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Nebraska Biomechanics Core Facilty 2007 Annual Report, Issue 6

Nebraska Biomechanics Core Facility
University of Nebraska at Omaha

University of Nebraska Omaha

NEBRASKA BIOMECHANICS CORE FACILITY

2007 ANNUAL REPORT

APRIL 2008 ISSUE 6

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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 to 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, PhD
Isaacson Professor and Director of the Nebraska Biomechanics Core Facility

FEATURED TOPICS IN THIS REPORT:

Co-Director's Message

The current Biomechanics Laboratory became the Nebraska Biomechanics Core Facility Center in 2007. It has provided me an exciting research environment since I arrived in 2005. To continue our exploration of the many facets of human movement, we recently purchased many research instruments. Given that I have a heavy teaching responsibility, my focus in research will be in my area of expertise, examining human locomotion in stair climbing and foot functions. With focus comes progress. Enjoy this report of our growth.

Shing-Jye Chen

Shing-Jye Chen, PhD
Co-Director of the Nebraska Biomechanics Core Facility

UNO Announces the Nebraska Biomechanics Core Facility (NBCF)

Biomechanics is the newest rising biotechnology in Nebraska. Our mission is to provide new understanding of the dynamical aspects of human movement via multidisciplinary approaches. Towards that end, our research team has worked intensively to establish long-term collaborations with other scientists at the University of Nebraska at Omaha (UNO), the University of Nebraska at Lincoln (UNL), the University of Nebraska Medical Center (UNMC), the Creighton Medical Center, the Omaha Veterans Administration Hospital, and the Boys Town Research Institute. This year the Nebraska Research Initiative has provided a one-time award of $621,980, split over two years, for the purchase of additional equipment to facilitate collaborative research projects. Based on this award, UNO has decided to rename the HPER Biomechanics Laboratory as the Nebraska Biomechanics Core Facility (NBCF). Fifteen researchers from UNO, UNMC and UNL are named investigators on this proposal with Dr. Daniel Blanke as principal investigator. The researchers come from UNO's Biomechanics Laboratory, Mathematics and Psychology; UNMC's Pediatrics, Surgery and the College of Public Health; and UNL's Construction Engineering, Mechanical Engineering, Electronics Engineering and Industrial and Management Systems Engineering. Dr. Nick Stergiou has been appointed as the Director of NBCF beginning this role on July 1, 2008.

Biomechanics deals with the development and usage of advanced techniques from biology, mathematics, and engineering to address biomedical problems. This grant recognized the Biomechanics Laboratory as a facility where engineers, scientists and clinicians gather to gain insights on healthy and abnormal movement patterns. This grant will enhance our existing facility with the additional state-of-the-art equipment and software to provide biomechanical support for surgeons, physical therapists, biomedical engineers and other professionals. Our Core Facility is equipped with key biomechanical research technologies. It will provide services of consultation, data analysis, data collection and software training. This system of collaboration and equipment with an interdisciplinary focus helps research scientists to realize their research goals in biotechnology and biomechanics. Within this newsletter, new pieces of equipment obtained by the NBCF grant will be mentioned along with the preliminary studies they were purchased for and their possibilities for further development. Contributing to our new equipment purchases is a grant we share with the Exercise Physiology Laboratory for $150,000 from the University of Nebraska Foundation. In 2008, we have launched our first Nonlinear Summer Workshop under the auspices of NBCF to teach other researchers, with varied backgrounds, new techniques in nonlinear analysis and its applications. Eventually the NBCF will be a self-sustaining enterprise supporting research in Nebraska in the area of biotechnology. The NBCF promises to be an exciting venture for all our collaborators to use in their exploration of the biomechanics of human movement.

NEW COLLEGE APPOINTS DRS. BLANKE AND STERGIOU

On January 18, 2007, the Nebraska University system announced the creation of the College of Public Health (CoPH) located on the University of Nebraska Medical Center (UNMC) campus. Dr. Jay Noren, formerly provost for the University of Nebraska, became Dean of the College of Public Health. The CoPH needed experienced leaders to solidify the existing Centers and Departments, which now make up CoPH. Therefore, Dr. Noren immediately recruited two knowledgeable faculty members from the UNO School of Health, Physical Education and Recreation (HPER) for his core faculty group.

The first recruit from HPER was Dr. Daniel Blanke, Director of the School of Health, Physical Education and Recreation (HPER). Dr. Blanke, founder of the Biomechanics Laboratory, helped to initiate and launch the Master of Public Health Program (MPH) in 2000. He now chairs the Department of Health Promotion, Social and Behavioral Health within the CoPH.

The second faculty member he recruited was Dr. Nick Stergiou known for his collaborations with both the Medical Center and Lincoln campuses in occupational health. The Dean assigned Dr. Stergiou as a Professor to the Department of Environmental, Agricultural and Occupational Health, where he also chairs the graduate program committee.

Both Drs. Blanke and Stergiou continue to hold their primary appointment in the School of HPER and have a special appointment with the College of Public Health. They have committed a percentage of their time to the CoPH. During the past year, they have interviewed and recruited numerous professors for the new college. Their various committees are creating new graduate majors and doctoral programs as well as developing needed courses. Since the CoPH draws its members from both the Lincoln and Omaha campuses as well as at the Medical Center, they held a retreat to strengthen existing collaborations, build new intercampus collaborations, and generally solidify the new CoPH.

The CoPH is a principal provider of both professional and continuing education for the public health workforce of Nebraska and for the region. Drs. Blanke and Stergiou view their appointments as an exciting opportunity to contribute to healthy community growth. For more information about the CoPH and the programs provided, please visit their webpage at: http://www.unmc.edu/publichealth.

LAB EXPANDS WITH NEW PERSONNEL

Two people joined our team in September 2007. First is Dr. Mukul Mukherjee. Originally, a physical therapist in India, he moved to Kansas City in 2002 and obtained his PhD in Rehabilitation Science from the University of Kansas Medical Center in 2006. As a post-doctoral researcher, he brings us a wealth of technical experience in a clinical setting. He also brings with him his recently funded proposal with the American Heart Association. His project on "*The effect of augmented sensory feedback in motor learning of upper limb movements in chronic stroke survivors*" will benefit from the collaboration of Pierre Fayad, MD, Department Chairman of Neurological Sciences at the University of Nebraska Medical Center. This aggressive study will incorporate rehabilitation and robotics, as our laboratory expands in upper extremity related research.

Dr. Mukherjee also heads the project of expanding our immersive Virtual Reality system. Our single screen Virtual Reality System will increase to a large area surrounded on three sides by screens and mirrors. Our patients and subjects will be able to easily interact with this new environment. We have planned several studies, such as: the effect of external visual cues on the chaotic structure of gait, the effect of visual perturbation on locomotor adaptation, and how information gained by these projects can be incorporated in the rehabilitation of stroke survivors.

Second is a visiting professor, Dr. Claudia Rodriguez-Aranda, who is on a one year sabbatical from the University of Tromsø in Norway. She received her BA and MA in Developmental Neuropsychology and Behavioral Neurosciences from the University of Tours, France and her PhD in Psychology from the University of Tromsø in 2006. She is now an associate professor at Tromsø and specializes in cognition in the elderly. Drs. Rodriguez and Stergiou are both interested in studies of how cognitive functions influence gait variability in healthy elderly and elderly fallers. They developed an interesting and original set of experiments that are very promising. They commenced these experiments during Dr. Rodriguez stay in our laboratory with healthy populations. Our laboratory will be able to continue the experimental protocol with other populations and continue close collaboration with Dr. Rodriguez in the future. We are already working on abstracts and articles for publication from our preliminary findings. In addition, we have plans for cooperation in new projects that Dr. Rodriguez will carry out in her laboratory in the University of Tromsø, Norway. As a matter of fact, a grant proposal was already sent to the Norwegian Research Council in which Dr. Stergiou is the international collaborator. This will assure a long and productive relationship between our laboratory and Dr. Rodriguez's lab.

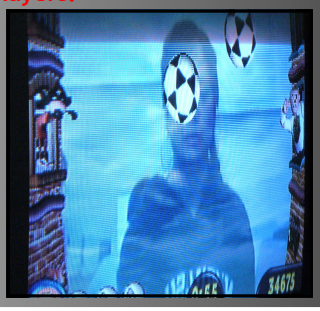
THIS PROJECT WAS FUN!

Dr. Nick Stergiou is participating in an NIH grant with CommGraphics Incorporated. The goal of this National Institutes of Health grant is to develop a new kind of a virtual reality game that addresses the National Cancer Institute's goal of helping children increase physical activity to reduce cancer risk. In June 2007, Marleen and Dr. Bryan Rickertsen brought students from Bryan Junior High School to the Biomechanics Laboratory. With the cooperation of the Exercise Physiology Laboratory graduate assistant, Jorge Zuniga, BS, Dr. Stergiou and his doctoral student Dimitris Katsavelis, MS, tested the physiological responses of a dozen Bryan Junior High School students to Nano Legends™, which is the prototype videogame. This videogame uses the whole body to control the hero's actions on the video screen. The game was enormous fun to play and all the children (some times even the participating adults!!) were eager to play. Video gaming that engages the children in physical activity can also battle the current obesity epidemic. The measured physiological responses of the students while playing this video were compared to the same measurements taken while they were walking on a treadmill and playing some other video games. The superiority of Nano Legends™ was clearly demonstrated. This is the first in a series of collaborations with CommGraphics located in Lincoln, NE.

Back Row: Dr. Bryan Rickertsen, Dr. Shing-Jye Chen, Marleen Rickertsen, Dimitrios Katsavelis, Front Row: Jorge Zuniga, Neil Wineman.

Dimitrios Katsavelis and Jorge Zuniga observing Nano Legends™ players.






Tours Tours Tours Tours Tours Tours Tours Tours Tours ToursTours

Below are listed several special visitors who came to look at our laboratory and see exactly what we do. Each student group set up posters on their project with a video and/or demonstration of the data collection process. They gave each person a quick review of the purpose of their study and the current findings. They all expressed their pleasure of receiving a personal review of the work we do in the laboratory.

Linda Pratt, PhD,	Executive Vice President and Provost for the University of Nebraska	February 2007
Jane Potter, PhD	UNMC Chief of Geriatrics	September 2007
Center of Advancement in Surgical Technology Advisory Committee		October 2007
Paula Turpen, PhD and Brian Detter	VC of Research at UNMC	December 2007
Joe Selig	Senior VP for NU Foundation-Omaha	January 2008
Lee Terry & Staff	U.S. Representative	January 2008
Kate Howard, Joe Britton, and Bob Holmstedt	U.S. Senator Ben Nelson's office	February 2008
Sarah Pullen	Senator Hagel's Defense staffer	March 2008
Harmon Maher, PhD	Associate Vice Chancellor for Academic and Student Affairs	March 2008

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

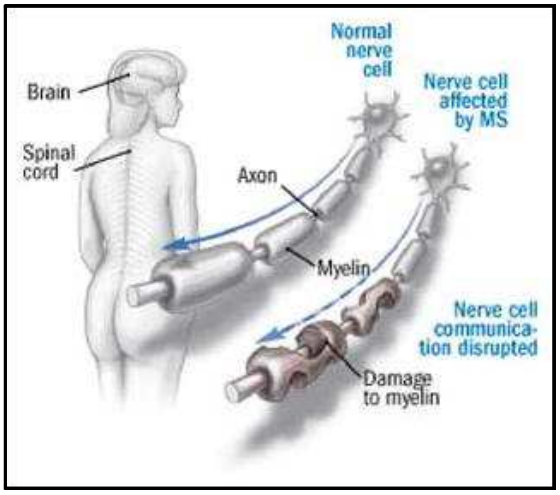
WELCOME AND HELLO!

Open House for Two Colleges

On November 9th, the College of Education (COE) hosted an Open House of the Biomechanics Laboratory, inviting faculty and staff from the College of Information Science and Technology (CIST) and the Peter Kiewit Institute (PKI). Nearly 60 students and faculty from both colleges attended the Open House. Given over lunch, both COE and CIST faculty enjoyed learning about the different aspects of our lab and the possibilities of collaborations. During the Open House, stimulating conversations were initiated on scientific experiments and research projects. These conversations led to the development of a Nebraska Research Initiative proposal titled: "Bioengineering Innovation: A Novel Wireless Mobility Monitoring System, with Dr. Youn as the principal investigator. This is only one example of a collaboration initiated at our Open House.

Laboratory Update: Newest Project

Multiple Sclerosis and Exercise Studies

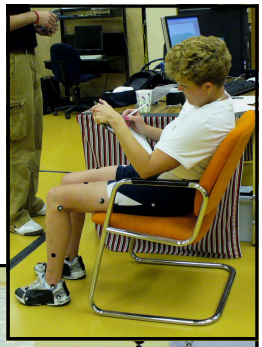


Multiple sclerosis (MS) is an autoimmune disease. In this progressive disorder, inflammation destroys the protective myelin nerve covering, leaving multiple areas of scar tissue (sclerosis). Symptoms and severity of symptoms vary widely and may progress into episodes of crisis alternating with episodes of remission. MS affects approximately 400,000 Americans and is the most common progressive neurological disease in young adults. The damaged myelin sheath leads to a breakdown in communication between the brain and the muscles regarding what movement is to be performed (i.e. raise arm) which leads to muscle weakness. As a result of the miscommunication between the brain and muscles, people with MS have inconsistent movement patterns, poor balance, and a long list of possible other problems. Current treatment varies according to individual symptoms and the discretion of the treating physician. There is a variety of medications prescribed to help control symptoms as they appear. To help improve overall mobility the physician may employ rehabilitation. Unfortunately, these treatment options do not always sufficiently control symptoms or help to slow the progression of the disease. It is not known if exercise intervention is of benefit to MS patients.

Increasing the demands placed on the system through resistance training may improve the communication between the nervous system control centers and the muscles. Resistance training would require increased communication between the brain and the muscles in order to perform the desired movement more efficiently. This translates into improved balance and improved walking mechanics. The MARS Foundation of Ames Iowa funds our newest project, "Impact of Resistance Training on Balance in Multiple Sclerosis Patients". The overall goal is to determine whether a standardized resistance-training program will help to improve or maintain balance and mobility in MS patients. Dr. Mary Filipi from the College of Nursing of the University of Nebraska Medical Center, is the principal investigator on this study and has extensive experience working with this clinical population. She provides clinical support and patient recruitment on this project. Jessie Huisinga, MS, is facilitating the gait analysis portion of this study. Jessie received her BS in Biomedical Engineering from the University of Iowa, her MS in Exercise Science from UNO. She is pursuing her doctorate through the Medical Science Interdepartmental Area (MSIA) Graduate Program through the University of Nebraska Medical Center (UNMC) under the mentorship of Dr. Stergiou. In addition to the resistance training study, we are working with Dr. Jennifer White, of the University of Nebraska at Omaha, to explore the effects of physical activity education in a social support environment. It will report what effect the socially supportive physical activity has on the day-to-day physical activity level of MS patients. This study will use quantitative measures such as accelerometers and gait analysis to measure changes in the amount, frequency, and intensity of physical activity. It will also measure changes in walking mechanics because of the intervention.

Ms. Huisinga

Dr. White



MS patient testing subject activities for data collections.

Laboratory Update:

Defining How Infants Learn to Sit

Dr. Stergiou and his colleagues from the Munroe Meyer Institute, Reggie Harbourne and Dr. Wayne Stuberg, continue to refine and disseminate their information from grants, a new collaborative study, a Research Summit and a proposed grant. At the heart of these activities is our desire to understand the development of sitting in infants, develop biomechanical tools to assess sitting behaviors in typically developing infants, and to identify treatments for infants who are having difficulty learning to sit. The goal is to identify infants with problems very early in life. Frequently the medical community hesitates to label a young infant as having cerebral palsy or other neuron-muscular problems. However, at this point in their neuromuscular development, infants with developmental delay difficulties can achieve great benefit from early therapeutic intervention.

Typical collection

The broad implications in studies similar to ours were explored during the July 2005 III Step Convention. An article in *PT Magazine* featured both the III Step Outcomes and our researcher Regina Harbourne, PT. The article *Rehabilitation and the Brain: Stepping into the Future* quoted Ms. Harbourne, "We can change, we can learn, we can improve our movement-even if we have some type of neurological insult or an insult at birth to our nervous system." The quantification of movement through biomechanics, documents those changes in a way that can be used to discover the best treatments for a particular disorder. The collaboration between Munroe Meyer and Biomechanics continues to have a far reaching effect in both scientific communities. In fact, as a group, we were invited to hold a Motor Development Symposium at the 2007 NASPSPA Conference. The symposium was very well received.

Infant receiving Physical Therapy from Ms. Harbourne, PT.

Our first project, a grant funded by the U.S. Department of Education and the National Institute on Disability and Rehabilitation Research (NIDRR) has developed internationally unique research work. Through professional meetings in several disciplines, extensive publication, grant writing, and by granting requests to study in our lab, we communicate how valuable our work is for noninvasive diagnosis. In this $450,000 three year study which ends after a no cost extension in May 2008, we learned that stages of sitting can be reliably defined using biomechanic 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 clearly be demonstrated using biomechanical tools. We have also demonstrated that the effectiveness of different types of treatment for infants with developmental motor delays, such as cerebral palsy, 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/. This website is dedicated to sharing information from our findings to parents of infants, especially parents whose infant may be experiencing a delay in the ability to sit. As part of our explorations in the development of sitting posture in infants with cerebral palsy, we have recently submitted a new proposal to NIDRR to test the efficacy of other treatments used in early treatment of moderate to severe cerebral palsy, a group of children who have been neglected in previous intervention studies.

While the data collections are over for the initial NIDRR study, our team continues to seek infants that possibly have benign congenital hypotonia for Dr. Stergiou's $577,182 K-25 Mentored Quantitative Research Career Development Award from the National Institute of Child Health and Human Development of the National Institutes of Health (NIH). He is now in year three of this five year grant. Each semester he meets several times with his three mentors in Omaha. First, he meets with his primary mentor Dr. Jeffrey French, University of Nebraska at Omaha-Psychology, who teaches him basic behavioral research. Next, he meets with his clinical mentor, Dr. Bradley Schaefer, who serves as Dr. Stergiou's guide in

Sitting Infant

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applied clinical pediatrics. Dr. Schaefer is also the Chief of Medical Genetics at the Munroe-Meyer Institute for Genetics and Rehabilitation. Dr. Stergiou consults with Dr. Jack Heidel, the chair of UNO's Mathematics Department. Dr. Heidel assists him in his efforts in applying mathematical chaos and nonlinear dynamics to clinical pediatrics. Finally, a couple of times a year, he meets with his frequent collaborator, Dr. John Jeka from the University of Maryland. Dr. Jeka is the Director of the Cognitive Motor Neuroscience Laboratory, which has been investigating human postural control for over 10 years. During 2007, Dr. Stergiou took a three-hour class each semester as part of this grant.

Scientists nationwide have noted Dr. Stergiou's progress in infant motor behavior and neurophysiology. He was honored with an invitation to attend *APTA Section on Pediatrics Research Summit II: Early Intervention for Children with or at Risk for Physical Disabilities* as a distinguished research scientist. *RS II* took place in October 2007 in Alexandria, Virginia. From his participation in this meeting, an excellent collaboration has been initiated with Dr. Stacey Dusing from the Virginia Commonwealth University. In this research work, Dr. Stergiou is assisting Dr. Dusing in investigating variability changes during lying down on a pressure mat in term and pre-term babies. In November 2007, he was also invited as a guest lecturer at the Kinesiology Seminar given by Dr. Beverly Ulrich at the University of Michigan. In February 2008, he was invited by Dr. Tom Buchanan the Chair of the Mechanical Engineering Department of the University of Delaware to speak about our research in Robotic Surgery and Motor Development.

Dr. Dusing

Dr. Stergiou's expertise in nonlinear analysis and human movement variability were sought by Dr. Beverly Ulrich's *Center for Motor Behavior and Pediatric Disabilities* for investigating how children with Down syndrome learn to walk. In February of 2007, Dr. Ulrich's doctoral student, Beth Smith, PT, spent a week in the Nebraska Biomechanics Core Facility studying nonlinear analysis techniques. Ms. Smith then asked Dr. Stergiou to be on her Doctoral Committee. She recently proposed her dissertation. Ms. Smith incorporated her studies with us in Dr. Ulrich's laboratory. Her dissertation describes the gait variations in people with Down's Syndrome throughout their lifespan. This is a marvelous collaboration with a leading laboratory in Motor Development and we feel that we will be doing more studies together in the future.

Dr. Ulrich

Our newest study with infants is in collaboration with the Boys Town Research Hospital (BTRH). In keeping with BTRH philosophy of "improving the lives of children and their families through education and technology" Dr. Michael Gorga, director of the Clinical Sensory Physiology Laboratory and doctoral candidate Anastasia Kyvelidou, MS, have initiated a new study based on our current research on the sitting control of infants. They are studying 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. By studying the effect of sight, hearing and balance they hope to find an early identification method for finding infants with potential hearing problems. Anastasia needs infants between 6 to 9 months of age to participate in a one session data collection at Motion Analysis Lab at the Munroe Meyer Institute at the University of Nebraska Medical Center.

Ms. Kyvelidou and Dr. Gorga

Working with Dr. Stergiou on these projects are his graduate research assistants Joan Deffeyes, MS and Anastasia Kyvelidou, MS. Joan received a MS in Mechanical Engineering from Stanford. Anastasia received her MS in Exercise Science from the University of Nebraska at Omaha. Both Joan and Anastasia are currently pursuing their doctorate under the direction of Dr. Stergiou.

Ms. Deffeyes

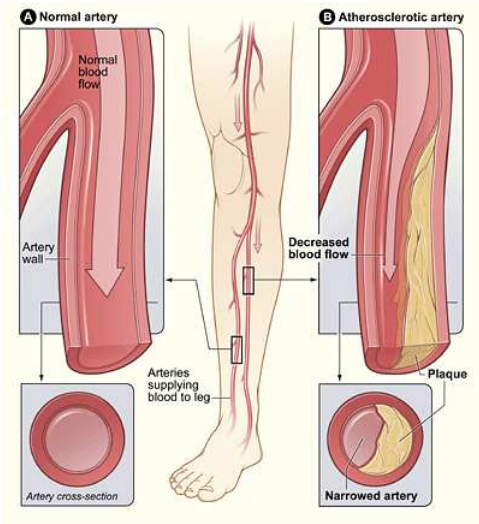
Since our last report, this group has presented a total of twenty-one abstracts at the following conventions: XXI Congress of the International Society of Biomechanics, XVIth Biennial International Conference on Infant Studies, 2008 American Physical Therapy Association Combined Sections Meeting, CSM 2007, Neuroscience 2007, American Society of Biomechanics 2007 Annual Meeting, Gait and Clinical Movement Analysis Society 12th Annual Meeting, and SRCD Biennial Meeting (Society for Research in Child Development).

NONLINEAR ANALYSIS REVEALS GAIT CHANGES

Dr. Celis

In 2007 and 2008, Dr. Nick Stergiou, in collaboration with Dr. Iraklis Pipinos, Dr. Jason Johanning and Dr. Thomas Lynch from the Department of Vascular Surgery at UNMC and the Nebraska Western Iowa Veteran Affairs Hospital, continue to evaluate the effect that peripheral arterial disease (PAD) has on gait. Rolando Celis, MD, a General Surgery Resident, is also working in this study. At present he is doing research with Dr. Johanning and is interested in new technologies and how biomechanics is applied to the field of Surgery. He will finish General Surgery training in 2010.

PAD is a circulatory disorder in which blockages occur in the peripheral arteries. 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. Patients can experience pain in one or both legs after walking a short distance. This disorder causes progressively disabling pain. PAD patients' experience decreasing ability to do the simple activities of daily living, such as walking from their car into the grocery store, because of the pain in their legs. 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. The pain goes away with rest as the blood returns to the muscles. Persons with PAD can experience impaired balance, increased risk of falls, more depression and physical dependence. These limitations are more pronounced in the elderly leading to falls, nursing home placement and subsequent loss of functional independence.



The research team is concluding the second year of a two-year $150,000 grant from the American Geriatrics Society awarded to Dr. Johanning. This grant titled "Assessing the ambulatory disability incurred by peripheral arterial disease (PAD) and the effect of revascularization utilizing advanced biomechanical techniques and functional outcomes" aims to understand the walking difficulties in patients with PAD and their ability to improve impaired ambulation with treatment. This research is unique because no other laboratory has ever examined, in such detail, how PAD patients walk. By using specific biomechanical measures, we are able to identify differences between treatment methods such as life style changes, pharmacological treatment and surgical intervention, that previous research has been unable to find. We have conclusively determined that PAD patients do have an altered gait pattern compared to healthy controls. Even without pain, both young and elderly PAD patients tend to have a slower walk with significant reductions in braking and propulsive forces. They also tend to walk with a wider stance and have both feet on the ground for a longer period during walking compared to healthy controls matched for age and weight. The ankle muscles seem to be the ones that are the most impaired. Currently, we are exploring differences in bilateral and unilateral patients with PAD. Our preliminary studies show that patients with only one leg affected make adaptations with their healthy leg in how they walk.

Sara Myers, MS, one of our doctoral students that works on this project received Scholarships from the American Heart Association ($2,000) and the National Aeronautics and Space Administration ($1,000). Closely related to the main study above, her scholarships allow her to explore variability in the gait patterns of PAD patients. She received her BS and MS in Exercise Science from UNO. She is currently pursuing her PhD through the Medical Science Interdepartmental Area (MSIA)-Department of Surgery Graduate Program through the University of Nebraska Medical Center (UNMC) under the mentorship of Dr. Stergiou.

Ms. Myers

Since the study above is ending soon, our team is aggressively seeking funding from the Veterans Affairs, the American Heart Association, the National Institutes of Health, and the Nebraska Department of Health and Human Services

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(NDHHS) to continue this valuable study in different ways. For instance, our proposal sent to NDHHS is in collaboration with Stephen Rennard, MD, professor of Internal Medicine at UNMC and specialist in studies with smoking cessation. This proposal will study in more detail if smoking cessation in the early stages of PAD affects gait.

Other people working on Gait Studies related to PAD are Panagiotis (Panos) Koutakis, BS, Erin Fosnaugh and Jeffrey Kaipust. Panos received a scholarship from the Onassis Public Benefit Foundation to study under the mentorship of Dr. Nick Stergiou. He is pursing his MS in Exercise Science from UNO. Erin and Jeff are undergraduates in Exercise Science at UNO. Erin is a varsity soccer player for the University of Nebraska at Omaha. Jeff is doing his Senior Internship and Thesis as part of his training in the laboratory.


Mr. Koutakis,


Ms. Fosnaugh,


Mr. Kaipust

GAIT ANALYSIS IN THE REAL WORLD

Funds from the Nebraska Research Initiative have been used successfully to develop the Gait-O-Gram™, which is a portable wearable biomedical device that can provide a rapid assessment of the health of the neuromuscular system from gait data collected throughout the day. Beginning in 2007 our new collaborators, Dr. Song Ci and his doctoral student Jiucai Zhang from the University of Nebraska at Lincoln Computer and Electronics Engineering Department, and Dr. Stergiou's doctoral students Dimitris Katsavelis and Naomi Kochi work with Dr. Leslie Decker and our new post-doctoral assistant Dr. Mukul Mukherjee on the last year of a four-year $383,917 grant from the Nebraska Research Initiative. The title of the grant is "A Biomedical Device for Prognostic and Diagnostic Measures of Pathological Locomotive Bio Rhythms". These funds help us to develop the next generation of our prototype. The goal of our portable Gait-o-Gram™ is the monitoring of walking patterns for 24 hours during normal activities. It will be possible for the physical therapist, the neurologist, the orthopedist and other clinicians to receive and interpret the patients gait information at any time. They will use the custom, non-linear analysis software programs created to analyze the gait data. These programs provide the ability to investigate a large number of steps and identify changes that may occur due to disease. Our latest improvement, a wireless Gait-o-Gram™ has attracted venture capital interest. It will also be utilized for the clinical assessment of prosthetic alignment and the success of orthopedic interventions such as knee ligament reconstruction.


Dr. Decker

Sensor placement for GOG collection

Dimitrios Katsavelis, MS, is currently working on his doctoral degree through the University of Nebraska Medical Center under the mentorship of Dr. Stergiou. As part of his dissertation he is exploring the effect of virtual reality on human movement variability from both linear and nonlinear perspectives. Results from his recent projects imply that asynchronous optic flow elicits less predictable forward walking kinematic patterns that are indicative of reduced stability and adaptability. Experiments with backward walking revealed increased kinematic variability as expressed by both linear and nonlinear measures when compared to corresponding values of forward walking. Finally, the direction of optic flow did not affect the amount or structure of variability in backward walking. This is due to the high complexity involved in walking backwards. These facts are already submitted for publication in prestigious scientific journals.


Mr. Katsavelis

Exciting preliminary studies combined our first wireless Gait-O-Gram™ and our virtual walking environment, both featured in last year's newsletter. The ultimate goal is to have persons with gait disturbances walking in a safe and pleasant environment as part of their rehabilitation regime. Our first studies were so promising that in 2008 we will build a Virtual Reality Rehabilitation Prototype. This Prototype will be a small room, made out of projectors, a body weight support system and screens with a treadmill in its center called N-VEN (NBCF Virtual Environment for Neuro-rehabilitation). The person walking

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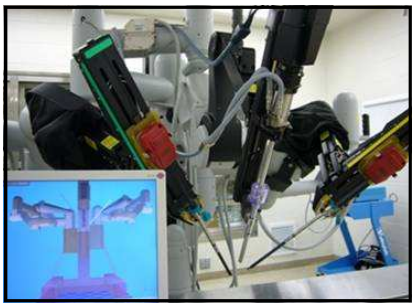
on the treadmill will be surrounded on three sides with a seamless simulated environment. The Gait-O-Gram™ will continually evaluate the participant's walking strategies. The eventual goal will be for patients, such as a recent stroke sufferer or a recent leg amputation patient, to learn new walking strategies in a safely supportive environment. The therapist is able to manipulate this environment to make the subject think they have corners to turn or obstacles to step over. New patterns can be explored and mastered in this environment with the help of the patient's clinician.

This project regularly attracts students from the Peter Kiewit Institute who wish to develop an aspect of the Gait-O-Gram™. During the 2008 Spring semester, Demaka Adams, from UNL Engineering, contributes to our knowledge while working on her senior project. Aspects of this work were presented at the International Society for Posture and Gait Research 18th International Conference and at the 2007 NASPSPA Conference. Also, involved in this project is Naomi Kochi, MS, who is developing many of the software aspects of this project. Naomi received her MS in Mathematics from UNO. She is pursuing her PhD under the direction of Dr. Stergiou.

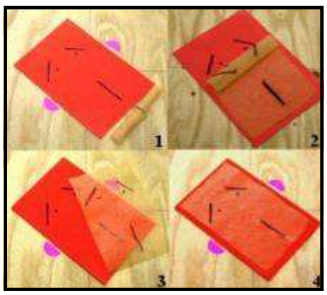
Ms. Kochi

EDUCATIONAL TRAINING PROGRAM IN ROBOT-ASSISTED SURGERY

Robotic surgery is the use of robots, like the daVinci™, in performing surgery. Dr. Stergiou, his post-doc Dr. Siu and their collaborators from the UNMC Department of Surgery, Drs. Dmitry Oleynikov and Marsha Morien, and from UNL Engineering, Drs. Shane Farritor, Susan Hallbeck and Steven Platt, are on the last year of a four-year $1,185,852 grant from the Nebraska Research Initiative. This grant entitled "New Robotic Surgical Tools for Minimal Access Surgery" ultimately aims to develop an international certificate program for surgeons training in robot-assisted laparoscopy administered here in Omaha.



Our team has developed a number of "surgical training tasks" which mimic commonly performed procedures in robotic laparoscopic surgery, such as mesh alignment, knot tying and needle passing. We used several biomechanical parameters, which we identified, to examine proficiency in robotic surgery and in our "surgical training tasks". Our proficiency criteria emphasize accuracy and consistency over speed. Over the course of this grant, we have demonstrated how student surgeons trained by our "surgical training tasks" have been able to quickly transition these skills into life-like tissue. We have also implemented those surgical tasks into a virtual environment and made our virtual reality training tasks into a complete set of training simulations. At present, we are testing the completeness of our training program. Soon we will be able to offer an international certificate program for surgeons training in robot-assisted laparoscopy in Omaha. Our team also submitted a new two-year grant proposal with Dr. Oleynikov as the principal investigator. In this proposal, our team will design an independent virtual training simulator for robotic surgery with more realistic scenarios implemented into all applications. This new grant will explore a new dimension of future surgical education here in Nebraska.



Mesh Alignment task.

Dr. Joseph (Ka-Chun) Siu has done preliminary studies on how actual operating room (OR) noise affects robotic assisted surgical performance. He found that the pre-recorded noise from the OR negatively affects surgical performance. That led him to design an extension of their previous study to test the hypothesis, "Do different types of music have different impacts on surgical performance?" So far, the pilot results show that music containing high pitches, loud voices such as Rap/Hip-Hop affects the surgical performance and increases the time to complete surgical tasks. On the other hand, music with less volume divergence from loud to soft, less pitch disparity and rhythmic melodies such as classical and jazz enhances surgical performance and reduces the completion time of standardized surgical tasks.

Dr. Siu

(Continued on page 12)

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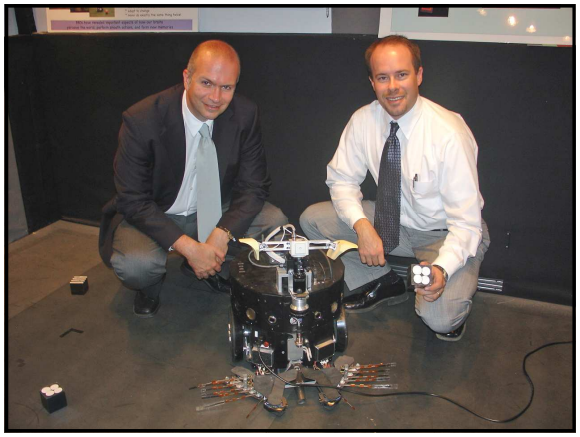
In 2007 and 2008 our postdoctoral researchers, Drs. Joseph Siu and Mukul Mukherjee along with doctoral candidate Irene Suh (Lee) worked on all the improvements mentioned above. They had eleven abstract presentations at the following conventions: The Society of American Gastrointestinal Endoscopic Surgeons, American Hernia Association Annual Meeting, Annual Minimally Invasive Robotic Association Meeting, Medicine Meets Virtual Reality Conference, Neuroscience Annual Meeting, Annual Nebraska Research and Innovation Conference, International Society of Biomechanics, North American Society for the Psychology of Sport and Physical Activity, Center for Advanced Surgical Technology Stimulation Symposium at UNMC. In addition medical students Eric Monk and Timothy McAuliffe, not only participate in data collections but also contribute in subject recruitment and data processing. Irene Suh, MS, received her BS in Computer Science and Mathematics from the University of Nebraska at Omaha and her MS in Mathematics from UNO. She pursues her PhD studies in the Medical Sciences Interdepartmental Area Program at UNMC under the guidance of Drs. Siu, Oleynikov and Stergiou.

Ms. Suh, MS



Drs. Stergiou and Kurz with "Darwin"

Speaking about robots, Dr. Stergiou along with collaborator and previous doctoral student Dr. Max Kurz were able to visit The Neurosciences Institute (NSI) while attending the Society for Neuroscience 2007 Annual Meeting. This was only able due to the generosity of Dr. Gerald Edelman, a Nobel price winner. Drs. Stergiou and Kurz visited with Dr. Edelman and received advice on their projects. They were also able to interact with many members of the NSI's facilities. Their visit was highlighted by their interaction with NSI's newest "Darwin" robot. Their website is: http://www.nsi.edu/

LATEST DEVELOPMENTS:

STAIRCASE Recently, the Nebraska Biomechanics Core Facility received a mechanically built 4-step structured staircase equipped with force measurement scales and a force instrumented handrail system from the Munroe-Meyer Institute. This specially designed biomechanics staircase is used to study stair negotiation, which is a highly demanding task for individuals recovering from injury, or those with gait impairment associated with stroke, Parkinson's disease, or other neurological disorders. A basic component of staircase design includes a handrail system to assist individuals during stair climbing. However, there is a lack of research involving how a handrail system functions during stair climbing and the amount of force distributed through the handrails during stair negotiation. The Nebraska Biomechanics Core Facility added two force plates and amplifiers so that all four steps and the handrail system can measure the forces exerted during stair negotiation. Our first projects are to measure the accuracy of the handrail force measurement, which has never been fully utilized. This will provide the foundation for future stair climbing studies in the lab, especially for those that will investigate populations dependent on an assistive handrail during stair climbing. Dr. Shing-Jye Chen, the Co-

Staircase and handrail system

Mr. Radovic

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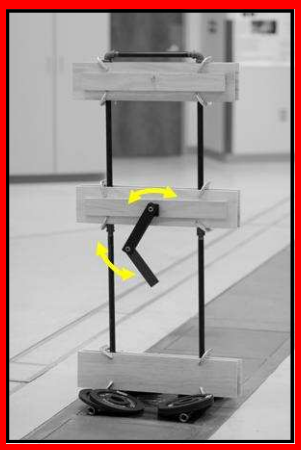
Director of the laboratory, leads these investigations with his graduate assistants Matija Radovic, BS and Nicholas Hanson, BS. Matija received his BS in Education from the University of Belgrade, Serbia. Nick received his BS in biology from UNO. Both are pursuing their MS degree in Exercise Science under the guidance of Dr. Chen.

The Nebraska Biomechanics Core Facility also purchased the Tekscan force pressure insole system. Dr. Chen, an expert in foot mechanics, will continue his previous studies using the Tekscan System. Eventually projects will be designed which will combine both the biomechanic staircase and the Tekscan system.

Mr. Hanson

PROJECT CHAOS Researchers in many labs, including our own, in an attempt to understand neuromuscular control of human movement, are applying concepts from nonlinear dynamics and chaos theory. However, mathematicians using pure numbers, uncontaminated by experimental noise, developed the mathematical algorithms we use. In order to bridge the gap between mathematical theory and experimental reality, we are using two pendulums as model dynamical systems. The single pendulum moves at only one joint, and the double pendulum moves at two joints. The dynamics of both pendulums are very well understood. The single pendulum is too simple to produce chaotic motion, but the double pendulum has sufficient degrees of freedom to produce chaotic motion. We are using physical pendulums with the same data acquisition techniques that we use for the study of human motion in order to acquire movement data from the pendulums. We plan to apply the mathematical algorithms from chaos theory to the experimental data from the pendulums. This may verify that the mathematical algorithms uncontaminated by experimental noise agree with what is known about the dynamics of the pendulum. If the mathematical algorithms give us our hypothesized results for the pendulum data, we will have a previously unknown confidence in interpreting the results of the algorithms when applied to human movement data, such as postural sway. Joan Deffeyes, a doctoral student under Dr. Stergiou in the University of Nebraska at Omaha Psychobiology program, is leading this project.

Single Pendulum: requires only one angle to specify position.



Double Pendulum: requires two angles to specify position.

GAIT AND COGNITION PROJECT Dr. Leslie Decker and Dr. Nick Stergiou began a preliminary study in collaboration with Dr. Jane Potter and Dr. Claudia Rodriguez-Aranda. Jane Potter, MD is a professor in Internal Medicine and section chief of geriatrics and gerontology at UNMC. This project seeks to determine the effects of visual and auditory distraction along with the sense of balance on the variability of gait patterns. As people age, they are more prone to developing cognitive deficits and mobility problems that threaten independence. Recent research has noted the strong interconnection between gait, cognition and age-related changes. Walking is a fundamental activity that requires the contribution of different mental abilities such as attention, planning and/or memory. The recurrent number of falls experienced by healthy and demented elderly demonstrate the gait problems in aging. Our study is using specific tasks to determine which mental tasks (distraction) cause gait changes. This preliminary study will be used to elaborate on preventive methods, treatments and strategies to avoid falls in aging populations. The Gait-O-Gram™ and high-speed motion capture cameras are used to study the gait patterns in healthy young and elderly individuals.

Headphones to block noise plus mike to record responses while naming items and walking.

Other Global Connections

Orthopedic Center in Sports Medicine (OCSM): Ioannina Medical Center in Greece. Dr. Stergiou is the Scientific Consultant for OCSM. In his ongoing collaboration with OCSM, Dr. Stergiou works closely with Dr. Georgoulis, the Director of OCSM, and other orthopedic surgeons in a well equipped biomechanical laboratory. Each year he spends several weeks at OCSM setting up new protocols and revisiting established ones. This year their collaborative work resulted in many published articles, many submitted for publication and multiple presentations at conferences. Their successive studies have led to some very important findings regarding the reconstruction of one of the most important knee ligaments, the anterior cruciate ligament. For example, they are exploring the effect of the location of the femoral tunnel drilling during the reconstruction, on the way patients perform dynamic activities post rehabilitation. They have recently found that the anterior cruciate ligament reconstruction affects muscular activity of the vastus lateralis during activities of high intensity. One of their newest hypothesis is that current surgeries change the dynamics within the knee causing wear in places that are different than the typical wear patterns of a normal knee.

Drs. Georgoulis and Stergiou with the OCSM staff.

Pierre and Marie Curie University: Paris, France. Dr. Stergiou in collaboration with the team "Locomotion" (Drs. Anick Abourachid, Remi Hackert, and Marc Herbin) at the National Museum of Natural History, work on the exploration of gait variability in small mammifers (i.e., rats, ducks, lemurs). Dr. Stergiou is helping to establish experimental protocols to investigate gait variability in animal locomotion by applying nonlinear analysis techniques. Recently, "Locomotion" began collecting long-term gait data with birds (ducks) using the technology of cineradiography with miniature treadmills and force platforms embedded in the walkway. Cineradiography allows the simultaneous visualization of movement of internal body structures. "Locomotion" works on the analyses of locomotor motions in connection with the morphology of the internal organs. Their French website is located at: http://www.mnhn.fr/mnhn/usm302/

Lemur

Instituto de Biomecánica de Valencia (IBV): Spain. IBV was set up by the Polytechnic University of Valencia (UPV) and the Medium and Small Size Valencian Industry Institute (IMPIVA). It consists of 150 professionals from different academic backgrounds that work together in an interdisciplinary approach. At the end of November 2007, Dr. Nick Stergiou was one of the top lecturers in the *New Trends in Sport Movement Analysis International Workshop* given by the IBV. In addition, Dr. Stergiou worked with several members of IBV on the newest analytical techniques in biomechanics. This visit was such a great success that IBV has decided to invite Dr. Stergiou for another visit at the end of 2008. During his visit, Dr. Stergiou also visited the facilities of Valencia Football Club and interacted with members of their training staff. Valencia FC is one of the best soccer clubs in Europe. IBV's website is located at: http://www.ibv.org/

Dr. Stergiou holding the jersey of Valencia FC, with members of IVB outside the Mestalla Stadium

Other Exciting News—Master's Degrees Received

Sara Myers and Jessie Huisinga: Graduated Summer 2007, Masters in Exercise Science with concentrations in Biomechanics. They are both continuing with doctoral studies at the University of Nebraska Medical Center, Medical Sciences Interdepartmental Area, sponsored by the Department of Surgery.


Dr. Cavanaugh

Dr. Jim Cavanaugh, formerly a doctoral student of Dr. Stergiou and Dr. Guskiewicz, received a prestigious award for his dissertation research work. Specifically, results from his dissertation were published as cited below. The article was selected as the winner of the 2006 Journal of Athletic Training Kenneth L. Knight Award for *Outstanding Research Manuscript*. The award was presented at the annual meeting of the National Athletic Trainers Association (NATA) on June 28, 2007 in Anaheim, CA.

Cavanaugh, J.T., Guskiewicz, K.M., Giuliani, C., Marshall, S., Mercer, V.S., & Stergiou, N. Recovery of postural control after cerebral concussion: New insights using Approximate Entropy. Journal of Athletic Training 41(3):305-13, 2006.

AWARDS RECEIVED

AWARD FOR DISTINGUISHED RESEARCH OR CREATIVE ACTIVITY 2008

Researchers wear several hats. They hunt for funding, hunt for graduate assistants, post-doctoral researchers and fellow faculty. Each year UNO awards a tenure track faculty member the Award for Distinguished Research or Creative Activity. The competition is stiff. The criteria includes, research of sufficient originality and distinction to merit attention at the national level or beyond; the ability to foster and enhance the quality of research and creative activity at the University; and evidence that the researcher publicly manifests the University's commitment to and support of such accomplishment.

Dr. Nick Stergiou was awarded the UNO Award for Distinguished Research or Creative Activity of 2008. Congratulations to Dr. Stergiou for this significant achievement.

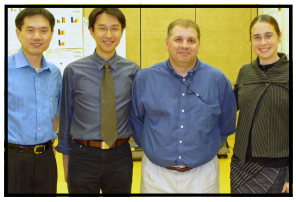
FACULTY AND STUDENT AWARDS RECEIVED

1. Nick Stergiou, Ph.D. is now the Education Committee Chair for the American Society of Biomechanics.
2. *Sara Myers, MS:* Kate Field Grant-in-Aid, University of Nebraska at Omaha. 2006-2007.
3. *Sara Myers, MS:* NASA Nebraska Space Grant Columbia Memorial Scholarship, University of Nebraska at Omaha. Spring 2007.
4. *Anastasia Kyvelidou, MS:* UNMC Graduate Studies Fellowship, University of Nebraska Medical Center 2007-2008.
5. *Jessie Huisinga, MS:* Student Research Support, University Committee on Research and Creative Activity. Spring 2007.
6. *Panagiotis Koutakis, BS:* Scholarship, Alexandros Onassis Public Benefit Foundation. 2007-2009.
7. *Jessie Huisinga, MS:* NASA Nebraska Space Grant Scholarship, University of Nebraska at Omaha. Fall 2007.
8. *Anastasia Kyvelidou, MS:* Sigma Xi Grant-in-Aid of Research Grant, Fall 2007.
9. *Sara Myers:, MS:* NASA Nebraska Space Grant Scholarship, University of Nebraska at Omaha. Spring 2008.
10. *Nicholas Hanson, BS:* Student Research Support, University Committee on Research and Creative Activity. Spring 2008.
11. *Anastasia Kyvelidou, MS:* Sigma Xi Grant-in-Aid of Research Grant, Spring 2008.
12. *Anastasia Kyvelidou, MS:* Sigma Xi elected as an Associate Member by the Committee on Qualifications and Membership of the Society, Spring 2008.

GUEST PRESENTATIONS:

Dr. Michael Gorga, director of the Clinical Sensory Physiology Laboratory at the Boys Town National Research Hospital, Presented: *Distortion product otoacoustic emissions in relation to hearing loss*, on October 19, 2007. We also gave him a complete tour of the laboratory and cemented our collaboration with him for Anastasia Kyvelidou's doctorial dissertation work.

Dr. Michel Ladouceur Presentation, Assistant Professor in the Department of Integrative Physiology at the University of Iowa, Presented: *The Neural Control of Walking in Spinal Cord Injured Participants with an Incomplete Motor Function Loss*, on May 11, 2007. We introduced him to our projects.



Dr. Allison Okamura, associate professor of Mechanical Engineering at the Johns Hopkins University, Presentation: *Haptics for Robotic-Assisted Surgery,* on August 24, 2007. Along with other guests, we introduced her to our projects.

IN THE NEWS:

Featured in SporTime (Jan 3, 2007 Issue) (Copyright © 2007 bwin International Ltd.) Greek Newspaper article featuring Dr. Stergiou's research and his love of the Sport team PAOK titled "PAOK, my love". http://www.unomaha.edu/biomech/archive.php

Featured in *Gateway Newspaper* February 20, 2007 by Charley Reed. "Dr. Stergiou gives double meaning to the 'sole' of a Maverick " http://www.unomaha.edu/biomech/sole.php

UNO TV's *Consider This* interviewed Dr. Nick Stergiou and Reggie Harbourne, PT on INFANT STUDY. February 23rd, 2007 http://www.unomaha.edu/biomech/unotv.php

Nebraska Biomechanics Core Facility

Back Row:
Jessie Huisinga, Panos Koutakis, Nick Hanson, Dr. Joseph Siu, Dr. Dan Blanke, Dr. Nick Stergiou, Dr. Shing-Jye Chen, Dr. Leslie Decker, Dimitrios Katsavelis, Jeff Kaipust, Matija Radovic, Sara Myers.

Front Row:
Naomi Kochi, Joan Deffeyes, Lisa Holst, Dr. Mukul Mukherjee, Natasha Kyvelidou, Erin Fosnaugh, Dr. Claudia Rodriguez-Aranda, Irene Lee.

Professional Journal Publications

1. Brown-Clerk, B., Siu, K-C, Katsavelis, D., Lee, I., Oleynikov, D., Stergiou, N. (2008) Validating advanced robot-assisted laparoscopic training task in virtual reality. *Studies in Health Technology and Informatics*. 132:45-9.
2. Myers, S.A., Johanning, J.M., Stergiou, N., Lynch, T.G., Longo, G.M., Pipinos, I.I. (2008) Claudication distances and the Walking Impairment Questionnaire best describe the ambulatory limitations in patients with symptomatic Peripheral Arterial Disease. Accepted for publication in the *Journal of Vascular Surgery*. 47(3):550-555.
3. Narazaki**,** N**.**, Narazaki**,** K**.**, & Stergiou, N. (2007). Kinetic and kinematic analysis of a judo throwing technique: Osoto-gari. *Bulletin of the Association for the Scientific Studies on Judo*, *Kodokan*. 11:19-32.
4. Cavanaugh, J.T., Mercer, V.S., Stergiou, N. (2007) Approximate entropy detects the effect of a secondary cognitive task on postural control in healthy young adults: a methodological report. *Journal of Neuroengineering and Rehabilitation.* 4:42.
5. Kurz, M.J. & Stergiou, N. (2007). Do horizontal forces influence the structure of chaotic gait patterns? *Journal of Neuroengineering and Rehabilitation*. 4(1):30.
6. Moraiti, C., Stergiou, N., Ristanis, S., Georgoulis, A.D. (2007) ACL deficiency affects stride-to-stride variability as measured using nonlinear methodology. *Knee Surgery Sports Traumatology and Arthroscopy.* 15(12):1406-13.
7. Scott-Pandorf, M.M., Stergiou, N., Johanning, J.M., Robinson, L., Lynch, T.G., Pipinos, I.I. (2007) Peripheral arterial disease affects ground reaction forces during walking. *Journal of Vascular Surgery*. 46(3):491-9.
8. Stergiou, N., Ristanis, S., Moraiti, C., Georgoulis, A.D. (2007) Tibial rotation in anterior cruciate ligament (ACL)-deficient and ACL-reconstructed knees: A theoretical proposition for the development of osteoarthritis. *Sports Medicine* 37(7):601-13.
9. Kurz, M.J., & Stergiou, N. (2007) Hip actuations can be used to control bifurcations and chaos in a passive dynamic walking model. *Journal of Biomechanical Engineerin*g. 129(2):216-22.
10. Fiedler, M.J., Chen, S-J, Judkins, T.N., Oleynikov, D, Stergiou, N. (2007) Virtual reality for robotic laparoscopic surgical training. *Studies in Health Technology and Informatics.* 125:127-9.
11. Narazaki, K., Oleynikov, D., Stergiou, N. (2007) Objective Assessment of Proficiency with Bimanual Inanimate Tasks in Robotic Laparoscopy. *Journal of Laparoendoscopic Advanced Surgical Techniques.* 17 (1):47-52.
12. Georgoulis, A.D., Kiapidou, I-S., Velogianni, L., Stergiou, N. Boland, A.(2007) Herodicus, the father of sports medicine. *Knee Surgery Sports Traumatology and Arthroscopy.* 15(3):315-8.
13. Georgoulis, A.D., Ristanis, S., Chouliaras V., Moraiti, C., & Stergiou, N. (2007) Tibial rotation is not restored by ACL reconstruction with a hamstring graft. *Clinical Orthopaedics and Related Research.* 454:89-94.

Selected Published and presented Abstracts Since 2006

1. Willett, S.L., Harbourne, R., DeJong, S.L., Stergiou, N. (2008). A comparison of developing sitting postural control in 2 infants receiving different treatment approaches. *Pediatric Physical Therapy*, 20, 122.
2. Chen, S-J, Huisinga, J.M., Myers, S.A., Radovic, M., Pipinos, I.I., Johanning, J.A., Stergiou, N. (2007) The Effects of Peripheral Arterial Disease on Gait Stability. *Journal of Biomechanics*, 40, S41.
3. Deffeyes, J.E., Stergiou, N., Harbourne, R.T., Kyvelidou, A., DeJong, S.L., Stuberg, W.A. (2007) Sitting Postural Sway Can Assess Severity of Infant Developmental Delay. *Journal of Biomechanics*, 40, S249.
4. Brown-Clerk, B., Siu, K-C, Katsavelis, D., Lee, I.H., Oleynikov, D., Stergiou, N. (2007) Electromyographic Activity Determines Task Difficulty for Robotic Laparoscopic Training Programs. *Journal of Biomechanics*, 40, S243.
5. Harbourne, R.T., Deffeyes, J.E., DeJong, S.L., Stuberg, W.A., Kyvelidou, A., Stergiou, N. (2007) Nonlinear tools provide us with a viable alternative to investigate variability in motor development and control. *Journal of Sport & Exercise Psychology,* 29, S7-8.
6. Smith, B.A., Stergiou, N., Ulrich, B.D. (2007) A comparison of two surrogation algorithms to investigate stability and periodicity in toddler gait. *Journal of Sport & Exercise Psychology,* 29, S8.
7. Katsavelis, D., Siu, K-C, Brown-Clerk, B., Lee, I.H., Oleynikov, D., Stergiou, N. (2007) Learning Robotic Surgical Skills with a Virtual Reality Environment. *Journal of Sport & Exercise Psychology.* 29: S91.
8. Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Stuberg, W.A., Kyvelidou, A., Stergiou, N. (2007) Severity of Infant Developmental delay can be assessed using variability measures of sitting postural sway. *Journal of Sport & Exercise Psychology,* 29, S28.
9. Harbourne, R.T., Deffeyes, J.E., DeJong, S.L., Stuberg, W.A., Kyvelidou, A., Stergiou, N. (2007) Nonlinear variables can assist in identifying postural control deficits in infants. *Journal of Sport & Exercise Psychology,* 29, S31.
10. Kyvelidou, A., Stuberg, W.A., Harbourne, R.T., DeJong, S.L., Deffeyes, J.E., Stergiou, N. (2007) Postural control in typically developing infants and adults during sitting. *Journal of Sport & Exercise Psychology,* 29, S37.

11. Kochi, N., Stergiou, N., Cavanaugh, J.T. (2007) Linear and nonlinear measures of variability in step activity data reveal motor control strategies employed by relatively active and inactive older adults. *Journal of Sport & Exercise Psychology,* 29, S99.
12. Siu, K-C., Lee, I.H., Brown-Clerk, B., Katsavelis, D., Oleynikov, D., Stergiou, N. (2007) Nonlinear analysis validate the need to learn surgical skill. *Journal of Sport & Exercise Psychology,* 29, S130.
13. Stergiou, N., Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Kyvelidou, A., Stuberg, W.A. (2007) Characterizing postural sway in infants with typical versus delayed development of sitting. *Pediatric Physical Therapy*, 19, 84.
14. Willett, S.L., Harbourne, R., DeJong, S.L., Stergiou, N. A comparison of developing sitting postural control in 2 infants receiving different treatment approaches. Proceedings of the *2008 American Physical Therapy Association Combined Sections Meeting,* Nashville TN, 2008. #311.
15. Stergiou, N., Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Kyvelidou, A., Stuberg, W.A. Quantitative measures of development of neuromuscular control in infant sitting. Proceedings of N*euroscience 2007,* San Diego, California, cd-rom #132.3/D23.
16. Siu, K-C, Brown-Clerk, B., Lee, I.H., Katsavelis, D., Oleynikov, D., Stergiou, N. The Negative Impact of Noisy Environment on Robotic Surgery. Proceedings of N*euroscience 2007,* San Diego, California, cd-rom # 411.23/YY20.
17. Stergiou, N., Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Kyvelidou, A., Stuberg, W.A. Lyapunov exponent correlations with range of postural sway as an indicator of delayed development of sitting. Proceedings of the International Society for Postural and Gait Research (ISPGR) *XVIII Conference 2007.* p. 113.
18. Tanwar, H., Decker, L., Huisinga, J.M., Stergiou, N. Design and validation of low cost wireless system to evaluate gait variability. Proceedings of the International Society for Postural and Gait Research (ISPGR) *XVIII Conference 2007.* p. 178.
19. Wutzke, C.J., Stergiou, N., Pipinos, I.I., Johanning, J.M., Threlkeld, A.J. Gait Adaptability in People with Unilateral Trans-tibial Amputations in Response to Variable Walking Speed and Body Weight Support. Proceedings of the *2007 American Society of Biomechanics Annual Meeting,* Stanford, California, cd-rom #302.
20. Myers, S.A., Stergiou, N., Pipinos, I.I., Johanning, J.A., Kochi, N. PAD causes alterations in the variability of gait patterns. Proceedings of the *2007 American Society of Biomechanics Annual Meeting,* Stanford, California, cd-rom #63.
21. Kyvelidou, A., Stuberg, W.A., Harbourne, R.T., DeJong, S.L., Deffeyes, J.E., Sun, J., Stergiou, N. Test-Retest Reliability of Sitting Posture in Typically Developing Infants. Proceedings of the *2007 American Society of Biomechanics Annual Meeting,* Stanford, California, cd-rom #138.
22. Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Stuberg, W.A., Kyvelidou, A., Stergiou, N. Approximate Entropy is Robust to Non-Sationarity in Analysis of Infant Sitting Postural Sway. Proceedings of the *2007 American Society of Biomechanics Annual Meeting,* Stanford, California, cd-rom #150.
23. Kyvelidou, A., Stuberg, W.A., Harbourne, R.T., DeJong, S.L., Deffeyes, J.E., & Stergiou, N. (2007) Frequency Domain Analysis of the Center of Pressure Time Series During Sitting In Typically Developing Infants and Infants with Developmental Delays. Proceedings of *the 12th Annual Gait & Clinical Movement Analysis Society Meeting*. Springfield, Massachusetts. SP-14.
24. DeJong, S.L., Harbourne, R.T., Kyvelidou, A., Stuberg, W.A., Deffeyes, J.E., Stergiou, N. (2007) Kinematics of sitting postural control in typically developing infants. Proceedings of *the 12th Annual Gait & Clinical Movement Analysis Society Meeting.* Springfield, Massachusetts, SP-9.
25. Myers, S. & Stergiou, N. Gait adaptations in persons experiencing claudication. Proceedings of the *Annual Meeting of the Nebraska Academy of Sciences Aeronautics & Space Science Section*. Lincoln, Nebraska. 2007.
26. Stergiou, N. Past, present and future of non-linear methodology in biomechanics. International Workshop *New Trends in Sport Movement Analysis*. Instituto de Biomecánica de Valencia, Valencia, Spain, November 2007.
27. Stergiou, N. Motor Coordination. Symposium. Instituto de Biomecánica de Valencia, Valencia, Spain, November 2007.
28. Stergiou, N. Human Movement Variability. Symposium. Instituto de Biomecánica de Valencia, Valencia, Spain, November 2007.
29. Stergiou, N. Methods in nonlinear analysis. Symposium. Instituto de Biomecánica de Valencia, Valencia, Spain, November 2007.
30. Siu, K-C, Lee, I.H., Mukherjee, M., Oleynikov, D., Stergiou, N. The Effect of Environmental Noise on Robotic Surgery. To be a Podium Presentation at the *3rd Annual Minimally Invasive Robotic Association (MIRA) Meeting, Rome*, January, 2008, Rome, Italy.
31. Ristanis, S., Chouliaras, V., Moraiti, C., Stergiou, N., and Georgoulis, A.D. Current autografts used for ACL Reconstruction do not restore tibial rotation during pivoting. Presented at the *International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) 6th Biennial Congress* held in Florence, Italy, May, 2007.
32. Ristanis, S., Chouliaras, V., Moraiti, C., Stergiou, N., and Georgoulis, A.D. Quadrupled Hamstrings Autograft vs Bone-patellar tendon-bone Autograft: Changes in Movement Variability During Walking after Anterior Cruciate Ligament Reconstruction. Presented at the *Orthopedic Research Society 2007,* San Diego, California, March, 2007.

33. Stergiou, N. Human Movement Variability: Applications in Robotic Surgery and Motor Development. Invited presentation at the *University of Delaware*, February , 2008.

34. Kyvelidou, A., Stuberg, W.A., Harbourne, R.T., DeJong, S.L., Sun, J., Stergiou, N. Reliability of center of pressure measurements during sitting in typically developing infants. Podium presentation at the 2008 *American Physical Therapy Association Combined Sections Meeting,* Nashville TN, February, 2008.

35. Kyvelidou, A., Stuberg, W.A., Harbourne, R.T., DeJong, S.L., Deffeyes, J.E., Stergiou, N. Quantity and quality of COP variability changes across sitting development of typically developing infants. Podium presentation at the 2008 *American Physical Therapy Association Combined Sections Meeting*, Nashville TN, February, 2008.

36. Celis, R., Pipinos, I., Stergiou, N., Myers, S., Huisinga, J., Lynch, T., Johanning, J. Gait abnormalities are present prior to the onset of claudication in both young and old claudicants. Podium presentation at *the American College of Surgeons 93rd Annual Clinical Congress*, October 7-11, 2007, New Orleans, Louisiana.

37. Stergiou, N. Motor Development from a Nonlinear Perspective. It was presented at the *University of Michigan Kinesiology Seminar Series*. Ann Arbor, Michigan, November, 2007.

38. Stergiou, N. A New Theoretical Model for Intervention Strategies. Invited investigator. Presented at the *Second National Research Summit (RS II) on: Early Intervention for Children with or at Risk for Physical Disabilities.* This summit was sponsored by the Section on Pediatrics of the American Physical Therapy Association. It was held in Alexandria, Virginia, October, 2007.

39. Harbourne, R.T., and Stergiou, N. Nonlinear Analysis Techniques in Motor Development. *Motor Development Symposium at the 2007 NASPSPA Conference* held in San Diego, California, June, 2007. Co-organizer.

40. Myers, S.A. & Stergiou, N. Gait adaptations in persons experiencing claudication. Proceedings of the *Annual Meeting of the Nebraska Academy of Sciences Aeronautics & Space Science Section*. Lincoln, Nebraska, April, 2007.

41. Stergiou, N., Deffeyes, J., Harbourne, R.T., DeJong, S.L., Kyvelidou, A., Stuberg, W.A. Nonlinear analysis of sitting postural sway indicates developmental delay in infants. Poster presented at the *XVIth Biennial International Conference on Infant Studies*. Vancouver, Canada, March, 2008.

42. Kyvelidou, A., Harbourne, R.T., Deffeyes, J.E., Stuberg, W.A., Sun, J., Stergiou, N. Reliability of body sway measurements during infant sitting posture development. Poster presented at the *XVIth Biennial International Conference on Infant Studies*. Vancouver, Canada, March, 2008.

43. Harbourne, R.T., Deffeyes, J.E., DeJong, S.L., Kyvelidou, A., Stuberg, W.A., Willett, S., Stergiou, N. Efficacy of a Perceptual-Motor Intervention for Sitting Postural Control in Children with Moderate to Severe Cerebral Palsy Using Measures of Complexity. Poster presented at the *XVIth Biennial International Conference on Infant Studies*. Vancouver, Canada, March, 2008.

44. Ristanis, S., Chouliaras, V., Moraiti, C., Stergiou, N., and Georgoulis, A.D. Current Autografts used for ACL Reconstruction do not restore tibial rotation during pivoting. Poster presentation at the *ISAKOS 6th Biennial Congress*, (*International Society of Arthroscopy and Knee Surgery and Orthopedic Sports Medicine) 2007* held in Florence, Italy, May, 2007.

45. Moraiti, T., Stergiou, N., Vasiliadis, V., Tzimas, Patras, K., Ristanis, S., Georgoulis, A.D. Patellar Tendon vs Hamstrings Graft: How effective are they in restoring walking dynamics after ACL reconstruction. Poster presentation at the *ISAKOS 6th Biennial Congress*, (*International Society of Arthroscopy and Knee Surgery and Orthopedic Sports Medicine) 2007* held in Florence, Italy, May, 2007.

46. Kyvelidou, A., Stergiou, N., Deffeyes, J.E., Harbourne, R.T., DeJong, S.L., Stuberg, W.A., Blanke, D. Development of upper body coordination during sitting in typically developing infants. Poster presentation at the *SRCD Biennial Meeting (Society for Research in Child Development).* Massachusetts, March, 2007.

47. Ristanis, S., Stergiou, N., Moraiti, C., Chouliaras, V., Georgoulis, A.D. The Effectiveness of ACL Reconstruction with Quadrupled Hamstrings and BPTB Auto grafts. An in-vivo study comparing tibial rotation. Poster presentation at the *Orthopedic Research Society 2007.* San Diego, California, March, 2007.

48. Judkins, T.N., Oleynikov, D., Bochkarev, V., Stergiou, N. Validation of Robotic Surgical Skill Assessment Using Subjective Expert Evaluation. Poster presentation at the *Medicine Meets Virtual Reality 15 convention.* Long Beach, California, February, 2007.

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