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Nebraska Biomechanics Core Facility 2008 Annual Report, Issue 7

Nebraska Biomechanics Core Facility
University of Nebraska at Omaha

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Nebraska Biomechanics Core Facility

**Strive for Excellence**

**Director’s Message**

Our annual report will give you a brief look at who we are, what we do and a quick update on our studies. We hope that after reading about us that you will want to come to the Nebraska Biomechanics Core Facility and visit us in person as well.

Following Nebraska and National initiatives, the laboratory is interdisciplinary in nature. Our thriving enterprise features engineers, mathematicians, scientists, surgeons, and clinicians exchanging ideas to gain additional insights on healthy and abnormal movement patterns. Using techniques from biology, engineering and mathematics, we have revolutionized the way we perceive how the neuromuscular system controls human movement. Our success often leads us to new opportunities to advance the laboratory’s research initiatives. Unfortunately these opportunities require funding beyond allocations provided by the state. We continually pursue and frequently receive grants that support our research efforts. You will read about many of these awards on the following pages. While this funding is critical, charitable gifts from individuals, such as you, also are vital in advancing our work. Private support, for example, further enables us to:

- purchase upgraded equipment and new technology,
- attract and retain outstanding faculty and graduate students,
- fund a laboratory addition to alleviate the current shortage of research and office space.

To learn more about how you can support the important work of the Nebraska Biomechanics Core Facility, turn to page 20. Your gift will make a difference — enhancing our scientific pursuits and ultimately helping improve the lives of those we serve and beyond.

Thank you for your consideration,

Nick Stergiou, Ph.D.
Isaacson Professor and Director of the Nebraska Biomechanics Core Facility
Nebraska Biomechanics Core Facility faculty and personnel have established a strong network at a local, national and international level. Supporters of our endeavors for excellence include local and national foundations, institutes and associations that have granted us 14 awards for a total of $6,626,549 during the last year!!!

The Nebraska Research Initiative has granted to Dr. Daniel Blanke (principal investigator; PI) a one-time award of $621,980 over a period of two years (2007-2009) for the purchase of equipment to facilitate collaborative research projects. Our laboratory is now a fully-equipped core facility that can provide services of consultation, data analysis, data collection, and software training, to the entire University of Nebraska research community and its partners. Other Nebraska Research Initiative grants include a two-year award of $453,863 for the construction of a portable device (Balance-O-Gram) to evaluate sitting posture in infants (2008-2010), a four-year award of $389,917 for the construction of a portable device (gait-o-gram) that serves as a prognostic and diagnostic tool for people with walking impairments (2004-2008), a two-year award of $538,000 for the construction of a novel wireless mobility monitoring system (2008-2010), a two-year award of $681,057 to study the use of virtual simulators and robotic manipulators for the improvement of robotic surgical educational training (2008-2010) and a four-year award of $1,185,852 for constructing and testing new robotic surgical tools for minimal access surgery (2004-2008). Dr. Stergiou serves as PI for the first two Nebraska Research Initiative grants, while he is a co-investigator for the latter three. The last grant that is associated with robotic-assisted surgery comes from the University of Nebraska Medical Center for a four-year award of $769,698 granted to the Center for Advanced Surgical Technology (2005-2008).

Our leading project is related with our first lifetime milestone – sitting. Dr. Stergiou has received a K-25 research award of $577,182 from the National Institute of Health to examine postural functions in infants by utilizing advanced mathematical methods (2005-2010). Our ongoing collaboration with Monroe-Meyer Institute at UNMC has resulted in funding from the most prestigious national institutions. The National Institute of Disability and Rehabilitation Research has granted to our research group a four-year award of $450,000 to investigate the dynamics of development of sitting in children with cerebral palsy (2004-2008), and a new three-year award of $600,000 to investigate interventions of sitting in young children with moderate to severe cerebral palsy (2008-2011). Dr. Stergiou serves as PI in all aforementioned projects ‘propelling’ him to be considered an expert in infants’ postural control during sitting. He also serves as a co-PI for a grant from the American Physical Therapy Association to explore the development of early postural interventions of sitting and reaching in preterm infants ($30,000; 2009-2010).

In addition, Dr. Stergiou serves as a mentor for a two-year Career Development Scholars award granted to Dr. Jason Johanning from the American Geriatrics Society to evaluate walking abnormalities in individuals with peripheral arterial disease ($150,000; 2006-2008), and for a two-year post-doctoral fellowship awarded to Dr. Mukherjee from the American Heart Association to study upper limb movements in chronic stroke survivors ($85,000; 2008-2010).

Lastly, Dr. Stergiou serves as a co-investigator for a two-year award of $100,000 from the MARS foundation to investigate the impact of resistance training on balance in multiple sclerosis patients (2007-2009).

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**Back Row (left to right):**
- Panos Koutakis,
- Jeff Kaipust,
- Dimitrios Katsavelis,
- Nick Stergiou,
- Dan Blanke,
- Sara Myers,
- Jessie Huisinga,
- Jenna Yentes.

**Front Row (left to right):**
- Mukul Mukherjee,
- Mira Momcilovic,
- Anastasia Kyvelidou,
- Irene Suh,
- Leslie Decker,
- Joseph Siu.
Internship opportunities in our lab!!!

The following students performed their internship in NBCF laboratory during 2008-2009.

- Jeff Kaipust (BS in Exercise Science at UNO).
- Katy Renahan (MS in Neuroscience and Applied Cognitive Science at University of Guelph, Canada)
- Jake Riggle (BS in Biological Systems Engineering at UNL)
- Kenneth Swantek (BS in Biotechnology at UNO)
- John Ernst (BS in Biotechnology at UNO)

NEW PERSONNEL

Jenna Yentes

Jenna - an Omaha-born doctoral candidate - received her Bachelor of Science in Kinesiology from the University of Northern Colorado (2000) and her Master of Science in Kinesiology from California State University at Fullerton (2006). Over the past year Jenna gained experiences by being involved with the majority of our projects. She also submitted a doctoral student proposal to the National Institute of Health and a tobacco proposal to study motor patterns in patients with chronic obstructive pulmonary disease. She is currently helping with the PAD and gait & cognition projects, while she is also responsible for projects that are related with our instrumented staircase. For her doctoral dissertation, she is planning to investigate motor behavior during dual motor task performance.

Mira Momcilovic

Mira received her Bachelor of Science in Exercise Science from Belgrade, Serbia (2008). She joined our program last Fall and she helps with data collections and analysis. She is currently assigned to work with projects that are related with our instrumented staircase. She also teaches the laboratory section of Anatomy and Physiology.

Jeff Kaipust

Jeff was born and raised in Omaha. He received a Bachelor of Science in Exercise Science from UNO (2008). He is currently working on his master thesis, which is dealing with how rhythmic aspects of music can affect the way we walk. He also helps with data collections and analysis for the MS and PAD projects and he teaches the laboratory section of Biomechanics.

Dr. Blanke, founder of the Nebraska Biomechanics Core Facility Laboratory and Director of the School of Health, Physical Education and Recreation, helped to initiate and launch the Master of Public Health Program in 2000. He now chairs the Department of Health Promotion, Social and Behavioral Health within the College of Public Health at the Medical Center. Both Drs. Blanke and Stergiou have interviewed and recruited numerous faculty for the new college. They also participate in various committees that create new graduate majors and doctoral programs as well as developing needed courses. They held a retreat to strengthen existing collaborations, build new intercampus collaborations, and generally solidify the new college.

Dr. Stergiou continues to hold his primary appointment at University of Nebraska at Omaha (UNO) and has a special appointment with the College of Public Health. In addition, he continues to hold appointments with the UNO Psychology Department, the Department of Pediatrics and Surgery from the University of Nebraska Medical Center, and the Physical Therapy Department at Creighton University. Dr. Stergiou is also the Chair of the Education Committee for the American Society of Biomechanics and Member of the Executive Board.

Reappointment to the Isaacson Professorship for a second three-year term.

http://www.unomaha.edu/biomech/also/intern.php

Featured News | 3
The Nebraska Biomechanics Core Facility laboratory is fully equipped with key biomechanical research technologies and can provide services of consultation, data analysis, data collection, and software training, to the entire University of Nebraska research community and its partners. We are able to provide biomechanical support for surgeons, physical therapists, biomedical engineers and other related professionals. We will continue fostering collaborative projects seeking to integrate modern biomechanical techniques with biotechnology related research activities. Our laboratory will promote the University of Nebraska as a leader in biotechnology and will enhance the economic development of the state via biotechnology-based industrial growth.

LIST OF AVAILABLE DEVICES:
- Eight-camera motion capture system (Motion Analysis)
- Force platforms (Kistler & AMTI).
- Instrumented treadmill (Bertec).
- Instrumented staircase (custom-made).
- Computerized Dynamic Posturography (Neurocom)
- Two electromyographic devices (Delsys & Bangoli)
- Insoles for temporal parameters (Stride Analyzer).
- Pressure insoles (Tekscan).
- Four electrogoniometers (Biometric).
- Eye-tracking system (FaceLab 5).
- Two weight-bearing devices (LiteGait & custom-made).
- Two isokinetic dynamometers (Biodex system II & III)
- Multi-screen virtual reality system (custom-made).
- Stroke therapy robot for upper extremities (InMotion).
- Computerized Speech Lab (KayPentax).
- Two motorized treadmills.
The Nebraska Biomechanics Core Facility laboratory offers a five-day nonlinear analysis workshop. The purpose of this workshop is to introduce research scientists, clinicians, educators and students to a variety of mathematical methods for the analysis of biological time series. Instructors will use class discussions and hands-on practice to facilitate understanding of the material covered in the lectures. Participants with varied backgrounds are welcome.

For more information, please, check our website:

http://nbcf.unomaha.edu/nonlinear09.php

I am very pleased with my experience in the NBCF Nonlinear workshop in 2008. I found the facilities and personnel to be quite hospitable and accommodating, but nothing compared to the quality of information that was disseminated during the lecture and hands-on sessions.

The knowledge I gained from Dr. Stergiou and his lab group bolstered my confidence in using nonlinear analysis techniques in the design of new studies, and prompted me to re-visit some of my older work to find underlying results that had previously gone unnoticed!

I can say with certainty that this experience was a corner-stone in my research career. I left with a great exposure to nonlinear analysis techniques and the experience of working with these analysis tools in both Matlab and CDA under the guidance of proven experts.

This experience is unmatched in quality, hospitality, and information versus any other experience that I have had. I would highly recommend this workshop to anyone interested in nonlinear analysis!

The following participants successfully completed our first nonlinear analysis workshop. Congratulations and thank you for your participation!!!

Daniel Russel
Dwight Waddell
Joshua Haworth
Jose Algaba del Castillo
Juan Garbalosa
Maria Lebiedowska
Mathias Hieronymus
Orlando Fernandes
Stacey Dusing

Reading, PA
Oxford, MS
Oxford, OH
Seville, Spain
Hamden, CT
Washington D.C.
Oxford, OH
Lisbon, Portugal
Richmond, VA
Rationale: Cerebral palsy (CP) is a term used to describe a group of chronic conditions affecting body movements and muscle coordination. It affects 2 to 3 children per 1,000 live births and is caused by damage to one or more specific areas of the brain, usually occurring during fetal development or infancy. It also can occur before, during or shortly following birth. Children with CP may not be able to walk, talk, eat or play in the same ways as most other children. So far, there is no known cure for CP, thus the medical intervention is limited to the treatment and prevention of complications arising from CP’s effects. However, because infants with symptoms of CP are not always diagnosed in the early months after birth, they miss the opportunity of early intervention services. Early intervention protocols are crucial for a child’s motor development because the nervous system is very pliable in infancy and can be “re-shaped” based on the treatment.

General goal: To develop and evaluate innovative rehabilitation interventions in order to improve movement deficits related to sitting balance present in CP children.

Status: Recently, we completed the first part of this project (US Department of Education, National Institute of Disability and Rehabilitation Research; NIDRR, 2004-2008), and determined how reliable our methodology was, described the progression of sitting in typically developing infants and tested the efficacy of two different early intervention protocols in infants with developmental delay or diagnosed with CP. In this $450,000 four-year study which ended in December 2008, we learned that stages of sitting can be reliably defined using biomechanical tools. We also learned that the progress and strategies of an infant with developmental motor delays is different from that of a typical infant learning to sit. These differences can be clearly demonstrated using biomechanical tools. We have also verified that the effectiveness of different types of treatment for infants with developmental motor delays, such as CP, can be objectively measured to a greater degree with biomechanical tools, than by the tools clinicians and physical therapists presently use. As part of this grant, our team launched a new website:  

http://www.unomaha.edu/infant/

We have recently had a new grant proposal (NIDRR, 2008-2011) funded, and the goal is to test the efficacy of other treatments used in early intervention of moderate to severe cerebral palsy children aged between 2 and 6 years, a group of children who have been neglected in previous intervention studies.

Dr. Stergiou is now in year four of his K-25 Mentored Quantitative Research Career Development Award from the National Institute of Child Health and Human Development of the National Institutes of Health. In this project, we determined how infants that are born prematurely differ in the development of sitting from term infants. We demonstrated that term infants develop differently in the front-to-back and side-to-side direction than premature infants, which is very helpful for therapeutic interventions and especially in targeting different aspects of sitting development.

We have also received a new grant from the Nebraska Research Initiative to build the Balance-o-Gram, which is a portable force platform that can be carried to different locations, such as patient’s home, clinical office or laboratory to collect biomechanical data from an infant’s body sway. This biomedical device will help in the detection of early balance impairments during sitting development in infancy.

In collaboration with Dr. Stacey Duising, we have received a grant from the American Physical Therapy Association to explore how early postural intervention can affect sitting balance or reaching in Infants born preterm. (2009-2010). Dr. Duising is an assistant professor at the Virginia Commonwealth University.

Our collaboration with the Boys Town National Research Hospital for the research study proposed by our doctoral candidate Anastasia Kyvelidou is still going strong and we have almost completed the data collection with the typically developing infants. This study is based on our current research on the sitting control of infants and we are interested in the contribution of three kinds of stimuli on the sitting control in typically developing infants and comparing it to the sitting control of infants with hearing loss. These infants may have damage to the hearing nerve in both ears and it is usually accompanied with deficiencies in the vestibular apparatus, which is the center of the brain controlling balance. Currently, there are no diagnostic tools that can identify early, in the first year of life, infants that have vestibular problems. Thus, there is a missed opportunity for early intervention services. By studying the effect of sight, hearing and balance we hope to find an early identification method for finding infants with potential hearing and vestibular problems.
Future goals: In the future, the project will continue to expand the investigation of rehabilitation options for developmentally delayed infants and children by developing and evaluating new treatment protocols. Additionally, the project will seek to explore new technologies which may be applied to diagnose and monitor the health status of this population.

Funding: This project is currently funded by US Department of Education, National Institute of Disability and Rehabilitation Research, the National Institutes of Health, and the Nebraska Research Initiative. Dr. Stergiou is the principal investigator on all these grants. Anastasia Kyvelidou is currently funded by the Bukey and MacDonald Fellowship from the University of Nebraska Medical Center and with a Regents Tuition fellowship.

People involved: Dr. Nick Stergiou, Dr. Joseph Siu and graduate student Anastasia Kyvelidou are the Nebraska Biomechanics Core Facility laboratory personnel working on this project. Anastasia Kyvelidou received her BS in Physical Education from the Aristotle University of Thessaloniki, her MS in Exercise Science from UNO, and is currently pursuing her doctorate through the University of Nebraska Medical Center. In addition, Jenna Yentes assists with data collection and analysis, as well as lab volunteers. Regina Harbourne and Sandy Willett from the Munroe-Meyer Institute at UNMC have extensive experience working with this clinical population. They provide clinical support and patient recruitment on this project. Other collaborators include Lisa Kelly-Vance and Bridgette Ryalls from the Psychology Department at UNO.
Rationale: Peripheral arterial disease (PAD) is a debilitating disease affecting 8 to 12 million people in the United States. The most common characteristic of this disease is the hardening and narrowing of the arteries in the legs. PAD patients develop increased pain in their legs when they walk for more than a block or even up a slight incline. As they walk, their leg muscles need more blood. Since their blood vessels are partially blocked, oxygen doesn’t reach their working leg muscles which results in pain. Persons with PAD experience limitations of daily activities including impaired balance, high risk of falls, poor health outcomes and physical dependence. These limitations are more pronounced in the elderly leading to falls, nursing home placement and subsequent loss of functional independence. Vascular procedures to treat these patients constitute the third most common group of operations performed in the Veterans Affairs hospitals nationwide. With the expected increases in our elderly population, PAD is fast becoming one of the most significant causes of morbidity and mortality for our nation’s veterans.

General goal: To determine the limitations caused by the disease and also to decide which treatments are best for the PAD patients.

Status: A total of 95 PAD patients and 31 controls have been tested and analyzed since 2004. Results from this project have shown that patients with PAD have problems walking compared to healthy controls. Specifically, the ankle is not able to push the body forward like it should. We have also established that patients with PAD have more variable movement patterns at the ankle, knee and hip as compared to healthy controls. This could possibly make PAD patients less stable and more likely to fall. The changes in walking patterns occur before pain starts, which means that pain itself is not causing the changes. Our team is currently working to find out if blood flow, muscular changes or another mechanism is responsible for mobility problems in these patients. We are also working to determine if patients’ walking patterns improve following pharmacological and surgical treatments.

Future goals: Modify treatment strategies based on results of our studies. Develop devices for screening, assistance and rehabilitation for patients with PAD.

Funding: The research team concluded the last year of a three-year grant from the American Geriatric Society awarded to Dr. Johanning. Other funds include the American Society of Biomechanics and NASA awards that have been awarded to Sara Myers.

People involved: Dr. Jason Johanning, along with Dr. Iraklis Pipinos, Dr. Thomas Lynch and Dr. Matthew Longo are collaborators from the Department of Surgery at UNMC and the Omaha Veterans Affairs Nebraska-Western Iowa Health Care System. Dr. Nick Stergiou, and graduate student Sara Myers are the NBCF laboratory personnel working on this project. Sara Myers received her BS and MS in Exercise Science from UNO, and is currently pursuing her doctorate through the University of Nebraska Medical Center. In addition, Panagiotis Koutakis, Jenna Yentes and Jeff Kaipust assist with data collection and analysis, as well as lab volunteers and interns.
**Rationale:** Multiple Sclerosis (MS) is a disease of the central nervous system that affects approximately 400,000 Americans and is the most common progressive neurological disease in young adults. The disease generally attacks the myelin sheath that covers nerve cells which leads to a breakdown in communication between the brain and the muscles. As a result, people with MS have inconsistent movement patterns, poor balance, and a long list of possible other problems. This disease varies in severity with some patients only experiencing mild muscle weakness while others may be confined to a wheelchair. Current treatment varies according to individual symptoms though medication and physical therapy are popular options.

**General goal:** To develop and evaluate innovative rehabilitation interventions in order to slow disease progression and improve movement deficits, related to both balance and walking, present in MS patients.

**Status:** There are two ongoing studies within the scope of the MS project. In the first study, we assess the effectiveness of resistance training in improving walking and balance parameters. Over the past two years 29 patients with MS completed six months of training and three gait assessments, while 6 patients are currently in training. Results from study have been presented at four different national conferences, whereas 5 manuscripts are in progress.

In the second study, we assess the effectiveness of elliptical training in improving walking parameters as a result of neuroadaptive mechanisms. The study has been recently approved by the Institutional Review Board and we have collected five pilot subjects. Currently, eleven are enrolled with more being actively recruited.

**Future goals:** In the future, the project will continue to expand the investigation of rehabilitation options for MS patients by developing and evaluating new treatment protocols. Additionally, the project will seek to explore new technologies which may be applied to monitor the health status of MS patients.

**Funding:** The project is currently funded by the MARS foundation (Ames, IA). Dr. Mary Filipi is the principal investigator of this grant, while Dr. Stergiou and Jessie Huisinga are listed as co-investigators. Additional funds include the American Society of Biomechanics and the NASA awards that have been granted to Jessie Huisinga.

**People involved:** Dr. Nick Stergiou, and graduate student Jessie Huisinga are the NBCF laboratory personnel working on this project. Jessie Huisinga received her BS in Biomedical Engineering from the University of Iowa, her MS in Exercise Science from UNO and is currently pursuing her doctorate through the University of Nebraska Medical Center. In addition, Jenna Yentes and Jeff Kaipust assist with data collection and analysis, as well as lab volunteers and interns. Dr. Mary Filipi from the College of Nursing at UNMC has extensive experience working with this clinical population. She provides clinical support and assists in patient recruitment on this project.
**Rationale:** Risk of falls may be related to changes in certain aspects of brain function. This research seeks to develop tools to identify older people at risk for falls. Walking under dual-task conditions could be helpful in detecting walking disorders at a preclinical stage and planning targeted therapeutic interventions to prevent falls.

**General goal:** To investigate the relationship between walking variability and cognitive tasks relying exclusively on language and auditory modalities.

**Status:** We have collected a total of 35 young adults and 14 healthy elderly (non-fallers). Results showed that 1) high-demanding cognitive tasks result in more “robotic” looking and rigid walking patterns in healthy young adults, 2) subjects performing first the cognitive tasks and then cognitive tasks while walking, are more prone to cope with dual-tasks than subjects in the reverse order, 3) the dichotic listening test, which measures auditory attentional capacities, had a greater effect on stride width and than verbal tasks in healthy young adults, 4) modulation of attention to the right ear seems to affect principally the motor control of the left side of the legs in the elderly (results have been interpreted within the framework of brain laterality reorganization in aging), and 5) difficulty of the cognitive task is important in shaping the relationship between cognition and gait control. This preliminary work resulted in the acceptance of two peer-reviewed abstracts for Neuroscience 2008, one peer-reviewed abstract for Gait and Clinical Movement Analysis Society (GCMAS) 2009, and one peer-reviewed abstract for the International Association of Gerontology and Geriatrics (IAGG) World Congress of Gerontology and Geriatrics 2009.

**Future goals:** Our ultimate goal is to design and test new therapeutic interventions that will effectively target dual-task decrements during walking, hence reducing falls and improving functional status and quality of life in elderly.

**Funding:** The project is currently funded by the Nebraska Geriatric Education Center grant awarded to Dr. Potter. Additional funding includes a NASA award that have been granted to Sara Myers and 2 grants from the Nebraska Research Initiative.

**People involved:** Dr. Nick Stergiou, Dr. Leslie Decker and graduate students Sara Myers, Jenna Yentes, Dimitrios Katsavelis and Mira Momcilovic are the NBCF laboratory personnel working on this project. Dr. Decker, a post-doctoral research associate, received her BS in Kinesiology and Exercise Science, her MS in Physiology and Biomechanics and her PhD in Biomechanics from the University of Pierre & Marie Curie in Paris, France. We have collaborators from the Computer and Electronics Engineering Department at the University of Nebraska-Lincoln (Dr. Song Ci, Assistant Professor, and Dr. Lim Nguyen, Associate Professor), the Section of Geriatrics at UNMC (Dr. Jane Potter), the Department of Special Education and Communication Disorders at UNO (Dr. Mary Friehe, and Dr. Amy Teten) and the Pittsburgh Claude D. Pepper Older Americans Independence Center (Dr. Stephanie Studenski).

Dr. Jane Potter (Chief of the Section of Geriatrics, Department of Internal Medicine at UNMC) provides clinical support and patient recruitment on this project.
**Rationale:** As costs continue to decline and system usability improves, innovative virtual reality (VR) approaches have emerged that demonstrate the value for scientific understanding and treatment of difficult clinical conditions. The rationale behind these applications is that a VR system will allow the patient to walk in an environment that can be more pleasant than a hospital room. With VR the therapist can also incorporate additional challenges to be tried in a user-friendly and safer situation. However, research has not kept pace with the engineering and the scientific support for the application of these systems is limited.

**General goal:** To lay the foundation for a proper utilization of advanced biotechnology, such as virtual reality (VR) environment, on gait related disabilities.

**Status:** There are three ongoing studies that are being conducted in young healthy adults. The first study investigates the effect of VR on locomotor adaptation in healthy individuals adapting to a load attached to one of the lower limbs. Preliminary results from this study were presented at the Neuroscience Conference. The second study explores the effect of changes in the width and frequency of VR environments on walking strategies as reflected by step width and step frequency. The third is a preliminary study from Dimitrios’ doctoral work. Dimitrios has conducted two experiments in a single-screen VR environment trying to identify walking stability in different optic flow conditions. He has developed the algorithms for our VR environment and he is currently working with Dr. Dan Cliburn, a computer scientist from the University of the Pacific, to expand the VR environment onto three screens.

**Future goals:** Collect data from healthy young and older adults, as well as from clinical populations. Studies will include simple and complex VR environments of various optic flows and dimensions.

**Funding:** The project is currently funded by a grant from the American Heart Association awarded to Dr. Mukherjee, and a research fellowship from UNMC awarded to Dimitios Katsavelis.

**People involved:** Dr. Nick Stergiou, Dr. Mukul Mukherjee, Dr. Joseph Siu and graduate student Dimitrios Katsavelis are the NBCF laboratory personnel working on this project. Dr. Mukherjee, a post-doctoral research associate, received his BS in Physical Therapy from India and his PhD in Rehabilitation Sciences from the University of Kansas Medical Center. Dimitrios received his BS in Physical Education from the Aristotle University of Thessaloniki, his MS in Exercise Science from UNO, and is currently pursuing his doctorate through the Medical Science Inter-departmental Area (MSIA) Graduate Program through UNMC. Dr. Jane Potter (Chief of the Section of Geriatrics at UNMC) provides clinical support and patient recruitment.

Set up of the 3D visualization system (1) and overhead configuration (6) of its components. Screenshots of the virtual reality environment (2) with different texture (3-5). The environment as seen from the user by using circular polarized glasses (4) and as seen by an observer (5).
Rationale: Robotic surgery is a form of minimally invasive surgery performed by a surgeon who controls a specialized robot like the daVinci™. With the advancement of medical developments of new technology, it is now more challenging to learn surgical techniques, requiring more experience and practice to master them. This led us to consider alternative training environments outside the operating room. Virtual simulation has been increasingly implemented in medical education. Training in virtual simulation provides a risk-free and low-cost environment for surgical trainees to learn new surgical techniques using a surgical robot.

General goal: To implement an effective, quantifiable and cost-efficient training environment for surgical trainees. The implementation of a training program using simulation will provide trainees an optimal opportunity to learn robot-assisted techniques independently and effectively.

Status: There are three ongoing studies that are being conducted in this project. One study is developing a training module with the daVinci™ surgical robot to learn fundamental surgical skills. The second one is exploring whether concurrent cognitive distractions affect the performance of robotic surgical tasks, and investigating whether feedback enhances the performance of robotic surgical tasks when cognitive distractions are present. The third study is developing a portable, cost-effective training simulator for robot-assisted surgery.

People involved: Dr. Nick Stergiou, Dr. Joseph Siu, Dr. Mukul Mukherjee, and graduate student Irene Suh are the NBCF laboratory personnel working on this project. Dr. Siu, a post-doctoral research associate, received his BS in physical therapy from Taiwan and his PhD in Human Physiology from the University of Oregon. Irene received her BS in Computer Science and her MS in Mathematics from UNO. She is currently pursuing her doctorate through the Medical Science Inter-departmental Area (MSIA) Graduate Program through the University of Nebraska Medical Center. In addition, Dr. Dmitry Oleynikov, a robotic surgeon, from the University of Nebraska Medical Center and Dr. Song Ci, a computer engineer, from the University of Nebraska-Lincoln are the collaborators in this project.

Future goals: The long term goal is to develop a training program for surgical trainees in robotic surgery that will be located at UNMC.

Funding: The project is currently funded by the Nebraska Research Initiative (2008-2010) and the Center for Advanced Surgical Technology, University of Nebraska Medical Center.

Our VRAMIST® simulator

Insite® Vision System: Stereoscopic 3d vision
Hand manipulators with eight-degree of freedom motion
Animate surgical tasks
Da Vinci Surgical System: 1) surgeon’s console, 2) image processing equipment, and 3) surgical arm cart.
Endowrist® instruments: reproduce hand movements
Foot pedals for Dvss navigation, magnification, and reorientation

http://www.unmc.edu/cast/
**ROBOTIC REHABILITATION IN STROKE PATIENTS**

Dr. Mukherjee is a post-doctoral research associate, who has received a grant from the American Heart Association. His project deals with the effect of augmented sensory feedback in motor learning of upper limb movements in chronic stroke survivors. The main goal of the project is to determine whether training with visual feedback enhances the learning process of a new environment in chronic stroke survivors and to apply this training to examine the effect on accuracy during reaching movements. Dr. Mukherjee is working closely with Dr. Nick Stergiou and he also collaborates with Dr. Pierre Fayad, department chair of Neurological Sciences at the University of Nebraska Medical Center. Results from this study will further the understanding of sensorimotor control of reaching movements in stroke subjects and may provide a new direction for stroke rehabilitation.

**PATH INTEGRATION & SPACE NAVIGATION**

Panagiotis Koutakis just finished his Master Thesis under the guidance of Dr. Nick Stergiou. He explored how young healthy adults navigate in space after having visual or somatosensory feedback. Participants performed either a simple task (circle) or a complex task (figure-eight). Furthermore, each participant was allowed to either visually inspect the selected pathway or was guided through it while blindfolded. Participants were then asked to walk blindfolded through the pathway. Results showed that while somatosensory feedback is more dominant during simple tasks, visual feedback becomes more important as the complexity of the task increases.

Panagiotis has received funding from the Alexandros Onassis Public Benefit Foundation. He will continue working with Dr. Stergiou during his doctorate.

**STATE COLLABORATIONS**

**UNIVERSITY OF NEBRASKA MEDICAL CENTER**
- Department of Surgery
  - Iraklis Pipinos, MD – Vascular Surgeon
  - Jason Johanning, MD – Vascular Surgeon
  - Thomas Lynch, MD – Vascular Surgeon
  - Dmitry Oleynikov, MD – General Surgeon
- Department of Internal Medicine
  - Jane Potter, MD – Chief of Geriatrics
  - Brenda Keller, MD – Section of Geriatrics
  - Kalpana Padala, MD – Section of Geriatrics
  - Steven Rennard, MD – Pulmonary Care
- Department of Neurological Sciences
  - Pierre Fayad, MD – Chair
- College of Nursing
  - Mary Filipi, PhD – Neuroscientist
- College of Public Health
  - Kendra Schmid, PhD – Biostatistician

**UNIVERSITY OF NEBRASKA AT OMAHA**
- College of Education
  - Jennifer Huberty, PhD – Health Promotion
  - Elizabeth Leader-Janssen, PhD – Special Education and Communication Disorders
  - Amy Teten, PhD – Special Education
- College of Arts & Sciences
  - Jeffrey French, PhD – Psychobiologist
  - Lisa Kelly-Vance, PhD – Psychologist
  - Brigitte Ryalls, PhD – Cognitive Psych.
  - Dora Matache, PhD – Mathematician
  - Jack Heidel, PhD – Chair in Mathematics
- College of Information Science & Tech.
  - Hesham Ali, PhD – Dean
  - Jon Youn, PhD – Computer Scientist
  - Raj Dasgupta, PhD – Computer Scientist
  - Bastola Dhundy, PhD – Computer Scientist

**UNIVERSITY OF NEBRASKA AT LINCOLN**
- College of Engineering
  - Song Ci, PhD – Computer Engineer
  - Hamid Sharif, PhD – Computer Engineer

**CREIGHTON UNIVERSITY**
- Joseph Threlkeld, PhD – Physical Therapist

**MADONNA REHABILITATION HOSPITAL**
- Judith Burnfield, PhD – Physical Therapist

**BOYS TOWN INSTITUTE**
- Michael Gorga, PhD – Director of the Human Sensory Physiology Laboratory

**MUNROE-MEYER INSTITUTE**
- Wayne Stuberg, PhD – Physical Therapist
- Regina Harbourne, MS – Physical Therapist
- Sandy Willett, PhD – Physical Therapist
- Shelley Smith, PhD – Molecular Geneticist
- Max Kurz, PhD - Biomechanist

Directional error between the ideal and the actual trajectory during a figure-eight pathway.
IOANNINA MEDICAL CENTER – GREECE

Over the past 10 years, the NBCF laboratory has established a successful collaboration with the Orthopedic Sports Medicine Center of Ioannina (OSMCI). The OSMCI is a contemporary research laboratory that belongs to the Orthopedic Surgery Department of the University of Ioannina. Anastasios D. Georgoulis, Professor of Orthopedic Surgery, is the founder and director of the OSMCI. The personnel from OSMCI ranges from medical students and residents, to physical therapists, exercise physiologists and biomechanists. For more information, please visit:

http://www.osmci.gr/en/home

We have several ongoing experiments to identify the best way to reconstruct the Anterior Cruciate Ligament (ACL). Dr. Stergou is currently the Scientific Consultant of OSMCI, who designs almost all ongoing experiments at this laboratory. He also helps with the organization and structure of OSMCI. He visits Ioannina at least three times a year to ensure that all projects progress smoothly.

VARIABILITY IN ANIMAL LOCOMOTION – FRANCE

In collaboration with the team "Locomotion" located at the National Museum of Natural History of Paris (France), we have determined experimental protocols to investigate movement variability in small vertebrates (e.g. duck and quail models, dog models, rat and mouse models with Parkinson’s disease) using advanced mathematical methods.

People Involved: Dr. Leslie Decker, Dimitrios Katsavelis and Ken Swantek.
Collaborators: Drs. Jean-Pierre Gasc, Anick Abourachid, Marc Herbin and Rémi Hackert

COGNITION IN ELDERLY – NORWAY

Dr. Claudia Rodriguez-Aranda is a Professor in Psychology at the University of Tromsø and specializes in cognition in the elderly. Sharing a common interest in studying the relationship between cognitive and motor functions, Dr. Rodríguez and our lab personnel designed experimental procedures using dual-task paradigms to understand how cognitive demands, especially those related to attention, affect gait. We commenced these experiments during Dr. Rodríguez stay in our laboratory with healthy populations. Our laboratory continues the experimental protocol with healthy elderly and fallers.

NATIONAL COLLABORATORS

UNIVERSITY OF MICHIGAN
Beverly Ulrich, PhD – Professor in Movement Sciences and Director of the Developmental Neuromotor Control Lab
Beth Smith, MS – Physical Therapist, Doctoral Candidate.
Research interests: Infants, Down Syndrome, Parkinson’s Disease.

UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
Kevin Guskiewicz, PhD, ATC – Professor and Department Chair of Exercise and Sport Science.
Darin Padua, PhD, ATC – Associate Professor and Director of the Sport Medicine Research Laboratory.
Research interests: Sport-related Concussion, ACL Injury.

UNIVERSITY OF DELAWARE
Cole Calloway, PhD – Associate Professor in Physical Therapy Research interests: Motor Behavior, Infant Development.

UNIVERSITY OF NEW ENGLAND
Jim Cavanaugh, PhD – Assistant Professor in Physical Therapy Research interests: Ambulatory Activity, Parkinson’s Disease.

UNIVERSITY OF MARYLAND
John Jeka, PhD – Professor in Kinesiology Research Interests: Motor Control, Sensorimotor Integration.

VIRGINIA COMMONWEALTH UNIVERSITY
Stacey Dusing, PhD – Assistant Professor in Physical Therapy Research interests: Preterm Infants, Pediatric Physical Therapy.

UNIVERSITY OF CALIFORNIA, BERKELEY
David Anderson, Phd
Research interests: Optic Flow, Infant Development.

UNIVERSITY OF THE PACIFIC
Dan Cliburn, PhD – Assistant Professor in Computer Science Research Interests: Virtual Reality, Visualization.

UNIVERSITY OF NEVADA, LAS VEGAS
Janet Dufek, PhD – Associate Professor
John Mercer, Phd – Associate Professor
Research interests: Aqua Locomotion, Forensic Biomechanics.
Below are listed special visitors, who came to look at our laboratory and get information with respect to our ongoing research projects. Each project group set up posters and provided a quick overview of the experimental procedures, the purpose of their study and the current important findings. All visitors expressed their pleasure of receiving a personal review of the work we do in the laboratory.

- Emily Dank, TCF Prosthetic Representative Trainee to complete her internship at VA Nebraska-Western Iowa... March 2008
- Sarah Pullen, Senator Hagel’s Defense staffer ... March 2008
- Dr. Shane Farror’s Class, UNL-Mechanical Engineering... April 2008
- Dr. Mary McDermott, Northwestern University... April 2008
- Michael Brzica & 2 staffers Rep... May 2008
- Dr. Richard Hoffman, Executive VP and Provost... May 2008
- Dr Jennifer Larsen, UNMC Director of Diabetes Center... August 2008
- Dr. Teten, UNO Psychology... August 2008
- Dr. Timothy Broderick, DOD-TATRC... August 2008
- Mike Peter, UniMed... September 2008
- Drs. Hynes, Conway & Edick, UNO Administration... November 2008
- Glenn Wragge with PT & OT students from Millard Public Schools... January 2009
- National Multiple Sclerosis Society representatives... February 2009

In addition, we regularly give tours to interested class groups such as high school, Biology classes, faculty and student candidates, and interested collaborators. If you are interested in a tour, please, make arrangements by calling at (402) 554-3075.

**SOCIAL EVENTS**

- NBCF members and visitors/guests always enjoy intellectual discussions, interaction and food!!!
- Basketball Game
- Halloween Party
- Lost in Virtual World

Dr. Robert Crowther, who is an associate lecturer at the James Cook University in Australia, visited our lab from May 12-16.

His common research interest in patients with peripheral arterial disease led him to our lab to share and gain experience on this clinical population.
Guest Presentations & Awards

Dr. Petra Hauf
Professor in the Department of Psychology at St. Francis Xavier University, Nova Scotia, Canada. Presented: Baby Do – Baby See – Baby Learn: Action Understanding during infancy.

Dr. Daniela Corbetta
Associate Professor in the Department of Psychology at the University of Tennessee, Knoxville. Presented: Motor Development, Complexity & Sensorimotor Experience.

Dr. Tony Wilson
Assistant Professor in the Department of Neurological Sciences at the University of Nebraska Medical Center.

Dr. Kalpana Padala
Assistant Professor in the Department of Internal Medicine at the University of Nebraska Medical Center.

Dr. Nicholas Smith
Director of the Perceptual Development Laboratory at Boys Town National Research Hospital, Omaha, Nebraska.

Dr. Debra Romberger
Professor and Vice Chair of research in the UNMC Department of Internal Medicine and associate Chief of staff research and development at the Omaha Division of the Veterans Affairs Nebraska-Western Iowa Health Care System

Dr. Robert Crowther
Associate lecturer and manager of the Movement Analysis Laboratory at the James Cook University, Australia.

AWARDS

1. Nick Stergiou, Ph.D. Honored at the 2008 Research Innovation Awards hosted by the University of Nebraska Medical Center and the UNeMed Corporation for his recent invention the Balance-o-Gram.
3. Anastasia Kyvelidou, MS: Sensory Information and Sitting Postural Control of Infants. UNMC. McDonald and Bukey Fellowships for 2008-2009.
13. Sara Myers, MS: The interaction between cognitive and gait function in healthy young. NASA.
17. Anastasia Kyvelidou, Dimitrios Katsavelis, Sara Myers & Panagiotis Koutakis. Awarded at the University of Nebraska at Omaha Centennial Celebration Research Fair. March 2009.
ARTICLES – REFEREED JOURNALS


PRESENTATIONS - ORAL


KEYNOTE SPEAKER

1. Stergiou N. Human Movement Variability From A Motor Development Perspective. Invited lecture at the University of Ioannina Medical Center, Thessaloniki, Greece, April, 2008.


CHAPTER & SECTIONS


For more than 25 years, the revolutionary work of the Nebraska Core Facility Biomechanics Laboratory at UNO has led to a new understanding of human movement; such as how people stand, walk and physically interact with their environment. The laboratory has earned an international reputation for excellence in basic and clinical research.

Our research in cerebral palsy and peripheral arterial disease, for example, has influenced the treatment and therapy options available to persons living with these disabilities. The laboratory has patented the wireless Gait-O-Gram, a biomedical instrument, designed to measure an individual’s walking parameters. Currently research efforts are also focused on robotic assisted surgery, multiple sclerosis, stroke and elderly populations.

These achievements bring opportunities to advance our program. But this growth requires funding beyond allocations provided by the state. Charitable gifts to the Nebraska Biomechanics Excellence Fund are needed to help advance the critical work occurring in the Biomechanics Laboratory. This funding will support new equipment, a laboratory addition, student scholarships and faculty support.

Join us in our efforts by making a gift today. Please complete the pledge card below and return it to the University of Nebraska Foundation, at 1010 Lincoln Mall Ste 300, Lincoln NE 68508-2886. Or visit us at

http://biomech.unomaha.edu

Yes, I/we would like to support the Nebraska Biomechanics Core Facility Laboratory with a gift to:

☐ Nebraska Biomechanics Excellence Fund # 103240  ☐ Other________________

☐ My check for $ ____________ is enclosed, payable to the University of Nebraska Foundation.

☐ Please charge $ ____________ to my: ☐ VISA ☐ MasterCard ☐ Discover ☐ AmEx

____________________________________________________________
Card Number       Exp. Date

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Signature (for credit card payment or to establish a pledge)       Date

☐ I’d like to fulfill my pledge of $ ____________ payable over _______ years
(not to exceed five years) beginning ________ (month) of ________ (year).

☐ My company___________ will match this gift. The company form is enclosed. (If you,
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☐ I have already included the Foundation in my estate plans through my will, trust or life insurance.

☐ Please send information about making a planned gift. You may call 1-402-458-1100 to speak with a planned giving professional.

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http://www.nufoundation.org

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