consultation*, National Council of Teachers of English, Urbana, IL, 1986.

Jensen, G., and DiTiberio, J., Personality and Individual Writing Processes, *College Composition and Communication* 35, 285-300, 1984.

Jung, C., *Psychological Types*, Harcourt Brace, New York, NY, 1923.

Law, J., and Murphy, C., Formative Assessment and the Paradigms of Writing Center Practice, *Clearing House* 71, 106-108, 1997.

McPherson, B., and Mensch, S., Students' Personality Type and Choice Of Major, *Academy of Information and Management Sciences Journal* 10, 1-18, 2007.

Myers, I., *The Myers-Briggs Type Indicator: Manual*, Consulting Psychologists Press, Palo Alto, CA, 1962.

Myers, I., *Gifts differing*, Consulting Psychologists Press, Palo Alto, CA, 1980.

O'Toole, T., and Torabi, M., A Comparison of Personality Types Considering Tobacco Use, *American Journal of Health Studies* 17, 20-25, 2001.

Thompson, T., Personality Preferences, Tutoring Styles and Implications for Tutor Training, *The Writing Center Journal* 14, 137-149, 1994.

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Transcript Profile of Hexose Transporters Along the Horse Gastrointestinal Tract

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Abstract

Dietary carbohydrate imbalances and hexose malabsorption in horses have been implicated in the etiology of many metabolic disorders such as laminitis and colic. To test the hypothesis that hexose transporter transcripts are in lower abundance in the large intestine compared to the small intestine of the horse, mRNAs of candidate genes encoding for hexose transporter proteins were quantified in small and large intestinal segments of the horse. Four adult horses euthanized due to illness unrelated to gastric disturbances were used. Mucosal samples were taken from two segments of the small intestine (distal jejunum and ileum) and three segments of the large intestine (cecum, left ventral colon and left dorsal colon). Complementary DNA was manufactured from all samples and mRNA abundances of the genes encoding candidate hexose transporters GLUT1, GLUT2, GLUT5 and SGLT1 were determined using relative quantitative PCR. The $2^{-\Delta\Delta C_T}$ method was used to compare the candidate hexose transporter gene mRNA abundances in the ileum, cecum, left ventral colon and left dorsal colon to that of the jejunum. Relative to the jejunum, mRNA abundance of the gene encoding GLUT1 was not different in the ileum, cecum, and left ventral colon, and increased ($p \leq 0.05$) in the left dorsal colon. mRNA abundances of the genes encoding GLUT2, GLUT5 and SGLT1 were not different in the ileum and decreased ($p \leq 0.01$) in the cecum, left ventral colon and left dorsal colon relative to the jejunum. The majority of the hexose transporters examined were in low abundance in the large intestine, indicating that there is little absorption of glucose, galactose or fructose across the large intestine of the horse. The physiological relevance of increased transcript abundance of the gene encoding GLUT1 in the equine large intestine is unknown.

Introduction

In mammalian omnivores, hydrolytic digestion of soluble carbohydrates occurs in the stomach and small intestine, followed by absorption of sugar hexoses (glucose, fructose and galactose) across the small intestine. Absorption is a very efficient process in order to minimize flow of nutrients into the large intestine. Increased availability of sugars to the large intestine can produce diarrhea resulting from an osmotically induced back-flux of water into the lumen or increased bacterial overgrowth (Cheeseman 2002).

The horse is a monogastric herbivore, thus relying on forages as its main diet and an enlarged cecum and proximal colon for fermentative digestion of structural carbohydrates. High and/or sudden intake of soluble carbohydrates such as those found in grains increases flow of unabsorbed sugars to the large intestine, thus shifting the large intestinal microbiota in favor of lactobacilli growth and increasing risk for colic and laminitis (Milinovich 2006). It is likely that the large intestine is limited in its capacity for sugar absorption. Monosaccharide absorption from the small intestinal lumen occurs via hexose transporters SGLT1, GLUT5, GLUT1 and GLUT2 located in both the apical and basolateral membranes of the absorptive epithelial cells (Barone 2009).

To date, large intestinal hexose transporters in the horse have not been characterized. Dyer and colleagues (2002) have determined D-glucose uptake and mRNA abundance of SGLT1 in the small intestinal apical membrane. Merediz and colleagues (2004) reported the presence of GLUT5 protein on the apical membrane and of GLUT2 on the basolateral membrane. Transcript abundance of the gene encoding SGLT1 was shown to parallel glucose uptake in intestinal brush-border membrane vesicle preparations, implying that mRNA abundance likely reflects change in transporter protein abundance

(Dyer 2009). To date, no studies have reported on the abundance of hexose transporter transcripts in the horse's large intestine. Profiling the glucose transporters' expression across the horse's small and large intestinal tract would provide a better understanding of nutritionally-induced gastrointestinal dysfunctions in horses. To test the hypothesis that hexose transporter gene expression in the large intestine is lower than in the small intestine, mRNA abundances of candidate hexose transporter genes were determined in segments of the small and large intestine of the horse.

Material and Methods

Animals and Tissue Collection

Animals and tissues used in this study are the same as described in our previously published study (Woodward 2010). Briefly, four horses (3 Standardbreds, 1 Thoroughbred; 2 geldings, 2 mares) of ages 3 to 10 years were used. Horses were maintained on a diet consisting of a mixed alfalfa and timothy grass hay provided at 2% of the horse's body weight and 1.4 kg of a concentrate meal containing 10% crude protein (Purina Omelene) and were euthanized due to health conditions unrelated to gastric disturbances. Samples were collected from two segments of the small intestine (the distal jejunum and ileum) and three segments of the large intestine (the cecum, the left ventral colon and left dorsal colon). Anatomical locations of each sample collection site were documented on the first horse and repeated on each subsequent horse. After collection of each segment, the mucosal layer was gently separated from the serosa, cut into small pieces (~1 g) and flash frozen in liquid Nitrogen. Samples were stored at -80°C until isolation of RNA.

RNA Isolation and cDNA Manufacture

RNA was extracted from the mucosal tissue and tested for purity and quality as previously described (Woodward 2010).

cDNA was synthesized using RNA from each treatment as template in reverse transcription reactions using Superscript III reverse transcriptase and oligo(dT)15-18 primer (Invitrogen, Carlsbad, CA, USA) as recommended by the manufacturer. Final cDNA concentrations were quantified by spectrophotometry (NanoDrop 1000, Thermo Scientific, Wilm-

ington, DE). Samples were then diluted to a working stock of 10ng/μL and stored at -200°C.

mRNA Abundance Assay of Candidate Genes by Quantitative PCR

We used the following primer pairs: 5'-GCTGCCAAATACGATGAGATCA-3' and 5'-GCCCAGGATGCCCTTGA-3' for the reference gene GAPDH (Glyceraldehyde 3-phosphate dehydrogenase, Accession No. XM001496020); 5'-GCATGCTTGAGCCTTCTCT-3' and 5'-TTCCGCCGGCCAAAG-3' for SLC2A1 (encodes GLUT1, Accession No. DQ139875); 5'-TTGCGAGGCCTGATGCTAT-3' and 5'-GATGGAGGTCAGGGAGCTCAT-3' for SLC5A1 (encodes SGLT1, Accession No. AJ292081); 5'-CTGTCTGTGTCCAGCTTTGCA-3' and 5'-GCCACCCACCAAAGAATGAT-3' for SLC2A2 (encodes GLUT2, Accession No. AJ715983); and 5'-TGACGTTGCTGTGGTCCATT-3' and 5'-TCCGACGAAGCCTCCAAA-3' for SLC2A5 (encodes GLUT5, Accession No. AJ555215) for our assays.

Efficiency of primers was determined using the relative standard curve method for real-time PCR as previously described by Yuan et al. (2006). Briefly, in this standard curve method, cycles to threshold (C_T) were regressed against known cDNA concentrations and the slope of the resulting linear equation used to compute the efficiency of the primer using the equation $(10^{-1/\text{slope}} - 1) \times 100$. The 2-fold, 5-point relative standard curve was made using cDNA from a pool of RNA of all the samples. Duplicates of each standard were included on each assay plate along with duplicates of experimental samples and non-template controls. Primers for selected genes were designed using Primer Express software (v. 3.0, Applied Biosystems, Foster City, Ca) with default features and were based on publicly available equine cDNA and EST sequences deposited in NCBI.

Before qPCR, primers were compared to published equine genome sequence using BLAST (Altschul 1997) and optimized for forward and reverse concentration using a primer optimization matrix (Mikeska 2009). For the qPCR assays, calculated amounts of cDNA templates (10ng/μL) were combined with 12.5 μL 1x SYBR Green master mix (Applied Biosystems), a calculated amount of each primer's working stock and brought to a 25 μL total using DNase/RNase-free water. Reactions were performed in MicroAmp

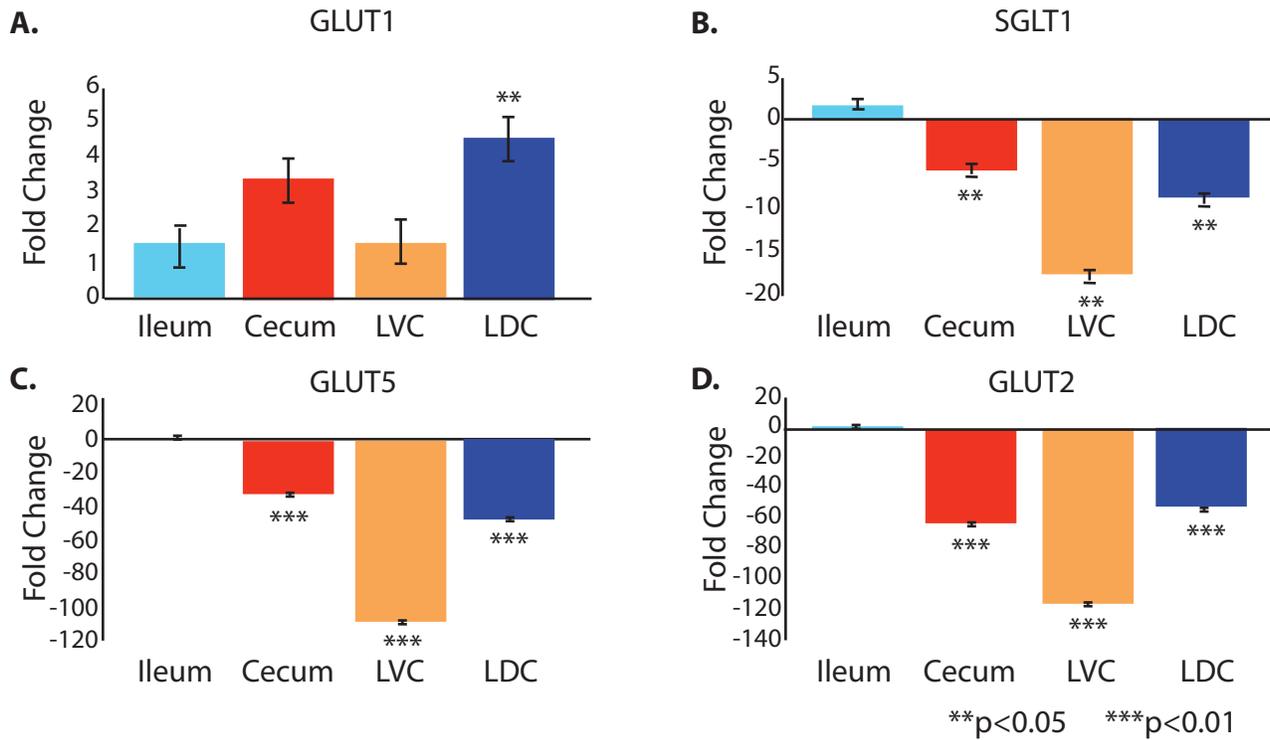


Figure 1. Fold change in mRNA abundance of the hexose transporters A) GLUT1, B) SGLT1, C) GLUT5 and D) GLUT2 in equine intestinal segments relative to mRNA abundance in the equine jejunum. Each bar represents mean fold change \pm standard error of the mean. LVC and LDC correspond to Left Ventral Colon and Left Dorsal Colon, respectively.

Optical 96-Well Reaction Plate (Applied Biosystems) with an ABI Prism 7000 Sequence Detection System (Applied Biosystems).

qPCR conditions were a single cycle of 50°C for 2 min followed by 95°C for 10 min for initial denaturation, followed by 40 cycles of 95°C for 15 sec and 60°C for 1 min for primer annealing and elongation. To ensure a single amplicon was produced, we added a final dissociation stage of 95°C for 15 sec, 60°C for 1 min and 95°C for 15 sec. This step also served to validate primer pairs. A non-template control (RNase-free water) was used for every primer pair during each qPCR run.

Statistical Analysis

We used the PROC MIXED procedure (SAS version 9.0, SAS Institute Inc., Cary, NC) to analyze our data as previously described (Woodward 2010). Briefly, we included the fixed effect of intestinal tract section and the random effect of individual horses in our model and compared the mean cycles to threshold (C_T) of each segment to the mean C_T of the jejunum using the student's t-test. Differences in C_T were log-transformed to represent fold-change in mRNA abun-

dance using the $2^{(-\Delta\Delta C_T)}$ method (Livak 2001). We report results for each gene individually as normalized C_T values and as a fold-change relative to the jejunum. Significance was determined at $p < 0.05$.

Results

The primers designed for each gene were analyzed using the relative standard curve method for qPCR as described by Yuan et al. (2006). GAPDH was appropriate for use as the housekeeping or reference gene as there was no difference in mRNA abundance between segments ($p = 0.98$). The actual C_T values for the jejunum, ileum, cecum, left ventral colon and left dorsal colon were 23.31, 23.12, 22.69, 23.07 and 22.58. Each candidate transporter C_T value was normalized to that of GAPDH, and the normalized C_T compared to that of the jejunum. Relative to the jejunum, abundance of transcripts encoding GLUT1 was not different in the ileum, cecum, and left ventral colon, and increased in the left dorsal colon ($p \leq 0.05$). mRNA abundances for genes encoding the transporters GLUT2, GLUT5 and SGLT1 were not different in the ileum and decreased ($p \leq 0.01$) in the cecum, left ventral colon and left dorsal colon relative

to the jejunum (Figure 1). For GLUT2, GLUT5 and SGLT1, the largest fold decrease when compared to the jejunum was noted in the left ventral colon.

Discussion

This study is the first to report on the characterization of hexose transporter transcript abundances across proximal and distal intestinal segments of the horse. Herein, we have shown that the majority of glucose transporters' mRNA profiled are in lower abundance in the large intestine compared to the small intestine, in particular, transcripts encoding GLUT2 and GLUT5. There was a disproportionate abundance of transcripts encoding SGLT1 compared to GLUT2 and GLUT5, indicating that glucose transport, if any, by colonic epithelial cells, is restricted to the apical membrane. Indeed, SGLT1 is responsible for transport of glucose and galactose with low capacity and high affinity across the apical membrane of the intestine epithelial cell by way of sodium co-transport (Dyer 2002). Transcript abundance of the gene encoding SGLT1 was shown to parallel glucose uptake in intestinal brush-border membrane vesicle preparations (Dyer 2009) and transcript abundance of the gene encoding GLUT5 was shown to parallel protein expression (Merediz 2004). These prior results indicate that mRNA abundance likely reflects change in transporter protein abundance.

Horses gradually offered diets containing grain have an increased capacity for D-glucose transport compared to that of horses maintained on grass diets via increased expression of SGLT1 in the mid and distal intestine (Dyer 2009). Modulation of SGLT1 by dietary sugar content has also been noted in other species such as rats and mice. In addition, in the young weaned sheep, a ruminant, dietary changes from milk to grass with increased forage utilization by the rumen is associated with a decrease in the activity and expression of small intestinal SGLT1. Bypassing the rumen by adding D-glucose directly to the luminal content of the ovine small intestine stimulated functional expression of SGLT1 (Dyer, 1997) (Wood 2000). The ability of SGLT1 to increase in expression in response to an increase in dietary sugar may explain in part the low mRNA abundance of SGLT1 in the large intestine of the horse compared to the small intestine.

On the other hand, GLUT5 is responsible for transport of fructose across the apical membrane of the intestinal epithelial cell by way of facilitated diffusion, with high capacity and low affinity for fructose (Merediz 2004). GLUT2 is responsible for transport of glucose, galactose and fructose from the intestinal epithelial cell into the blood stream via the basolateral membrane by facilitated diffusion, with high capacity and low affinity. In rodents, cattle and horses, GLUT5 has greater abundance in the duodenum and proximal jejunum when compared to the distal jejunum and ileum. In immunodeficient rats, an increase in GLUT5 expression in the proximal small intestine has been observed and suggested to be a mechanism designed to reduce the availability of nutrients to the microflora located in the more distal sections of the gastrointestinal tract (Douard 2008). Immunohistochemical staining of the horse's small intestine demonstrated exclusive expression of GLUT5 on the brush border membrane of the villus enterocyte with no expression in either the crypts or the basolateral membrane, as also shown in the human small intestine (Merediz, 2004). GLUT2 transporters have been shown to reside in intracellular vesicles and to be recruited to the apical membrane upon signaling following glucose consumption. When sugar concentrations exceed the absorptive capacity of SGLT1 and GLUT5, unsaturated, high capacity GLUT2 is rapidly translocated to the apical membrane (Leturque 2009). Stimulation by insulin results in the movement of GLUT2 transporters back into the cytoplasm attached to vesicles (Leturque 2009). However, horses appear to lack GLUT2 transporters on the apical membrane, explaining in part their decreased ability to digest high quantities of soluble carbohydrates in the proximal small intestine. Conversely, according to Cheeseman (2002), the majority of intestinal glucose absorption in the dog, a mammalian omnivore, is due to the translocation of GLUT2 to the apical membrane. As demonstrated for SGLT1, horses maintained on concentrate diets increase intestinal expression of GLUT2 transporter (Dyer 2009). However, this increased expression occurs only at the basolateral membrane only.

GLUT1 is responsible for basal uptake of glucose used in cellular respiration. GLUT1 increases in expression when the cell is experiencing glucose stress with increasing expression with decreasing glucose concentration (Wertheimer, 1991). In this study,

GLUT1 expression increased in the distal portion of the large intestine compared to the jejunum, possibly due to the lower luminal content of free sugars.

In conclusion, hexose transporters examined in this study and known to be involved in absorption of hexoses in the small intestine were in low abundance in the large intestine, in particular those of high capacity and low affinity, such as GLUT2 and GLUT5, indicating that there is likely a reduced capacity for absorption of glucose, galactose or fructose across the large intestine of the horse. Although we recognize that the level of expression in the large intestine may be in part due to the low luminal content of free sugars, the fold difference in expression was markedly high, pointing to low basal expression level relative to the small intestine. Conditions resulting in under-expression of these transporters in the small intestines, or the feeding of diets with high amounts of carbohydrates, may lead to excess carbohydrates in the large intestine that are unavailable to the horse but readily available to the microbiota. Hence, soluble carbohydrate feeding to horses should be carefully carried out taking into consideration both the dietary and anatomical factors affecting changes in expression of hexose transporters, and the relative capacity of those hexose transporters for absorption in the small intestine. 🍎

References

- Altschul, S., Madden, T., Schaffer, A., Zhang, J. et al., Gapped BLAST and PSI-BLAST: a New Generation of Protein Database Search Programs, *Nucleic Acids Res* 25, 3389-3402, 1997.
- Barone, S., Fussell, S., Singh, A., Lucas, F., et al., Slc2a5 (GLUT5) Is Essential for the Absorption of Fructose in the Intestine and Generation of Fructose-Induced Hypertension, *J Biochem* 284, 5056-5066, 2009.
- Cheeseman, C., Intestinal Hexose Absorption: Transcellular or Paracellular Fluxes, *J Physiol* 544, 336, 2002.
- Douard, V., and Ferraris, R., Regulation of the Fructose Transporter GLUT5 in Health and Disease, *Am J Physiol Endocrinol Metab* 295, E227-E237, 2008.
- Dyer, J., Hosie, K., and Shirazi-Beechy, S., Nutrient Regulation of Human Intestinal Sugar Transporter (SGLT1) expression, *Gut* 41, 56-59, 1997.
- Dyer, J., Fernandez-Castano, M., Salmon, K., Proudman, C., et al., Molecular Characterization of Carbohydrate Digestion and Absorption in Equine Small Intestine, *Equine Vet J* 34, 349-358, 2002.
- Dyer, J., Al-Rammahi, M., Waterfall, L., Salmon, K., et al., Adaptive Response of Equine Intestinal Na⁺/Glucose Co-Transporter (SGLT1) to an Increase in Dietary Soluble Carbohydrate, *Pflugers Arch* 458, 419-430, 2009.
- Kellett, G., Brot-Laroche, E., Mace, O., and Leturque, A., Sugar Absorption in the Intestine: The Role of GLUT2, *Annu Rev Nutr* 28, 35-54, 2008.
- Leturque, A., Brot-Laroche, E., and Le Gall, M., GLUT2 Mutations, Translocations, and Receptor Function in Diet Sugar Managing, *Am J Physiol Endocrinol Metab* 296, E985-E992, 2009.
- Livak, K., and Schmittgen, T., Analysis of Relative Gene Expression Data using Real-Time Quantitative PCR and the $2^{-\Delta\Delta C_T}$ Method, *Methods* 25, 402-408, 2001.
- Longland, A., and Byrd, B., Pasture Nonstructural Carbohydrates and Equine Laminitis, *J Nutr* 136, 2099S-2102S, 2006.
- Merediz, E., Dyer, J., Salmon, K. and Shirazi-Beechy, S., Molecular Characterization of Fructose Transport in Equine Small Intestine, *Equine Vet J* 36, 532-538, 2004.
- Mikeska, T., and Dobrovic, A., Validation of a Primer Optimization Matrix to Improve the Performance of Reverse Transcription – Quantitative Real-Time PCR assays, *BMC Res Notes* 2, 112-117, 2009.
- Milinovich, G., Trott, D., Burrell, P., van Eps, A., et al., Changes in Equine Hindgut Bacterial Populations during Oligofructose-Induced Laminitis, *Environ Microbiology* 8, 885-898, 2006.
- Murer, H., Sigrist-Nelson, K., and Hopfer, U., On the Mechanism of Sugar and Amino Acid Interaction in Intestinal Transport, *J Biochem* 250, 7392-7396, 1975.
- Shirazi-Beechey, S., Molecular Biology of Intestinal Glucose Transport, *Nutr Res Rev* 8, 27-41, 1995.
- Wertheimer, E., Sasson, S., Cerasi, E., and Ben-Neriah, Y., The Ubiquitous Glucose Transporter GLUT-1 belongs to the Glucose-Related Protein

Family of Stress-Inducible Proteins, *Proc Natl Acad Sci USA* 88, 2525-2529, 1991.

Wood, I., Dyer, J. and Shirazi-Beechy, S., Expression of the Na⁺/Glucose Co-Transporter (SGLT1) in the Intestine of Domestic Wild Ruminants, *Pflugers Arch* 441, 155-162, 2000.

Woodward, A., Holcombe, S., Steibel, J., Staniar, W., et al., Cationic and Neutral Amino Acid Transporter Transcript Abundances are Differentially Expressed in the Equine Intestinal Tract, *J Anim Sci* 88, 1028-1033, 2010.

Yuan, J., Reed, A., Chen, F., and Stewart, C., Statistical Analysis of Real-Time PCR Data, *BMC Bioinformatics* 7, 85-97, 2006.

University Undergraduate Research and Arts Forum



MSU Union - Site of 2010 UURAF

The Fall issue of ReCUR accepts submissions from all participants in the annual University Undergraduate Research and Arts Forum (UURAF). UURAF, which is held every April in the MSU Union, is an opportunity for MSU undergraduates to present the results of their research and creative works as either a poster, an oral presentation or a performance. Students present work spanning a wide range of disciplines at MSU, which are divided among 16 different categories. These presentations are evaluated by MSU faculty who identify the top presentations for each category. First Prize Awards are also given to the best oral and poster presenters in each category. In addition, two Grand Prize Awards are given, one award for the best presentation in the Humanities, Social Sciences and Communication Arts and Sciences and a second award for the best presentation in Science, Mathematics and Engineering.

At the April 16, 2010 UURAF, more than 530 students from 14 different colleges presented their work. The two Grand Prizes were awarded to Andrew Keller, for his work “Cooperation among Women’s Organizations: the Case of Turkey”, and I Rin, for his work, “Potential Involvement of *Arabidopsis* UPF2 in Regulation of Flowering Timing”. 42 First Place Awards were presented to 56 students. A complete list of these recipients can be found at the following website (urca.msu.edu/files/uuraf/awards/uuraf-awards_2010.pdf.)

Two of the articles published in this issue were submitted by First Prize Award recipients at the 2010 UURAF: Mark Kelly, who won first prize in one of the oral presentation categories for the Humanities and Performing Arts, and Nathanael Taylor, who won first prize in the oral presentation category of Agriculture and Animal Science. In addition, Arthur Manoli III and Douglas Kline, First Prize Poster winners in one of the Biochemistry and Molecular Biology and one of the Microbiology, Immunology and Infections Disease Groups, respectively, submitted their previously published work for recognition in the Highlights of the Undergraduate Literature section of this issue.

UURAF is co-sponsored by the Office of the Provost -Undergraduate Education and the MSU Honors College under the leadership of the Director of Undergraduate Research. ♡

Assessing Interactions and Play Inside and Outside of the Music Classroom

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Abstract

Early childhood music teachers are just given a glimpse into a child's musical development by being able to assess the child's musical responses only inside the classroom. In this case study, data sheets recording musical responses of two-and-a-half-year-old Nathan, as well as observations from his music class, were used to determine his musical development. In addition, his mother was interviewed regarding his musical play at home. Nathan's responses within the home environment differed from his responses within the classroom setting. Therefore, there may be advantages for early childhood music teachers to develop ways to assess a child's musical development both inside and outside the classroom, taking into account musical responses during interactions and play within the home environment.

Introduction

Previous studies have investigated the role of music in a young child's growth and development. To this day, one of the key studies in the field of early childhood music is Moog's "Musical Experience of the Pre-school Child" (1976). Moog takes an in-depth look at the relationship between music learning and the characteristics of a child's growth and development. Moog found that children often use music within their playtime activities, creating songs and movements to support the activities in which they are engaged (1976). Since then, more studies have investigated the role of music during play (Burton 2002; Young 2004). These studies found that children sporadically interweave music throughout playtime activities, either subconsciously or consciously, to support and enhance their actions as well as exploration of their surroundings. The music that children create can provide insight to their thoughts and actions during play.

Children not only create music independently to support their play, but also use it during their interactions with caregivers and parents. Traditionally in many cultures, parents will often sing to their children when interact-

ing with them. As a result, additional studies have found that a child's musical experiences at home have a positive effect on a child's musical responses in other environments, as well as the child's likelihood to sing or play an instrument in the future (Custodero 2006; Custodero 2003).

Despite these findings that musical play and musical interactions with caregivers at home influence musical development, few music teachers have developed ways to assess these dimensions in detail. Children with the ability to audiate and to respond to music may do so during play in the home environment differently than they do in the classroom, which music teachers cannot witness and assess. It is with the intent of improving learning and assessment in early childhood music classrooms that this case study was completed.

One of the theories used in describing how young children acquire musical understanding is Music Learning Theory (MLT). This theory, created by Edwin E. Gordon, takes into account the importance of play and interactions between child and caregiver and outlines a method to best help children learn music. As a child "grows" and develops musically, he or she produces responses that reflect different stages of preparatory audiation in MLT that categorize responses in both structured and unstructured informal guidance. When a child audiates, this means that he or she can hear and "formally comprehend in [his or her] mind the sound of music that no longer or may never have been physically present" (Reynolds 1998,). To explain this process, Gordon has developed three types of preparatory audiation that children experience as they realize their music aptitude: Acculturation, Imitation and Assimilation (Table 1). Within these three types are seven stages of musical development.

A MLT early childhood music classroom is an environment of unstructured informal guidance, described by Gordon (2003) as operating based on the "natural sequen-

Table 1. Types and Stages of Preparatory Audiation

TYPE	STAGE
<p>Acculturation <i>Birth to age 2-4:</i> Engages with little consciousness of the environment.</p>	<p>Absorption: Hears and aurally collects the sounds of music in the environment.</p> <p>Random Response: Moves and babbles in response, but without relation to, the sounds of music in the environment.</p> <p>Purposeful Response: Tries to relate movement and babble to the sounds of music in the environment.</p>
<p>Imitation <i>Age 2-4 to age 3-5:</i> Engages with conscious thought focused primarily on the environment.</p>	<p>Shedding Egocentricity: Recognizes that movements and babble do not match the sounds of music in the environment.</p> <p>Breaking the Code: Imitates with some precision the sounds of music in the environment, specifically tonal patterns and rhythm patterns.</p>
<p>Assimilation <i>Age 3-5 to age 4-6:</i> Engages with conscious thought focused primarily on self.</p>	<p>Introspection: Recognizes the lack of coordination between singing and breathing and between chanting and muscular movement, including breathing.</p> <p>Coordination: Coordinates singing and chanting with breathing and movement.</p>

tial activities and responses of the child” received within the classroom. A music teacher using the MLT method has the primary responsibility of engaging children in musical activities to further the realization of music aptitude—the measure of one’s potential to learn music—and overall musical development. However, parents have the opportunity to encourage and witness a majority of the child’s music learning at home. Music Learning Theory deems the participation of parents both inside the classroom and at home as an important part of the child’s music learning, stating that

“[P]arents who can sing with relatively good intonation and can move their bodies with flexible and free flowing movement and enjoy doing so, even though they do not play a musical instrument, meet the basic requirements for guiding and instructing their children in music.” (Gordon 2003)

Therefore, this case study sought to compare a child’s musical responses, both in school and at home with the intent of improving ways in which music teachers can take into account the play-driven progress a child makes through the stages of musical development within the home environment as well as within the classroom.

Methods

Setting

Using the influence of play and interactions at home as the basis for further study, a small population of participants in early childhood classes at MSU’s Community Music School (CMS) were invited to participate in a voluntary study. These early childhood classes met for the duration of 45 minutes once a week for 10 weeks. In each class, a parent or caregiver accompanied every student. Early childhood music teachers at the CMS were MLT certified teachers. Teaching assistants were also present during class times, providing a proper musical model while occasionally leading musical activities alongside the teacher and observing students’ musical behaviors.

Participants

Nathan (pseudonym), a 2.5-year old boy at the time of data collection, was selected for this case study. Nathan and his mother attended the Tuesday morning early childhood class offered once a week at CMS for the duration of 45 minutes. Nathan had no siblings. However, he spent most of his time at home with his mother, who is a trained musician who pursued music degrees at the collegiate level and is familiar with MLT. Though his mother had been singing to him since he was born, the Tuesday morning class was the first time he participated in any early childhood music class (Personal communication, December 16, 2009). In class, Nathan was a quiet and well-behaved child. His mother communicated with him in Greek, sang, and encouraged his participation in activities, yet he did not produce as many musical responses as the other students.

Data Collection

The data collected came from three sources: (1) CMS Early Childhood Program data sheets used during his music class to record musical responses by the teacher

msu.edu/archive.html), (2) data sheets created by the author for parents to record observations (Appendix B, which is also available at recur.msu.edu/archive.html), and (3) communication with Nathan's mother through e-mail. Early childhood music teachers at the CMS regularly assessed their students, using data sheets to record three types of responses—tonal, rhythmic, and movement—observed during class (Appendix A). As a teaching assistant for early childhood music classes, the author was also responsible for recording students' responses during the class period. Teachers of these classes often chose to provide the parents with compact discs containing recordings of the songs and chants used in class. The teachers recorded these so that the child could experience the songs and chants as he or she had heard them in class, giving the child the opportunity to hear them in other environments such as in the car or at home.

Initially, parents were asked to participate in this study by documenting their child's reactions to these recordings along with any other instances of musical play outside the classroom using data sheets created by the author. Parents recorded musical responses of their children in three different categories: Tonal, Rhythmic and Movement. The author chose these three categories in the creation of parent data sheets because they were present in the teacher data sheets as well as in the stages of preparatory audiation according to Gordon's Music Learning theory. On these data sheets, simplified definitions of the three categories with examples are given to clarify what parents might see and hear from their child as a response, such as, "child may attempt any of the following: high to low pattern from class; trying to sing pitches; repeating melodic patterns related to songs he or she hears from the class and CD" (Appendix B). Besides information collected from the data sheets, the author conducted an informal interview through e-mail with the participating child's mother to gain further insight on his musical activities at home. After collecting data from parents, the author chose Nathan for the case study after his mother consented to provide further information to the author through e-mail.

Results

Aside from Nathan's sporadic responses during the class periods, information regarding his musical play at home showed further insight into his musical development. To analyze the data, the author compared the number

of responses recorded within the classroom on the CMS data sheet to the number of responses recorded at home on the parent data sheet in the areas of Tonal, Rhythm, and Movement. Data collected by the teacher and author using the CMS data sheets showed that overall, he absorbed sounds during his time in the class because there were a number of instances when Nathan's response was recorded as making eye contact with the teacher, author or his mother in response to their singing. This eye contact is a notable attribute of Absorption, one of the early stages of Acculturation, and falls under the response "Absorbs Sounds" in the CMS data sheet (Figure 1). The data collected showed a greater number of musical responses within the home which indicated that he was in later stages of Acculturation and moving towards the Imitation stage, however, especially in the areas of tonal and rhythmic responses.

Above all, Nathan's movement with music indicated that he was in fact past the Acculturation stage as he showed the ability to move to both macrobeats and microbeats in music. It is important to note that purposeful rhythmic and movement responses relate to macrobeats and microbeats present in music. Gordon Institute for Music Learning defines macrobeats as "those beats that one arbitrarily feels to be the longest. In most cases, macrobeats are paired: one macrobeat naturally 'goes with' a succeeding macrobeat of equal or unequal duration. In dancing to music, persons normally step naturally to each pair of macrobeats with one foot followed by the other" (2008-2009). Microbeats, on the other hand, are defined as "shorter than macrobeats and are derived from the equal temporal division of macrobeats. In most cases, macrobeats are divided into either two or three microbeats of equal duration" (Gordon Institute for Music Learning 2008-2009)

Nathan showed fluid movement with scarves on several occasions during music class as well as five instances of pulsing to both macrobeat and microbeat, signs that indicated he was entering the Imitation stage of preparatory audiation. Nathan particularly displayed movement responses within the home environment that reflected even further growth and development characteristic of children his age than responses displayed within the classroom environment. According to Moog's findings, children between the ages of two and four often experience moving to the beat by moving with songs they sing while playing.

"At first children can keep time, not to music

which they hear, but to their own spontaneous songs... most children only manage to accompany part of their singing with rhythmically matching movements sometime between the ages of two and four. When they do this, children use movements which they have made in an uncoordinated way to music which they have heard or sung themselves” (Moog 1976).

Nathan’s mother recorded him moving to the macrobeat and microbeat while singing at home and jumping to the macrobeat and microbeat (Results reported on Parent Response Charts on November 4 and 17, 2009). These movement responses are not only indicators of Nathan’s overall growth and development but indicators of later stages of preparatory audiation in comparison to his movement responses in class, as feeling beat without tension is first seen in the Imitation stage and expanded to include both macrobeat and microbeat movement in the Assimilation stage.

In class, the teacher recorded four responses of Nathan singing the resting tone of the music. He also attempted a three-note, diatonic, stepwise Acculturation tonal pattern on one occasion. More commonly, he would choose to quietly respond in a monotone whispering voice instead of trying to sing different pitches (Teacher Data Sheet, Julie Kastner, Fall 2009). One of the most memorable musical responses from Nathan, however, occurred outside of the classroom. When his mother prompted him to use his singing voice at home: “I did get him to sing patterns once at home by prompting him, ‘Please let me hear your real voice.’ I did get it, slightly flat but following the pitch direction of Acculturation patterns and Imitation patterns” (Personal communication, December 16, 2009). In another specific instance, he was playing with a microphone prop when singing random pitches (Parent response chart, November 17 2009). Nathan’s mother recorded him as having responded to Acculturation tonal patterns on three additional occasions at home, which resulted in a greater number of tonal responses within the home environment than within the classroom environment.

Discussion

Overall, a brief glimpse into the musical activities of two-and-a-half-year-old Nathan at home provided a much clearer assessment of his musical development.

Greater numbers of musical responses in the categories of tonal, rhythm and movement occurred at home than in the classroom. As the results of this study were based on one child, further research is necessary to determine the disparity between musical responses in and out of the classroom as well as develop ways in which teachers can assess responses in the home environment. However, if the disparity between Nathan’s responses in class and at home holds true for other children, early childhood music teachers who fail to assess musical responses within the home environment could be incorrectly assessing a child’s musical development.

While MLT was developed with a child’s physical, social and cognitive growth in mind, it is important to remember that not every child experiences development in the same way and at the same rate. For some children, different stages of their development can affect their behavior in the music classroom. Nathan’s social development appeared to play a large role in his behavior during the class period, which is common for children of his age. In Moog’s reference to Kroh’s findings of children between the ages of two and three, “He begins to differentiate between the various instinctive drives of his individual personality” (1976). According to Nathan’s mother, he was beginning to understand how he learns information and presents what he has learned to others, saying “he has a very unique personality and likes to get things right. He would not show you what he can do until he can actually do it well” (Personal communication, December 16, 2009). Because of this aspect of his developing personality, Nathan was particular about the choice to respond in class, often choosing to quietly cling to his mother.

Moog’s studies also found that between the ages of two and three “there is a tendency towards self-protection and traits such as shyness, reserve and self-consciousness appear” (1976). It is possible that many factors contribute to a child’s disposition towards shyness in the classroom, including the unfamiliar environment and presence of the teacher. In the case of a MLT early childhood classroom, the presence of other children and their parents as well as presence of one or both of their own parents may also contribute to a child’s shy behavior. Nathan’s choice to only present information once he knew he could present it with some correctness could be interpreted as a form of self-consciousness. In relation to MLT, this self-consciousness is a part of the Imitation stage of preparatory audiation. Given Nathan’s

self-conscious personality observed in this study, his response when prompted to sing by his mother at home seems logical. In Moog's (1976) findings, many children of Nathan's age were more likely to respond musically when prompted: "Only a minority took the initiative themselves; three quarters of the children needed to be invited."

In conclusion, Nathan's ability to engage in singing, chanting, and moving to music at home, with both things he has learned in class and songs he creates during play, would appear to be an integral part of his music learning and his progression through the different stages of preparatory audition. However, many children like Nathan are not invited to engage in musical play in the traditional classroom setting of structured formal guidance. Conversely, teachers and parents often tend towards a form of play as adults that is "structured, nonspontaneous, filled with rules, and usually something that must be done well... For children, play is an end in itself; for adults, play is a means to an end" (Tamowski 1994).

Therefore, it can be said that the home environment which encourages play and interaction with caregivers can give critical information that leads to more accurate assessment in a child's musical development that can help early childhood music teachers tailor their instruction. It is through play that children learn about their surroundings, absorbing all that he or she is capable of absorbing and engaging in musical play as an intrinsically motivating part of gaining understanding about the world around them (Gordon 2003; Tarnowski 1994). As found by Burton (1992), "Young children's spontaneous songs and chants may be a reflection of how children organize musical information from their environments. In addition, those musical reflections may be indicative of how young children think and develop musically."

The teachers of early childhood music classes are at a disadvantage because they do not get to witness the ways in which a child's exposure to music in class (an unfamiliar environment) affects his or her play at home (a familiar environment). Providing observation sheets, similar to those used in this case study, can be one way in which parents record their child's musical responses and become even more involved in their child's learning. Nevertheless, the exploration and development of other methods to holistically assess a child's music learning are needed. When the understanding of a child's music learning through interactions and play both at home and

in the classroom is furthered, this will lead to more effective music education for young children. ♡

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References

- Burton, S., An Exploration of Preschool Children's Spontaneous Songs and Chants, *Visions of Research in Music Education* 2, 7-16, 2002.
- Custodero, L., Singing Practices in 10 Families with Young Children, *Journal of Research in Music Education* 54, 37-56, 2006.
- Custodero, L., and Johnson-Green, E., Passing the Cultural Torch: Musical Experience and Musical Parenting of Infants, *Journal of Research in Music Education* 51, 102-114, 2003.
- Gordon, E., *A Music Learning Theory for Newborn and Young Children*. G.I.A. Publications, Chicago, IL, 2003.
- Gordon Institute for Music Learning. *Rhythm Content Learning Sequence* (2008-2009). Retrieved November 10, 2010, from http://www.giml.org/mlt_lsa_rhythmcontent.php.
- Moog, H., *The Musical experience of the pre-school child*, Schott Music, London, UK, 1976.
- Reynolds, A., Taggart, C., Gordon, E., and Valerio, W., *Music Play: the Early Childhood Music Curriculum Guide for Parents Teachers & Caregivers Spiral*. GIA Publications, Chicago, IL, 1998.
- Tarnowski, S., and Leclerc, J., Musical play of preschoolers and teacher-child interaction, *Update: Applications of Research in Music Education* 13, 9-16, 1994.
- Young, S., Young Children's Spontaneous Vocalizing: Insights into Play and Pathways to Singing, *International Journal of Early Childhood* 36., 59-74, 2004.

Wealth Inequality and Monetary Policy: An Analysis of the Effects of the Federal Funds Rate on the Distribution of Wealth

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Introduction

Since 1979, the percentage of wealth held by the top of wealth holders in the United States has increased steadily. While substantially lower than its peak in the 1920s, the figure is around 35% as of 2007 (Wolff 2009). By contrast, the bottom 80% of households controls a mere 15% of the wealth in the U.S. In simpler terms, nearly 40% of all wealth in the U.S. is controlled by a little over 1 million households. A recent study by Hurst and colleagues (1998) shows that there is limited wealth mobility between generations, and that there is very limited mobility during the lifetime of a typical individual.

This paper addresses the way in which wealth inequality in the United States is inadvertently affected by monetary policy. We analyze the relationship between wealth inequality (measured by the share held by the top one percent of households) and the Federal Funds rate, which is one of the primary tools used in implementing monetary policy. We demonstrate how real short-term interest rates positively relate to wealth inequality.

Wealth and Accumulation

As defined by Leones and Wolff (2002), wealth is gross marketable assets minus liabilities, which is equivalent to net worth. In order to explain variations in wealth inequality, we begin by identifying the economic variables that affect wealth. We focus on the following five factors that may affect household wealth inequality:

- 1) Credit-market conditions, as measured by the real interest rate.
- 2) Employment markets, as measured by the unemployment rate.
- 3) Changes in the price level, as measured by the inflation rate.
- 4) Changes in asset prices, as measured by changes in stock indices and real-estate prices.

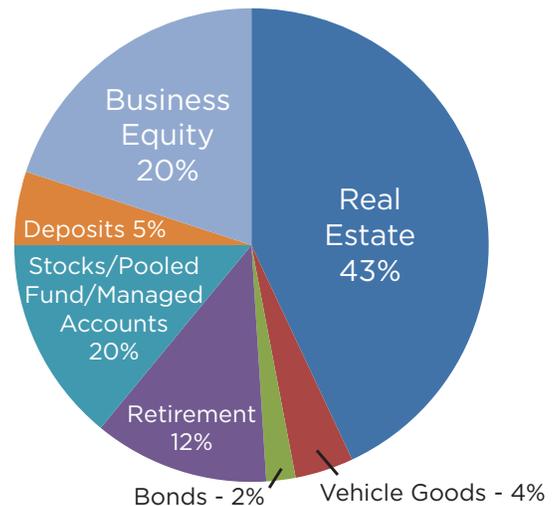


Figure 1. Mean Household Asset Allocation

- 5) Changes in aggregate income, as measured by GDP growth rates.

We do not suggest that these variables are the only ones that have an effect on wealth inequality. Wealth inequality may be affected by a wide variety of economic, social, psychological and demographic influences. Therefore, we acknowledge the possibility that our results may suffer from omitted-variables bias and endogeneity bias. Thus it is appropriate to urge caution in interpreting the results.

Portfolio Allocation and Asset Accumulation

As shown in Figure 1, the three most important components of household wealth are real estate, business equity, and financial assets (Survey of Consumer Finances 2007). Real estate is related to all five of the explanatory variables listed above. Employment affects real-estate wealth, by providing the financial inflows that allow mortgage commitments to be met and down payments to occur. Inflation affects the real value of the asset, and threatens to diminish the purchasing

power available to the individual asset holder. The interest rate plays an even more important role in the process of acquiring real estate. Because the interest rate is the cost of credit, it affects access to real-estate wealth. The rate of interest also plays a critical role in the case of adjustable-rate financing, where fluctuations in the rate may potentially hinder equity accumulation. Finally, the most obvious variable affecting movements in real-estate wealth is change in housing prices.

Business equity is unimportant in the asset allocation of the typical household, but it figures prominently in the average. The vast majority of business equity is held by the top 10% of households, which held 93% of all business equity as of 2007 (Survey of Consumer Finances). Financial assets include pension plans that allow the less wealthy to participate in financial innovation. Nevertheless, the bottom 90% of households control only a modest share of these assets. The bottom 90% of households own 18.8 percent of stocks and mutual funds, 40.8% of pension accounts, 42.3% of deposits, and 45.1% of life-insurance policies. Unemployment influences access to financial assets directly, since labor-market earnings have a large effect on the ability to accumulate investments, and employment provides access to pension plans and other pooled funds.

Inflation effectively reduces the real value of fixed debt instruments. In addition, the interest rate directly relates to the present value of current financial positions, which raises or lowers the opportunity costs of holding current positions. Also, stock prices may be influenced by inflation, and movements in equity markets have a substantial influence on the current valuations of financial wealth. So far, we have described the asset allocation of the average household and its relationship to the behavior of our five economic variables. We have argued that wealth is directly influenced by the performance of our variables, three of which are directly targeted by the Federal Reserve when implementing policy. Next, we direct our attention towards debt, which is a second component of wealth.

Debt and Interest

According to Wolff (2009), the bottom 90% of wealth holders owned just 27.9% of all household wealth in 2007. However, they were responsible for 73.4 % of

all debt. Thus the top percentiles of wealth holders hold the bulk of the assets in the United States, while the debt is more concentrated among those with relatively little wealth.

Wealthier creditors view the interest rate as a rate of return, a profit for forgoing current consumption, or a risk premium. Extended periods of continuously tight monetary policy which lead to higher market interest rates reflect a higher rate of return for wealthy creditors. On the other hand, for the debtor, the rate of interest represents a cost. During extended periods of high market interest rates, the debtor is at a loss, since the cost of financing the process of accumulation has risen. On this basis, we might expect that extended periods of high market interest rates would result in higher wealth inequality.

However, increasing interest rates also may occur in response to rising inflation. Inflation produces transfers from the creditor to the debtor. Therefore, it is possible that an upward movement in the price level may diminish wealth inequality.

Finally, it is important to explain why we discuss the role of the Federal Reserve in this paper. As the central bank of the United States, the Fed attempts to maintain maximum employment and price stability through its open-market operations. The Fed exerts influence on short-term interest rates, with the hope of absorbing and distributing liquidity within the market. By doing so, the Fed is influencing interest rate yields other than the explicit overnight Federal Funds Rate. Although the Fed's open-market operations have less influence on longer-term securities, they may nevertheless play an important role, since the Federal Funds Rate is a benchmark interest rate on which other interest rates are based.

At this point we have established the argument for why higher interest rates may cause greater wealth inequality in the United States, and why the Federal Reserve's open-market operations may have latent effects on wealth inequality.

The Model

We hope to demonstrate that there is a positive relationship between the distribution of wealth and the interest rates that are influenced by the policies of the Federal Reserve. The following equation summarizes

the linear effects of income, inflation, asset prices, and interest rates on the concentration of wealth held by the top one percent.

$$\text{Top } 1\%_t = \beta_0 + \beta_1 \text{Interest}_{\text{avt}} + \beta_2 \text{Inflation}_{\text{avt}} + \beta_3 \text{Unemployment}_{\text{avt}} + \beta_4 \text{Dow}_{\Delta\%t} + \beta_5 \text{GDP}_{\Delta\%t} + \beta_6 \text{Time} + \varepsilon_t$$

Here we regress Top 1%_t (the amount of wealth held by the top one percent of households at time t) on Interest_{avt} (the ten-year average real interest rate of three-month Treasury bills), Inflation_{avt} (the five-year average of inflation rates), Unemployment_{avt} (the five-year average unemployment rate), Dow_{Δ%t} (the real percent change in the Dow Jones Industrial Average over the previous five years), and GDP_{Δ%t} (the real percent change in Gross Domestic Product over the previous five years). Finally, we regress on Time (the year of observation) to control for trending. We ultimately expect that when controlling for market conditions, an increase in our interest-rate variable will lead to a higher concentration of wealth among the top one percent of households.

Variables

The measurements used to describe wealth inequality in the United States are estimates of the percent of aggregate household wealth held by the top one percent of wealth holders. In total there are 23 observations for various years between 1922 and 2007. The estimates used in this regression splice two separate data sets created by Edward Wolff of NYU into one continuous data set. (Wolff 2002, Wolff 2010).

The first set of estimates come from his book *Top Heavy*, where Wolff incorporates work by several previous other authors with his own estimates, to create measurements of the wealth held by the top one percent for 1929, 1933, 1939, 1945, 1949, 1953, 1958, 1962, 1965, 1969, 1972, 1979, 1981, 1983, 1986, 1989, 1992, 1995, and 1998. The estimates for these years are based on two primary data sources. These are the Survey of Consumer Finances (SCF) produced by the Federal Reserve and estate-tax records provided by the Statistics of Income Division within the IRS. The SCF is a triennial cross-sectional survey that gathers extensive information on the financial standing of American households. The Federal Reserve also conducted the Survey of Financial Characteristics of Consumers (SFCC) in 1962 and the Survey of Changes in Family

Finances (SFF) in 1963. These are also used in creating the wealth distribution estimates. Using the SCF, SFCC and the SFF, Wolff constructed his estimates of the distribution of wealth among American households for later years of observation. Earlier years of observation rely primarily on estate-tax records. Here Wolff uses estimates from Lampman (1962) and Franklin and Smith (1974), who use a technique known as the estate-tax multiplier. This technique estimates wealth distribution by weighting each estate-tax return by the inverse probability of death for a given age group (Kopczuk 2004).

This technique yields unbiased estimates of wealth distribution if the probability of death is uncorrelated with wealth. However, there are three pitfalls that limit the independence between the two variables. First, extreme financial burdens for the years preceding death may diminish the wealth holdings of the dying, causing estate-tax returns to underestimate wealth holdings. Second, an individual's wealth may be directly correlated with mortality rates, if wealthy individuals are less likely to die than the less-wealthy members of a given age group. Finally, there is the issue of tax avoidance. Wealth holders are likely to give their wealth away prior to death, in an attempt to avoid estate taxes (Kopczuk 2004).

Fortunately the estimates created by Wolff do not rely solely on the estate-tax multiplier; Wolff uses survey information as well. This helps to mitigate the potential for bias within the estate-tax multiplier. However, it is appropriate to note the potential for inaccuracy in the estimates.

The second collection of estimates produced by Wolff come from his 2010 paper, in which he used data from the Survey of Consumer Finances, as well as a high-income supplement from the IRS. Here he produced estimates for 1983, 1989, 1992, 1995, 1998, 2001, 2004, and 2007 (Wolff 2010). In order to add the 2001, 2004, and 2007 estimates to the previous estimates, we simply shifted the 2001, 2004, and 2007 values down by 3.2 percentage points. This is easily allowed since the changes in the 1983-1998 estimates in *Top Heavy* reflect the changes in SCF estimates, rather than the estate-tax multiplier. All estimates for the latter years in *Top Heavy* were shifted down by 3.2 percentage points, in order to adjust for the difference in levels that is produced when using the estate multiplier and SCF data. Also there appears to be some inconsisten-

cies in Wolff's data set when he shifts between usage of the SCF and the estate multiplier. Wolff uses the estate multiplier for 1976, but he uses SCF data for 1962 and 1983. This appears to have created an artificial decrease in the concentration of wealth held by the top one percent in 1976. Saez points out that this generates an inconsistency in Wolff's data set when it is compared to similar estimates done by other researchers (Kopczuk 2004). In order to compensate for this discrepancy, we have deleted the 1976 observation from the data set. This yields the final data set as seen in the Appendix, which is available online at recur.msu.edu/archive.html.

One area of concern within our model is the manner in which wealth inequality fluctuates in comparison to our explanatory variables. Wealth inequality evolves over long time periods, but our explanatory variables all tend to fluctuate rather frequently. It is difficult to compute the effects on a long-term trend by observing short-term fluctuation in explanatory variables. Therefore, we have incorporated long-term trends into all of our explanatory variables. By doing so, we have attempted to adjust the model to capture general market conditions that have persisted for a sufficient period of time that they are able to affect the distribution of wealth.

An explicit Federal Funds rate (FFR) has been set by the Federal Reserve since 1955. However, the observations of wealth inequality date back to 1922. In order to measure the relationship between wealth inequality and the FFR, we must use an appropriate proxy variable. The interest rate on the three-month Treasury bill can be thought of as a proxy for the Federal Funds rate, due to its similarity to and strong correlation with the FFR. Between 1955 and 2009, the correlation coefficient between the average annual effective Federal Funds Rate listed by the Federal Reserve Bank of New York and the annual average three-month Treasury bill rate is 0.987.

Next, we use a rolling 10-year average of real three-month Treasury bill yields, in order to measure long-term trends. Average annual yields provided by the Census Bureau of the United States were converted to real yields using the percentage change in the Consumer Price Index provided by Robert Shiller (2009). The 10-year average was then found by averaging together the nine years preceding each observation as well as the year itself.

One might expect that if wealth inequality were to be affected by the rate of interest, it would require relatively long periods of time to take effect. This is why we have chosen such a long period of time for the interest-rate variable. Later we will discuss what happens when we vary the length of the averages.

The inflation variable in this model is the five-year average inflation rate calculated by averaging together the annual percentage change in CPI levels provided by Shiller for the four years preceding each observation, as well as the year itself (2009). A shorter span was used for average inflation rates than for the interest-rate variable because inflation affects the current value of wealth immediately, and longer term trends seem to be unnecessary.

The unemployment rate variable was calculated similarly to the inflation variable, in that it is a five-year average. The raw data come from the Bureau of Labor Statistics and Christina Romer. The data were then averaged to create five-year unemployment rates ending in the year of observation (Romer 1986).

The Dow Jones Industrial Average (DJIA) variable is the percentage change in the DJIA from the previous year's observation, after it has been deflated to real terms using the Shiller CPI data (2009). Here we use an annual average of the DJIA. Once there is a movement in the price of a stock, the market value of wealth holdings in stock is affected instantly. On this basis, we argue that it is unnecessary to extend this variable to longer periods of time.

We also include a variable representative of GDP fluctuations. We use raw estimates of real GDP in 2005 dollars and we calculate their five-year percentage change in the same way as for the inflation variable. Data were extracted from the Bureau of Economic Analysis' database for all years following 1929. For the years prior to 1929, we use data from John Kendrick (1961). The variable measures the percentage change in real US GDP over the previous five years for each year of observation.

Finally, we include a year variable to account for changes in wealth inequality that may correlate with variables that have systematic changes over time. For all variables described above, we found that we retain consistent results at robust levels of significance when we relax the assumptions regarding the length of averages and percent changes. (See the Appendix).

Table 1. Results of regressing the percent of wealth held by the top 1% of households on explanatory variables

$R^2 = 0.7756$ Obs - 22	Interest	Unemployment	Dow	CPI	GDP	Year
Coefficient	0.8028421	-0.0255755	0.49331	-0.290415	0.0271398	-0.0180714
Newey-West standard error	(0.1237248)	(0.0377118)	(0.0095395)	(0.1086715)	(0.111457)	(0.0186722)
t-statistic	6.49	-0.68	6.49	-2.67	6.49	-0.97
Significance at 97.5% (Keifer-Vogelsang Critical Values)	Yes	No	Yes	No	No	No

Results

Table 1 is the result of regressing the percent of wealth held by the top one percent of households on the explanatory variables previously discussed. Because there is strong autocorrelation in this model, we have used Newey-West Standard errors with a truncated lag of 20. By setting the truncated lag in this model to the highest allowable value, we can be confident that serial correlation is accounted for. As expected, this has substantially lowered our standard errors from the simple OLS regression making the t-statistics particularly large. If traditional t-critical values are used, we would artificially reject the null hypothesis. Therefore, we must use Kiefer-Vogelsang critical values that account for this discrepancy. Using these critical values we are able to properly test for significance (Table 1).

The regression results display strong statistical significance for both the Dow variable and the Interest variable. The Appendix also contains many regressions with different variations of the explanatory variables regarding the averaging used. Although the coefficients do vary slightly in magnitude and significance, there is little qualitative difference from this model.

The coefficient and significance on the Dow variable is to be expected. As indicated in the 2007 Survey of Consumer Finances, the top one percent of wealth holders own approximately 38.3% of all stock in the United States (Survey of Consumer Finances, 2007). One could logically deduce that as stock prices increase systematically, the benefits of these gains are disproportionately distributed to the top one percent. The empirical evidence in this regression supports this conclusion. As indicated in the chart above, when the Dow Jones Industrial Average increased by ten percentage points over the previous five years, there was on average a corresponding 0.4933 percentage point increase in the share of wealth held by the top one percent.

Most importantly, we see that there is a strong statistical relationship between wealth inequality and interest rate variable. As mentioned before, the interest rate variable used in this regression is the ten-year average of yields on three-month Treasury bills. However, our Appendix shows the results for several regressions in which the averages used for the interest-rate variable are shorter, and yet we retain statistical significance. Figure 2 illustrates the results of these regressions. The x-axis is the number of years used in the averaging of the interest-rate variable. On the y-axis is the t-statistic obtained from regressing the top one percent on the given interest-rate variable as well as the other explanatory variables explained earlier.

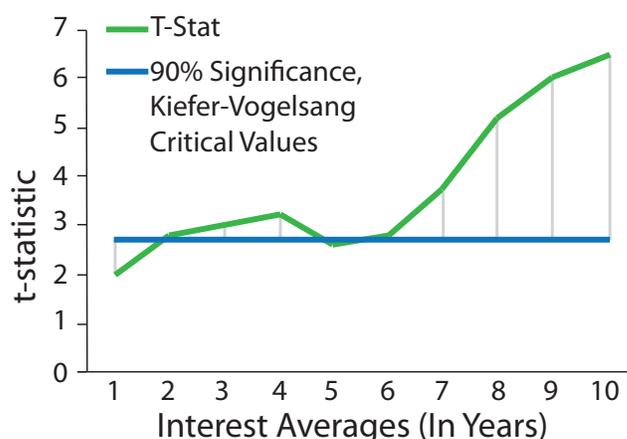


Figure 2. Effects of Averaging on the Significance of Interest Rates

For example, a value of three on the x-axis indicates that the interest-rate variable is an average of yields over the previous two years as well as the year of observation. Although there is statistical significance for all values other than five and one, this graph illustrates that there is increased significance in this model as longer averages are used. This gives support to our usage of a long-term average on interest rate yields in measuring the effects of monetary policy on wealth inequality. This graph shows that the farther into the past that we look regarding the interest rate, the stron-

ger the relationship becomes with current measures of wealth inequality.

The coefficient on the ten-year average interest rate indicates that an increase of one hundred basis points corresponds with a 0.8028 percentage point increase in the percent of household wealth held by the top one percent. The sample average of the wealth holdings of the top one percent is 31.87%; thus the coefficient indicates that the relationship between the two variables plays a practically significant role if there is a large swing in interest rates. Because of the way the variable is calculated by an average, in a sense it incorporates a lagged effect of interest rates on wealth inequality. Because this relationship increases in significance over time, it makes it easier to imply causality. The results of this regression provide support for our hypothesis that the Fed's manipulation of market interest rates, in its attempts to enforce stability and growth, are inadvertently affecting the distribution of wealth.

Conclusion

We have empirically analyzed changes in the wealth holding of the top one percent of U.S. households. In accordance with our thesis, the changes in wealth holdings may be affected by monetary policy actions. As shown in our results section, the interest rate, a tool of monetary policy, has a positive and significant effect on wealth inequality. We have shown that increases in short-term interest rates are associated with increases in wealth inequality, as measured by the share of total wealth held by the top one percent of households. We conclude that the relationship is positive; however, we have yet to define it as causal. Our results can only testify to the fact that higher interest rates are associated with higher inequality. In our introduction, we explain the logical framework that may lead to this conclusion and the reasoning behind the results.

Relatively little literature exists on the topic of wealth as it relates to monetary policy, so there is little room to cite references that are in line with our conclusions. Fed Chairman Ben Bernanke has alluded to results similar to ours, although he was referring to income inequality, rather than wealth inequality. In a 2003 speech, Bernanke states that an accommodative monetary stance may alleviate income inequality (Bernanke 2003).

Research by Grüner (2001) proposes a relationship similar to ours, although the direction of causality suggested by Grüner is the reverse of the direction that we suggest. Grüner looks at the ways in which the interest rate may be affected by the distribution of wealth. He uses the predictions of capital-market theory regarding the way in which wealth inequality affects entrepreneurial spirits. This in turn influences the supply and demand for capital. On this basis, Grüner builds an argument that wealth inequality influences market interest rates. While both our study and Grüner's provide insight into the topic and are based on empirical research that is statistically significant, the two studies differ in their causal interpretations.

In our regressions, we see increased statistical significance for the relationship between the interest variable and wealth inequality as we use longer averages prior to each observation. This is similar to using incrementally increasing lags within the model when measuring the effects of interest rates. Given these results, we find it difficult to conclude that wealth inequality would cause fluctuations in the interest rate. If Grüner's causation story were to hold, it would be highly improbable to achieve the increased precision in the coefficient on the interest-rate variable (Figure 2.) However, this does highlight the potential for endogeneity within our model. It is possible that there is an underlying social phenomenon in the economy that is both correlated with interest rates as well as wealth inequality, leading to an omitted-variable bias that may be overstating or understating our results. As mentioned earlier in the paper, this bias is a serious concern, and our results must therefore be received with caution. Many other variables that may affect wealth inequality and interest rates are not captured in our model. Also, all of the variables used in the regression move together in systematic ways, and it is possible that this collinearity may magnify any endogeneity that may exist. Therefore, further analysis of the true relationship between wealth inequality and the interest rate must be performed before any definitive statements can be made.

We understand that our remarks may effectively challenge the true scope of monetary policy, since we raise questions of tradeoffs between stability and equity. The purpose of this paper is not to discredit the Federal Reserve, but rather to highlight a possible externality of monetary policy on the distribution of wealth. 🍀

Acknowledgements

The authors would like to thank Professors Jeff Biddle, Tim Vogelsang and Charles Ballard for their invaluable advice, direction and guidance.

References

Bernanke, B., The Jobless Recovery, Remarks at the Global Economic and Investment Outlook Conference, Carnegie Mellon University, Pittsburgh, Pennsylvania, Nov 6, 2003, <http://www.federalreserve.gov/boarddocs/speeches/2003/200311062/>.

Bucks, B., Kennickell, A. Mach, T., and Moore, K., Changes in U.S. Family Finances from 2004 to 2007: Evidence from the Survey of Consumer Finances, *Federal Reserve Bulletin* 95, A1-A55, 2009.

Franklin, S., and Smith, J., The Concentration of Personal Wealth, 1922-1969, *American Economic Review* 62, 162-167, 1974.

Grüner, H., Wealth Distribution and Interest Rates: Empirical Evidence for the US, *CEPR Discussion Papers* 3106, 2001.

Hurst, E., Luoh, M., and Stafford, F., Wealth dynamics of American Families, 1984-94. *Brookings Papers on Economic Activity* 1, 267-337, 1998.

Kendrick, J., *Productivity Trends in the United States*, Princeton University Press (for NBER), Princeton, NJ, 1961.

Kiefer, N., and Vogelsang, T., Heteroskedasticity-Autocorrelation Robust Standard Errors Using the Bartlett Kernel without Truncation, *Econometrica* 70, 2093-2095, 2002.

Kopczuk, W., and Saez, E., Top Wealth Shares in the United States, 1916-2000: Evidence from Estate Tax Returns, *National Tax Journal* 57, 445-487, 2004.

Lampman, R., *The Share of Top Wealth-Holders in National Wealth, 1922-56*. Princeton University Press (for NBER), Princeton, NJ, 1962.

Romer, C., Spurious volatility in historical unemployment data, *Journal of Political Economy* 94, 1-37, 1986.

Shiller, R., Long term stock, bond, interest rate and consumption data, 2009, <http://www.econ.yale.edu/-shiller/data.htm>.

<http://www.econ.yale.edu/-shiller/data.htm>.

Wolff, E. *Top heavy: the increasing inequality of wealth in America and what can be done about it*. New Press, New York, 2002.

Wolff, E., Recent Trends in Household Wealth in the United States: Rising Debt and the Middle-Class Squeeze - An Update to 2007, *Working Paper* No. 589, The Levy Economics Institute of Bard College, 2010.

Undergraduate Literature Highlights (Continued from page 6)

Modeling Networks involved in Immune Cell Differentiation

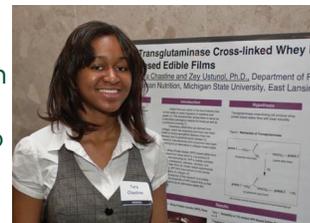
Douglas Kline worked with Professor Norbert Kaminski at MSU as part of a collaborative research group that modeled B lymphocyte terminal differentiation. They found that a bistable switch governs B cell terminal differentiation which promotes irreversible cell differentiation. Their model also revealed that individual B cells exhibit heterogeneous differentiation responses due to stochastic gene expression; this likely plays an important role in fine-tuning the level of immune response. Finally, they observed that dioxin, a carcinogen, both inhibits differentiation and may allow mature B cells to revert back to naïve cells.

Zhang, Q, Bhattacharya, S., Crawford, R., Conolly, R., et al., Stochastic Modeling of B Lymphocyte Terminal Differentiation and Its Suppression by Dioxin, *BMC Systems Biology* 4, doi:10.1186/1752-0509-4-40, 2010.



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About the Contributors

Katelin McArdle | Department of Professional Writing



Mark Kelly

Mark Kelly, a fourth year History major from Madison, Wisconsin, is the author of “The Elusive Significance of the Fart in Chaucer’s Summoner’s Tale” on pages 8-13. He described the development of this work. “This

essay began as a term paper for Dr. Tess Tavormina’s Chaucer class (ENG 410) in the spring of 2009. It was further expanded upon through an Independent Study with Dr. Tavormina during the fall of 2010, and a version of it was presented at the Michigan State University Undergraduate Research and Arts Forum (UURAF) in the spring of 2010, winning a first prize award.”

Deanna Koenig

Deanna Koenig, author of “Incorporating the MBTI into Tutor Training Increases Client Satisfaction with the Writing Center” on pages 14-20. Deanna is a fourth year Psychology major from Canton, Michigan. Asked about the origin of this work, she responded, “During the consultant training class, I was introduced to common tutoring approaches used in the writing center; I realized quickly that no approach worked well with every student. I started looking for a way to help consultants individualize their approach to each client, the very first time they see them, and I also wanted to apply my major (psychology) to my job. I found some information about the MBTI in the writing center and designed a study to assess whether or not teaching consultants about the effects of personality on writing and tutoring would help them help their clients in an individualized, productive way.”

Editor’s Note: Photo Unavailable

Denise Martaus

Denise Martaus is a fifth year Music Education student from Findlay, Ohio, and is the author of “Interactions and Play Both In and Out of the Music



Classroom: A Case Study” on pages 28-32. When asked to explain the idea for the project, she answered, “While exploring my Honors project options for a music education course in the Fall 2009 semester, I became interested in the difference between children’s musical

responses at home and in the classroom. I wanted to investigate the possibility that children in an early childhood music class do not respond and interact in ways that accurately reflect their musical development due to a number of factors in the classroom environment. One student from an early childhood music class at MSU’s Community Music School was selected for my case study research and found to have a greater amount of musical responses at home than within the classroom. If this disparity holds true for other children, I conclude that it would be valuable for music teachers to develop ways in which they can further understand and assess their students’ interactions with music both at home and at school.”



Alexander Roeder

Alexander Roeder, who graduated from MSU in Spring 2010 with a degree in Advertising/Graphic Design, is from Walled Lake, Michigan. He is the artist of “Greenhouses Winter Untitled” on page 21. He shared his

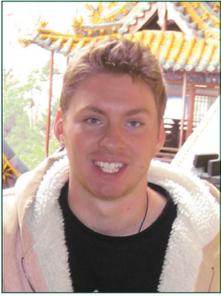
inspiration for the photo. “I’ve always admired the greenhouses at night. The glow of the lights inside has seemed to be something mysterious and eerie. I wanted to capture an ephemeral moment that embodies both of those characteristics.”

Elías David Schecker Da Silva and Michael Watson

Elías David Schecker Da Silva, a fourth year Economics



student from Santo Domingo, Dominican Republic, and Michael Watson, a Spring 2010 MSU alumnus with a degree in Economics from Lansing, Michigan, are co-authors of “Wealth Inequality and Monetary Policy: An Analysis of the Effects of the Federal Funds Rate on the Distribution of Wealth” on pages 33-39.



Elías explained his motivation behind the paper. “Growing up in the developing world, I was exposed to vast inequalities in the distribution of wealth which led me to question the nature of

such disparity. Consequently, I jumped at the chance of teaming up with my colleague, Michael, when he proposed we look at government policies that might affect the inequalities that so fascinated me. The end product is this paper that seeks to shed new light on the topic.”

Michael also reflected on his inspiration for the paper. “It is always important to think outside of the

box. Looking back on my college experience, my most memorable moments would never have happened if I didn’t believe in that statement. My year in Beijing, my year playing football at Western Michigan University, my semester spent starting and subsequently closing my first company all happened because I was willing to take a risk and try something new. And this was also the driving force behind our paper. If we can look at a problem like wealth inequality from a different angle, just maybe we can shine some light on a relationship that before was in the shadows.”



Nathanael P. Taylor

Nathanael Taylor, a Spring 2010 alumnus and current Animal Science graduate student from Montego Bay, Jamaica, is an author of the article “Transcript Profile of Hexose Transporters along the Horse Gastrointestinal Tract” on pages 22-27. He described the inspiration for this work. “I have always been interested in

improving the care and treatment of animals. I believe that research on the mechanisms involved in nutrient absorption is one such way in which improvements can be made.”

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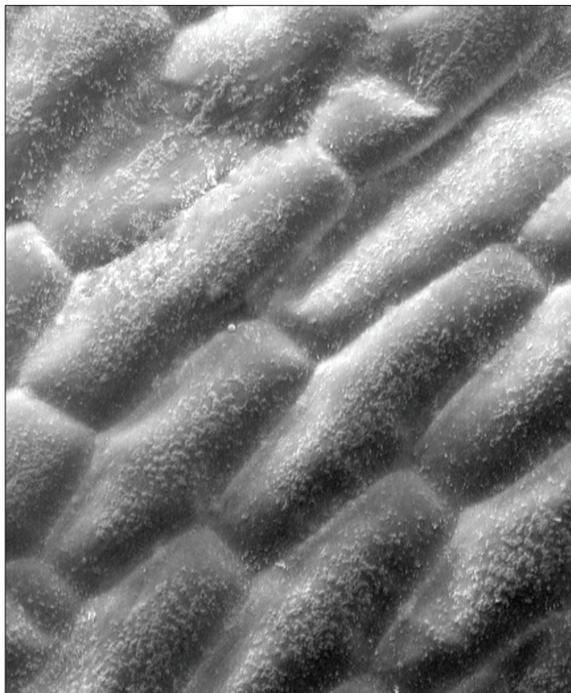
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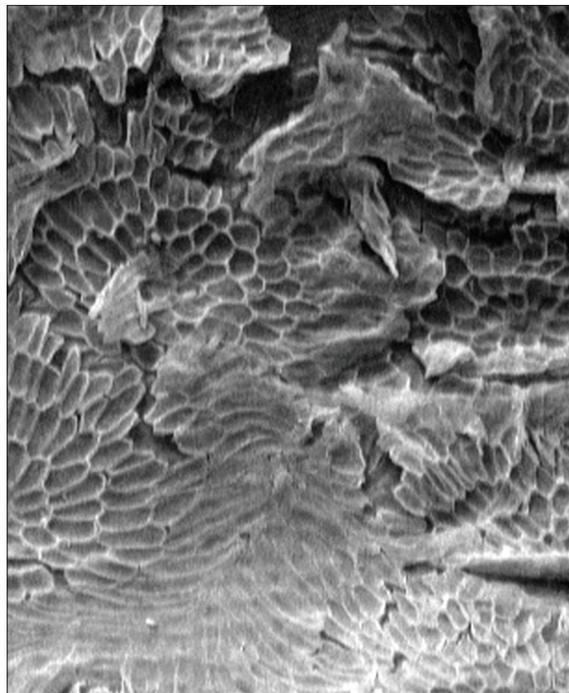
220X Magnification of a Spider Plant



The image on the back cover is a 2-dimensional scanning electron micrograph of the leaf of a spider plant captured at 220X magnification with the CamScan 4400 Scanning Electron Microscope (SEM). The leaf was cut into an approximately 3 mm square. It was then soaked in 0.4% glutaraldehyde for 30 minutes, followed by successive soaking in 25, 50, 75 and 95% ethanol for 15 minutes each, followed by 3 repeated 15 minute soakings in 100% ethanol. The sample was then dried to the critical point with carbon dioxide, mounted on an adhesive metal stub and coated with layers of gold and osmium to make them conductive.

The image was obtained by Karla Kapplinger, a recent MSU graduate, with the assistance of Sara Longanbach, a Materials Science and Engineering graduate student, and Carol Flegler, a SEM specialist at the Center for Advance Microscopy at MSU, as part of an Honors Research Seminar (UGS 200H) led by Dr. Carl Boehlert, Associate Professor of Materials Science and Engineering. In this seminar, students learned how to use the SEM to analyze a wide variety of materials.

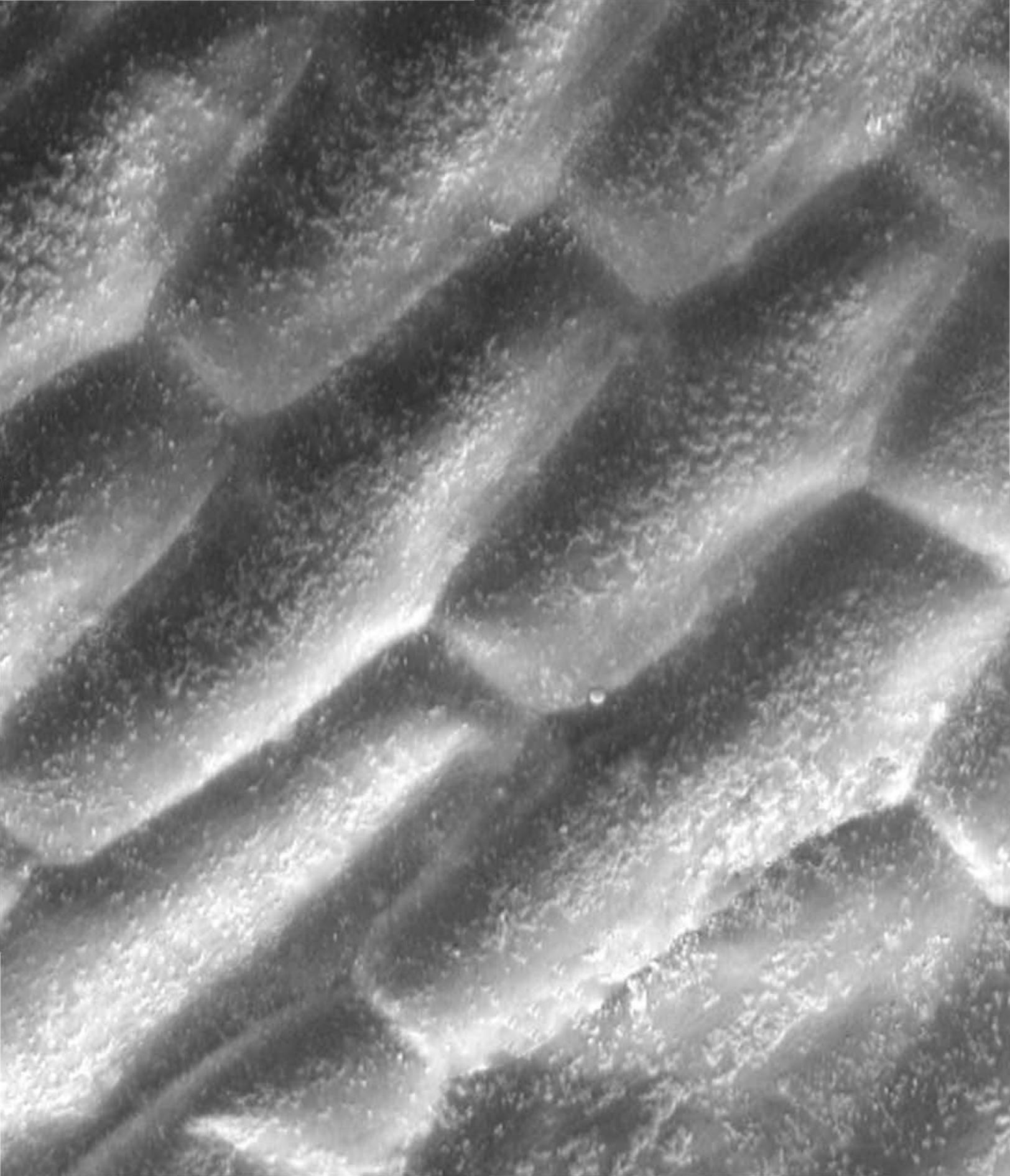
160X Magnification of a Silver Vase Bromeliad



They in turn shared their knowledge with high school students in the local community.

Dr. Boehlert is one of many professors who has taught Honors Research Seminars since their introduction to MSU in the 2006-2007 academic year. These seminars provide an opportunity for first and second year Honors College students to gain early exposure to undergraduate research in a wide variety of fields. Through Spring 2010, more than 600 students have participated in 64 seminars.

Presentation of their work at UURAF (<http://urca.msu.edu/uuraf/>) is often a requirement for students participating in these seminars. The image of the spider plant from the back cover and reproduced at left, as well as the second image of the Silver Vase Bromeliad, were presented at UURAF in 2008 by Karla Kapplinger. Both images were captured using the same methods except that a lower magnification (160X) was used for the Silver Vase Bromeliad.



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