Motion Assessments in Virtual Reality Environments

Lanna Klausing
Dr. Megan Reissman

University of Dayton
Department of Mechanical and Aerospace Engineering

Background and Motivation

- Typical rehabilitation for conditions of the upper extremities require reaching motions
  - Stroke[1]
  - Parkinson's[2]
  - Multiple Sclerosis[3]
- Less-Advanced VR has been previously evaluated as a rehabilitation tool
  - Wii-habilitation
  - Applied to stroke[1], MS[4], Parkinson's Disease[5]

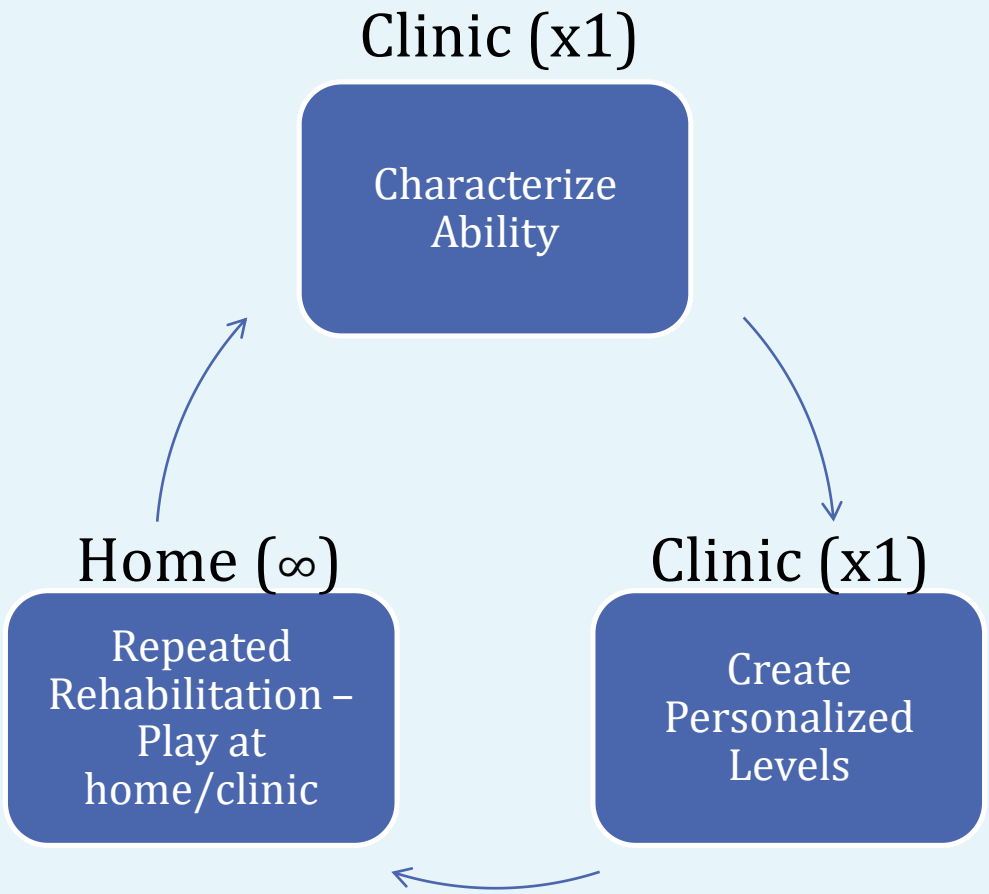
© Harvard Health

© Moss Rehab

Research Goal

Grand Challenges Scholars Program –

- Enhance Virtual Reality
- Engineer Better Medicines
- Advance health Informatics



Aspects of Movement

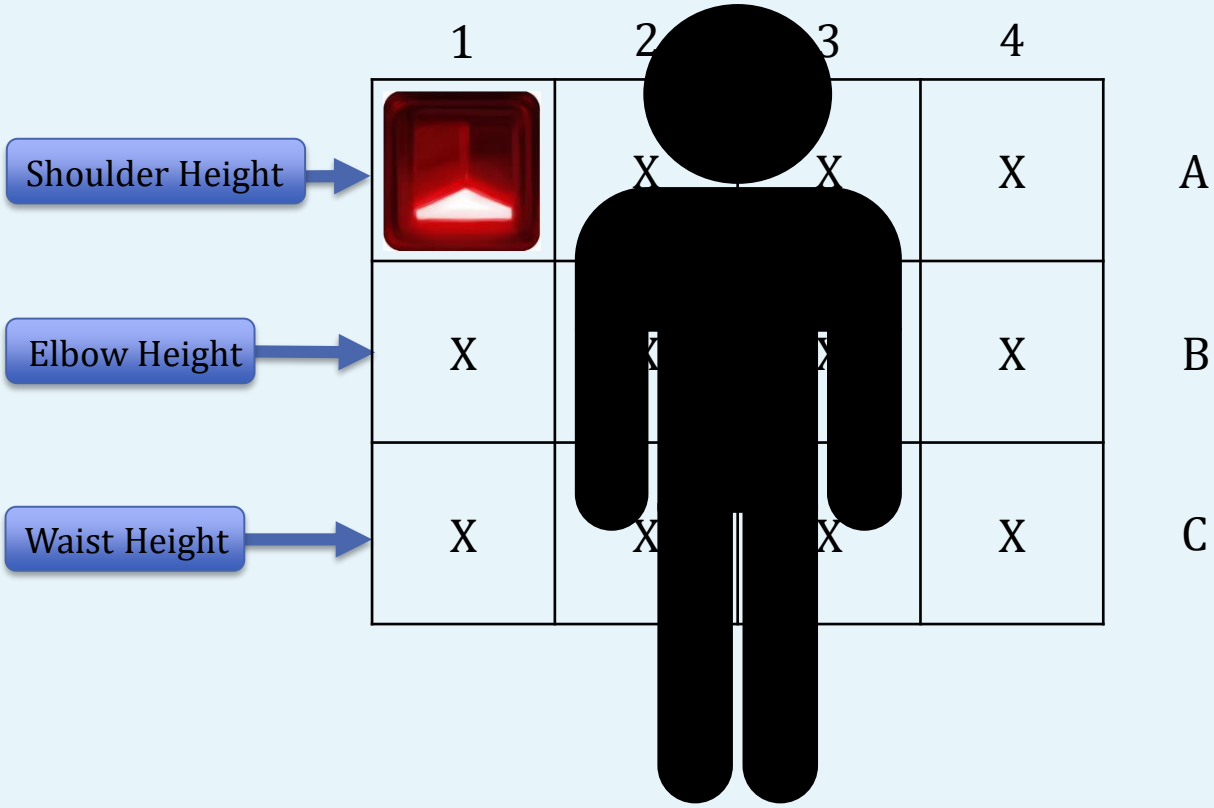
- Arm/hand used

Left (red) Right (blue)

- Direction of the movement

Left Down Up Right

Box Placement



Aspects of Movement

Unilateral (alternating)

One arm moves at a time

Bilateral (matching)

Both arms complete the same task

Bilateral (opposing)

One arm has the opposite direction task

Design of Experiment

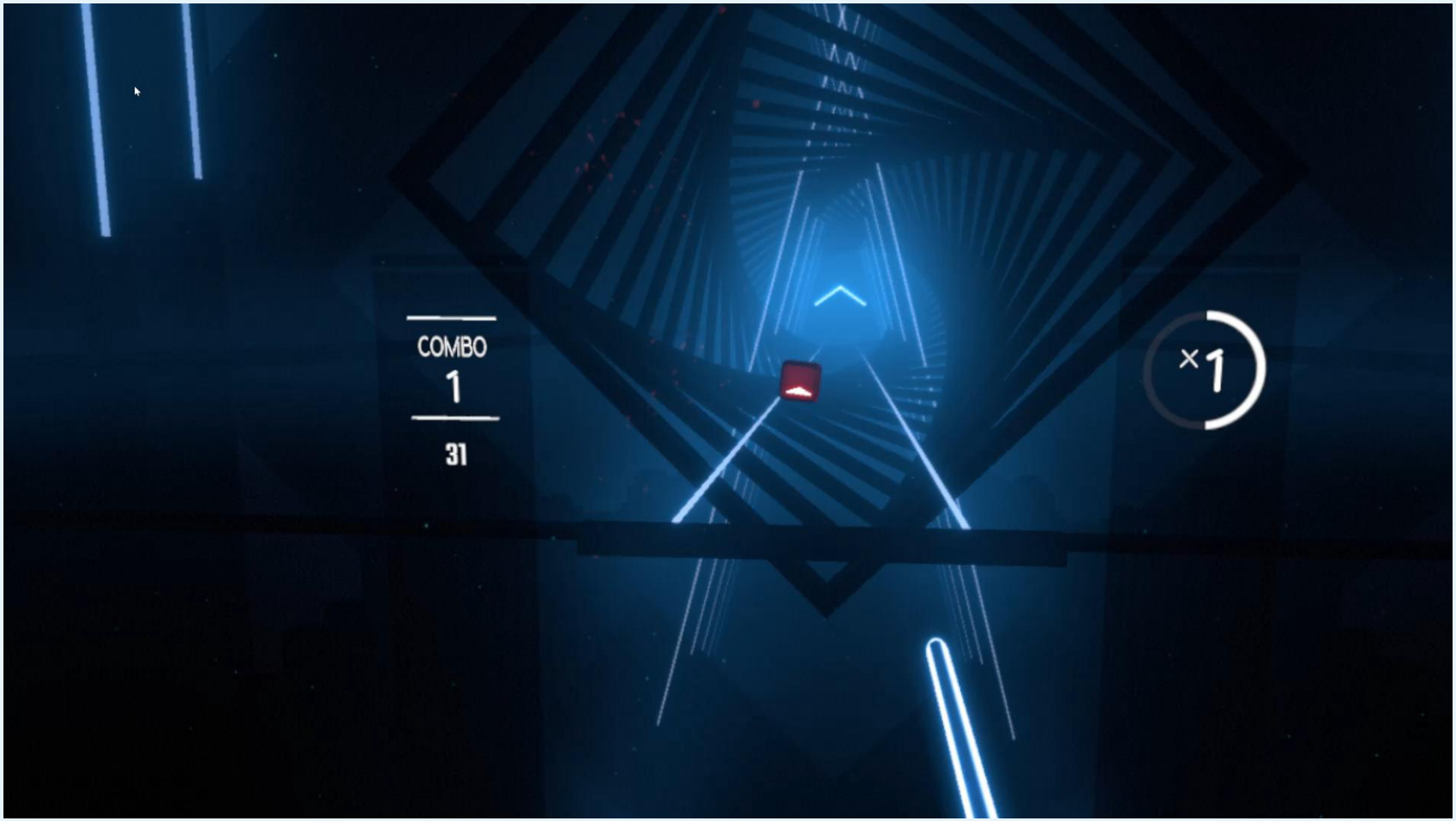
Factors	Levels		
Group	Control Group	Multiple Sclerosis	Parkinson's
Side	Left Side	Right Side	
Task Height	Shoulder Level	Elbow Level	
Task Type	Unilateral (alternating)	Bilateral (matched)	Bilateral (opposing)

Data Collection

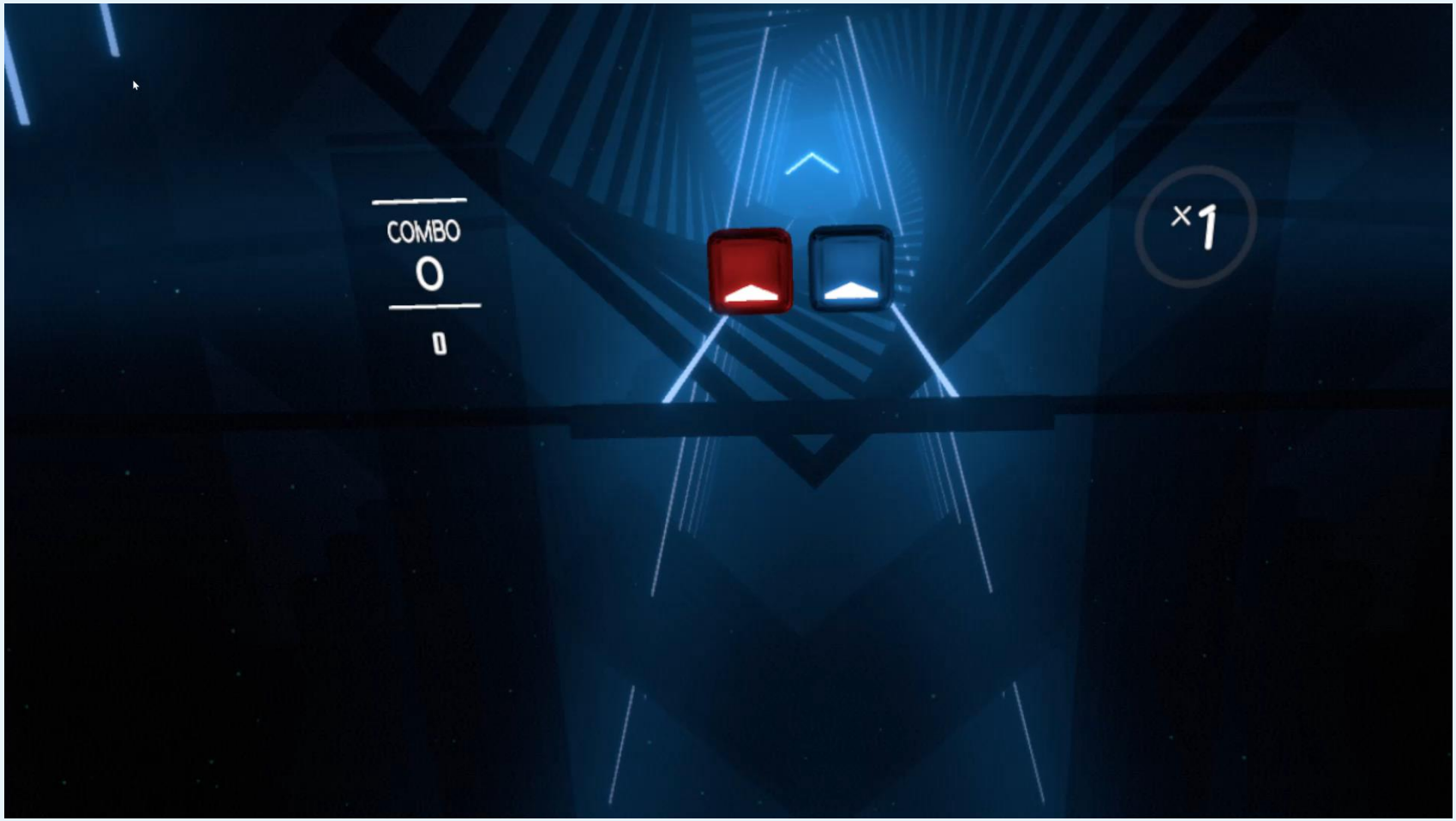
Xsens Awinda Motion Capture suit

HTC Vive Pro Virtual Reality System

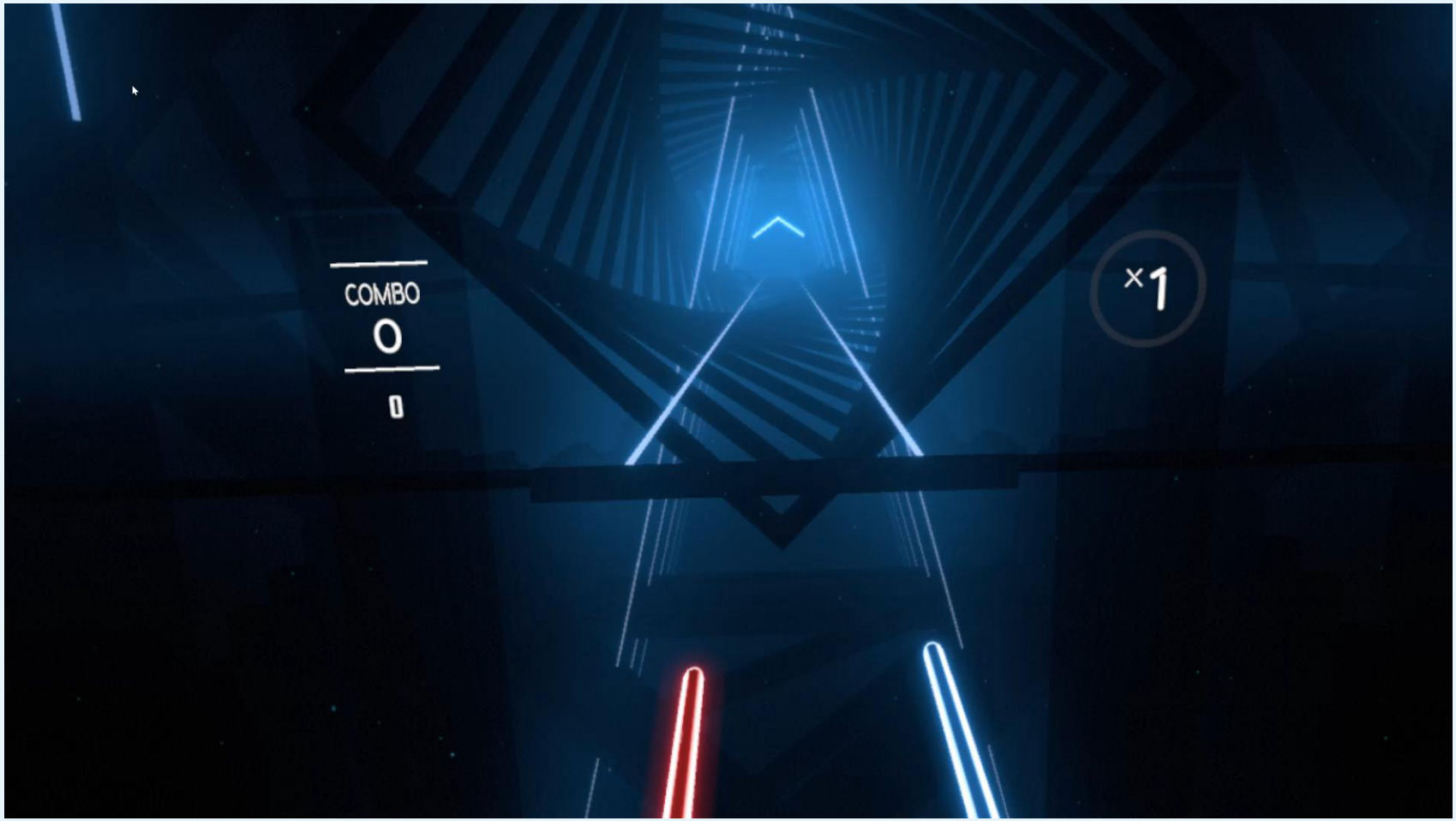
Unilateral (alternating) Level



Bilateral (matching) Level



Bilateral (opposing) Level

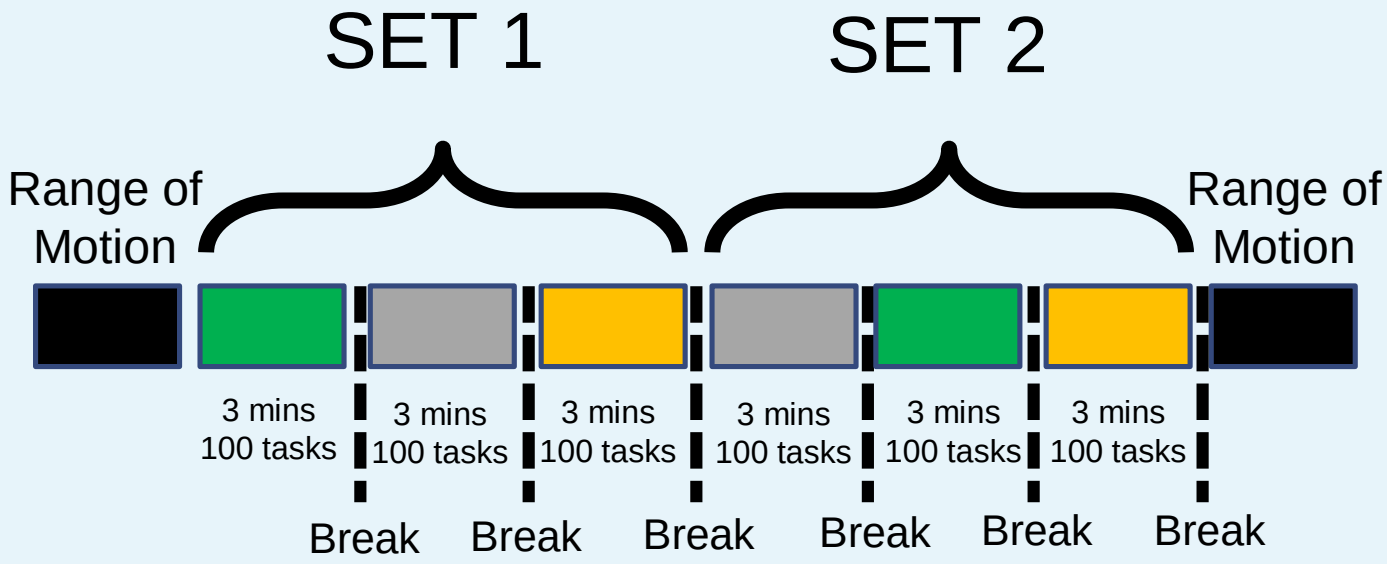


Protocol Timeline

Unilateral – One Hand

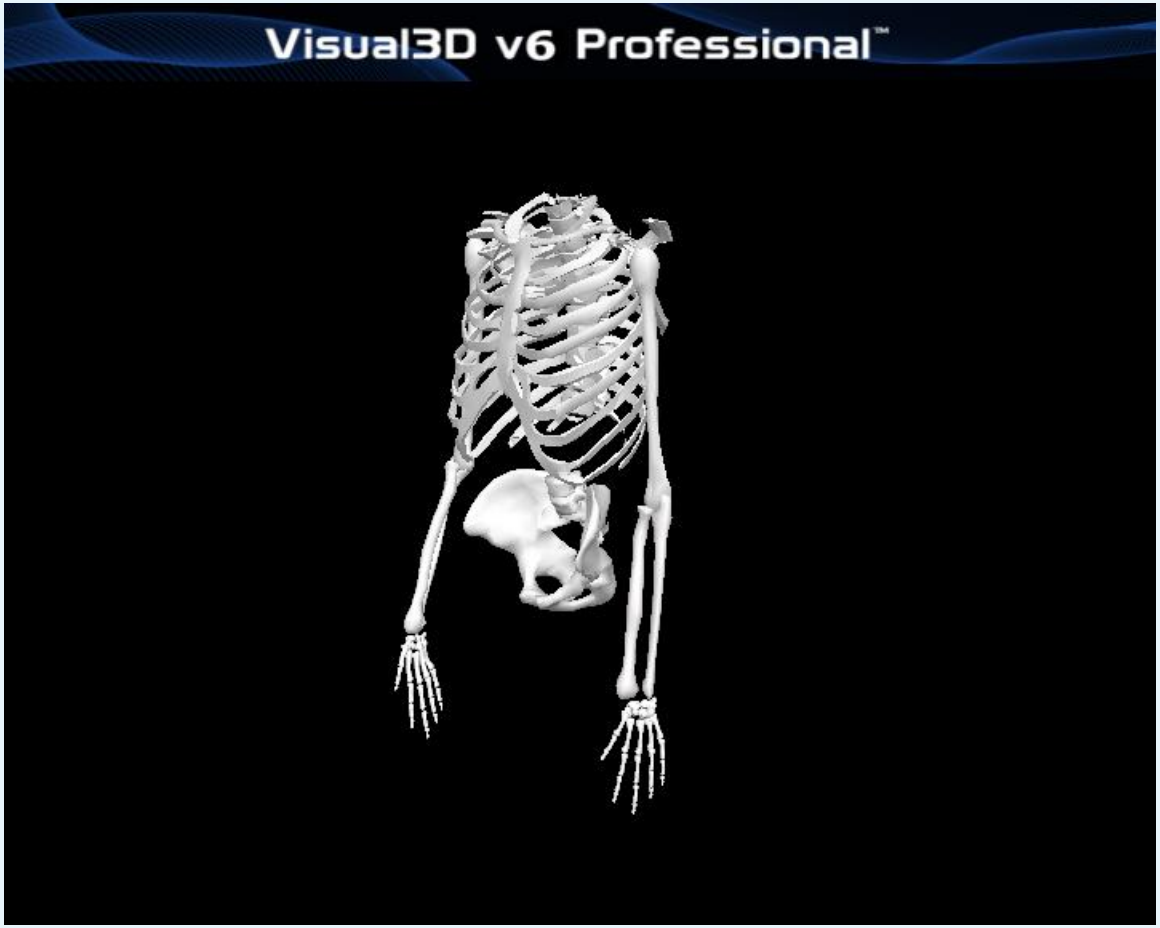
Bilateral – Both Hands, same direction

Bilateral – Both Hands, opposite direction



Protocols submitted to health and safety board (IRB), awaiting IRB approval

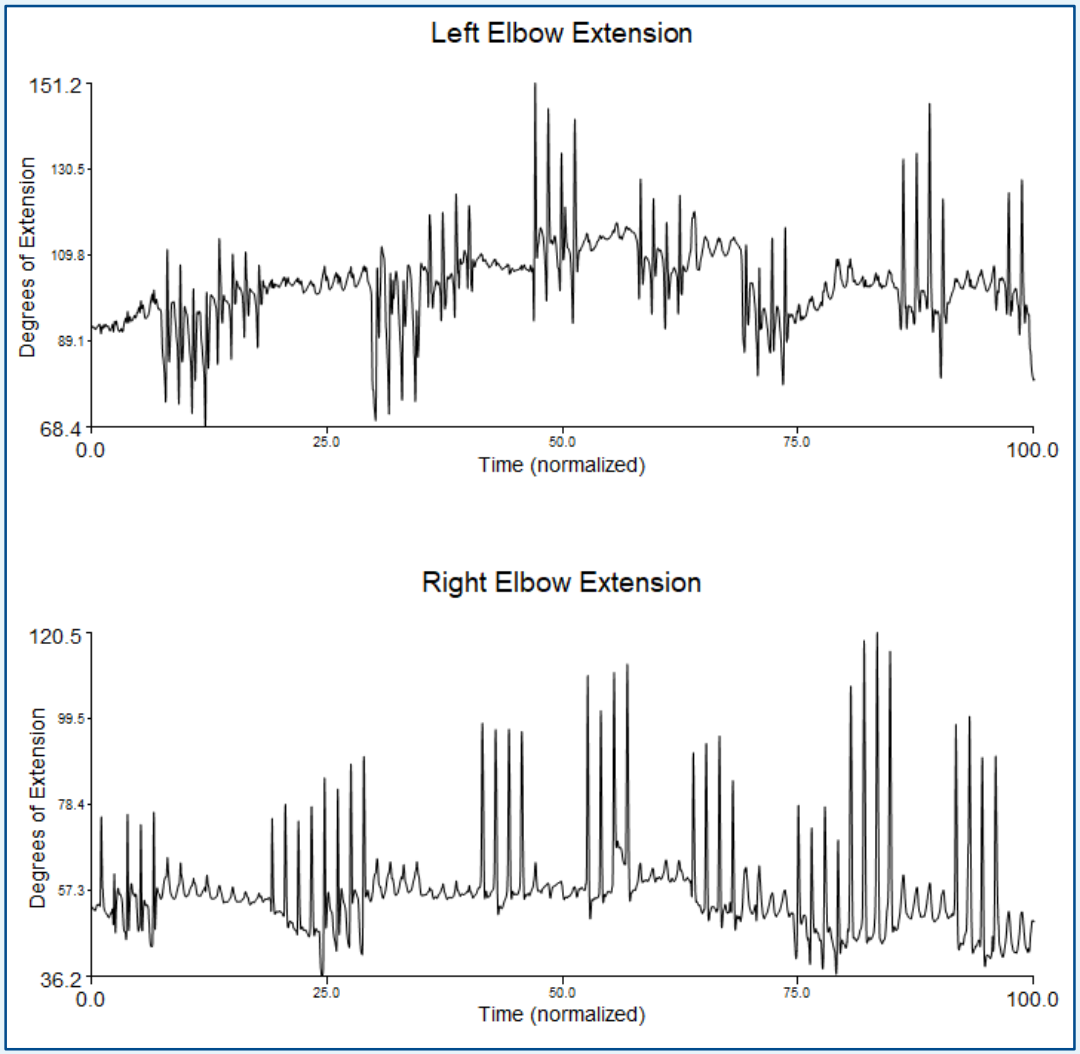
Data Visualization



Metrics

- Shoulder
  - range of motion and joint speed
- Elbow
- Wrist
- End Point – what the hand is doing

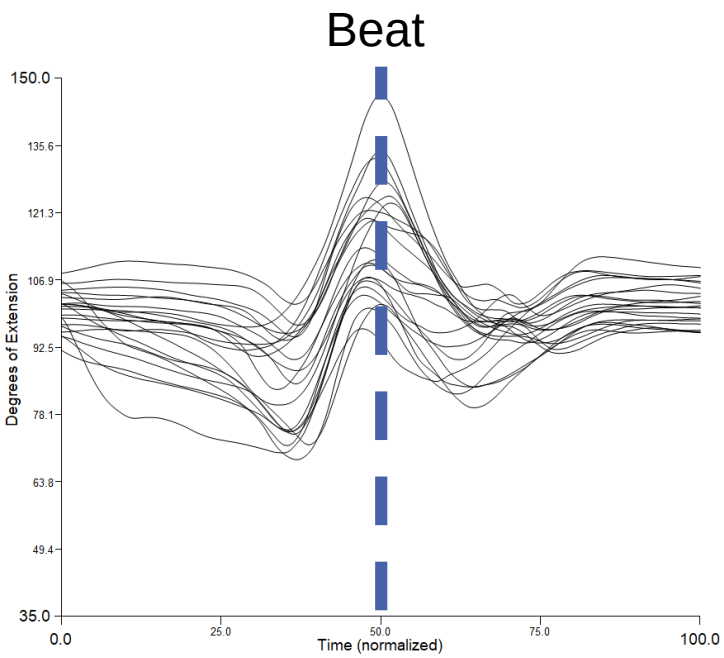
Unilateral Elbow Extension



180° Fully Straight

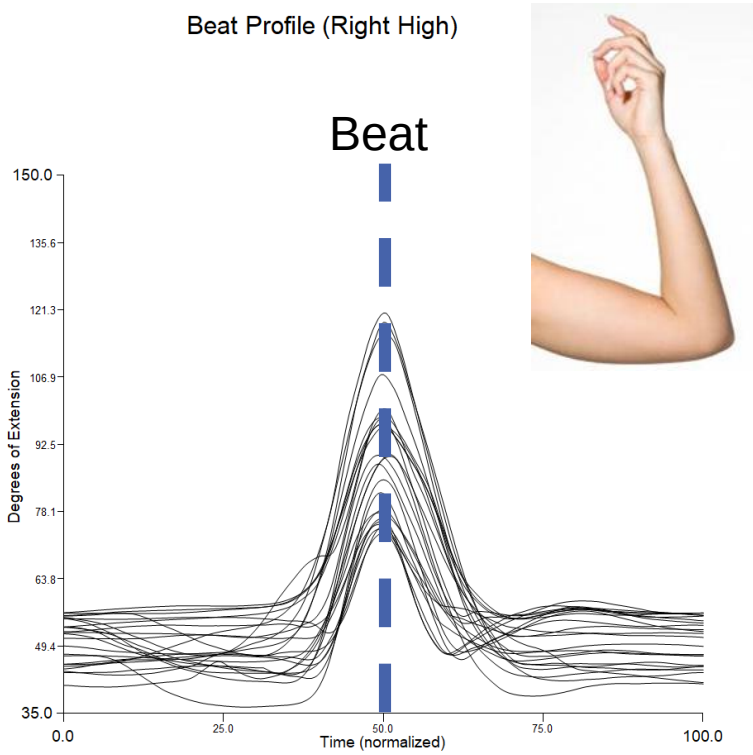
~80° Partially Bent

MS01 (Left Side Impaired)

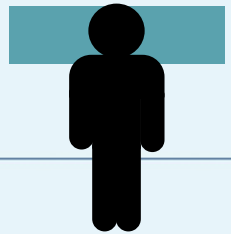


Impaired Side

University of Dayton page 2



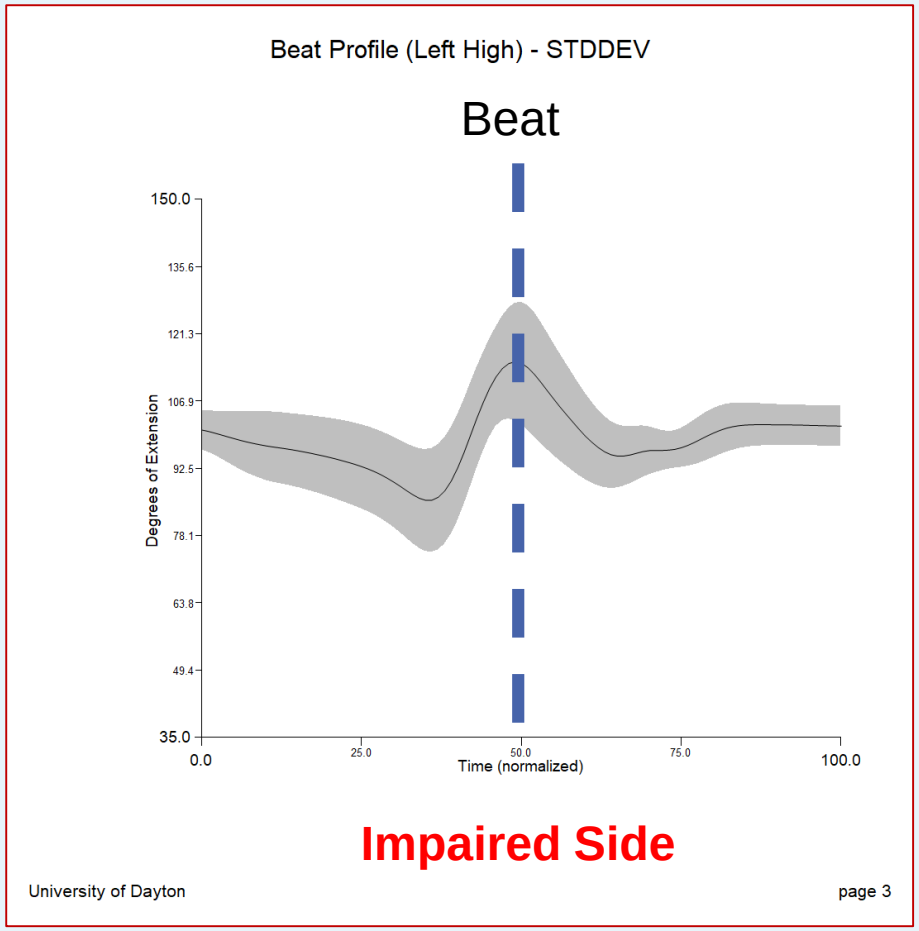
University of Dayton page 6

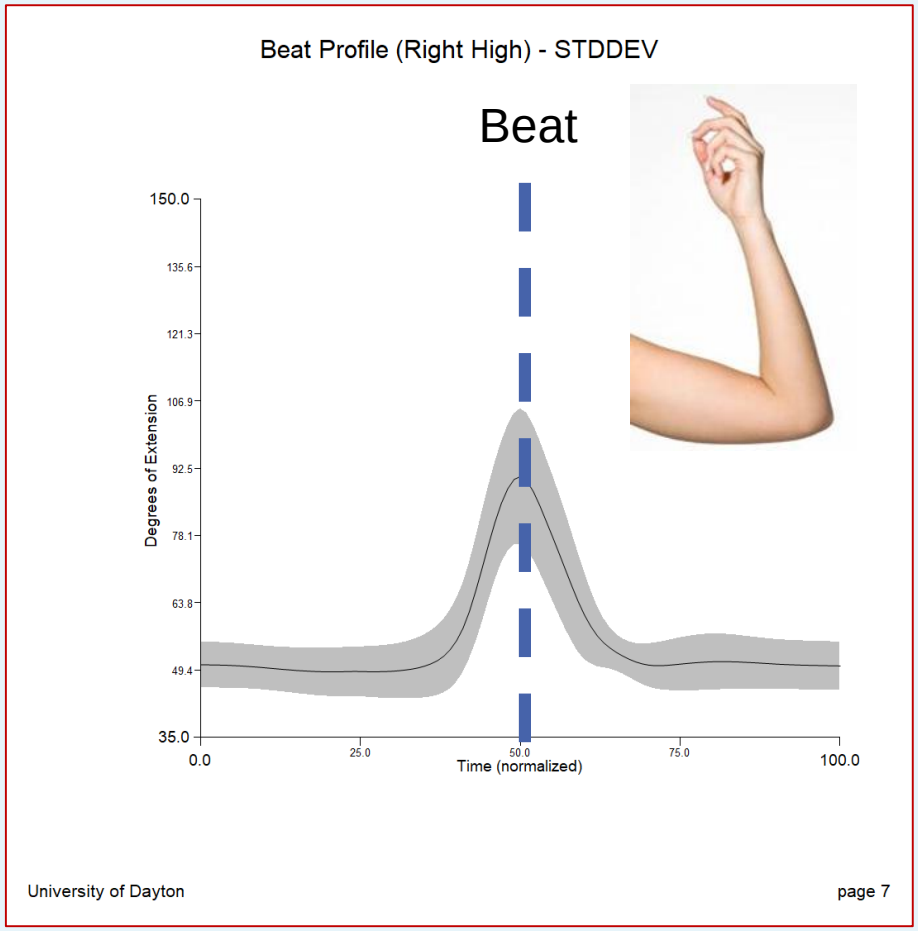


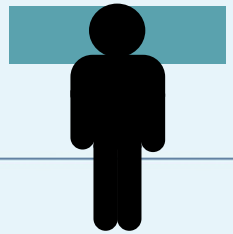
Shoulder-Height Blocks

University of Dayton

MS01 (Left Side Impaired)

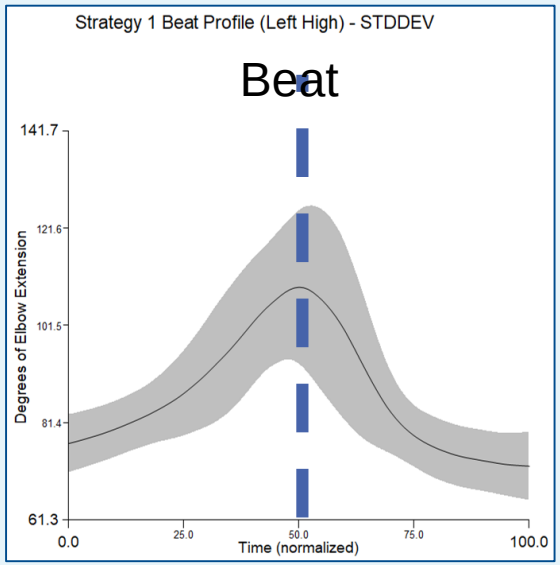


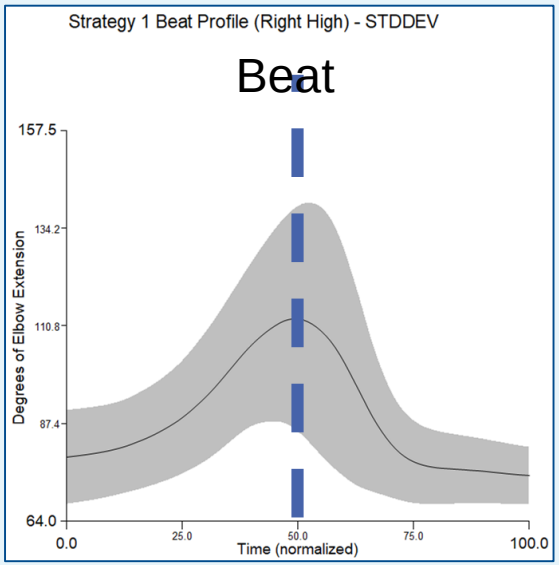




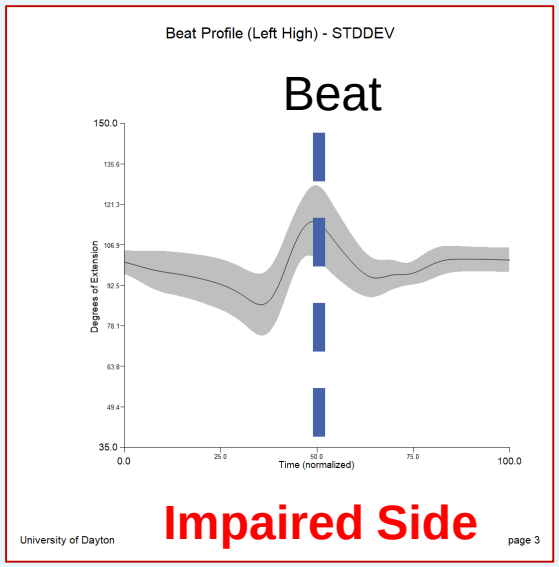
Shoulder-Height Blocks

Healthy Control Group

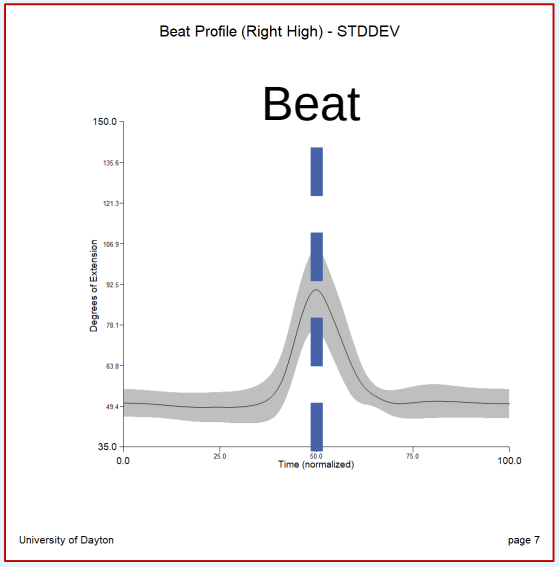




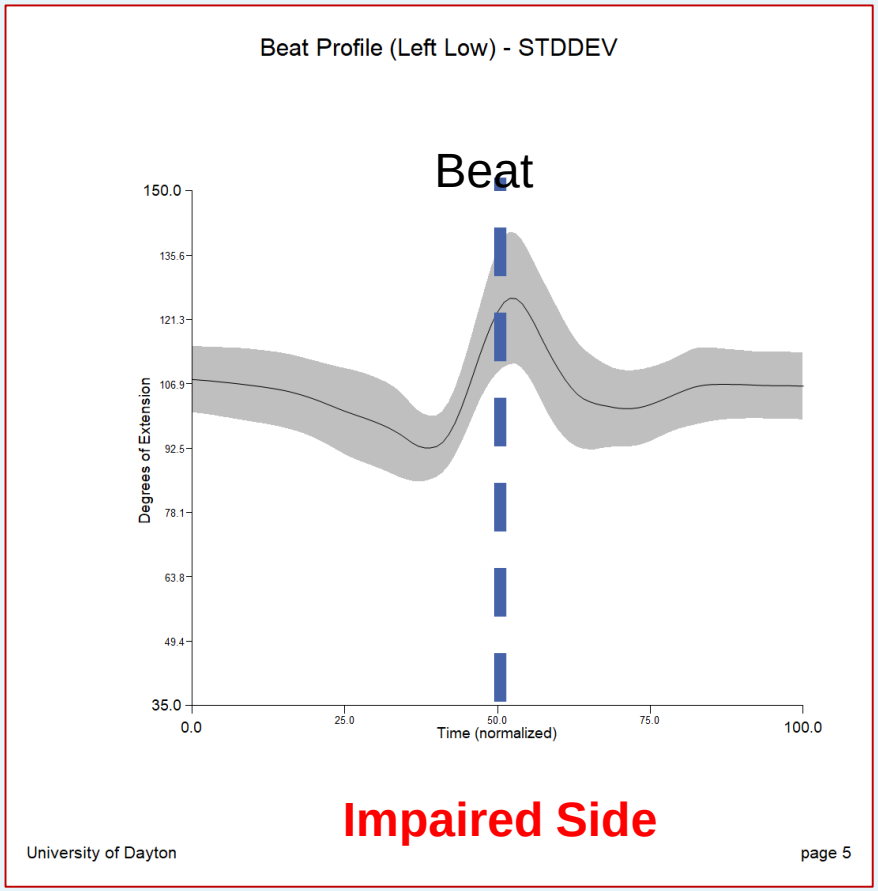
MS01

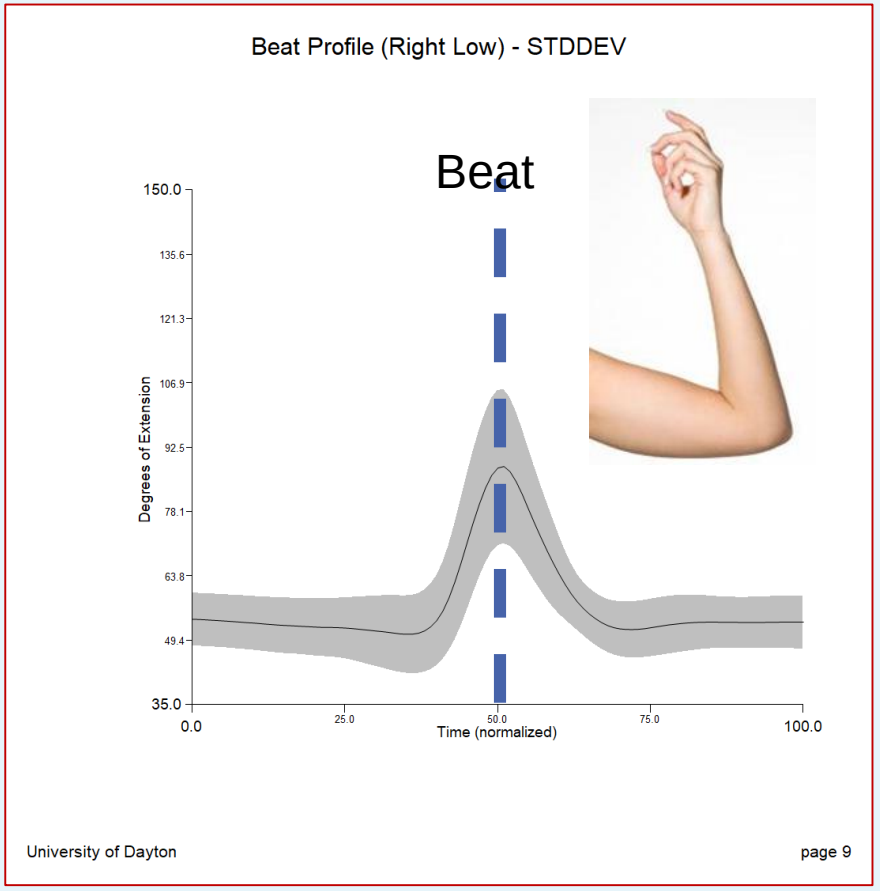


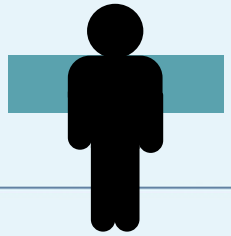
Impaired Side



MS01 (Left Side Impaired)

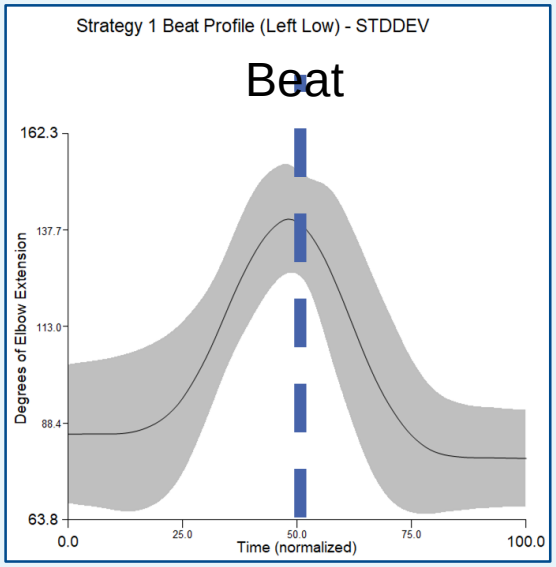


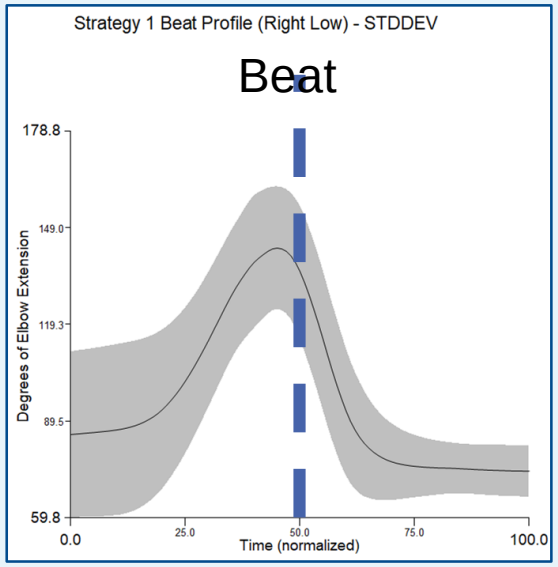




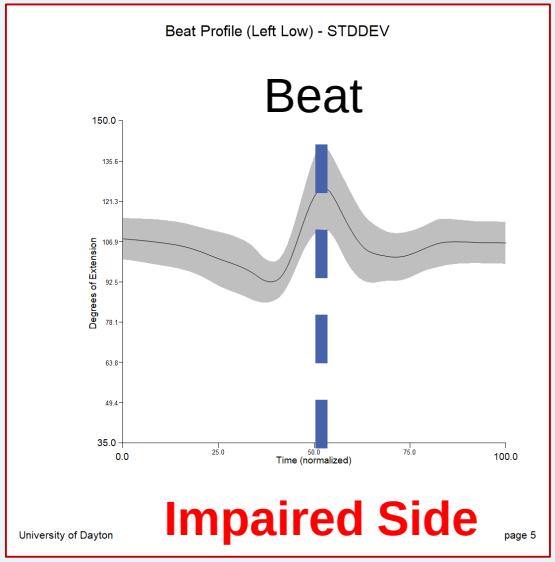
Elbow-Height Blocks

Healthy Control Group

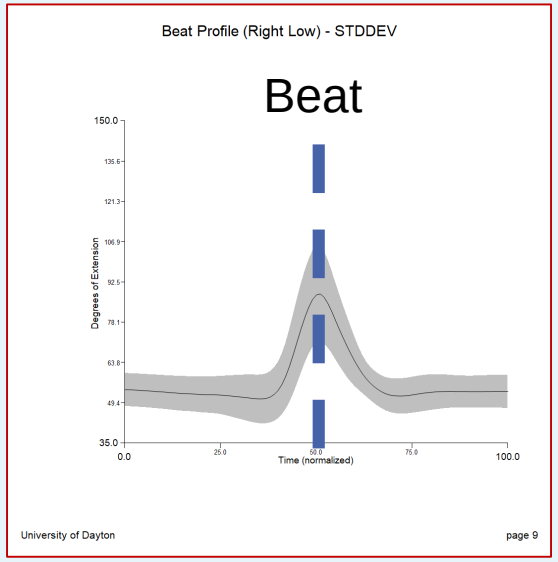




MS01



Impaired Side



Future Work

- IRB Final Revisions
- Recruitment
- Proceed with testing
- Analyze joint kinematics
- Data processing

Acknowledgements

University of Dayton Summer
Undergraduate Research Experience

Dr. Megan Reissman
Dr. Kurt Jackson
Dr. Allison Kinney

Sydney Lundell
Alice Luanpaisanon
Katie DeVictor

References

1. Ho, T.H., Yang, F.C., Lin, R.C., Chien, W.C., Chung, C.H., Chiang, S.L., Chou, C.H., Tsai, C.K., Tsai, C.L., Lin, Y.K., Lee, J.T. (2019). Impact of virtual reality-based rehabilitation on functional outcomes in patients with acute stroke: a retrospective case-matched study. *Journal Of Neurology*, *266*(3), 589–597. https://doi.org/10.1007/s00415-018-09171-2

2. Agostino, R., Berardelli, A., Formica, A., Accornero, N., & Manfredi, M. (1992). Sequential arm movements on patients with Parkinson's disease, Huntington's disease, and Dystonia. *Brain,* 115, 1481-1495. https://academic.oup.com/brain/article-abstract/115/5/1481/322235

3. Mark, V.W., Taub, E., Bashir, K., Uswatte, G., Delgado, A., Bowman, M.H., Bryson, C.C., McKay, S., & Cutter G.R. (2008). Constraint-induced movement therapy can improve hemiparetic progressive multiple sclerosis: preliminary findings. *Multiple Sclerosis,* 14, 992-994.

4. Russo, M., Vincenzo, D., De Cola, M.C., Logiudice, A.L., Porcari, B., Cannavo, A., Sciarrone, F., De Luca, R., Molonia F., Sessa, E., Bramanti, P., & Calabro, R.S. (2018). The role of robotic gait training coupled with virtual reality in boosting the rehabilitative outcomes in patients with multiple sclerosis. *International Journal of Rehabilitation Research,* 41(2), 166-172. https://doi.org/10.1097/MRR.0000000000000270.

5. Mendes, F.A.d.S., Pompeu, J.E., Lobo, A.M., da Silva, K.G., Oliveira, T.d.P., Zomignani, A.P., & Piemonte, M.E.P. (2012). Motor learning, retention and transfer after virtual-reality-based training in Parkinson's disease – effect of motor and cognitive demands of games: a longitudinal, controlled clinical study. Physiotherapy, 98(3), 217–223. https://doi.org/10.1016/j.physio.2012.06.001.