BIOGRAPHICAL SKETCH

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NAME: Steven A. Kautz

eRA COMMONS USER NAME (credential, e.g., agency login): KAUTZ159

POSITION TITLE: Professor and Chair

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Michigan State University, East Lansing, MI	BS	1983	Geology
University of Texas, Austin, TX	MA	1989	Geology, Kinesiology
University of California, Davis, CA	PhD	1992	Biomedical Engineering

A. Personal Statement

I am widely recognized as an expert in applying biomechanical and neurophysiological principles to understand the coordination of locomotion in persons with post-stroke hemiparesis. My research combines theoretical and experimental studies of the control of locomotion, functional biomechanics and clinical neurorehabilitation with the goal of improving walking in persons with neurological disorders, predominantly post-stroke. I have more than 20 years of experience in measuring motor performance related to neuromuscular control and have published nearly 100 peer-reviewed articles. I have been PI or Co-PI of funding in rehabilitation totaling more than $20 million.

I also am the PI and Program Director for the South Carolina Research Center for Recovery from Stroke, an NIH-funded Center of Biomedical Research Excellence (COBRE). This center grant established a research center in recovery from stroke that supports research projects ranging from basic science investigation in animal models through clinical trials. It supports full-scale mentored research projects for five junior faculty members and establishes four fully staffed, full service scientific core resources to support stroke recovery research: Quantitative Behavioral Assessment and Rehabilitation; Brain Stimulation; Neuroimaging; and Clinical and Translational Tools and Resources (including subject recruitment, study design and biostatistics). Note that I also am the Director of the COBRE QBAR Core. In addition, the COBRE provides support for pilot research projects in stroke recovery. Thus, junior faculty, postdoctoral fellows and PhD students have tremendous opportunities for career development in our laboratories.

I also am the PI and Program Director for the National Center of Neuromodulation for Rehabilitation, one of six NIH-funded Centers within the NIH Rehabilitation Research Infrastructure Network. This grant established a research center to advance the science of neuromodulation as applied to rehabilitation.

I also have extensive experience as a mentor to junior faculty and PhD students. I currently am mentoring two VA CDA-2 awardees and one NIH P20 awardee, and am on the mentor team for one NIH K01 awardee. I have mentored (or been on the mentoring team of) 21 career development awardees. The three VA CDA-2 awardees that have completed their awards with me as their primary mentor have each been awarded VA Merit Awards in stroke rehabilitation upon the completion of their CDA award. In total, I have served as a mentor for more than $4 million dollars of awards to junior faculty.

B. Positions and Honors

<u>Positions and Employment</u>

1992-2002	Biomedical Engineer, Neuromuscular Systems Group, Rehabilitation R & D Center, VA Medical Center, Palo Alto, CA
1994-2000	Consulting Assistant Professor, Dept. of Functional Restoration, School of Medicine, Stanford University, Stanford, CA

2000-2002	Consulting Associate Professor, Dept. of Functional Restoration, School of Medicine, Stanford University, Stanford, CA
2002-2009	Associate Professor, Dept. of Physical Therapy, College of Public Health & Health Professions, University of Florida, Gainesville, FL
2009-1/2010	Professor, Dept. of Physical Therapy, College of Public Health & Health Professions, University of Florida, Gainesville, FL
2002-6/2010	Biomedical Engineer, Brain Rehabilitation Research Center, Malcom Randall VA Medical Center, Gainesville, FL
2002-6/2010	Director, VA Rehabilitation Research Centers of Excellence and University of Florida Brooks Center for Rehabilitation Studies Human Motor Performance Laboratory, Gainesville, FL
1/2010-Present	Chair and Professor, Department of Health Sciences & Research, Medical University of South Carolina (MUSC), Charleston, SC
1/2010-Present	Professor, Division of Physical Therapy, MUSC, Charleston, SC
7/2010-Present	Rehab R&D Principal Investigator, Research Service, Ralph Johnson VA Medical Center, Charleston, SC

Honors

2009-2010	University of Florida Research Foundation Professorship, University of Florida, Gainesville
2009-2013	VA Research Career Scientist
2012	Medical University of South Carolina College of Health Professions Scholar of the Year
2014-2019	VA Research Career Scientist

C. Contribution to Science

1. Fundamental concepts of healthy and post-stroke control of locomotion. My lab has spent considerable effort on investigations into how the healthy and post-stroke nervous systems control locomotion. Such studies are crucial to identify post-stroke deficits and understand their underlying mechanisms in order to provide specific targets for rehabilitation. In a pair of papers in the *Journal of Neurophysiology* based on a novel pedaling paradigm, we showed that the control of the non-paretic leg substantially contributed to the impaired coordination pattern in the paretic leg and in fact could be responsible for a majority of the activation in the paretic leg for the most severely affected persons. This work provided strong evidence against unilateral interventions and provided evidence of the potential for imbalance between the two halves of the nervous system to functionally impact locomotor performance, perhaps also providing motivation to investigate brain stimulation techniques that inhibit the contralesional motor cortex. Other work published in journals such as *Brain* and *Stroke* investigated the coordination of locomotion with respect to alterations in speed, workload and body orientation relative to gravity.

a. **Kautz SA,** Patten C.. Interlimb influences on paretic leg in poststroke hemiparesis. *J Neurophysiol*, 2005; 93(5): 2460-73.
b. **Kautz SA**, Patten C and Neptune RR (2006). Does unilateral pedaling activate a rhythmic locomotor pattern in the nonpedaling leg in post-stroke hemiparesis? *J Neurophysiol.* 2006; 95(5); 3154-63.
c. Routson RL, **Kautz SA**, Neptune RR. Modular organization across changing task demands in healthy and poststroke gait. *Physiol Rep*. 2014; 2(6). PMCID: PMC4208640

2. Theoretical modeling studies of healthy and post-stroke control of locomotion. Theoretical modeling studies that account for task and musculoskeletal biomechanics are crucial in the neurological population in order to differentiate a "pathological" coordination pattern from one that is appropriate for the task given an altered neuromuscular system. A critical obstacle to progress in rehabilitation of lower extremity function is that there is little quantitative data that describe how muscular forces, in the context of motor coordination, produce normal or abnormal movement. My long-term colleagues (primarily Dr. Felix Zajac and Dr. Rick Neptune) and I together have been influential in arguing that an understanding of neural control principles applicable to human locomotion cannot be developed unless the complex task biomechanics are understood thoroughly – most notably in an influential two-part review article in *Gait & Posture*. We have developed new detailed understanding of normal muscle function and coordination in a series of articles using simulation and musculoskeletal modeling, the most impactful of which was a *Journal of Biomechanics* paper on the function of the individual plantarflexor muscles. We also have published several studies in the past few years (in *Journal of Biomechanics*, *Gait & Posture* and *Clinical Biomechanics*) that use simulation and musculoskeletal modeling to understand the coordination of hemiparetic walking in order to establish cause and effect relationships between specific coordination deficits and resulting functional limitations in walking. The result of our theoretical studies has been to advance the field's understanding of specific observed deficits of hemiparetic walking. The ability to answer questions such as "What are the observable consequences of an underlying impairment?" and "How would a walking pattern change if a specific impairment were ameliorated?" greatly facilitate the development of new measures and new targets for intervention.

a. Zajac FE, Neptune RR, and **Kautz SA** (2003). Biomechanics and Muscle Coordination of Human Walking: Part II: Lessons from Dynamical Simulations and Clinical Implications *Gait Posture*, **17**: 1-17.
b. Neptune RR, **Kautz SA** and Zajac FE (2001). Contributions of the ankle plantar flexors to support, forward progression and swing initiation during walking. *J Biomech*, **34**: 1387-1398.
c. Neptune RR, Clark DJ and **Kautz SA** (2009). Modular control of human walking: A simulation study. *J Biomech*, **42**: 1282-87.
d. Allen JL, **Kautz SA** and Neptune RR (2014). The influence of merged muscle excitation modules on post-stroke hemiparetic walking performance. *Clinical Biomechanics*; **28**: 697-704.

3. Mechanism-based rehabilitation of post-stroke locomotion. An underlying tenet of my rehabilitation research is the need for mechanism-based intervention, i.e., we need to understand exactly what the limiting impairments are and how different interventions or parameters of an intervention change those impairments and the underlying motor activity. To that end, I have spent considerable effort on the study of the immediate and cumulative effects of different rehabilitation interventions. A common theme in this work is detailed quantitative measurement of locomotor performance pre- and post-intervention (or experimental manipulation in training parameters) in order to determine the effect of the intervention on the movement and its coordination. I have explored mechanism-based rehabilitation through studies using locomotor training (e.g., body-weight supported treadmill training with therapist assistance as needed for leg and trunk control). First, as reported in a recent paper in *Archives of Physical Medicine and Rehabilitation,* we studied the response to locomotor training in a chronic post-stroke population. This study's focus on determining the different characteristics of responders and non-responders to the intervention was particularly important to understanding how to determine who may or may not benefit from the intervention. Other ongoing work is studying: 1) the different motor patterns resulting in the paretic leg when speed, body weight support or manual assistance to the trunk or non-paretic leg occurs during locomotor training, and 2) the potential effectiveness of applying transcranial direct current stimulation (tDCS) immediately before training to prime the nervous system for locomotor rehabilitation.

a. Bowden MG, Behrman AL, Neptune RR, Gregory CM, **Kautz SA.** Locomotor rehabilitation of individuals with chronic stroke: difference between responders and nonresponders. *Arch Phys Med Rehabil. 2013*; 94(5): 856-62.
b. **Kautz SA**, Duncan PW, Perera S, Neptune RR, Studenski SA. Coordination of hemiparetic locomotion after stroke rehabilitation. *Neurorehabil Neural Repair. 2005;* 19(**3)**: 250-58.
c. Bethoux F, Rogers HL, Nolan KJ, Abrams GM, Annaswamy TM, Brandstater M, Browne B, Burnfield JM, Feng W, Freed MJ, Geis C, Greenberg J, Gudesblatt M, Ikramuddin F, Jayaraman A, **Kautz SA**, Lutsep HL, Madhavan S, Meilahn J, Pease WS, Rao N, Seetharama S, Sethi P, Turk MA, Wallis RA, Kufta C. The effects of peroneal nerve functional electrical stimulation versus ankle-foot orthosis in patients with chronic stroke: a randomized controlled trial. *Neurorehabil Neural Repair.* 2014; 28(7): 688-97.

4. **Mechanism-based measurement of post-stroke locomotion.** All of my work has been crucially facilitated by development of a mechanism-based measurement framework. I have developed and continue to develop quantitative measures of: 1) normal neurological function, 2) underlying structural and functional damage after stroke, 3) experience-dependent neural plasticity during rehabilitation, 4) structural and functional changes post-rehabilitation, and 5) the functional recovery of each individual patient. While my funded projects have focused on understanding underlying mechanisms, I have consistently sought to translate that work by developing measurements informed by those underlying mechanisms (mechanism-based measurement). In a paper in *Stroke*, we demonstrated that generation of propulsion by the paretic leg is important for walking performance and as an indicator of the severity of discoordination of the paretic leg. This work has been influential in providing a target for subsequent rehabilitation interventions. In a paper in the *Journal of Neurophysiology,* we demonstrated that better walking performance was associated with increasing independence from mass flexion and extension coactivation patterns. This recently published (2010) work has quickly become influential as a clinical example of the important insights available with cutting-edge muscle

synergy analysis approaches. Additional measurements we have developed include foot placement in a body-centered reference frame and a measure of dynamic balance based on changes in frontal plane angular momentum (both presented in *Gait & Posture*).

a. Bowden MG, Balasubramanian CK, Neptune RR, **Kautz SA**. Anterior-posterior ground reaction forces as a measure of paretic leg contribution in hemiparetic walking. *Stroke*. 2006; 37(3): 872-76.
b. Bowden MG, Clark DJ, **Kautz SA**. Evaluation of abnormal synergy patterns poststroke: relationship of the Fugl-Meyer Assessment to hemiparetic locomotion. *Neurorehabil Neural Repair*. 2010; 24(4): 328-37.
c. Clark DJ, Neptune RR, Ting LH, Zajac FE and **Kautz SA.** Merging of health motor modules predicts reduced locomotor performance and muscle coordination complexity post-stroke. *J Neurophysiol.* 2010; **103**(2): 844-57. PMCID: PMC2822696.
d. Nott CR, Neptune RR, **Kautz SA**. Relationships between frontal-plane angular momentum and clinical balance measures during post-stroke hemiparetic walking. *Gait Posture*. 2014; 39(1): 129-34. PMCID: PMC3823741.

Complete List of Published Work in MyBibliography:
http://www.ncbi.nlm.nih.gov/sites/myncbi/steven.kautz.1/bibliography/41148010/public/?sort=date&direction=ascending

D. Research Support

Ongoing

P2C HD086844 Kautz (PI) 09/15/15-06/30/20
NIH/NICHD
National Center of Neuromodulation for Rehabilitation (NC NM4R)
This center is one of six NIH-funded Centers within the NIH Rehabilitation Research Infrastructure Network. This grant established this center to advance the science of neuromodulation as applied to rehabilitation in the United States. The overarching goal is to exert a sustained, powerful influence on the research field of NM4R. We seek to fulfill that goal through translational activities and programming to achieve the following specific aims: 1. Train researchers in NM4R; 2. Provide scientific programming in NM4R; 3. Develop a research community in NM4R; and 4. Advance the field of NM4R. We seek to achieve these aims through several components: a) Promotion and Dissemination, which provides workshops, seminars, scientific programming and technical briefs; b) Collaborative Opportunities, which allows investigators to obtain expert consulting and in-person hands-on training; c) Pilot Studies, which provides funding for NM4R research; and d) Tech Development, which provides new scientific findings and new methodologies to advance the field of NM4R.
Role: PD/PI of Center, Leader of the Collaborative Opportunities Component

P20 GM109040 Kautz (PI) 06/02/14-03/31/19
NIH/NIGMS
South Carolina Research Center for Recovery from Stroke
This center grant establishes a research center in recovery from stroke. It provides mentored research projects for five junior faculty members and establishes four fully staffed full service scientific core resources to support stroke recovery research: 1) the Quantitative Behavioral Assessment and Rehabilitation (QBAR) Core provides resources for kinematic, kinetic, EMG and metabolic cost assessments and rehabilitation protocols; 2) the Brain Stimulation Core provides TMS-based neurophysiological assessments and supports rTMS and tDCS protocols for rehabilitation; 3) the Neuroimaging Core provides structural and functional MRI and MR spectroscopy analyses; and 4) the Clinical and Translational Tools and Resources Core provides subject recruitment resources, a bioinformatics-enabled subject registry and database, and biostatistical support. In addition, all cores provide regular mentoring programs and the center sponsors regular seminars in stroke recovery research as well as a competitive pilot projects program.
Role: PD/PI of Center, Director of QBAR Core

U54 GM10494 Binder-MacLeod (PI); Kautz (Site PI) 09/25/13-05/31/18
NIH/NIGMS
Delaware Clinical and Translational Research Program (DE-CTR)
The overall goal the Delaware CTR is to provide a research infrastructure for clinical and translational

research. MUSC is the out-of-state participant in a Delaware consortium. The objective of this infrastructure grant is to establish new collaborative research relationships between investigators from MUSC and the University of Delaware.
Role: Site PI

A9272S Kautz (PI) 10/01/14-09/30/19
VA Research Career Scientist Award
VA Rehabilitation R&D Service
The Research Career Scientist Award is conferred to non-clinician scientists by appointment in recognition of outstanding achievements and contributions to VA research. It is one of the highest achievements in the VA peer-reviewed research system. The award pays my complete VA salary so I can perform my VA research at no charge to individual grants. No scientific effort is directly tied to this project. The major goal is to develop, enhance and perform rehabilitation research.
Role: PI/Awardee

Completed
12 IRG 9430057 Kautz (PI) 01/01/12-12/31/14
American Heart Association
Do Spinal and Cortical tDCS Suggest Distinct and Synergistic Neuromechanical Mechanisms for Post-stroke Walking Recovery?
This is an AHA Innovative Research Grant. In Yr 1 this project compares different electrode configurations for cortical tDCS for effectiveness during a locomotor training session post stroke. In Yr 2 it tests cortical, spinal, combined and sham tDCS during a locomotor training session post-stroke.
Role: Principal Investigator

UL1 TR000062 Brady (PI) 07/14/09-06/30/14
NIH/NCATS
South Carolina Clinical & Translational Research Institute (SCTR)
The goal of this institutional Clinical and Translational Science Award (CTSA) is to create a sustainable home at MUSC to advance clinical and translational research as a distinct discipline and facilitate collaboration across multiple disciplines. Dr. Kautz leads the Novel Clinical & Translational Methodologies Program and is PI of a pilot project laying the groundwork for a large-scale stroke data repository (Comprehensive Stroke Clinical, Biological, Physical & Occupational Therapy Data Repository Pilot Project).
Role: Leader, Novel Clinical & Translational Methodologies Program; Leader, Stroke STOR Pilot Project

A6776S Kautz (PI) 01/01/09-12/31/13
VA Rehabilitation R&D Service
VA Research Career Scientist Award
The Research Career Scientist Award is conferred to non-clinician scientists by appointment in recognition of outstanding achievements and contributions to VA research.
Role: PI/Awardee

Clinical Trial Kautz (Co-PI); Feng (Co-PI) 09/15/11-12/31/12
Innovative Neurotronics
Randomized Trial of the Innovative Neurotronics WalkAide Compared to Conventional Ankle-Foot Orthosis in Stroke Patients (INSTRIDE)
This clinical trial tests the WalkAide (a functional electrical stimulation based device to control foot drop) versus an ankle-foot orthotic, which is the current standard of care for those with foot drop after stroke.
Role: Co-Principal Investigator