Targeting Rhythm to Improve Economy: One Session of Music-Based Rhythmic Locomotor Training Improves Post-Stroke Economy

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Background

Patients post-stroke use substantially more energy to walk than those without stroke. Incorporating rhythmic auditory stimulation into post-stroke gait training can influence the temporal control of gait and improve post-stroke walking function[1-7].

Hypothesis

We hypothesized that a single session of music-based rhythmic gait training delivered from an automated training platform (see *Methods*) would result in reductions in the metabolic cost of walking (i.e., improved walking economy).

Experiment Overview

3-Min Treadmill Test at CWS	30-Min Music-Based Rhythmic Locomotor Training	3-Min Treadmill Test at pre-CWS
• Walking Economy (ml/kg/m) • Spatiotemporal parameters		• Walking Economy (ml/kg/m) • Spatiotemporal parameters

CWS=comfortable walking speed, determined as the average speed of three 10-meter walk test trials conducted over ground.

Participants

# of participants: 11

Age: 63.0 ± 14.1 (range 35 to 77) years

Sex: 9 subjects were male, 2 were female

Hemiparesis: 5 with L sided hemiparesis, 6 subjects with R sided hemiparesis

Assistive Devices: 4 subjects walked with AFO's, 4 with no bracing, 1 with a single point cane, 1 with a Bioness system, and 1 with shoe orthotics.

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Image 1. Spatiotemporal and metabolic data were collected before and after 30-min of overground training on a treadmill set to matched walking speeds pre and posttraining.

Methods

Digital Rehabilitation Platform for Automated Music-based Rhythmic Gait Training
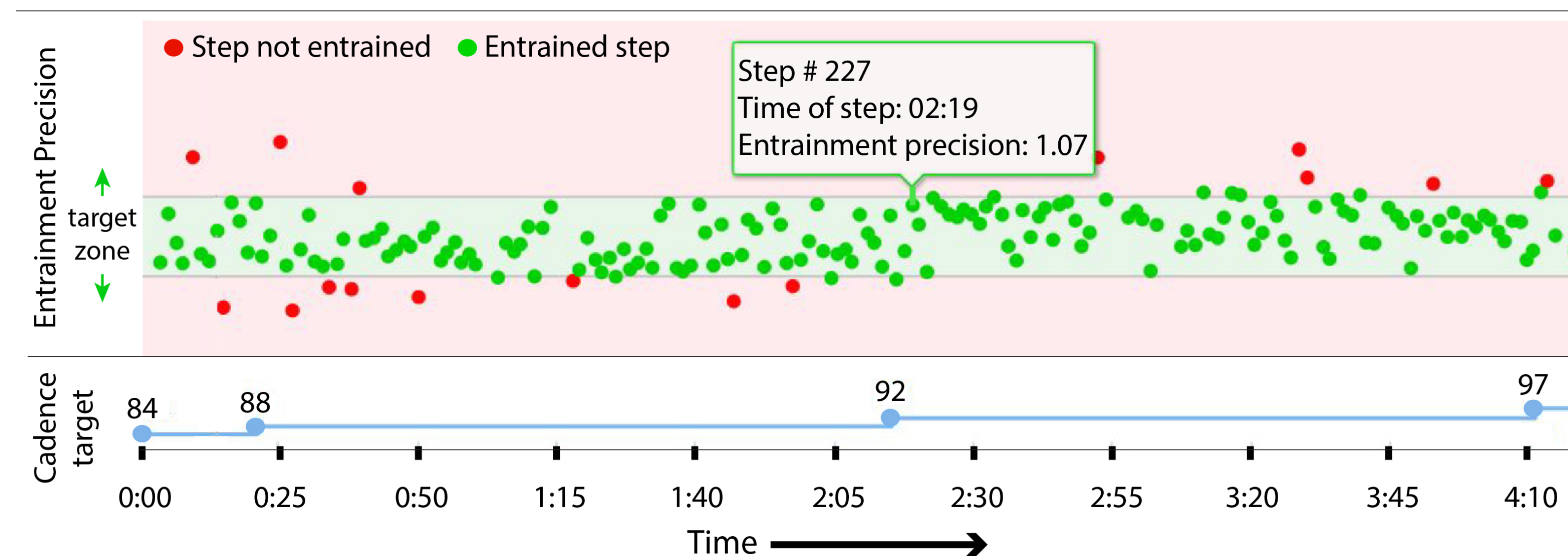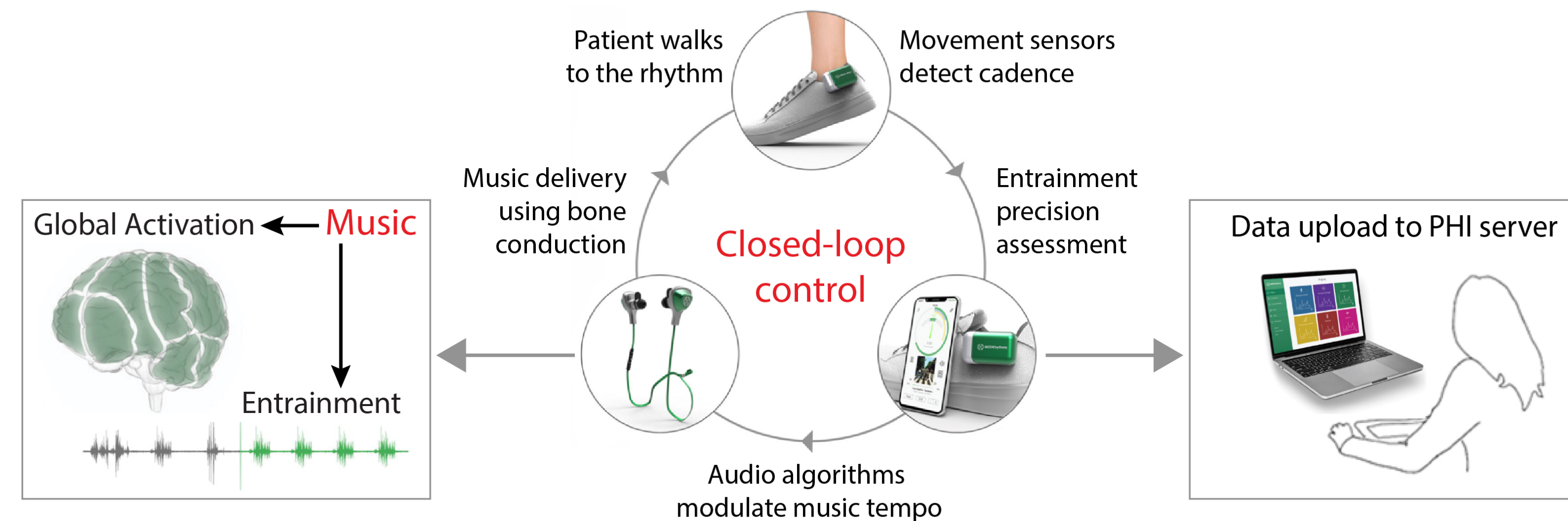

Figure 1. Top: Wearable sensors detect cadence, a smartphone pre-loaded with a user's music playlist provides the rhythmic stimulus. **Bottom:** Sample of training session data. Decision algorithms systematically prescribe, deliver, and progresses the target rhythm.

Summary

A single, fully automated, 30-min gait training session delivered by a digital rehabilitation platform improved the walking economy of people with post-stroke hemiparesis walking at matched walking speeds before and after the training. Study participants achieved a 9% average reduction in the energy cost of walking that was correlated with a reduction in step time asymmetry. Individuals with a higher energy cost of walking achieved the greatest improvement in walking economy. This promising rehabilitation technology warrants further study.

References: 1) Bunketorp-Kall L, et al. *Stroke*. 2017; 2) Ghai S, Ghai I. *Scientific Reports*. 2019; 3) Kobinata N, Ueno M, Imanishi Y, Yoshikawa H. *Journal of Physical Therapy Science*. 2016; 4) Moumdjian L, Buhmann J, Willems I, Feys P, Leman M. *Frontiers in Human Neuroscience*. 2018; 5) Reisman DS, Binder-Macleod S, Farquhar WB. *Topics in Stroke Rehabilitation*. 2013;20; 6) Yoo GE, Kim SJ. *Journal of Music Therapy*. 2016
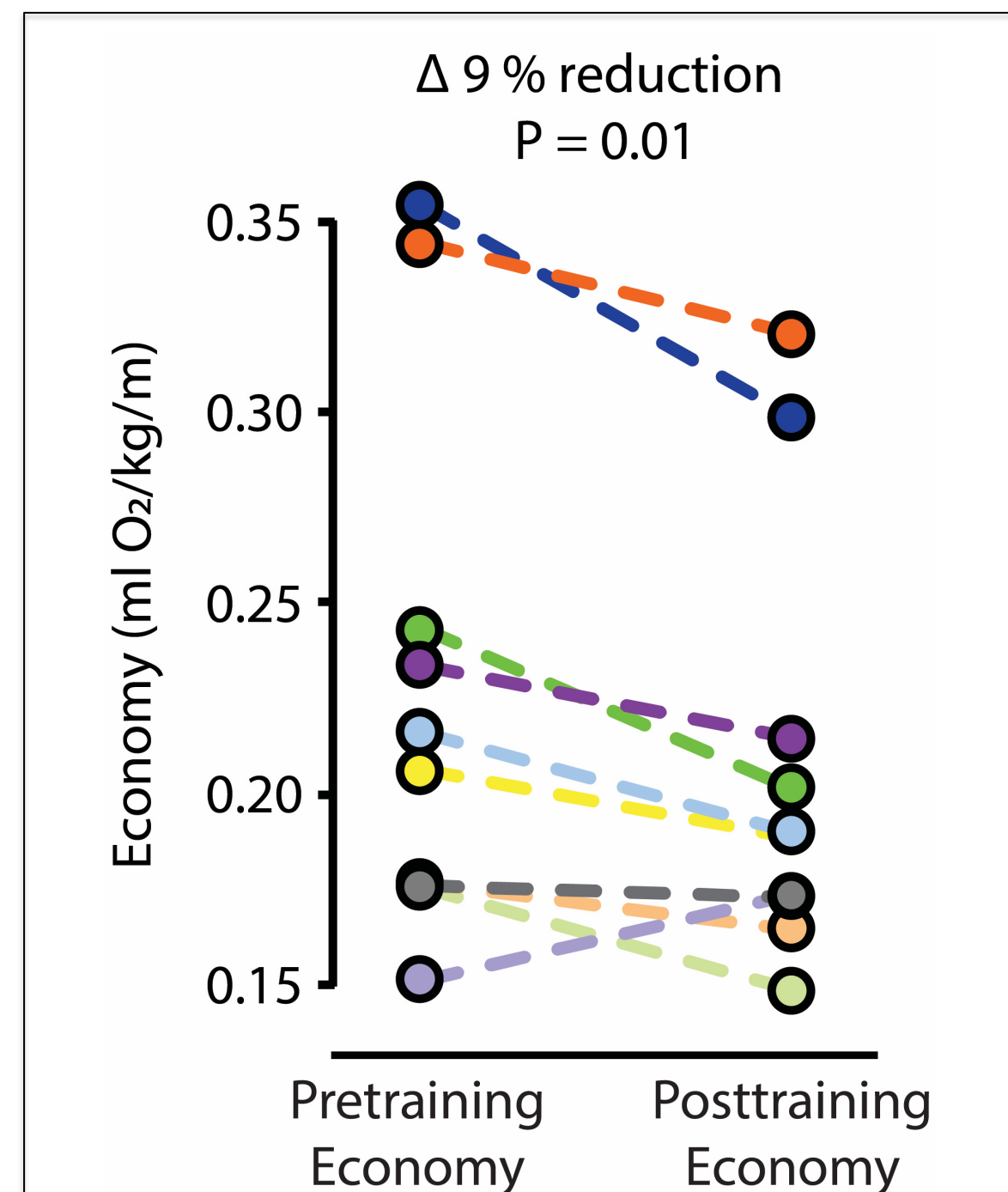
Results

Figure 2. Individual subject improvements in walking economy after one training session.
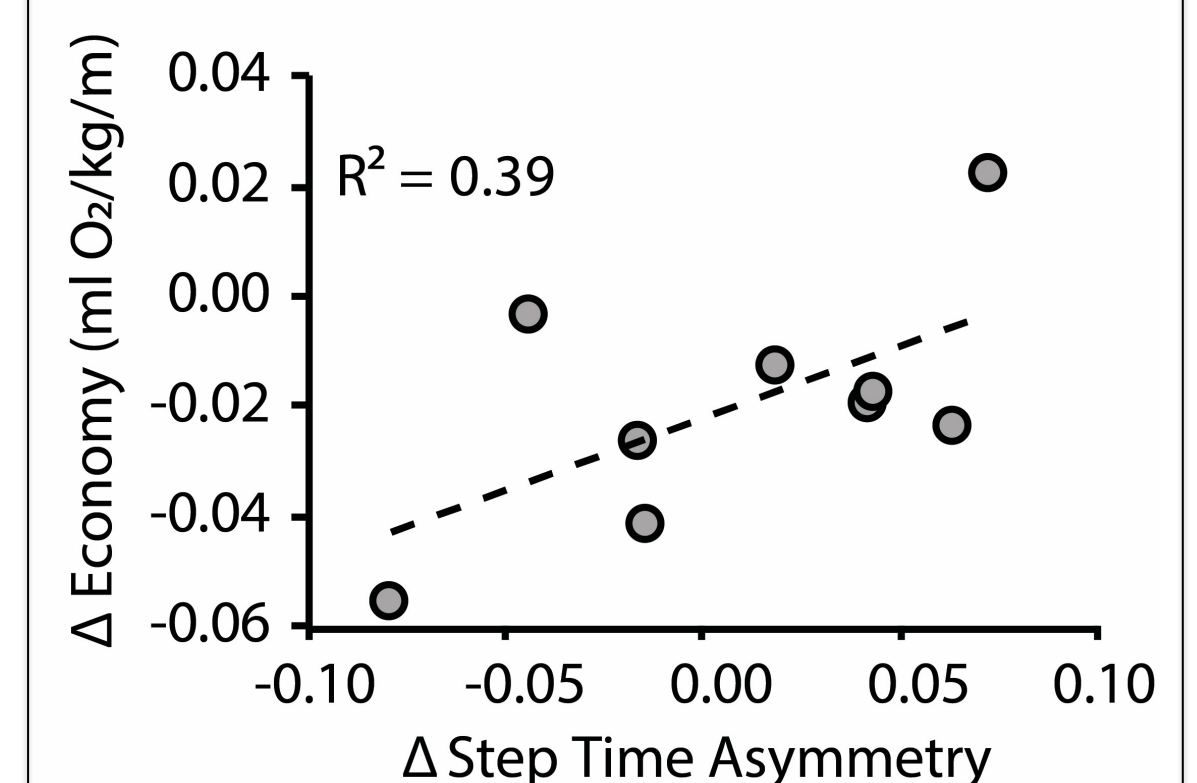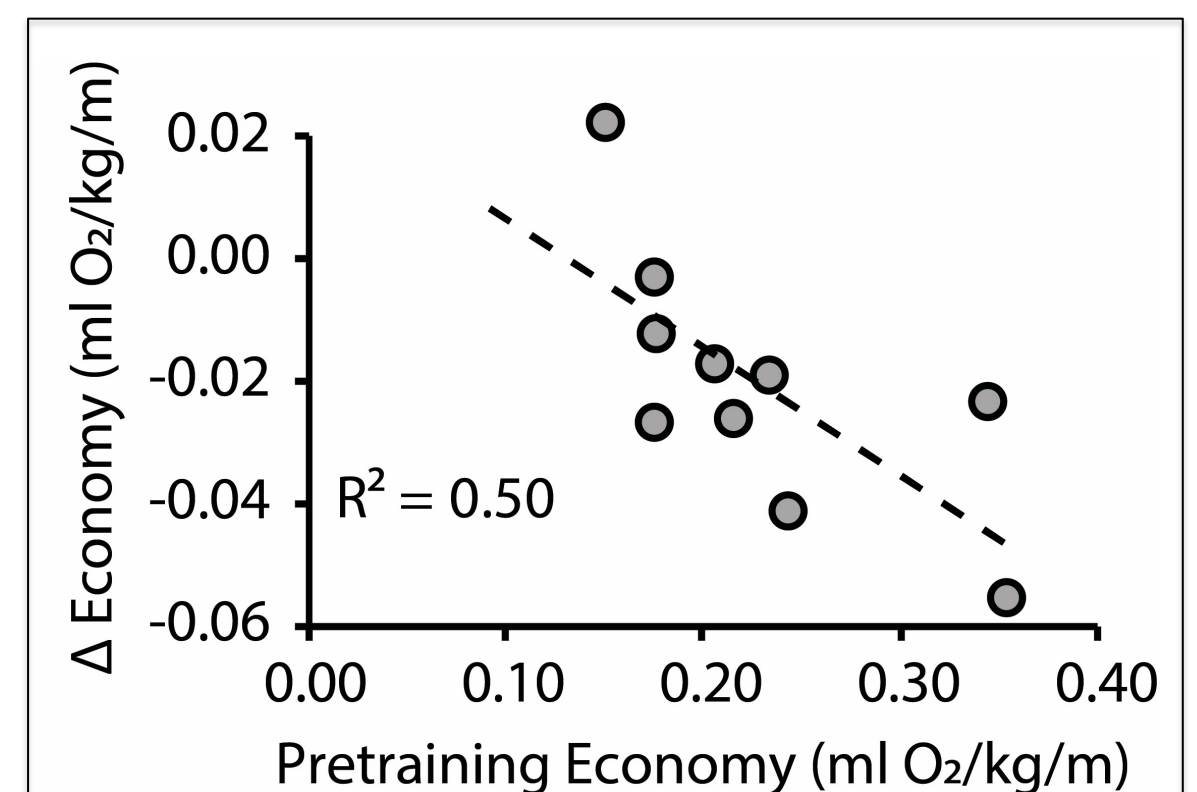

Figure 3. Improvements in walking economy were related to pretraining levels of walking economy (top) and changes in step time asymmetry (bottom).