This summer, the Vanderbilt Center for Science Outreach (CSO) enrolled 20 high school students from Middle Tennessee and beyond – extending as far as New Jersey, Oman, Puerto Rico and Germany – to participate in the Research Internship Program, an intense six-week advanced science experience. In addition, 22 students from the School for Science and Math at Vanderbilt (SSMV), a unique four-year, interdisciplinary, research-centered learning experience for students from Metropolitan Nashville Public Schools, spent the summer completing Research III as part of the SSMV curriculum. These 42 students were mentored by Vanderbilt University and Medical Center faculty in 36 laboratories spanning 18 different departments. The young scientists-in-training attended weekly meetings to extend their critical thinking skills and develop the research posters being presented today. They have also developed the requisite skills required for independent research projects.

The summer research staff in the CSO would like to thank all of the participating faculty, laboratory staff, postdoctoral fellows, and graduate and undergraduate students for providing mentorship, assistance, and insight into the world of scientific discovery. We would also like to acknowledge the many contributions of the entire Center for Science Outreach and the School for Science and Math at Vanderbilt.

Summer Research Coordinator and Lead Scientist, Interdisciplinary Science and Research Program
Tiffany Ellis Farmer

Director, School for Science and Math
Angela Eeds

**Director, Center for Science Outreach**
Virginia Shepherd

**Assistant Director, Center for Science Outreach**
Joe Lopez

**Associate Directors, Center for Science Outreach**
Jennifer Ufnar
Chris Vanags

**Scientist-in-the-Classroom Partnerships Coordinator**
Jeannie Tuschl

**Technology Coordinator**
Jeff Hazleton

**Teacher Outreach Specialist**
Tonja DeVault

**Scientists in Residence**
Julia Dobish
Josh Swartz

**Data Management Specialist**
Greta Clinton-Selin

**Instructors, School for Science and Math**
Jonathan Creamer
Mary Loveless

**Admissions and Administration, School for Science and Math**
Amanda Dixon

**Teaching Assistant, School for Science and Math**
Michael Weston-Sawkes

**Educational Consultant**
Harvey Sperling
Diet and Climate During and After the Fall of the Wari Empire in Ancient Peru
Jasmine E. Kelly, Larisa DeSantis, Danielle Kurin, and Tiffiny A. Tung

The ancient Wari Empire ruled over the central Andes from 600 to 1000 CE. This study evaluates the role of Wari governance and its decline (1000-1400 CE) in the distribution of foodstuffs and the effect of climate change on food production. Did Wari elites consume more maize and chicha (maize beer)—socially valued consumables—than did the commoners? And did this pattern change after Wari collapse? Differential consumption of plants that use C3 (non-maize) vs. C4 (maize) photosynthetic pathways are examined through analysis of dental disease and carbon isotope ratios ($\delta^{13}$C) in human enamel hydroxyapatite. Precipitation levels are examined through analysis of oxygen isotope ratios ($\delta^{18}$O). Hydroxyapatite was extracted from 19 human teeth and analyzed in a Finnigan Delta Plus XP mass spectrometer; dental data was collected from 40 archaeological skeletons. Results: individuals in the capital city have higher $\delta^{13}$C values than others, suggesting they enjoyed greater access to the socially valued food, maize. Consumption of maize declines slightly after Wari collapse, suggesting that the absence of state control contributed to only minor changes in food production. $\delta^{18}$O values suggest little severe change in precipitation levels, suggesting that food production was not adversely affected by a drought.

Identification of Motifs in the Intracellular Domain of the Engulfment Receptor Jedi-1 Required for Phagocytosis
Hyun J. Jin, Chelsea Cupp, Jami L. Scheib, and Bruce D. Carter

During development of the peripheral nervous system, approximately 50% of the neurons undergo programmed cell death as a normal pruning process. These cell corpses must be cleared to prevent an inflammatory response and possible autoimmunity. A novel engulfment receptor, Jedi-1, was recently discovered on glial cells that is necessary for the clearance of dead neurons. The purpose of this research was to determine how Jedi-1 signals engulfment. Jedi-1 is homologous to the Drosophila engulfment receptor, Draper, which signals through a tyrosine kinase that binds to an Immunoreceptor tyrosine-based activation motif (ITAM) on the receptor. In addition, Draper interacts with an adapter protein, GULP, through an NPXY sequence. The intracellular domain of Jedi-1 contains both an ITAM and an NPXY motif; therefore, we hypothesized that these sequences are required for Jedi-1 mediated engulfment. To test our hypothesis, we developed an engulfment assay using HeLa cells transfected with Jedi-1 or Jedi-1 mutants and scored engulfment of fluorescent microspheres. Expression of Jedi-1 led to a 6-fold increase in engulfment over control cells while mutants lacking either domain were significantly impaired in their engulfment ability. These results revealed that both the ITAM and NPXY motifs are necessary for Jedi-1 mediated phagocytosis.
Identifying and Quantifying M$_1d$G in Genomic DNA
Chenxi Zhu, Sarah C. Shuck, Philip J. Kingsley, and Lawrence J. Marnett

The production of reactive oxygen species (ROS) occurs during normal cellular metabolism and as a result of exposure to environmental agents. In patients with a history of chronic inflammation, the increased levels of oxygen radicals cause oxidative damage to DNA and other cellular macromolecules, including lipids. From these reactions, malondialdehyde (MDA) and base propenal are produced. Both MDA and base propenal lead to the formation of the mutagenic adduct M$_1d$G in DNA. The DNA damage can be used as a biomarker for cancer since it has been discovered that increased levels of M$_1d$G may be indicative of the development and progression of tumors. To further understand the role of oxidative damage in carcinogenesis, we developed an assay to measure the levels of M$_1d$G in genomic DNA. In our current assay, the levels of M$_1d$G were very low. However, we can use this data for the next step as we compare levels of M$_1d$G between normal genomic DNA and oxidatively stressed genomic DNA.

Effect of corazonin on the heartbeat of the mosquito Anopheles gambiae
Vivian A. Aluoch, Tania Y. Estevez-Lao, and Julian F. Hillyer

The mosquito heart, located underneath the dorsal midline of the abdomen, propels hemolymph (blood) throughout the mosquito’s body by contracting in both the anterograde (forward) and retrograde (reverse) directions. Several candidate neurohormones that regulate heart contractions have been identified, one of which is corazonin. Corazonin was first identified as a cardioacceleratory factor in the cockroach Periplaneta americana. Since it has this effect on cockroaches, we wanted to know corazonin’s effect on the mosquito’s heart. To test this, Anopheles gambiae mosquitoes were restrained dorsal side up in a manner that allowed us to visualize their contacting hearts using a stereomicroscope. We then acquired 60-second videos, injected various corazonin concentrations into the mosquitoes, and then took another video 10 minutes afterwards. Analysis of basal contraction rates revealed that the mosquito heart contracts at 1.9 Hz, and that 70% of the contractions propagate in the anterograde direction while 30% propagate in the retrograde direction. However, injection of corazonin did not significantly alter heart physiology. Thus, the function of corazonin in mosquitoes remains unknown.
**The Role of ssRNA virus NvitV2 in *Nasonia* hybrid mortality**

Ronnie Cela-Bedoya, Sarah Bordenstein, Robert Brucker, and Seth R. Bordenstein

In 2010, Oliveira et al discovered three new positive-sense single-strand RNA (ssRNA) viruses in the parasitic wasp *Nasonia vitripennis*, designated NvitV1, NvitV2 and NvitV3. NvitV2 is most closely related to three members of the *Iflaviridae* known to affect insect mortality at the early life stages. This virus was originally found only in the larval stage of *N. vitripennis*, but not in its sister species *Nasonia giraulti*. Crosses between *N. vitripennis* and *N. giraulti* have been shown to have a larval-stage hybrid mortality rate of approximately 90%. In this paper we test the hypothesis that NvitV2 is responsible for the high rate of larval mortality in *Nasonia* hybrids. The presence of NvitV2 was analyzed by performing RNA extraction, cDNA synthesis and polymerase chain reaction (PCR). The virus was proven to be present in *N. vitripennis* and *N. giraulti* hybrids as well as in *N. giraulti* pure breeding lines, in both the larval and adult stages. These observations do not support our hypothesis, which suggests that NvitV2 is not the main cause of larval mortality in *Nasonia* hybrids. This study does, however, offer the first discovery of the NvitV2 virus in *N. giraulti* and adults.

**Activation of G-protein signaling cascade in *Dictyostelium discoideum***

Shanna M. Rucker, Ryan B. Khodadadi, and Chris Janetopoulos

When the growth and division of cells becomes unregulated the results can be fatal, and can often lead to cancer. The regulation of cytokinesis and cell mobility are frequently studied in the amoeboid protozoan *Dictyostelium discoideum*. Many of the same genes found in higher eukaryotes are homologous in *D. discoideum*. Preliminary data in the laboratory suggested cells are quiescent at the onset of cytokinesis. To further demonstrate this, we are stimulating cells with chemoattractants at various stages during cytokinesis and observing a number of biosensors to see whether various signaling cascades are active. By imaging *D. discoideum* cells using fluorescent microscopy, we can observe the activity of several signaling molecules (PTEN, PI3K, Ras, and microtubules) tagged with green fluorescent protein (GFP). The cells were stimulated with folic acid before the onset of cytokinesis when they round up, as well as after cytokinesis. Surprisingly, when Ras activity was visualized with the Ras biosensor, RBD-GFP, the cells responded. Further studies will look at other signaling molecules to determine whether they are also active. Understanding where in the signaling pathway a block in activation occurs could possibly lead to manipulating other cells and controlling the overgrowth that can lead to cancer.
Low Volume Bacterial Chemostat in Microfluidic Devices Through the Use of Hexagonal Traps

Cristina Giron, Loi Hoang, Kevin Seale, and John Wikswo

Obtaining rapid diagnosis of sepsis is crucial for reducing morbidity and mortality rates associated with this bacterial infection. Proper diagnosis of sepsis is difficult because sepsis symptoms, such as rapid pulse, repertory difficulties and fever are seen as being common symptoms for other diseases/infections. Blood samples are either analyzed through the counting of white blood cells or blood culturing. Hospitals normally take 24 to 72 hours to identify bacterial pathogens and the associated drug susceptibilities from blood culture. In this work, a device containing hexagonal traps with three 3 μm wide openings was created through photolithography and processed through micro fabrication; this design allows bacterial entrance, trapping, and analysis. *Escherichia coli* OD50 (2 μm long; 0.5 μm in diameter) were perfused into the device along with Lysogeny Broth (LB). This solution was then re-circulated for 3 hours, allowing bacteria time to proliferate. Future research may show that it is possible for bacterial labeling, targeting identifiable markers in under 24 hours. Reducing the time necessary to culture bacteria leads to quicker detection of pathogens which allows for both quicker diagnosis of bacteria present and earlier administration of antibiotics necessary to combat harmful pathogens.

Using microfluidic devices to study the effect of two distinct environmental factors on endothelial cell alignment

Ravi Konjeti, Lucas H. Hofmeister, and Hak-Joon Sung

Cell processes in the microenvironment rely on distinguished physical or mechanical signals. Specifically, cell alignment relies on physical and mechanical signaling from the microenvironment. In the cardiovascular system, endothelial cells maintain a definite orientation to create fully functional vasculature. Studying the basic cell interactions at the microscopic level can lead to understanding relationships between biomaterials and endothelial cells. In this study, culture media and electrospun polycaprolactone (PCL) fibers provided two distinguished competing alignment signals for human umbilical vein endothelial cells (HUVEC) cultured within the polydimethylsiloxane (PDMS) microfluidic device. The aligned PCL fibers were permanently bonded to the microfluidic device, in which, the cells were in direct contact with the fibers and the controlled media. The cells seeded onto the PCL fibers alone have shown alignment correlating with the fiber configuration whereas growing cells within the microfluidic devices are proving to be complicated due to cell death within the apparatus itself. The preliminary results obtained from this test can further increase the knowledge of cell orientation and exterior signaling from the cell microenvironment.
**Rotary Fluidic Feed Through Device for use in Microfluidics**  
Schuyler Sanderson, Kevin Seale, and John Wikswo

Conventional microfluidic devices rely on mechanisms providing pressure to perform the desired functions of altering or observing individual cells. However these devices are bulky and expensive and are often difficult to operate. Centrifugal microfluidics is an emerging field of microfluidics aspiring to alleviate this problem, with centrifugal devices being a smaller and cheaper alternative that offer equal precision. However, centrifugal devices do not allow constant media flow through during operation. This work addresses this issue with centrifugal microfluidics through the fabrication of a device coupling both a stationary and rotating transfer face containing concentric channels of varying radii, the largest of 32 mm, with each having a width of 150 microns and a height of 50 microns. The faces of the device were designed in AutoCAD, impressed on 4 inch silicon wafers through photolithography, and fabricated with polydimethylsiloxane (PDMS). The faces were then adhered to 3 inch diameter borosilicate glass discs fixed to an axis. To ascertain the viability of the device, dye will be run through the device and volumetric differences will be collected across two transfer faces operating at low rpms. If these differences are minimal, than the device may be incorporated into other centrifugal designs to allow for constant media flow-through.

**The Effects of ATF4 and TGF-ß Mediation on Bone Integrity**  
Ahbid Zein-Sabatto, Adam Horch, Matthew Murry, Javier Esparza, Barbara Rowland, Alexander Makowski, and Jeffry Nyman

Transforming growth factor β (TGF-ß), along with activation transcription factor 4 (ATF4), are two widely expressed matrix proteins that have significant roles in bone formation. Previous studies indicate that TGF-ß decreases bone density and volume; meanwhile, ATF4 increases bone integrity. Unfortunately, not much has been done to correlate ATF4 with TGF-ß through drug suppression since both factors alter bone. In this study, ATF4 wild type and knock-out mice were treated with a TGF-ß suppression antibody (2G7) and a control antibody (12CA5) to isolate the effects of ATF4 and TGF-ß on bone structure and strength. Extracted L6 vertebrae and left femurs were assessed for bone structure by micro-computed tomography (µCT); the femurs were additionally assessed for water content by 1H NMR and biomechanical strength by 3 point bend testing. µCT data shows that 2G7 improves trabecular thickness and mineral density in the vertebrae of knock-outs; bone volume fraction also improved in the wild types’ metaphyses. Data from the NMR and biomechanical testing is still pending. Nevertheless, the changes in trabecular bone indicate that ATF4 affects the potency of 2G7. As a result, clinical treatments aimed to suppress TGF-ß expression to strengthen bone must account for ATF4.
**CANCER BIOLOGY**

**Evaluation of Bid phosphorylation status in myeloid malignancies**

Catherine A. Caffey and Kimberly B. Dahlman

Leukemia is the cancer of blood; white blood cells, specifically, develop abnormalities and proliferate at high rates, accumulating in the bone marrow. Acute myelogenous leukemia (AML) is a subtype of the disease that may have a poor prognosis upon diagnosis. AML is characterized by chromosomal translocations on chromosomes 8, 15, 16, and 18, but the pathophysiology is not yet completely understood. This study sought to elucidate the understanding of AML through study of Bid, a protein known to have closely linked correlation with development of chronic myelogenous leukemia (CML), another subtype of the disease that, like AML, is characterized by chromosomal translocation. Like CML, it was hypothesized that Bid may also be deregulated in AML. The mutation and phosphorylation status of BID and the corresponding protein, Bid, were analyzed in six human leukemic cell lines. No mutations in BID were identified. A Western blot was optimized and six leukemic cell lines were utilized to test assay conditions. Leukemic patient samples will be studied in continuing research to determine hypothesis accuracy. Further research is necessary in order to determine the precise effects of misregulation of Bid in AML. These studies may reveal a novel AML drug target in the apoptotic pathway.

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**CANCER BIOLOGY**

**Functional Analysis of a TGF-β Type II Receptor Polymorphism: Allele-specific Binding by Transcription Factor IRF-1**

Eriny Hanna, Xiaohong Li, Alicia Beeghly-Fadiel, Ryan J. Delahanty, and Lynn Matrisian

Transforming Growth Factor-β (TGF-β) signaling is critical in human cancer as its dual roles include both tumor promotion and inhibition. TGF-β primarily signals through the binding of ligands to the TGF-β type II receptor (TGFβR2). Driven by an epidemiologic association with breast cancer survival and results from in silico analysis indicating the presence of a putative transcription factor binding site, functional analysis of a single nucleotide polymorphism (SNP) in TGFβR2 was undertaken. Electrophoresis mobility shift assays (EMSA) demonstrated that the interferon regulatory factor 1 (IRF-1) binds to one of the SNPs of TGFβR2 in a differential manner. Binding occurred when the major allele (A) of the SNP was present, but not when the minor allele (G) occurred. IRF-1 regulates genes induced by interferons, and has also been shown to be involved in apoptosis and tumor suppression. In summary, these results demonstrate, for the first time, an allelic specific differential binding of transcription factor, IRF-1, to a SNP of the TGFβR2 gene. Further, they provide a biological explanation for the observed epidemiologic association between the SNP in TGFβR2 and breast cancer prognosis. Additional functional evaluation of allelic specific differences in TGFβR2 expression is currently underway.
**CANCER BIOLOGY**

**Consequences of altering Transforming Growth Factor Beta Receptor type III (TβRIII) expression in the prostate**

Anne M. Holmes, Omar E. Franco, William J. Taylor, Harold D. Love, and Simon W. Hayward

Prostate cancer is associated with increased expression of TGFβ ligands that can potentially elicit effects on the tumor cells and/or the local stroma. TβRIII, which mediates the action of the ligand TGFβ2, is downregulated in prostate cancer and has established roles in regulating cell migration and angiogenesis. TβRIII is reduced in human prostate cancer stroma; however, little is known about the consequences of TβRIII loss in the tumor microenvironment and the role that such changes play in tumor progression. In this study, TβRIII expression was suppressed in the normal human prostatic fibroblast line BHPrS-1 using shRNA. The urogenital sinus of embryonic lethal TβRIII-KO mice was rescued using renal capsule grafting. Expression of proteins – including vimentin, αSMA, p38 MAPK, and pSmad2 – were assessed in these samples. Furthermore, proliferation and major molecular downstream regulators were studied. Suppression of TβRIII in fibroblasts induced changes in proliferation. In the rescued knockout prostate, expression levels of several downstream signaling pathways, such as vimentin and smooth muscle actin, involved in differentiation were altered. Deletion of TβRIII decreased the amount of basal cells and caused an expansion of the smooth muscle. There was an increase in p38 MAPK consistent with a cancer phenotype.

**CANCER BIOLOGY**

**Curcumin, the Active Component of the Indian Spice Turmeric, Inhibits Growth and Virulence of the Bacterial Pathogen Helicobacter pylori**

Xinrui Qian, Daniel P. Barry, Rupesh Chaturvedi, and Keith T. Wilson

The bacterial pathogen Helicobacter pylori is carried by 50% of the world’s population. Without treatment, H. pylori infection is lifelong and causes inflammation-associated diseases including gastroduodenal ulcers and gastric cancer. In some cases, H. pylori is able to frustrate antibiotic treatment because of resistance. Studies have shown that curcumin, a chemical found in turmeric, inhibits inflammation and may have cancer-fighting properties. In this study we sought to determine if curcumin could also directly affect bacteria. We first tested the effects of curcumin on the growth rates of two strains of H. pylori that are known carcinogens. In the presence of curcumin, H. pylori grew significantly slower than in unsupplemented broth. We also monitored changes in bacterial pathogenesis. The H. pylori virulence factor CagA is associated with development of gastric cancer in humans. Bacteria grown in the presence of curcumin expressed lower levels of CagA than those grown in its absence. These findings indicate that curcumin does have anti-H. pylori properties, separate from its well-established anti-inflammatory effects. Due to its ability to inhibit the growth of H. pylori and suppress expression of CagA, its most important virulence factor, curcumin may be useful as an antimicrobial therapy for H. pylori infection.
Localization of p71, a microtubule-associated protein, to centrosomes and microtubules

Samantha A. Mendonsa, Sarah G. Hainline, and Laura A. Lee

The essential mechanism of duplication and division is known as the cell cycle. In eukaryotes, cells have evolved a complex network of regulatory proteins, known as the cell-cycle control system. We identified p71, an uncharacterized *Drosophila* protein, in a screen for novel proteins involved in regulating cell cycle progression. Preliminary studies indicate that p71 is expressed primarily in the adult *Drosophila* ovary and early embryo. p71 also associates with microtubules when expressed in cultured cells. Microtubules are dynamic cytoskeletal components, important for the separation of chromosomes in cell division. They have the ability to quickly rearrange themselves to form a bipolar mitotic spindle during cell division. We hypothesize that p71 associates with microtubules during the early embryonic cell cycles in *Drosophila*. To test this hypothesis, we immunofluorescently stained early embryos using antibodies raised against p71 and α-tubulin. During mitosis, p71 colocalized with α-tubulin along the mitotic spindle and at the spindle poles. Additionally, immunostaining experiments revealed that p71 colocalizes with a centrosome marker, centrosomin. These results suggest that p71 localizes *in vivo* to microtubules and centrosomes and may function as a microtubule-associated protein.

Optimizing transfection efficiency and determining release kinetics of plasmid DNA from polyurethane scaffolds *in vitro*

Laura K. Moribe, Elizabeth J. Adolph, and Scott A. Guelcher

Polyurethane (PUR) scaffolds can be used as delivery vehicles for biological molecules such as growth factor genes. If these genes successfully transflect cells, wound healing in skin defects can be enhanced. In this study, we focused on optimizing the transfection efficiency of plasmid DNA (pDNA) complexes and measuring the release kinetics of the complexes from PUR scaffolds *in vitro*. To optimize transfection efficiency *in vitro*, complexes using polyethyleneimine (PEI), hyaluronic acid (HA), and pDNA were created. PEI, a cationic polymer, was used for its ability to protect DNA and deliver it through the cell membrane. HA, an anionic glycosaminoglycan, was used for its ability to stabilize complexes. Different PEI:HA:pDNA charge ratios, media and cell lines were investigated. It was determined that PEI:HA:pDNA complexes with a charge ratio of 12:0:1 in DPBS transfected cells most efficiently. These complexes were then incorporated into PUR foams and their release kinetics were measured *in vitro*. Unfortunately, complexes in the releasate from the foams did not transflect cells. Thus, it was concluded that the reactions involved in the formation of the scaffold adversely affected the complexes. In the future, complexes will be encapsulated in microspheres to protect them from the PUR reaction.
Implementation and Assessment of Principal Component Analysis in the BioChemicalLibrary
Zhengyang Cong, Edward Lowe, and Jens Meiler

Principal component analysis (PCA) is a procedure for simplifying large and complex data sets, creating smaller and simpler matrices that better reveal underlying relationships. PCA reduces the dimensionality of data matrices by retaining the necessary variation of the data, producing an optimized representation of the original matrix without much noise. Artificial neural networks (ANNs) and support vector machines (SVMs), systems that possess vast potential in modeling relationships, are time-inefficient to train with large data sets. To reduce training time and noise in data, PCA was implemented in the BioChemICALibrary (BCL), a 400,000 line C++ library for modeling proteins and small molecules. After implementation, the PCA function mediated reduction of training data was benchmarked. From the large input matrix of training data, reduced matrices were produced to train the ANN and SVM. The results were compared to data generated through a descriptor selection method commonly used for reduction, Sequential Forward Feature Selection (SFFS). The results obtained through PCA data reduction were comparable to those obtained through SFFS while reducing data and training time by 1 to 2 orders of magnitude. Thus, PCA is useful for data and time reduction for training quantitative structure activity relation models of small molecules.

Pencil lead as a matrix for matrix-assisted laser desorption/ionization
Sarah D. Matos*, Austin J. Paul*, Jay G. Forsythe, and John A. McLean

Matrix-assisted laser desorption/ionization (MALDI) is an ionization process often used for mass spectrometry (MS) in which matrix molecules transfer laser energy to analyte molecules. It is an energetically soft process, keeping analyte molecules intact for detection. Previous research has shown that graphite serves as a successful matrix for various analytes but is difficult to apply to a sample plate. More recently, pencil lead (which contains graphite, waxes, and clays) has been investigated as a matrix because it is much easier to apply. The goal of this research is to explore pencil lead as a matrix and test its effectiveness in ionizing smaller analytes such as peptides. Moreover, comparisons between pencil leads of varying hardness and brand are facilitated by the use of imaging MS technology.

*These authors contributed equally to this work
**CHEMISTRY**

Predicting binding energy of Staphylocoagulase mutants

Erik Nebel and Jens Meiler

Thrombin is a protein involved in the process of blood clotting. It is found in the blood plasma of mammals as a precursor called prothrombin. Prothrombin is activated by proteolytic cleavage. In this process the first 15 residues of the N-terminus are removed.

The enzyme staphylocoagulase, produced by *Staphylococcus aureus*, is able to activate prothrombin without the usual proteolytic cleavage, thereby directly initiating blood clotting. This works as follows: the N-terminal tail of the toxin binds into a “pocket” of prothrombin resulting in a conformational rearrangement and activation of prothrombin.

To understand the underlying mechanism of this process, ~20 variants of the first two residues of the toxin (Isoleucine and Valine) have been analyzed for their ability to bind and activate prothrombin. Predictions of the interaction energies between prothrombin and all 400 amino acid combinations were generated using the computational protein structure prediction algorithm Rosetta. Rosetta predicts protein structures and intermolecular interactions through evaluation of van der Waal’s packing, solvation, hydrogen bonding and electrostatics. Comparison of the predicted binding energies with experimental measurements indicates the predictive power of these calculations. Staphylocoagulase variants expected to bind tightly to prothrombin will be experimentally validated.

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**HEARING AND SPEECH SCIENCES**

Are Goals for Newborn Hearing Screening and Follow-up for NICU Infants Being Met in the Monroe Carell Jr. Children’s Hospital at Vanderbilt?

Nawal Kirmani, Lindsey Rentmeester, Anne Marie Tharpe, and Linda Hood

The Joint Committee on Infant Hearing (JCIH) implemented policies and guidelines for newborn hearing screening stating that all infants should be screened for hearing loss by one month of age, have diagnostic testing by three months of age, and receive intervention, if needed, by six months of age (JCIH, 2007). The purpose of this study was to determine if the JCIH guidelines were met for the infants in the neonatal intensive care unit (NICU) at the Monroe Carell Jr. Children’s Hospital at Vanderbilt. A retrospective chart review was performed to examine data from NICU infants who did not pass newborn hearing screening. When considering chronological age, results show that on average NICU infants received hearing screening by two months of age, diagnostic testing by six months of age, and were fit with amplification, if appropriate, by ten months of age. This suggests that JCIH guidelines are not being met. However, when chronological age is corrected to account for prematurity, results show that on average NICU infants received hearing screening by one months of age, diagnostic testing by four months of age, and were fit with amplification, if appropriate, by seven months of age. These findings suggest that while we are meeting goals for newborn hearing screening in the NICU population, additional challenges remain in meeting follow-up goals.
Mechanical Engineering

Development of an Intelligent Heart Rate Sensitive Virtual Reality System in Real-Time

Shuvajit Das, Uttama Lahiri, and Nilanjan Sarkar

An intelligent Virtual Reality (VR) based system has the potential to adapt itself based on one’s affective state. This system shows potential in real world applications e.g., intervention for children with Autism Spectrum Disorder. Specifically, these children possess communication vulnerabilities in terms of expression of emotions e.g. anxiety. Thus having a system that can intelligently identify one’s anxiety level and adapt itself accordingly will be beneficial. The feasibility of such a system was investigated by employing a pulse plethysmograph (PPG) based heart rate (HR) sensor assembled in-house to communicate physiological changes experienced by a participant. An interface was developed between the PPG sensor and a real-time data analysis module (MatLab based). Then a VR based communication module (Vizard based) was developed to take different actions based on the changes in HR, as indicative of one’s anxiety level. A participant played a pong game of varying difficulty levels while his HR was being monitored in real-time. Subsequently, an avatar adaptively delivered different responses based on the variation in the participant’s HR. Overall, this study shows the feasibility of developing an intelligent interface between physiological monitors and a VR system capable of adapting in an individualized manner.

Mechanical Engineering

Technology for Micro-vascular Intervention in the Retina

Esther Miah, Haoran Yu, and Nabil Simaan

Vitreoretinal surgery is meticulous and requires precision. Surgeons are unable to perform surgery without complications due to numerous constraints. This report presents experiments performed to determine realistic parameters needed to create suitable models for testing robotic technologies on the eye. These models imitate the internal limiting membrane and the micro-vasculature of the retina while providing sufficient imaging contrast during Optical Coherence Tomography (OCT) imaging. The report also presents experiments implemented to determine optimal approach angles for stent deployment. Phantom retinal vessels were evaluated by OCT. Distinct ratios of agar solution were tested to improve OCT imaging contrast. The experimental setup for stent deployment is also evaluated to determine required approach angle for stent deployment. Results of this report provide guidelines for researchers at Vanderbilt on creating models for the micro-vasculature of the retina and the internal limiting membrane of the eye. The retinal vessels were not properly identified on OCT imaging due to the accumulation of air bubbles in the agar. However, the agar solution and ratio composition improved the OCT images. Results showed that smaller angles of approach were sufficient for stent deployment into the vessels without penetrating other layers of the eye. Micro-stent deployment could potentially serve as treatment for Branch Retinal Vein Occlusion.
MECHANICAL ENGINEERING

Evaluation of Curved Nitinol Stylets for Optimized Robotic Insertion of Perimodiolar Electrode Arrays

Yixian Su, Jason Pile, and Nabil Simaan

During cochlear implant surgery, a collection of metallic electrodes is inserted into the inner ear to partially restore hearing sensation. Such a perimodiolar electrode array (PEA) contains an internal straight stylet, usually made from steel. While the PEA is being inserted, the stylet is retracted, allowing the array to coil into the curved shape of the cochlea. This study evaluates the potential of using pre-curved stylets to change the shape of commercially available electrode arrays. Protocol is established for creating stylets with various shapes from superelastic Nitinol. In addition, image processing algorithms are described with the intention of presenting a model that accurately characterizes how an electrode array bends as a function of pull on the stylet. The results suggest that the extent of curvature used in the stylet shape is limited by the stability of the assembled stylet-electrode pair. Greater shape deviations between the stylet and the electrode array were shown to cause rotation of the stylet in a way that minimized the energy of the system. Though desired effects in electrode array shape modification were not obtained, insight on the behaviors of Nitinol stylets may shed light on a more optimal PEA setup during robotically assisted cochlear implant surgery.

MEDICINE

Identification of novel H. pylori adhesins responsible for binding the host cell receptor Decay accelerating factor (DAF)

Emily M. Alsentzer, Jennifer M. Noto, W. Hayes McDonald, and Richard M. Peek

Gastric adenocarcinoma is the second leading cause of cancer-related death worldwide. Helicobacter pylori is the strongest known risk factor for this malignancy, and adherence of H. pylori to gastric epithelial cells is critical for pathogenesis. Decay accelerating factor (DAF), a regulator of human complement, mediates adherence of H. pylori to the gastric mucosa and facilitates H. pylori-induced gastric inflammation. We sought to define the H. pylori constituents required for DAF-mediated adherence to gastric epithelial cells. To isolate H. pylori DAF-binding proteins, we used immobilized metal affinity chromatography with histidine-tagged DAF. Bound H. pylori proteins were eluted and visualized using silver stain, and candidate DAF-binding proteins were validated using DAF Far Western blotting. Bands of interest were subjected to tandem mass spectrometry for protein identification. Six novel outer membrane proteins were identified: FlaA and FlaB, which are known for their role in cellular motility, and HopQ, HofC, AlpA, and AlpB, which are H. pylori adhesins important for adherence to gastric epithelial cells. Future studies will confirm the role of each of these proteins in DAF-mediated adherence and H. pylori-induced gastric inflammation. Overall, these data provide novel insights into the pathogenic mechanisms that contribute to H. pylori-induced carcinogenesis.
Region of Importance: Determination of MTG16-Kaiso Interaction Domain
Lauren C. Lu, Caitlyn W. Barrett, Michael E. Engel, and Christopher S. Williams

MTG16, a myeloid translocation gene, and Kaiso are both transcriptional corepressors forming complexes with N-CoR and a number of histone deacetylases. Kaiso possesses direct DNA binding capabilities, while MTG16 requires interaction with trans-acting proteins to establish promoter specificity. While both have been shown to target known cancer pathways such as the WNT pathway, Kaiso may represent a MTG16 interacting protein vectoring MTG16 repression complexes to Kaiso targets. Preliminary experiments have demonstrated MTG16/Kaiso colocalization and identified similar transcriptional targets, such as matrilysin (Mmp-7). In this study, the essential domains on MTG16 for the binding to Kaiso were determined by cloning each Kaiso family member into expression vectors and co-transfecting Cos7 cells with MTG16 mutants (N-terminal deletion, C-terminal deletion, and NHR2 region deletion), and performing co-immunoprecipitations. Furthermore, the findings confirmed that full-length MTG16 co-immunoprecipitates with Kaiso and demonstrated that the first 363 amino acids of MTG16 were required for the Kaiso interaction. The MTG16/Kaiso interaction inhibits expression of proteins that promote colorectal tumorigenesis so mutations to their binding sites or loss of expression of either may result in increased expression of pro-tumorigenic MTG16/Kaiso targets such as Mmp-7 thus promoting tumorigenesis. Understanding the MTG16/Kaiso interaction could lead to novel therapeutics for colon cancer.

The Effect of TERC and TERT Genes on Telomere Length in Mice

In eukaryotic organisms, the ends of chromosomes contain telomeres: DNA “caps” that do not contain vital information, but protect the essential DNA by acting as a buffer zone, shortening during mitosis. Telomerase is the enzyme that reconstructs the telomeres after mitosis, with TERC and TERT genes encoding for its production. An anomaly in one of these genes results in ineffective telomerase and shorter telomeres.

Idiopathic pulmonary fibrosis (IPF) is a disease that causes “scarring” in the lungs, culminating in respiratory issues and often death in middle aged patients. Roughly ten percent of patients have TERC or TERT anomalies. To test whether having short telomeres is a cause of IPF, DNA was extracted from Wild Type mice, as well as mice with either the TERC or TERT gene “knocked out.” Furthermore, mice were treated with Bleomycin, a chemotherapy drug that helps cause IPF. If anomalies in the genes caused IPF, the knockout mice would develop IPF.

While real-time PCR did confirm that telomeres were shortened in the knockout groups, no group of mice was diagnosed with IPF at a faster rate than the other groups. The conclusion is that short telomeres are not the only factor in the development of IPF. More research will be conducted to see if any other causes can be identified.
**Medicine**

**Mapping Functional Domains of the Osteoblast Transcription Factor ATF4**  
Stephanie Sun, Xiangli Yang, and Lingzhen Li

Osteoporosis is a metabolic bone disease in which bone mineral density is reduced and consequently leads to increased risk of bone fracture. It is primarily caused by an imbalance of osteoblasts, which create new bone, and osteoclasts, which break down bone tissue. ATF4, or activating transcription factor 4, is a critical factor that regulates the terminal differentiation of osteoblasts. My goal was to cut ATF4 into three fragments and sub-clone them into the vector pcDNA 3.1 (+) so that I could study which parts are essential to the function of ATF4. I have made two constructs, pcDNA3.1 (+)/ATF4 1-111 and pcDNA3.1 (+)/ATF4 151-221. My results showed that ATF4 151-221 lost its transcriptional activity, whereas ATF4 1-111 retained its function with similar potential to the full-length ATF4. My findings confirm that the amino acids from 1-111 possess the ability to transactivate the target genes of ATF4, while amino acids from 151-221 cannot function alone. Further mapping to find the critical amino acids for the function of ATF4 is necessary for drug design to treat osteoporosis in the future.

**Microbiology and Immunology**

**Zinc Binding Sites of Zur Protein in Acinetobacter baumannii**  
Scott Blackwell, Indriati Hood, and Eric Skaar

*Acinetobacter baumannii* is a growing threat in the hospital setting, with traditional antibiotics becoming an obsolete method of treatment, as the bacteria is adept at rapidly developing antibiotic resistance. Zinc (Zn) is an element vital to the survival of bacteria. An important way bacteria acquire zinc is through the Zn uptake system (Znu) that code for proteins responsible for transporting zinc through the cell membrane. The expression of this genetic sequence is often regulated by a protein known as the Zinc uptake regulator (Zur), which acts as a transcriptional repressor when bound to zinc. When zinc is present in the cell Zur binds to the promoter region of the Znu operon, blocking transcription, and thus preventing the synthesis of zinc uptake proteins. When Zur is not bound with zinc, these genes will be expressed and the bacteria will continue normal synthesis of zinc uptake proteins. Although there are genes in *A. baumannii* that appear to encode a Znu sequence and a Zur-like protein, the specific functions of these proteins have yet to be confirmed. The focus of this project was to confirm that the Znu system plays a role in zinc uptake in *A. baumannii*, as well as to define the zinc binding sites in Zur.

In order to determine the role for the predicted Znu system in *A. baumannii*, we performed growth curve analyses comparing a mutant strain lacking ZnuB with wildtype in Zn-limiting conditions. The ZnuB knockout (ΔZnuB) demonstrated significantly less growth than wildtype bacteria in zinc deplete conditions, indicating that ZnuB plays an integral role in zinc uptake in *A. baumannii*. In order to define Zur’s zinc binding sites we first constructed three Zur mutants, all with mutations at different putative zinc binding sites. After running Zinc binding assays, we successfully quantified the level of zinc binding to each mutant. Future studies will combine various mutations, to form a protein that would demonstrate significantly worse zinc binding than wildtype Zur. This combination would allow for further confirmation of all sites responsible for zinc binding in the protein.
**MICROBIOLOGY AND IMMUNOLOGY**

**Epitope Mapping with Antibodies and the PYD Vector**

Jonathon Ferrell, Bryan Briney, Jordan Willis, Monique Marshal, Mason Sanders, Gopal Sapparapu, and James E. Crowe

Over 30 million people are infected with human immunodeficiency virus (HIV). A critical step toward generating an effective vaccine is greater understanding of the mechanism of neutralizing antibodies. I have begun mapping the epitope of a novel HIV neutralizing antibody, 4H19, using a competition ELISA.

Due to the large amount of protein required to fully elucidate the function of 4H19, high levels of recombinant expression are required. To facilitate rapid expression, I am cloning 4H19 into the pYD expression system. This system uses the PYD vector, which has the Epstien-Barr Virus origin of replication (oriP). This vector is transiently transfected into the 293-HEK derived cell 293-6E, which stably expresses Epstein-Barr virus Nuclear Antigen 1 (EBNA1). EBNA1 actively retains pYD in the nucleus of 293-6E cells, allowing prolonged expression following transient transfection. This semi-stable transfection is much more efficient than a standard transient transfection, allowing continuous expression for up to three weeks.

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**OPHTHALMOLOGY AND VISUAL SCIENCES**

**Characterization of CCL5 chemokine receptors in acute and chronic murine models of glaucoma**

Amanda C. Rehorn, Heather M. Cathcart, and Rebecca M. Sappington

Glaucoma is a common optic neuropathy that causes blindness through the degeneration of retinal ganglion cell neurons. CCL5 is a chemokine that is important in recruiting macrophages during the inflammatory immune response. Our previous work suggests that CCL5 is produced by retinal ganglion cells (RGCs) and glial cells in response to elevated intraocular pressure, a major risk factor for glaucoma. In this study, we sought to examine localization and quantify expression of two CCL5 receptors, CCR3 and CCR5 in both acute and chronic mouse models of glaucoma. We performed immunohistochemical analysis of CCR3 and CCR5 expression in retina from the DBA/2 mouse (chronic) and microbead occlusion (acute) models of glaucoma. Retina were co-labeled with cell type specific markers for microglia (Iba-1), astrocytes (GFAP), Muller cells (glutamine synthetase) and retinal ganglion cells (SMI-31). Quantification of receptor expression was performed using quantitative digital microscopy and graphed using Sigma Plot. CCR3 and CCR5 were expressed in multiple layers of normal and glaucomatous retinas. Expression of both receptors increased, particularly in retinal ganglion cells, in both models. The largest increases in expression were noted for CCR3. These data suggest that CCL5 may play a role in the response of retinal ganglion cells to glaucoma stressors and that this function could be autocrine in nature.
PATHOLOGY

Creating a Palatable Foodstuff that Contains a Full Daily Dose of Omega-3 Fatty Acids in a Single Serving
Ryan L. Driscoll, Michael Laposata, Adam C. Seegmiller, Waddah Kantrangi, and Jeffrey Sonsino

The American Heart Association and the American Psychiatric Association recommend daily omega-3 fatty acid intake of 1 gram. Folate and iodine have been successfully added as dietary supplements to common foodstuffs and present potential models for inclusion of 1 gram of omega-3 fatty acids in a dietary component which can be ingested daily. Because omega-3 fatty acids have odor and taste challenges, the inclusion of 1 gram of omega-3 fatty acids has not yet been achieved as a dietary supplement. In a pilot study, samples of mustards and ketchups, among others, were treated with 1 gram of omega-3 fatty acids in individual servings. From the foodstuffs, lipids were extracted and the present fatty acids were methylated and analyzed by gas chromatography-mass spectrometry. Taste tests were performed to determine whether the omega-3 fatty acids are detectable. A longer study with >100 subjects involved in a statistically rigorous taste test will be performed with fatty acid quantitation of all samples to confirm the presence of ≥ 1 gram of omega-3 fatty acids. We believe these studies will indicate that it is possible to include 1 gram of omega-3 fatty acids into a commonly ingested foodstuff and avoid the need to purchase expensive omega-3 containing capsules or drinking undiluted fish oil.

PEDIATRIC TOXICOLOGY

Effects of histone H2A fragment 36-44 (KGHYAERVG) on rat astrocytes
Tahreem Fatima, Marta Sidoryk-Wegrzynowicz, Yingchun Yu, Jiyang Cai, Uri Wormser, and Michael Aschner

Exposure to high levels of metals is known to be toxic to humans as they can cause neurological defects, especially in young children. A previous study demonstrated neuroprotective efficacy of histone H2A fragment 36-44 (KGHYAERVG) peptide, or IIIM1. This study was designed to explore the neuroprotective efficacy of IIIM1, testing the hypothesis that the peptide will improve the general health of 3-week old rat primary astrocyte cultures. Control (no IIIM1) and experimental (1, 5, 10 and 50 µg/mL of IIIM1) astrocytes were tested at four different timepoints: 24, 48, 72 and 96 hours. Lactate dehydrogenase (LDH) and 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assays, both markers of cell viability, and glutathione (GSH: a major antioxidant) levels were indistinguishable between IIIM1 and controls. These results suggest that IIIM1, a synthetic peptide not found naturally in cells might lead to cellular stress, or that the neuroprotective efficacy of the peptide can only be apparent in cells undergoing significant stress. We propose to further study this by creating conditions suitable to test our new hypothesis that IIIM1 shows neuroprotection only under stress.
Pharmacology

The Influences of Integrin αVβ3 and the Serotonin Transporter on Cell Adherence and Survival

Jordan Ashby Winters, Keaton M. Wadzinski, Tammy Jessen, and Ana M. D. Carneiro

In multicellular organisms, cell adhesion and survival are controlled by integrin-mediated cell signals. We recently identified that integrins interact with serotonin transporters (SERT) in platelets which could be important in platelet aggregation. In this study, we hypothesized that if you activate SERT, you modulate integrin αVβ3 activity. We tested integrin αvβ3 function by both cell adhesion and survival. Here, the effects of SERT activity on integrin αVβ3 function were studied using serotonin in Chinese hamster Ovarian (Cho) cells. In the preliminary studies, serotonin increases the speed of apoptosis, and citalopram, a Selective Serotonin Reuptake Inhibitor that increases the level of serotonin in the synaptic cleft, usually fails to rescue this effect. When serotonin is added, the attachment of SERT cells increases and this change is rescued by blocking SERTs with citalopram. Serotonin is believed to both be affecting the attachment and apoptosis in SERT-dependent and independent pathways, which could help with the development of more specific human pharmaceuticals.

Physics and Astronomy

B-Tagging in Heavy Ion Collisions at the CMS Detector: A Preliminary Investigation

Mark Arildsen, Eric Appelt, and Julia Velkovska

High-energy inelastic lead-lead collisions (PbPb) have been shown to result in the creation of a new state of matter, a soup of deconfined quarks and gluons (the constituent particles of protons and neutrons) called quark-gluon plasma (QGP) that was likely present in the early universe. Identifying b-jets (jets formed by the hadronization of b-quarks) in such collisions is especially important, as it could allow experimental differentiation between methods for determining QGP properties. B-tagging, the process of identifying b-jets, uses secondary vertex-seeking algorithms, since long-lived b-hadrons form a secondary vertex in an event. Although well-studied in proton-proton collisions (pp), b-tagging in PbPb is difficult, as tight tracking cuts, which hamper secondary vertex-seeking, must be imposed to prevent fake track proliferation. We have varied tracking methods using existing algorithms in order to improve b-tagging performance in PbPb. For each type of tracking method, histograms of discriminator distributions and efficiencies for the algorithms were created using a Monte Carlo simulation of jet-embedded data. There was some improvement, but performance was still far behind that in pp. We also explored the radiography of simulated b-jets. This exploration will help us understand how tracking must be improved in order to improve PbPb b-tagging performance.
Freestanding CNT films fabricated by post-EPD electrochemical separation

Jyotishka Biswas, Jaron Rottman-Yang, Isabel Gonzalo-Juan, and James H. Dickerson

A novel technique of producing buckypapers using electrophoretic deposition (EPD) and post-EPD electrochemical separation (PEPDECS) is introduced. Multiwalled carbon nanotubes (MWCNTs, AQ0101, 1 wt.%, Nanocyl Inc.) were deposited from an aqueous dispersion onto stainless steel substrates using a direct current EPD procedure. Following drying and reinsertion of the electrodes into deionized water, a simple reversal in the direction of the current between the electrodes and an increase in the electric field facilitated an intact separation of the film from the substrate. The surface morphology was studied using scanning electron microscopy, and MWCNT surface groups on both sides of the buckypaper were identified using Fourier transform infrared spectroscopy (FTIR). Although SEM images suggested similar morphology on both sides of the liberated film, FTIR results indicated that electrochemical changes occurred in MWCNT surface groups during PEPDECS, which were not observed for a previously reported mechanical separation technique. These changes allow the intact separation of the film from the substrate and occur only along the face directly in contact with the substrate. PEPDECS is a simple and effective procedure, which has the ability to rapidly produce intact freestanding MWCNT films without significant structural alterations.

Characterization of a thermionic electron beam for future graphene transmission experiments

Vikas Kumar, Jonathan Jarvis, and Charles Brau

Current biomolecular imaging techniques use either x-rays or high energy electrons and are thus hindered by radiation damage. However, recent investigations of DNA using low-energy electron point source (LEEPS) microscopy suggest that biomolecules are not damaged by electrons with energy levels between 30 and 200 eV. The current substrate used in LEEPS microscopy is an irregular carbon film, with bumps and holes that create an uneven electric field near the sample, causing a distortion of the image. Graphene, a flat, single-atom thick allotrope of carbon, would be an ideal substitute for the current substrates. However, its low-energy electron transmission properties are unknown. In this paper, we describe our efforts to determine the transmission coefficient and the dose of electrons required to destroy graphene as a function of energy.
**Physics and Astronomy**

**Novel Method for Fabrication of Free-standing Carbon Nanotube Films: Post-Electrophoretic Deposition Electrochemical Separation**

Jaron Rottman-Yang, Jyotishka Biswas, Isabel Gonzalo-Juan, and James H. Dickerson

The cost-efficient fabrication of free-standing carbon nanotube (CNT) films is of great interest for the industrially-feasible production of energy storage devices. Post-ElectroPhoretic Deposition ElectroChemical Separation (PEPDECS), a novel method of creating free-standing CNT films, follows the precedent of electrophoretic deposition (EPD) of CNT films, in which parallel-plate steel electrodes are placed in a CNT (AQ0101, 1 wt.%, Nanocyl Inc.) suspension, and said CNTs accrete onto the steel substrates due to ambient electric fields. PEPDECS involves the liberation of films previously deposited by EPD by applying an electrophoretic current to the film-coated electrode in a direction that is opposite of that employed in the original EPD process. Performed in deionized water, PEPDECS yields intact CNT films with random planar orientation of CNTs and flat, porous structure across both surfaces of the film. Scanning electron microscopy confirms that resulting films possess similar morphology to those produced by other techniques, such as mechanical cleavage. Fourier transform infrared spectroscopy confirmed the presence of electrochemical interactions between the deposited CNTs and the steel substrate during the PEPDECS process.

**Psychology**

**Schizotypy and the Potentiation of the Post-Auricular Reflex; a Preliminary Study**

Holden D. Bitner, Sohee Park, and Steven D. Benning

Disturbances in emotional processing are characteristic features of psychosis. Our understanding of these affective disturbances has remained rather superficial. These disturbances are associated with the social dysfunction of the psychotic and psychosis-prone portion of the human population, therefore understanding this issue is of great importance. Until recently, most biological measures of emotional processing dealt with adverse emotional processing. However, adverse emotional processing does not adequately address anhedonia, a key feature of schizophrenia. The post-auricular (PA) reflex has been demonstrated to be a reliable direct measure of positive emotion and hedonic processing. In this study, PA was recorded for subjects of college age while viewing stimuli of different emotional valences. Subjects were given the brief (B) version of the Schizotypal Personality Questionnaire (SPQ). Higher SPQ scores in various categories were related to higher emotional response to positive stimuli. Thus, the potentiation of the PA reflex was correlated with schizotypal personality. The relationship between schizotypy and the positive emotional processing as shown in this preliminary study warrants future studies of PA reflex as a direct measure of emotional processing in schizophrenic patients.
Infants’ Ability to Discriminate Objects by Visual and Tactile Exploration

Shanshan Hu, Ariel Borten, Vera Blau, and Amy Needham

This study was designed to investigate whether infants are able to discriminate between objects of different color or texture by having some prior experience with a selected object. Multisensory experiments have shown that infants perceive information more accurately when using multiple sensory systems. Infants were allowed to only look at a selected object, to only touch it, or to do both during a familiarization period. Next, their eye movements were recorded by an eye tracker while they watched stimuli on the monitor. The stimuli consisted of the object they explored (green and bumpy), and other objects that are either blue or smooth. According to the preliminary data, infants discriminate color objects when the objects are paired. Infants are attracted to novel objects, so they focused on the blue object more than the green object. The data did not show that infants discriminated between textures. They did mostly look around the areas of texture differences on the objects. These results suggest that at 7 months of age, infants regard color changes as more salient than texture changes. Possibilities for this tendency are discussed.

Changes in mental representation cause the “Hand-Reversal Illusion”

Linda Xu, Sang Wook Hong, and Frank Tong

The “Hand-Reversal Illusion,” a visuotactile illusion of the hands, is commonly seen in children’s play but has not appeared in scientific literature for over 60 years. This multimodal illusion is one of many illusions studied to gain insight into multimodal integration, the interaction of all senses. In the “Hand-Reversal Illusion,” subjects attempt to lift designated fingers while the hands are cross-folded, leading to conflict between visual input and proprioception. With open eyes, subjects predictably experience high error rates, but with closed eyes, error rates drop to zero. Consequently, researchers concluded that the illusion was dependent upon visual and proprioceptive conflict, and that, without visual input, the illusion could not exist (Van Riper, 1935). However, because subjects could decrease errors simply by increasing response time, we re-tested the illusion with reaction time measurements to verify the cause of the illusion. After video-recording several conditions and comparing frame counts, we found that, when tested with reaction time, the “Hand-Reversal Illusion” persists even without visual input. Furthermore, when only visual conflict exists and proprioceptive confusion does not, the illusion disappears, indicating that the illusion is not caused by visual and proprioceptive conflict but by the switched mental representation of the hands.
The Vanderbilt Center for Science Outreach (CSO) is dedicated to enhancing scientific and technological literacy through the establishment of unique partnerships between university scientists, K-12 educators, students, and the local and global science community.

To uphold this mission, the CSO has developed and implemented various educational programs in partnership with local and national K-12 classrooms. In addition to the Research Internship Program, the CSO also provides other programs, including summer science camps for middle school students; Scientist-in-the-Classroom Partnerships, pairing actual scientists with middle school teachers; professional development programs focusing on connecting scientists with in-service teachers; and the School for Science and Math at Vanderbilt. It is through these programs that the CSO has reached thousands of children and teachers since the early 1990s.

As a national leader in outreach efforts, the CSO is committed to elevating pre-collegiate science expertise and literacy, allowing the next generation to move forward with an increased desire to discover science.

Virginia L. Shepherd
Director, Center for Science Outreach
Professor of Pathology