NUPOC NEWS

The official newsletter of the Northwestern University Prosthetics-Orthotics Center



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Student Success

The MPO Class of 2026 has successfully completed both their Lower Limb Prosthetics and Lower Limb Orthotics sessions and are now beginning their Upper Limb Prosthetics and Orthotics coursework. Meanwhile, the MPO Class of 2027 has wrapped up their first session and is diving into session two—keep up the great work!

Faculty & Staff Achievements

We're proud to share several faculty recognitions this month.

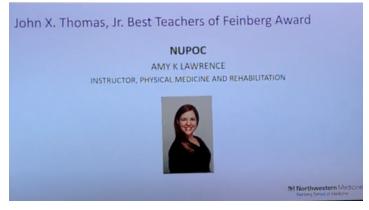
Amy Lawrence, PTA, MSPO, CPO, has been selected as a recipient of the John X. Thomas Jr. Award (Best Teachers of Feinberg Award), one of the highest honors for teaching excellence at the Feinberg School of Medicine. This award recognizes faculty who demonstrate exceptional dedication, innovation, and effectiveness in medical education. Previous recipients include NUPOC's own Matthew Major, John Brinkmann, and Chris Robinson.

Chris Robinson has been formally recognized as a Full Member of the Feinberg Academy of Medical Educators (FAME). FAME membership honors faculty who contribute to educational excellence and innovation across Feinberg. Chris joins **Mike Cavanaugh** and **Mindy Thrope** as the only other core MPO O&P faculty members currently part of FAME.

Congratulations to Amy and Chris for their continued leadership and dedication to advancing prosthetics and orthotics education at Feinberg!



Michael L. Cavanaugh, MSHI, CPO, NUPOC Director of Education, presenting Amy Lawrence, PTA, MSPO, CPO with the John X. Thomas, Jr Best Teachers of Feinberg Award



Amy Lawrence, PTA, MSPO, CPO receiving the John X. Thomas, Jr Best Teachers of Feinberg Award

Research Publications

Dr. Matthew Major continues to advance the understanding of biomechanics, rehabilitation engineering, and assistive technology through interdisciplinary research. His recent work explores topics such as gait dynamics, prosthetic design, neural and muscular adaptation, and user-centered device development. Below is a selection of recent publications featuring Dr. Major, reflecting NUPOC's ongoing commitment to evidence-based innovation in prosthetics and orthotics research.

Monteiro A, Major MJ, Fey NP. Transtibial limb loss influences muscle excitation, 3D dynamic balance, and their cross-sectional correlation in older individuals during walking. Clinical Biomechanics, 2025; ePub.

Hoegberg Z, Donahue S, Major MJ. An Open-Source Wearable System for Real-Time Human Biomechanical Analysis. Sensors, 2025, 25, 2931.

Murphy J, et al. Estimating the Replicability of Sports and Exercise Science Research. Sports Medicine. 2025, Jun 16. Epub ahead of print.

Jenz M, Garcia-Casal A, Shalom YB, Elwin ML, Major MJ. Design and Control of an Actuated Prosthetic Elbow to Restore Arm Swing for Persons with Upper Limb Absence. IEEE Int Conf Rehabil Robot. 2025:730-735.

Monteiro AS, Major MJ, Fey NP. Causal Inference Predicts that Muscle Excitation is Both a Contributor and Response to Frontal Plane Dynamic Balance During Gait of Older Individuals With and Without Transtibial Amputation. IEEE Int Conf Rehabil Robot. 2025:413-418.

Miri S, Jacobson M, Major MJ, Kim M. Day-To-Day User Adaptation to a Robotic Ankle-Foot Prosthesis. IEEE Int Conf Rehabil Robot. 2025:1617-1622.

Rosenblatt NJ, Schneider KL, Miller SA, Hagopian K, Hagg S, Reddin C, Churchill R, Dams GM, Calamari JE, Stachowiak A, Major MJ. Mixed methods analysis of an interdisciplinary intervention to promote balance confidence in lower limb prosthesis users. Frontiers in Rehabilitation Sciences, 2025; 6.

Zavaleta JL, Major MJ, Fatone S, Pankaj P. Mechanical stimulation in the residual femur during gait in transfemoral prosthesis users provides a potential reason for bone mineral density loss. International Journal for Numerical Methods in Biomedical Engineering, 2025; in press.

Research Publications

We're also proud to share recent publications from Steven A. Gard, PhD, Executive Director of NUPOC and Associate Professor of Physical Medicine & Rehabilitation. Dr. Gard's research continues to play a vital role in advancing scientific understanding of human gait, posture, and balance, particularly as they relate to individuals with lower limb amputation and mobility challenges. His work explores how biomechanics and assistive technology intersect to improve mobility, stability, and overall quality of life. Through extensive collaborations with researchers and clinicians around the world, Dr. Gard contributes to developing evidence-based insights that inform prosthetic and orthotic design, rehabilitation strategies, and clinical practice. His recent publications reflect NUPOC's ongoing commitment to research that bridges engineering innovation with patient-centered care, fostering progress in rehabilitation science and the broader field of human movement.

Nezhad ZG, Gard SA, Arazpour M (2025). The Effects of Hyperkyphosis on Balance and Fall Risk in Older Adults: A Systematic Review. Gait & Posture,118, 154-167.

Nezhad ZG, Gard SA, Arazpour M (2025). The Effects of Hyperkyphosis on Gait Parameters in Older Adults: A Systematic Review. Health Science Reports, 8(7), e70958.

Kristal A, Gaunaurd I, Kirk-Sanchez N, Gard S, Clark N, Da Silva E, Stieg F, Gailey R (2025). Spatiotemporal gait parameters influencing functional mobility of people with lower limb amputation. Prosthetics and Orthotics International (in press).

Arazpour M, Keshavarzi F, Gard SA (2025). The effects of virtual reality environment simulations on balance and gait rehabilitation in persons with lower extremity amputation. Prosthetics and Orthotics International (in press).

New at NUPOC



Jack Manning, PhD

Jack Manning is a postdoctoral fellow at NUPOC supported by the NU Pathophysiology & Rehabilitation of Neural Dysfunction (PRND) Training Grant (T32), conducting research under the mentorship of Matty Major, PhD, and Keith Gordon, PhD (NU Department of Physical Therapy & Human Movement Sciences) on the neuromechanical effects of Long-COVID. He graduated with a PhD in Motor Neuroscience from Texas A&M University where he investigated the neural control of human walking. His doctoral research examined how functional brain connectivity relates to the ability to perform cognitive tasks during walking, providing insight into the neural mechanisms that support adaptive motor control. Building on this foundation in basic neuroscience, Jack's career goal is to bridge the gap between research and clinical practice by developing translational approaches for the detection and rehabilitation of movement disorders, and he is very excited to be joining the team at NUPOC.



Sara Del Chicca, PhD Candidate

Sara Del Chicca is a visiting doctoral researcher at NUPOC from Politecnico di Milano, where she is pursuing a PhD in Mechanical Engineering. Her research focuses on developing monitoring systems to evaluate the performance of prosthetic feet throughout their life cycle. By using fiber Bragg grating (FBG) sensors, Sara's work aims to identify subtle variations in a prosthesis's mechanical response that may influence user biomechanics over time. Her studies combine laboratory testing and clinical trials to create more objective methods for assessing prosthetic function and durability.

New at NUPOC

Ria Bakshi

Ria, a senior at the Illinois Mathematics and Science Academy (IMSA), is investigating how post-stroke changes in walking patterns impact knee joint health. Now in her second year with us, Ria continues to bring curiosity and dedication to her research, contributing valuable insights to the field of rehabilitation science.

Dhivya Dharshne Kamaraj

Dhivya, a junior at IMSA, recently joined NUPOC and is diving into research on how impaired muscle control affects mobility in individuals post-stroke. We're excited to have her on board and look forward to the fresh perspective she brings to the team.

Anastasia Nagenrauft

Anastasia is an undergraduate student pursuing a Bachelor's degree in Biomimetics at the University of Applied Sciences in Bremen, Germany. She is completing her overseas internship at NUPOC under the mentorship of Dr. Matthew Major, working on lower-limb prosthetics projects. Anastasia will be with us through January 2026.

Dhivija Challa

Dhivija, a senior at IMSA, is participating in the Student Inquiry and Research (SIR) program. She is working with Dr. Steve Gard on a project exploring how prosthetic foot-ankle stiffness affects standing and walking performance in transfemoral prosthesis users. Dhivija is especially interested in how subtle changes in gait timing and symmetry can significantly impact daily mobility.

Aparna Sadhanagiri

Aparna, also a senior at IMSA and SIR program participant, was drawn to NUPOC's research through her interest in biomechanics and biomedical engineering. She is working with Dr. Steve Gard to study how a new commercially available prosthetic ankle joint influences standing and walking performance in transtibial prosthesis users.

Prosthetic Management for Therapy Professionals Fall 2025

NUPOC successfully hosted the Fall 2025 Prosthetic Management for Therapy Professionals course from October 6 to 8. This intensive three-day event brought together rehabilitation professionals from across the country for interactive lectures, live patient demonstrations, and collaborative discussions on prosthetic care. Participants gained hands-on experience in gait training, prosthetic prescription development, and functional rehabilitation for individuals with both upper and lower limb amputations.

Building on the success of this session, NUPOC is preparing for the Spring 2026 Prosthetics-Orthotics for Physicians and Therapists course. This four-day program will expand on the principles covered in the fall course, with additional emphasis on orthotic management and interdisciplinary clinical care.



From left to right: **Michael Socie**, MSPO, CPO/L - Shirley Ryan Ability Lab Prosthetist/Orthotist, **Kevin Ward** - NUPOC Model Demonstrator, **Kristi Turner**, DHS, OTR/L - Shirley Ryan Ability Lab - Clinical and Research Occupational Therapist

We're proud to share that five members of the Northwestern University Prosthetics-Orthotics Center (NUPOC) community participated in the Annual Lewis Landsberg Research Day on September 11, 2025.

This campuswide Feinberg School of Medicine event brings together faculty, staff, students, and trainees from across Northwestern to celebrate scientific discovery and collaboration. Research Day serves as a public forum for presenting current findings, exchanging ideas, and engaging in dialogue that strengthens the broader research community.

Poster sessions began at 2:15 p.m. across three campus locations, including the Simpson Querrey Biomedical Research Center, Robert H. Lurie Medical Research Center, and the Northwestern Memorial Hospital Feinberg Pavilion, where participants showcased innovative work in clinical, basic, and translational sciences.

NUPOC was proudly represented by:

Paul Hammond II, MS – Research Engineer

Sudeesh Subramanian, PhD – Postdoctoral Scholar

Paige Paulus, PT, DPT, PhD – Postdoctoral Scholar

Kiley Armstrong, MS, MPO, CPO – Research Prosthetist-Orthotist

Delaney Clawson – Biomedical Engineering Graduate Student



Paul Hammond II at Lewis Landsberg Research Day



ELEVATED VACUUM INTEGRATED SYSTEM (ELVIS): AN ELECTRO-MECHANICAL PUMP FOR VACUUM-ASSISTED SUSPENSION

Paul Hammond II¹, Ryan Caldwell^{2,3}, Andrew H Hansen^{4,5}, Greg Voss⁴, Stuart Fairhurst⁴, Delaney Clawson⁶, Matthew J Major^{1,3}

¹Jesse Brown VA Medical Center, Hanger Clinic, ³Northwestern University, ⁴Minneapolis VA, ⁵University of Minnesota, ⁶Vanderbilt University email: paul.hammond@northwestern.edu, web: http://www.nupoc.northwestern.edu



Introduction

- Vacuum Assisted Suspension (VAS) systems have demonstrated benefits to residual limb health and user mobility. [ii][2]
- Available commercial VAS systems are either mechanical or electrical
- Electrical pumps can be noisy and mechanical pumps struggle to maintain suction while stationary
- ELVIS is an innovative electro-mechanical pump that combines the advantages of both systems while mitigating their respective drawbacks. [3]
- Electrical system creates initial vacuum and the mechanical maintains pressure level while walking
- AIM1: Bench test to validate ELVIS's capabilities
 AIM2: Human subject tests to evaluate ELVIS's performand on individuals with lower limb loss

Methods and Analysis

Bench Testing Protocol

- Testing ELVIS's ability to generate vacuum in 5 canisters of known volumes [2]
- Mechanical Pump
- Cyclical compression of 5.5 mm at a rate of 23 mm/sec
- o 10 trials of 300 cycles





Activated and run until -17

Electrical Pump

Bench Test Outcomes

- Mechanical System
- Electrical System
- Cycles to -12 inHg Pressure
- Time to -17 inHg Pressure

Human Subject Testing Protocol

- ELVIS activated with participants standing until -20 to -21 inHg socket pressure
- Participants walked for 5 minutes while socket pressure collected at 1Hz
- 5 walking trials with the mechanical system engaged / 2 trials with the mechanical system locked (preventing opening and closing of the hinge)

Human Subject Testing Outcomes

- o Initial: minimum pressure (max vacuum) achieved and time to reach min pressure
- Walking: minimum and maximum pressure recorded

o 12 participant / 5 transfemor

Participants

- 12 participants (4f/8m, 54.4±17.7 years, 90.8±14.2 kg, 7 transtibial / 5 transfemoral amputation)
- Study Approved by the Jesse Brown VA Medical Center IRB.

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[3] Major MJ. J Med Dev. 9, 0445041-4, 1995.

Results

Bench Testing

The to -C I links

Washering and Design Shill Washer

Treadmill Walking

Man Minimum Pressure During Militial Vacuum

Treadmill Walking

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- ELVIS performed comparably to commercial electrical VAS systems when initially generating vacuum [4].
- ELVIS hybrid approach allowed the mechanical system to maintain and enhance vacuum during walking.

Acknowledgements

Funded by US Department of Veterans Affairs Merit Award (RX003090). Content does not reflect that of the US Department of Veterans Affairs or US Govt.



A PARAMETRIC NUMERICAL PLATFORM TO ANALYZE AND OPTIMIZE THE ENERGY ABSORPTION MECHANICS OF TRANSTIBIAL PROSTHESES TO SUPPORT USER MUSCULOSKELETAL HEALTH

Sudeesh Subramanian¹, Trevor Kingsbury², Kota Z. Takahashi³, Matthew J. Major^{1,4}

¹ Northwestern University, Chicago, IL; ²Naval Medical Center San Diego, CA; ³University of Utah, Salt Lake City, UT; ⁴Jesse Brown VA Medical Center, Chicago, IL Email: sudeesh.subramanian@northwestern.edu, web: http://www.nupoc.northwestern.edu

- Impact force absorption and optimized energy return of prosthetic components are crucial for promoting
 efficient gait and reducing secondary musculoskeletal health risks of prosthetic leg users [1].
- Previous research [2-4] focused on the in-vivo effects of commercial components with discrete stiffness-damping settings on prosthetic energy dissipation.
- · Individuals may require task-specific stiffness-damping that fixed, commercially available settings cannot offer.
- Fully mapping relationships between prosthesis viscoelastic properties and user performance outcomes are essential to better optimize prosthetic legs through device design and clinical prescription.

Aim: Develop a parametric numerical platform to analyze and optimize the viscoelastic characteristics of prosthetic legs.

METHODS METHODOLOGICAL FRAMEWORK CLINICAL TRIALS NUMERICAL SIMULATIONS Participants: Six unilateral tr > Age: 55 ± 13 yrs; > Mass: 82 ± 15 kg: 20 80 Biped leg model of transtibial prosthesis user comprising eight SA Avace * SA Pylon nput motions: Pelvis and joint rotations (gait speed 1.3-1.5m/s) Foot ground contact model: 10 spring-dampers along the plantar surface of each foot Four configurations of commen prostheses (SA: Shock Absorpti Optimization: Minimize error between experimental and simulated vertical ground reaction force (vGRF) by optimizing ground contact point location and stiffness-damping coefficients. Data collected with a 12-camera motion capture system with six force plates.

essed using Visual3D (HAS-

FOOT-GROUND CONTACT

DYNAMICS OPTIMIZATION Simulations Participant-1 Participant-2 pre 1.7m - Vergne 55-Reg (Height 1.67m - Vergne 66 % Stance Phase % Stance Phase — No Stance Phase — Spor areas and place (, 200 mins, c, 2 mins) — 1, 20 mins, c, 2 mins (, 200 mins, c, 2 mins) — 1, 20 mins, c, 0 mins (, 2 mins) % Stance Phase Comparing vGRF of simulations wi corresponding experimental trials -RMSE ranged from 0.46 to 1 N/kg.

Maximum error was as low as 0.3 N/kg N Stance Phone

compliance (k, and c,)
Lower pylon and ankle stiffness reduces vGRF loading rate but increased 1st peak vGRF is more sensitive to ankle stiff than the pylon stiffness. ined effects of pylon and ankle compliance

EFFECTS OF PROSTHESIS VISCOELASTIC PROPERTIES

20 40 50 50 % Stance Phase

- Higher 1st peak vGRFs with Higher 1* peak VGRFs with compliant (shock-absorbing) pylon compared to rigid pylon and solid ankle condition.
- Average walking speed slightly decreased with the compliant pylon, indicating a compensatory strategy that ultimately reduced peak vGRFs.

DISCUSSION

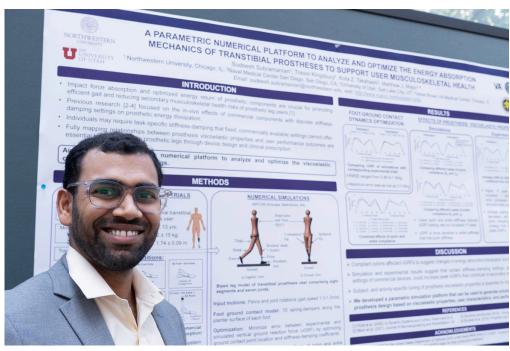
- > Compliant pylons affected vGRFs to suggest changes in energy absorption/dissipation during prosthetic stance.
- Simulation and experimental results suggest that certain stiffness-damping settings, particularly those fixed settings of commercial devices, could increase peak vGRFs that contribute to secondary musculoskeletal injury.
- > Subject- and activity-specific tuning of prosthesis viscoelastic properties is essential for improving user outcomes
- We developed a parametric simulation platform that can be used to generate solution spaces to optimize prosthesis design based on viscoelastic properties, user characteristics, and performance activity.

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This work is supported by the United States Department of Defense (DoD) under Award #W81xWH-21-2-0007. Content does not reflect the views of the United Stated Government. Authors are grateful to the NUPOC team for their constructive feedback.

Kinematic data was process Motion, Inc., Ontario, Canada). M Northwestern Medicine



Sudeesh Subramanian at Lewis Landsberg Research Day and his poster

Analysis: Estimate the integration effects of pylon and ankle stiffness (*k* coefficient) and damping (*c* coefficient) on vGRFs.

Dynamic Balance Adaptations in Response to Unilateral Bound Arm Walking

Paige F. Paulus¹, Bradley Moore², Paul Hammond II³, Rebecca Stine³, Noah Rosenblatt⁴, and Matthew J. Major^{1,2,3}

Northwestern Univ Dept of Physical Medicine and Rehabilitation, Northwestern Univ Dept of Biomedical Engineering, Jesse Brown VA Medical Center, Rosaland Franklin Univ Dept of Podiatric Surgery and Applied Biomechanics

- · Persons with unilateral upper limb (UUL) loss are more affected by gait perturbations than healthy individuals1, which may contribute to their ncreased fall risk².
- Less is known about how UUL restriction (i.e., bracing, casting) affects perturbation recovery in healthy individuals.



Research Objectives

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- . This study assessed the influence of UUL restriction on reactive balance
- control and muscle activation in healthy persons.
 We hypothesized that individuals would experience a greater disturbance to dynamic balance when recovering from a gait perturbation with UUL restrictions compared to an unbound condition.

Methods

- . Ten able-bodied individuals (6M, 44±16 yrs, height: 1.8±0.1 m, weight:
- 84.4±17.0 kg) participated in this IRB approved study (NCT04274218).
 Participants completed two steady-state (self-selected (SS) speed and speed of perturbation (PS) trials) and ten perturbation trials per
- Gait perturbations were a symmetrical treadmill (Figure 1A).

 Gait perturbations were a symmetrical treadmill belt acceleration (6.5 m/s²) then deceleration at initial contact of a random step.
- Kinematic data were collected with a 12-camera motion capture system
- at 120 Hz and processed using Visual3D (Figure 18). EMG data from bilateral medial gastrocnemius, tibialis posterior deltoid were collected at 960 Hz (Figure 1C).
- Dynamic balance was evaluated using whole-body angular momentum range (H)^{1,3} during steady-state and perturbation recovery (Figure 1D). Muscle activation demands was evaluated using integrated EMG (iEMG)⁴
- (Figure 1E).
- Between condition differences were evaluated using paired t-tests in

EMG dt $[I_i\omega_i + r_ixm_iv_i$

Figure 1: Data collection and analysis workflow. Steady-state data were averaged over the middle 10 strides and perturbation data were calculated from the first 5 post-perturbation steps per trial.

during SS (p=0.01), PS (p<0.01) and when recovering from the gait perturbation (p=0.05) (Table 1).

Table 1: Average II in each plane across all trials. Bold indicates significance between conditions. SS: self-selected speed steady-state trials, PS: perturbation speed steady state trials, PT: perturbation recovery trials.

	ı	Jnboun	d	Bound				
	SS	PS	PT	SS	PS	PT		
Sagittal	.034	.039	.039	.033	.039	.038		
Frontal	.024	.030	.030	.026	.029	.030		
Transverse	.011	.014	.014	.013	.016	.015		

There were no significant sagittal or frontal plane differences (p>0.08). No significant differences in muscle activity were observed (p>0.09).

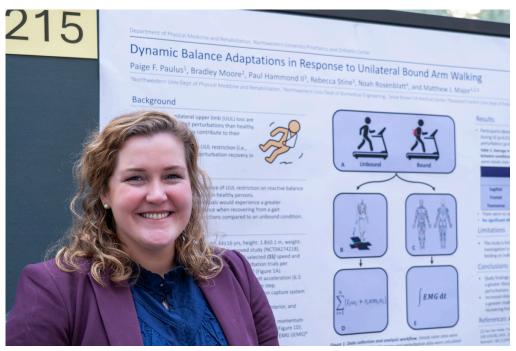
. The study is limited to the analysis of healthy individuals. Further investigation is needed to determine the influence of unilate binding on individuals with additional underlying conditions.

- Study findings partially support our hypothesis that UUL binding yields a greater disturbance to dynamic balance from unanticipated gait
- Increased disturbance was limited to the transverse plane, suggesting a greater challenge to regulating body spin and avoiding falls when recovering from trip-like perturbations.

References and Acknowledgements

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Supported by US Dept of Veterans Affairs (RXX03290). The contents do not represent the views of the U.S. Dept of Veterans Affairs or the United States Government.



Paige Paulus at Lewis Landsberg Research Day and her poster

Investigating Biases Among O&P Educators Toward People with Disabilities

Kiley Armstrong¹, Gloria Lee¹, Michael Cavanaugh¹, Whitney Doyle², Cody McDonald³, Roberto López-Rosado^{1,4}, Steven Gard^{1,5}

Background

- Orthotic and prosthetic (O&P) professionals primarily work with people with disabilities (PWD), making awareness of disability bias crucial for quality care. Bias-related discrimination across disability types can lead to psychological discrise, poorer health outcomes, and avcidance of medical treatment.¹³
 Explicit blasses are conscious beliefs and implicit blasses are unconscious, both of which
- Explicit bases are conscious beliefs and implicit biases are unconscious, both of which can affect dinician-patient interactions and healthcare contromes. Neatherace providers demonstrate low explicit base in high implicit bias. **However contromes. Neatherace providers demonstrate low explicit base in high implicit biases among U.S. DoR educators. This pilot study examined explicit in implicit biases among U.S. DoR educators acknowledging their, discussion may challenge or reinforce disability perceptions during training.** Education may challenge or reinforce disability perceptions.

Research Objectives

- The primary objectives of this pilot study were to:

 1. Assess explicit bias among QSP educators using the Symbolic Ablaism Scala (SAS). We hypothesized that QSP educators would demonstrate relatively low levels of explicit bias towards people with disabilities. **

 2. Assess implicit bias using the Dosality patrioties implicit Association Test (DA-IAT). We hypothesized that QSP educators would eshibit moderate to high levels of implicit bias toward people with disabilities. **

GOOD

Methods

Directors of each U.S. O&P graduate program were contacted and asked to share the study information with their educational faculty teaching ≥0.1 fulltime equivalent.

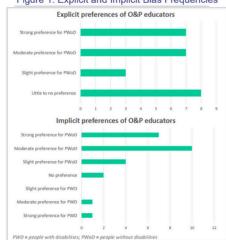
To achieve an effect size of 1.16, a priori power calculations determined a minim 8 participants should be included. One-way t-tests assessed whether implicit and explicit scores differed significantly from 0 (no bias).

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Table 1. Participant Demographics

Gender		Age (years)					Self-reported disability		Years in O&P			
Men	Women	25-34	35-44	45-54	55-64	65+	Yes	No	6-10	11-15	16-20	> 20
13	12	3	8	7	5	1	4	21	3	5	5	12

Figure 1. Explicit and Implicit Bias Frequencies





Data were collected from 25 participants. O&P educators' average explicit bias scores ranged from 0.12 to 0.60, with a mean of 0.33 (moderately prefer PVMO); 50 = 0.121, This score was significantly different than a mean score of 0 (no bias); (124) = 13.81, p.c.00.01, indicating an explicit preference for PVMO among O&P educators. The average implicit bias scores of O&P educators; ranged from -0.67 to 1.16, with a mean of 0.44 (moderate prejudice; 50 = 0.40). This score was significantly different from a mean of 0, 1749 | 5.47, p.c0.001, indicating an implicit preference for PVMO among O&P educators.

Limitations

Despite the a priori power calculations, findings are limited by a small sample size. Generalizability to the broader O.B.P field remains constrained, ruture studies should expand recruitment to include clinicians, residents, and students, and explored associations between bias scores and demographic categories such as age, gender, disability status, and years in the field.

Additionally, the implicit association test used in this study is limited in construct validity and test-retest reliability. A participant's results may reflect influence of extraneous factors, like cognitive load, fatigue, or familiarity with the test format. However, the IAT remains the best available tool to measure implicit attitudes.

Conclusions

Our findings partially supported our hypotheses; this study identified elevated levels of both explicit and implicit bias among O&P educators. These biases may shape studients' perceptions and potentially impact future care experiences for PVID. The results understoore the importance of implementing bias training for educational faculty and integrating abbies man disability studies into O&P curricults.

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Kiley Armstrong at Lewis Landsberg Research Day and her poster

Variable Impedance Prosthetic Ankle-Foot for Adaptive Walking in Persons with Lower Limb Loss



Delaney Clawson¹, Elizabeth Metzger², Matthew Elwin², Matthew J. Major^{1,2,3}

¹Department of Biomedical Engineering, Northwestern University, Evanston, IL, USA

²Department of Mechanical Engineering, Northwestern University, Evanston, IL, USA

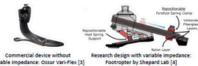
³Department of Physical Medicine & Rehabilitation, Northwestern University, Chicago, IL, USA

Northwestern ENGINEERING

Overview: Impedance of the ankle is important to activities of daily living. Here we present the design and mechanical testing of a spring-based variable impedance prosthetic ankle and future design advances.

Introduction

- Humans modulate the impedance (i.e., resistance to force) of the biological anklefoot complex to support stability and forward progression when ambulating across different scenarios, such as changes in speed, ramps, stairs [1]
- · An amputation above the ankle removes this key adaptive function for gait
- Only 3% of prescribed prosthetic ankle-feet have task adapting impedance [2]
 Without variable impedance: asymmetry, decreased walking speed, instability [1]
- · Variable impedance prosthetic ankle-feet are mainly limited to research purposes

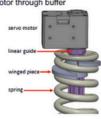


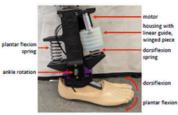
Slope walking without variable impedance ankle-foot

Project Aim: Design modular ankle device with variable impedance control

Initial Design

- · Two springs that compress independently during dorsiflexion and plantarflexion
- Servo motor rotates linear guide that moves winged piece along the spring controlling dorsiflexion movement to change the number of active coils
- Dorsiflexion stiffness is a function of the number of active coils
- Tiva Launchpad controlling rotary encoder, force-sensitive resistor, and servo motor through buffer





Initial Results

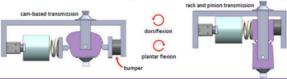
- Force-displacement measure with materials test system (Instron, Norwood, MA) to estimate impedance as a function of active coil number
- · Walking with simulator boot and changing impedance



Iterating Design

Goals of design improvements:

- Reduce build height → orient springs horizontally
- Rotation to linear motion → inclusion of a cam-based or rack and pinion transmission
- Approximate biological ankle impedance range → stiffer compression springs
- Reduce width → inclusion of bumper to set plantarflexion stiffness
- Electronics efficiency → new board, direct motor communication, single battery



References & Acknowledgements

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Delaney Clawson at Lewis Landsberg Research Day and her poster



Giving Opportunities

Donor support is essential to our continued success. Your gift can help support emerging researchers, P&O clinicians, and programs that will improve the lives of people who live with amputation or other physical impairments.

Contribute **online**. Or contact FSM Development (T: 312-503-2706)

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