

**TITLE:** Does reward increase movement vigor when bicycling?

**PROTOCOL VERSION DATE:** 1/4/2021

**VERSION:** 1.0

# **PRINCIPAL INVESTIGATOR (PI)**:

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# KEY PERSONNEL

**Name**: Alaa Ahmed

**Role in project**: Faculty advisor

**Name**: [Robbie Courter](mailto:roco4819@colorado.edu)

**Role in project**: Co-investigator

**Name**: Shruthi Sukumar

**Role in project**: Co-investigator

**Name**: Ross Wilkinson

**Role in project**: Co-investigator

# GENERAL RESEARCH STAFF

One research assistant may assist with this protocol. The PI will ensure that the appropriate CITI and protocol specific training are maintained. General Research Staff responsibilities will include distributing flyers, recruiting subjects, and assisting with laboratory testing. They will only perform laboratory testing of subjects with the accompaniment of the PI or Co-investigator.

# OBJECTIVES

Investigate the effect of reward on movement vigor in bicycle riders by comparing freely chosen cadence and freely chosen power output in the absence or presence of reward.

**Research question:** Does reward affect movement vigor in bicycle riders?

**Null hypothesis:** There will be no significant difference in freely chosen cadence nor freely chosen power output in the absence or presence of reward.

# BACKGROUND AND SIGNIFICANCE

# PRELIMINARY STUDIES

# RESEARCH STUDY DESIGN

Repeated-measures within-subjects design with one factor (Reward) and three levels within each factor (Reward vs. No Reward vs. Time contingent). The resistance of the ergometer is modelled on typical outdoor cycling conditions on level ground, whereby subjects can freely choose their power output and cadence by changing gear. Subjects will be asked to pedal at their preferred power output for a quarter mile (~1 to 2 min depending on chosen power output). Subjects will complete a total of 8 trials, consisting of one baseline condition, four replicates of the non-rewarded condition, two replicates of the reward condition, and one time contingent condition (See Figures 1 and Table 1). In the time-contingent condition, subjects will be asked to complete a quarter mile as fast as possible.

Experiment 1 - Ride a quarter mile

* Hypothesis: Reward will decrease the time to ride a quarter mile
* Power: Ad libitum
* Cadence: Ad libitum
* Ground velocity: Cube root of power output
* Gear ratio: Ad libitum
* Feedback: Distance, Verbal script for instructions
* Reward: Choice of candy bar for each reward trial + scaled reward for C (actually fixed at two candy bars) = total of four candy bars.
* Subjects: No neurological disorders.
* Fixed session time.
* Outcome measure: Time to complete quarter mile
* Secondary measures: average power output and cadence, rate of power development



**Figure 1.** A diagram showing the three conditions (A-C) to be tested.

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| **Option** | **Trial order** |
| 1 | BBA-BBA - C |

**Table 1.** The trial order is fixed as there are unlikely to be any order effects between A and B.

A = ~4 min?

B = ~5 min?

C = ~3 min?

C reward = A / C \* 5 = 240s / 180s \* $5 = $6.66

**Script:**

**Before beginning any trials:** This experiment will take 1 hour. You will complete a series of quarter-mile (400m, one lap around a track) cycling trials. Each trial will start with the easiest gear; once the trial begins you can change gears however you like. Please ensure your hands are on the handlebar for the duration of the trial.

**Familiarization:** This is the familiarization phase to help you get accustomed to the different gears. You will spend 20 seconds riding at each gear. We’ll let you know when the 20 seconds is up and you can switch to the next gear. Once you have experienced all the gears we will give you 30 seconds to explore all the gears, unrestricted.

**Practice Spin-up.**

**Baseline.** This is a baseline trial. In this trial, you will ride a quarter-mile (400m) however you like. We will start in the easiest gear.

**Before Reward trial:** For completing this trial you will get to choose a food treat from our selection. After completing this trial you will get a rest break.

**Post Reward trial:** That was great! Here is your treat. (You can only eat it after this trial)

**Before Non-Reward trial:** For this next quarter mile, after completing this trial you will get a rest break.

**Before Time Trial:** This is your final trial. We would now like you to ride a quarter-mile (400m) as fast as you can. The faster you go (relative to your previous trials), the more treats you could receive.

(If asked about performance measurement: Your performance is assessed relative to your previous trial completion times. Some people are faster than others.)

**Post Time Trial:** That was great! You can pick 2(?) food treats.

Timing:

Experiment 2 - Is vigor in cyclists power or cadence?

Conditions:

1. Fixed power
   1. Reward
   2. No Reward
2. Fixed cadence
   1. Reward
   2. No Reward

Rodger’s not so stupid experiments:

* Fixed number of crank rotations
* Reward performance
  + 1C - Complete a mile as fast as you can
  + 1D - Cover as much distance as you can in ~4 min

We performed a conventional power analysis (alpha = 0.05, power = 90%) to determine that a minimum sample size of 23 will be required to detect an effect size of 0.8 at our desired power. A sample size of 23 also allows us to detect effect sizes as small as 0.44.

The estimated duration of the study (recruitment through data analysis) is one year allowing for current and possible future delays due to the continued outbreak of COVID-19 and its variants.

Before beginning each “Reward” trial, participants will be informed of their opportunity to blindly choose a lucky dip prize immediately after completing the trial. Upon completion of each “reward” trial, an investigator will present the lucky dip basket to the participant and allow them to blindly select a prize.

During each experimental trial, we will measure cadence and crank power.

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| Name of procedure/instrument/tool | Purpose (i.e., what data is being collected?) |
| Wahoo KickR Bike Trainer | Provides apparatus for stationary cycling under different modes of resistance and motion. |
| Apple iPad | Runs Wahoo Fitness application. |
| Lucky Dip Basket | Contains individually wrapped gifts for the subject to blindly choose from. |
| Quarq DZero power meter | Measures crank angular velocity, torque, and power at 1 Hz. |
| Garmin Edge 1000 cycling computer | Collects and stores data from the Quarq power meter at 1 Hz. |

**Data analysis**

# FUNDING

This project will not receive financial support.

# ABOUT THE SUBJECTS

We plan to recruit and enroll 30 participants. Based on our experience, we anticipate that <10% of participants who are enrolled will elect to withdraw or be unable to complete the protocol due to the intensity of cycling. However, to be conservative, we seek permission to enroll up to 30 participants. Participants will be adults (>18 years of age), of any sex, and any ethnicity.

We will screen for apparently healthy adults who meet the guidelines set forth by the American College of Sports Medicine (ASCM, 2017). The latest American College of Sports Medicine guidelines indicate that a medical exam and diagnostic exercise testing are not warranted prior to beginning a vigorous exercise program for apparently healthy individuals who already participate in regular exercise and do not have any signs or symptoms of cardiovascular, metabolic, or renal disease. We will use a screening form to determine if these criteria are met (see Screening Form included with eRA submission).

The day prior to attending the laboratory for testing, participants will be screened over the phone for COVID-19 infection and exposure according to the procedures outlined by the Department of Integrative Physiology.

Inclusion criteria:

* >18 years of age
* Apparently healthy and cleared to participate in physical activity

Exclusion criteria:

* None.

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| Subject Population(s) | Number to be enrolled in each group |
| Apparently healthy adults | 30 |
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# VULNERABLE POPULATIONS

We will not enroll any vulnerable populations.

Students or staff who report to the investigators will not be specifically targeted for recruitment. These individuals may be enrolled and tested if they respond to the email or flyer recruitment materials distributed among the campus and Boulder communities.

# RECRUITMENT METHODS

The candidate population for this study will consist of volunteers recruited through word of mouth by the investigators, flyers, media posts, and email (Flyer, sample media post, and sample email attached). Flyers will be posted around the CU campus. Media posts will be advertised through the CU Boulder Today website. The flyer will also be emailed to friends, local cycling clubs/message boards etc. After obtaining verbal consent, participants will undergo the normal screening process and a testing session will be scheduled. In the 24 hours prior to the scheduled testing session, we will screen participants for COVID-19 infection, exposure, and risk using the attached screening form titled “IPHY Human Subjects Research Participant COVID-19 Visit Screening”. Participants will then be screened upon arrival for testing using the attached screening form. If the initial screening is done via telephone, participants will subsequently complete the screening form in person, in writing, when they first come to the laboratory before completing the consent form.

The recruitment materials provide an email address for the study (culocomotionlab@gmail.com). The investigators will monitor that email address and reply to candidate participants initially via email.

The investigator will examine the subject’s answers on each screening form and determine if they are eligible before asking them to read and complete the consent form.

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| List recruitment methods/materials and attach a copy of each in eRA |
| 1. Flyer |
| 1. Media post |
| 1. Email |
|  |

# COMPENSATION

Participants will be compensated for their time and effort with one $25 Amazon gift card. Participants will receive the gift card even if they choose to withdraw before completing the study protocol. We will hand the gift card to the participant at the end of the experimental session. Participants will also receive a lucky dip prize after each “Reward” condition. The lucky dip prizes will consist of a selection of sealed food items that have a low potential for causing allergies.

# INFORMED CONSENT

Candidate participants will be verbally informed of the requirements and goals of the study. If they are still interested in participating, consent forms will be read and signed by the participant before being involved in the study.

A member of the research staff will contact study participants within 24 hours prior to their planned study visit to complete the COVID-19 screening form. Upon reporting to the laboratory and after completing the test screening form, participants will be provided with a consent form and allowed to read it in a private room with just the investigators present. After the participant reads the form, an investigator will ask them if they have any questions and answer any questions. The investigator will then follow-up with a few questions to get some idea as to whether the subject actually read the consent form (e.g. “What will we be measuring in this experiment?”). If the subject’s responses seem vague, the investigator will ask the subject to re-read the consent form and the investigator will explain any uncertainties. Participants will be given as much time as required to decide on participation and reminded that they may also leave the study at any time.

# PROCEDURES

Participants will report to the front steps of the Clare Small building. All in-person screening and testing procedures will take place at the Locomotion Laboratory within the Clare Small building. Participants will be handed a sanitized clipboard and pen to fill out the screening and consent forms. Researchers and participants will be required to maintain social distancing, wear a face mask and frequently disinfect their hands with an anti-bacterial gel.

While taking the necessary precautions to minimize the risk of spreading COVID-19, participants will complete the screening and consent forms, and then begin the experimental procedure.

Testing will be performed on a test bicycle (Chisel, Specialized Bicycle Components, Inc., Morgan Hill, CA, USA) mounted in an inertial load ergometer (KickR, Wahoo Fitness). The frame size and geometry of the bicycle will be matched to the participant’s height. Cadence will be measured using a crank-mounted sensor. Power and cadence will be recorded by a cycling computer mounted to the handlebar (Edge 1000, Garmin Ltd, Olathe, KA, USA). The bike will be equipped with a crank-based mechanical power meter (Quarq DZero, SRAM, Corp, Chicago, IL, USA) with 172.5 mm long cranks. The power meter will be calibrated prior to each testing session.

Participants will warm up by cycling at a low-intensity for 5 min and then perform eight 4-min bouts of seated cycling. The intensity for the four iso-power trials will be set at a mechanical power output of 1.5 W/kg. The intensity for the four sim-resistance trials will be freely chosen by the participant. Each trial will be separated by a rest period of 1 min. The total time commitment for this session is expected to be <2 hours.

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| Visit # | Procedures/Tools | Location | How much time the visit will take |
| Visit 1 | * Screening and consent (~10 min) * Fit subject to test bike (10 min) * Warm-up (5 min) * Experimental trials (50 min) | Locomotion Laboratory, Clare Small Arts & Sciences, 1725 Pleasant St, Boulder, CO 80309-0354, USA | <2 hours |
|  |  |  |  |

# SPECIMEN MANAGEMENT

N/A

# DATA MANAGEMENT

Confidentiality of personal records will be strictly maintained in all published reports and oral presentations resulting from this study. All participants will be given an alphabetic participant code as an identifier for the study. Participant information will be kept in locked cabinets in a locked office (Temporary Building, room 110) under the supervision of Dr. Rodger Kram. Identifiable data will be shared with no one outside of the immediate research team. Data security for storage and transmission for electronic data stored on desktop computers will be managed via a secure network and password access. Data will be retained indefinitely, but the participant code identifier document (paper) will be destroyed in 1 year via shredding.

# PROVISIONS TO PROTECT THE PRIVACY INTERESTS OF PARTICIPANTS

We do not foresee this study having any significant impact on a participants’ privacy interests. All experiments will take place on the CU Boulder campus. Only the researchers involved in this study are likely to be present within the laboratory. Subjects will wear the same type of athletic clothing that they would wear when bicycling for exercise in public. We inform the subject in the consent form that they cannot expect complete privacy during the conduct of the study.

# WITHDRAWAL OF PARTICIPANTS

We do not anticipate any circumstances under which participants will be withdrawn without their consent. Participants who choose to withdraw prior to completing the experiments will be freely allowed to do so.

# RISKS TO PARTICIPANTS

Exercise can cause fatigue and minor discomfort. About 4 in 10,000 average people have chest pain or a heart attack and 1 in 10,000 people die during an exercise test. Fortunately, for an adult without overt heart disease, who exercises regularly, the risk of a cardiac event (heart attack) during exercise is very small, less than 1 chance in every 400,000 person-hours of exercising (approximately equal to exercising for 45 years, 24 hours per day).

It is possible that participants could be exposed to COVID-19 during testing. The risk of serious symptoms, hospitalization, and death will be mitigated by following the CDC, CU RIO R2R, and IPHY guidelines. Participants who are deemed eligible for our study will have been screened to be healthy adults who self-report being symptom-free and not having close contact with any persons confirmed to have COVID-19. Thus, our participants are deemed low-risk for developing serious symptoms due to COVID-19.

# MANAGEMENT OF RISKS

Bicycling on an ergometer is very low risk, as the rider is not moving relative to their surroundings. Thus, in the unlikely event of a fall, the rider will not collide with any objects with a substantial horizontal velocity. Thus, we are confident that these experiments do not present any undue risk to the participants or investigators.

If a participant experiences a non-life-threatening injury (for example: a cut, scratch or wrist sprain) that requires medical treatment, the experimenters will provide reasonable assistance in getting the subject to Wardenburg Health Center, or Urgent Care at the Boulder Medical Center. Professor Kram has more than 25 years of experience conducting these types of experiments and has never had a subject experience a serious injury during testing.

In the unlikely event of a life-threatening event (e.g. cardiac arrest), the investigator(s) would call 911, begin CPR, and await EMS arrival. Accordingly, all investigators are trained in CPR and AED and at least one investigator will be present during these experiments. A First Aid Kit and AED is always kept within the Locomotion Laboratory.

# POTENTIAL BENEFITS

The only direct benefit is that the participants will experience a moderate amount of physical exercise. This is non-clinical research that will provide new information regarding the effect of reward on movement vigor during seated cycling. The results of this study will further our understanding of how people move and the value they assign to the goal of the movement.

# PROVISIONS TO MONITOR THE DATA FOR THE SAFETY OF PARTICIPANTS

The proposed study is short-term in nature. If a participant reports an injury or substantive discomfort during or after participating, we will review our experimental procedures and take action to minimize/eliminate the risk of such problems.

# MEDICAL CARE AND COMPENSATION FOR INJURY

Research involves minimal risk

# COST TO PARTICIPANTS

There are no costs to the participants.

# DRUG ADMINISTRATION

N/A

# INVESTIGATIONAL DEVICES

N/A

# COLLABORATIVE STUDIES

N/A

# SHARING OF RESULTS WITH PARTICIPANTS

We intend to prepare the results of this study for presentation at scientific conferences and for publication in a scientific journal. In these ways, study results will be made part of the public record and will be made accessible to participants.