

FRL

Future Realities Research Lab

Adaptive Self-Efficacy-Based AI Coaching for Enhanced Indoor Cycling Performance A Personalized Machine Learning Approach

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MIAMI

Abstract & Goals

Abstract

- Psychological interventions found to increase performance of exercise endurance of up to 8% (McCormick et al., 2015). Most of these interventions, however, fail to account for individual response patterns.
- Perception of effort, rather than fatigue alone, limits performance (Marcora, 2008). Well-timed motivational affirmations may reduce perceived effort or increase motivation to tolerate discomfort.
- By delivering personalized motivational feedback in real time, this study aims to investigate whether an adaptive AI-driven system can enhance indoor cycling performance.

Hypothesis

- Participants receiving adaptive AI coaching will produce significantly higher mean power output during a 20-minute time trial compared to both static AI coaching and control conditions.

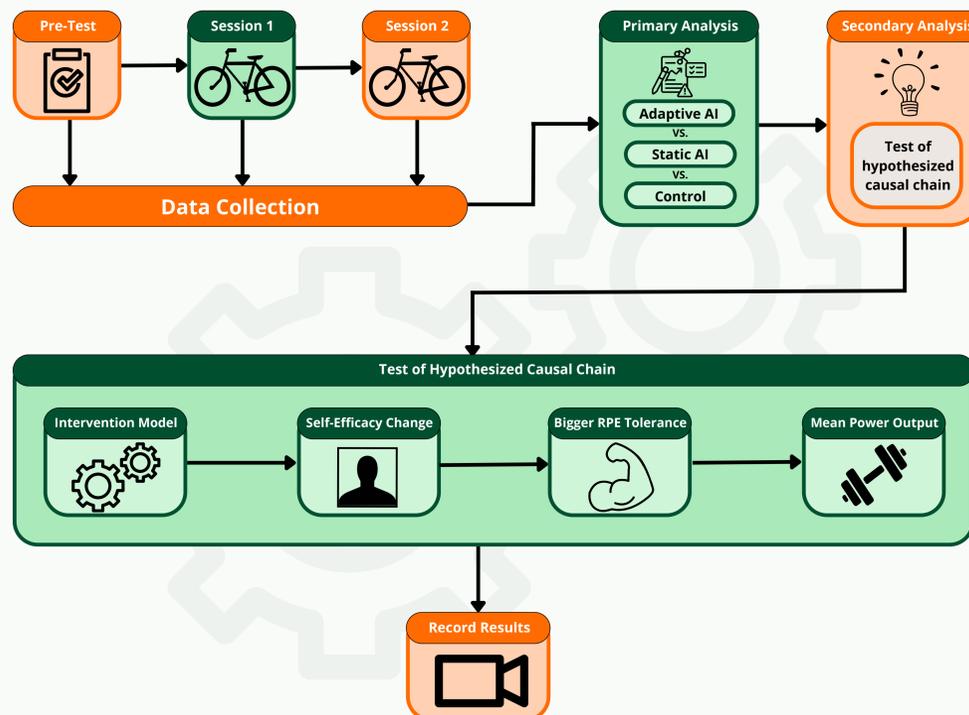


Figure 1. Participant flow & AI evaluation pipeline

Research Questions

- RQ1: Does adaptive AI-delivered motivational coaching improve mean power output during a 20-minute cycling time trial compared to static AI coaching and no-coaching control conditions?
- RQ2: Does intervention type (adaptive AI vs. static AI vs. control) differentially affect pacing strategy across the time trial?
- RQ3: Is the relationship between adaptive AI coaching and power output mediated by changes in self-efficacy and RPE tolerance?

Methods

Study Design

- Indoor Cycling environment
- Pre-survey → Session 1 → Session 2
- 3 groups: Adaptive AI, Static AI, Control

Data Collection

- Pre-Survey: motivation, self-efficacy, rate of perceived exertion (RPE), demographics, anthropometric data
- Session 1: Calibrate baselines, create initial mastery experience
- Session 2: Heart rate, power output, cadence
- Post-exercise questionnaire

AI Model

- **Thomson Sampling** contextual bandit algorithm
- Trained on Session 1 data
- Monitors performance continuously
- Evaluates whether to deliver an affirmation

Research in Progress

- This IRB-approved RCT (ClinicalTrials.gov registered) investigates whether adaptive AI coaching enhances cycling performance compared to static coaching and control conditions. Using a contextual bandit algorithm, the system delivers personalized affirmations based on real-time physiological data during a 20-minute time trial.

References

- McCormick, A., Meijen, C., & Marcora, S. (2015). Psychological determinants of whole-body endurance performance. *Sports Medicine*, 45(7), 997–1015. McCormick, A., Meijen, C., & Marcora, S. (2015). Psychological Determinants of Whole-Body Endurance Performance. *Sports medicine (Auckland, N.Z.)*, 45(7), 997–1015. <https://doi.org/10.1007/s40279-015-0319-6>
- Marcora, S. M. (2008). Do we really need a central governor to explain brain regulation of exercise performance? *European Journal of Applied Physiology*, 104(5), 929–931. McCormick, A., Meijen, C., & Marcora, S. (2015). Psychological Determinants of Whole-Body Endurance Performance. *Sports medicine (Auckland, N.Z.)*, 45(7), 997–1015. <https://doi.org/10.1007/s40279-015-0319-6>



Figure 2. Demos of the project, displaying data tracking, timing, and pre-session assessment