STRATEGIC LEARNING OF PROPULSIVE FORCES IN YOUNG UNIMPAIRED ADULTS

Luciana Herrero, Michael D. Lewek, PT, PhD

Joint Department of Biomedical Engineering, and the Division of Physical Therapy,Department of Allied Health Sciences

University of North Carolina at Chapel Hill

INTRODUCTION

- Stroke impairs the paretic leg's ability to generate sufficient propulsive force, resulting in slow, asymmetric gait [1].
- Increasing propulsive force is associated with faster speed [2], leading to improved quality of life and community participation [3].
- Individuals post-stroke have a propulsive reserve but the strategy to tap into it is unknown [4].
- The use of distorted visual feedback (DVF) may involve implicit and explicit learning [5] to tap into the propulsive reserve.
- Understanding what mechanisms are involved in altering propulsion will allow for the creation of improved rehabilitation strategies.

PURPOSE

To test the effect of strategic learning, using DVF of propulsive forces during treadmill walking, to determine the capacity to alter propulsion and the biomechanical mechanisms underlying any alterations in propulsion.

METHODS

Subjects

- 17 unimpaired individuals with no cardiorespiratory, neurological, or orthopedic disorders that may affect gait.
- Gender: 11 females, 6 males; Age: 22.4 ± 3.1 years old.

Protocol

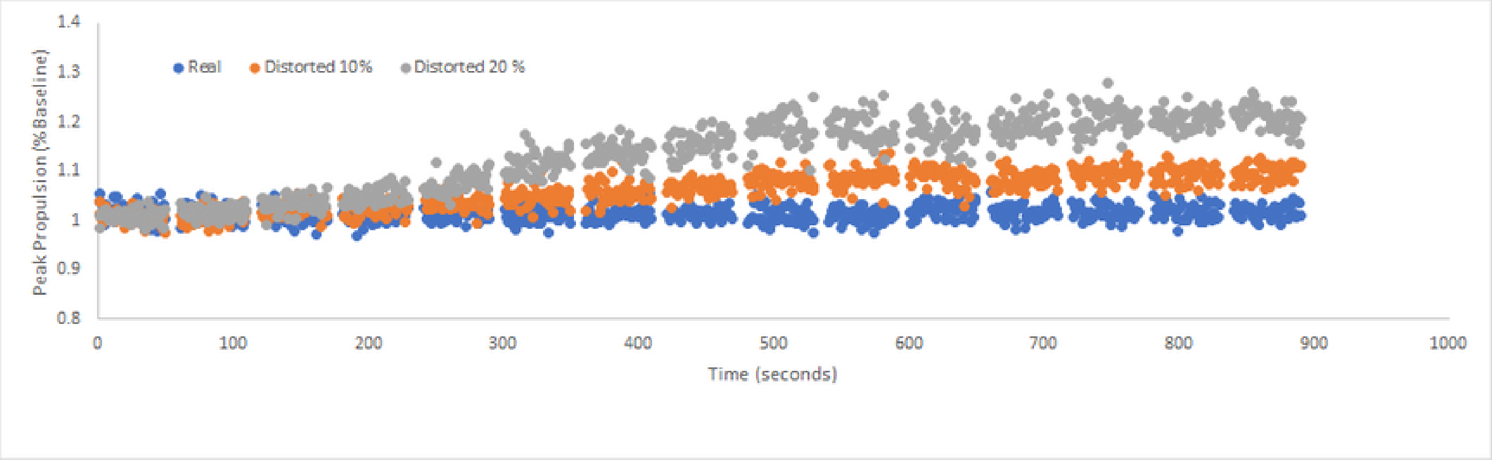
- Participants walked for 3 minutes of baseline with no visual feedback.
- They completed 3 visual feedback conditions
  - Real: no manipulation of displayed peak propulsion
  - 10DVF: displayed value was decreased by 10% over ~10 min
  - 20DVF: value was gradually decreased by 20% over ~10 min
- Participants were instructed to achieve as many steps as close to their baseline average as possible, staying in between the SD bounds.
- Subjects were asked to perform their max propulsive force for 1 min.

Data Analysis

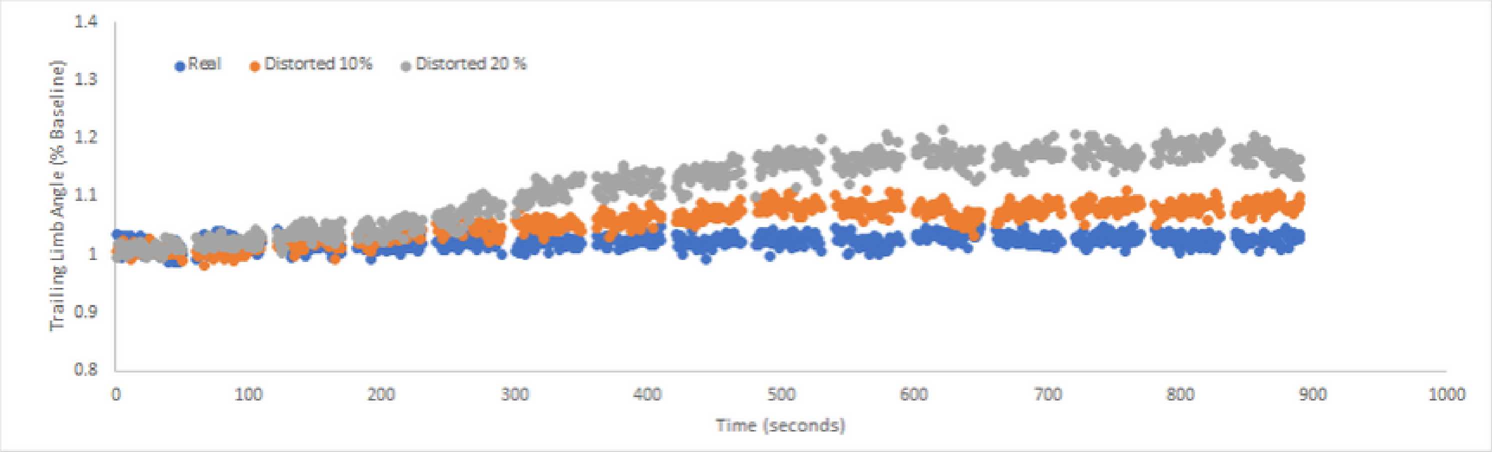
- Joint angles and moments were calculated with Vicon and Visual 3D.
- Primary outcome measures were compared between conditions with a repeated-measured ANOVA and post-hoc paired samples t-tests.

RESULTS

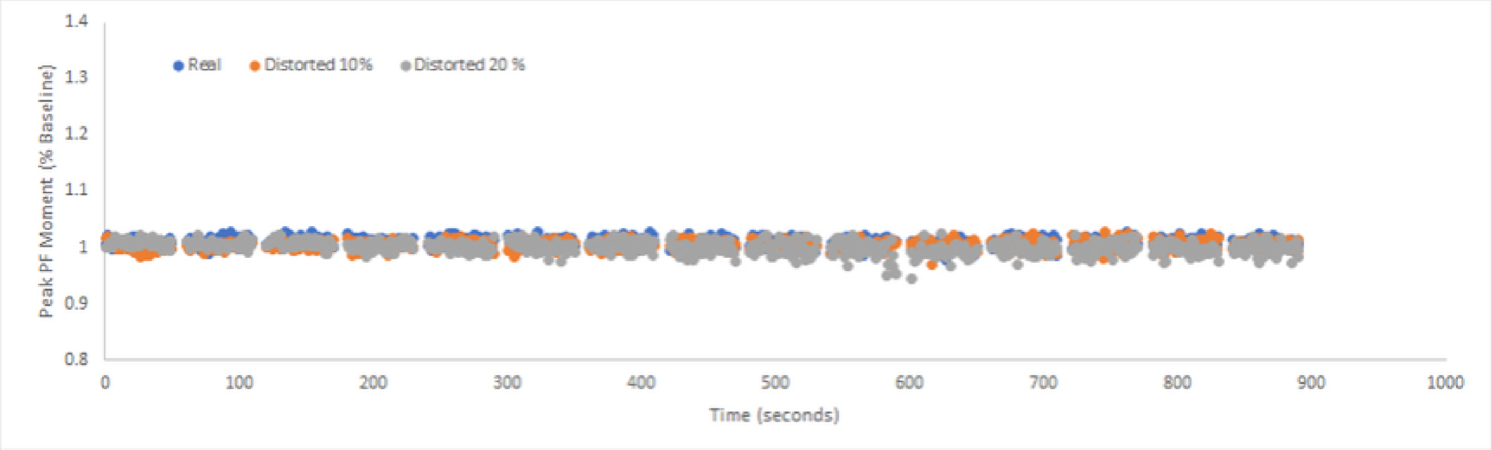
PEAK PROPULSION



TRAILING LIMB ANGLE



PEAK PLANTARFLEXION MOMENT



DISCUSSION

- Propulsive force increased in 10DVF and 20DVF compared to control condition.
  - Although the trailing limb angle (TLA) and plantarflexor moment dictate propulsive force, our subjects used TLA to manipulate propulsion rather than the plantarflexor moment.
  - The increased TLA was easily visualized as an increase in step length in the DVF10 and DVF20 conditions.
  - The plantarflexor moment was already sufficient (relative to someone post-stroke) and therefore was used more efficiently by increasing the TLA to increase the propulsive force.
- Peak hip flexion moment was lower in 20DVF than 10DVF and Real conditions. Increased effectiveness from plantarflexors likely reduced the need to rely on hip flexor muscle groups.
- For the Max condition, subjects increased their TLA, step length and peak plantarflexion moment.
  - Increase of plantarflexion moment during the Max condition occurred because using only the TLA was likely insufficient to produce the required higher propulsive forces.
- Implicit nature of feedback allowed for subject's naturally emerging patterns used to increase propulsion [2].
- Limitations: the visual feedback used bounds, instead of a mean to indicate the target. Thus, subjects could be withing the bounds but not achieving the desired level of propulsive force.

REFERENCES

1. Bowden, M.G., et al., Anterior-posterior ground reaction forces as a measure of paretic leg contribution in hemipareticwalking. Stroke, 2006. 37(3): p.872-6.
2. Hsiao, H., et al., The relative contribution of ankle moment and trailing limb angle to propulsive force during gait. Hum Mov Sci, 2015. 39: p.212-21.
3. Schmid, A., et al., Improvements in speed-based gait classifications are meaningful. Stroke, 2007. 38(7): p. 2096-100.
4. Lewek, M.D., C. Raiti, and A. Doty, The Presence of a Paretic Propulsion Reserve During Gait in Individuals Following Stroke. Neurorehabil Neural Repair, 2018. 32(12): p. 1011-1019.
5. French, M.A., et al., A locomotor learning paradigm using distorted visual feedback elicits strategic learning. J Neurophysiol, 2018.120(4): p. 1923-1931.