EXPLORING FREE-RIDING BEHAVIOR:

AN INSTRUMENTED BIKE STUDY ON THE INFLUENCE OF INFRASTRUCTURE DESIGN ON BICYCLING

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Foto Jonas Jacobsson, Unsplash

Purpose of PhD project

To further develop mathematical models for simulating bicycle traffic.

- Bicycle traffic have distinctive properties and dynamics.
- Focus on bicycle path segments.

To enable accurate microscopic traffic simulation analysis of bicycle traffic.

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Why Microscopic Traffic Simulation?

- High heterogeneity among characteristics of bicyclists.
  - MTS models individual entities, and their interactions in the traffic system.

A reliable tool for evaluating bicycle traffic performance (e.g., delays, platoon formations, queue length, etc.):

- Effects of infrastructure design on bicycle traffic… and redesign.
- Effects of changes in the traffic composition: more e-bikes, cargo-bikes, other forms of micromobility, etc.

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A bicycle traffic model

Interactions with the infrastructure and/or the environment.

- E.g., gradient, curves, wind.

Interactions between bicyclists

- E.g., following process, passing maneuvers.

Free riding

How do bicyclists “choose” speed?

Interactions with other road users

- E.g., scooters, pedestrians.

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Purpose

1. To characterize how elements of the infrastructure impact free riding.

- Infrastructure/environment: e.g., gradient, horizontal alignment, wind.
- Behavior: speed, acceleration, power output.

2. To develop/calibrate a model for simulating interactions with the infrastructure [future work].

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An instrumented-bike study

Allows for collecting long and detailed trajectories.

A semi-controlled experiment:

- No restrictions on behavior along a bicycle path.
  - “Bike as usual when commuting”
  - Participants use own bicycle.
  - Collect speed, acceleration, power output, heart rate, etc.
- Control for the route.

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Equipment

Event button

Accelerometers

Ultrasound distance-to-the-side sensor

Rearview radar for approaching vehicles

Bicycle computer

Dual power meter pedals

Aerometer

Front and back cameras

Cadence sensor

Heart-rate armband

Speed sensor

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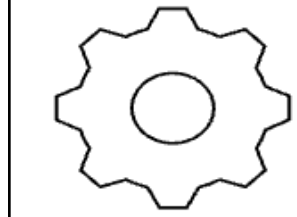
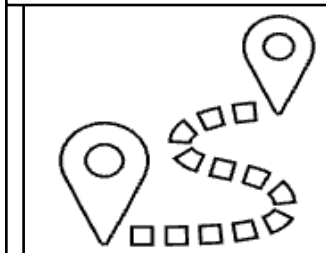
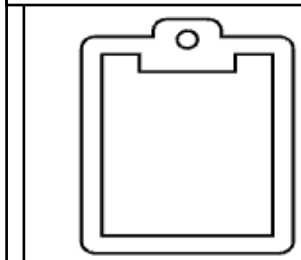
Experiment design

Individual characteristics	Calibration	Follow the route	Survey
			
E.g., total weight.	Bicycle resistance parameters.	To ride as when commuting.	Problems, insights, and perceived exertion.

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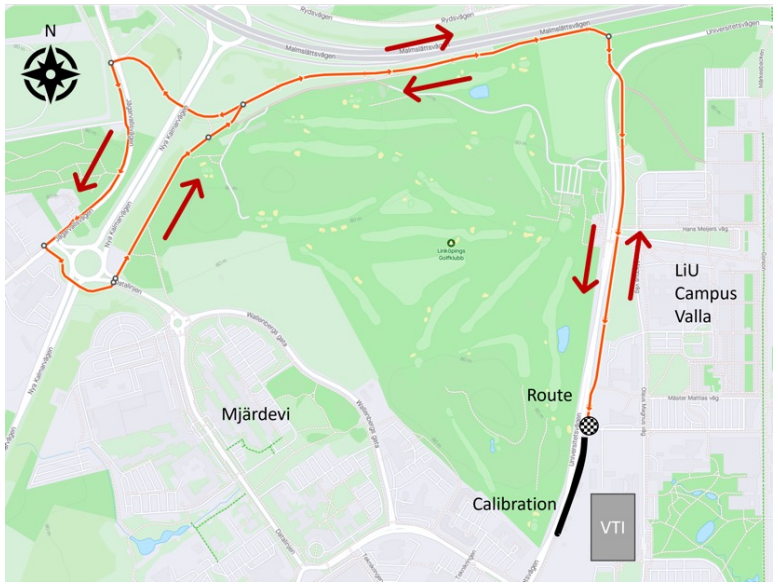
Two samples

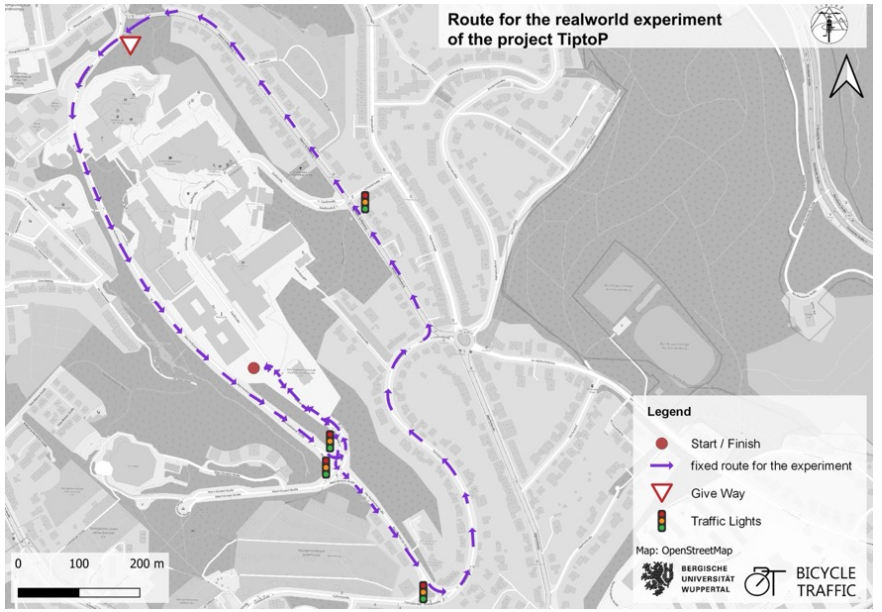
Linköping: **36** participants

- 5-km long off-street bicycle path.
- Light-moderate hills (up to +/- 5%).



Wuppertal: **30** participants

- 3.2-km long on-street (no bicycle lane).
- Moderate-steep hills (up to +/-10%).



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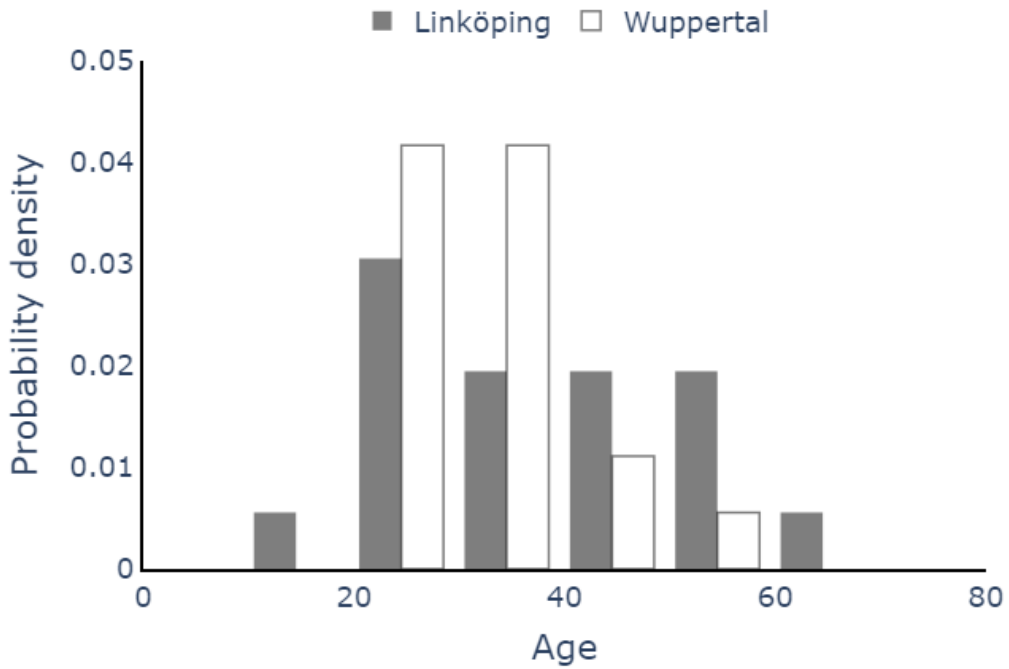
Two samples

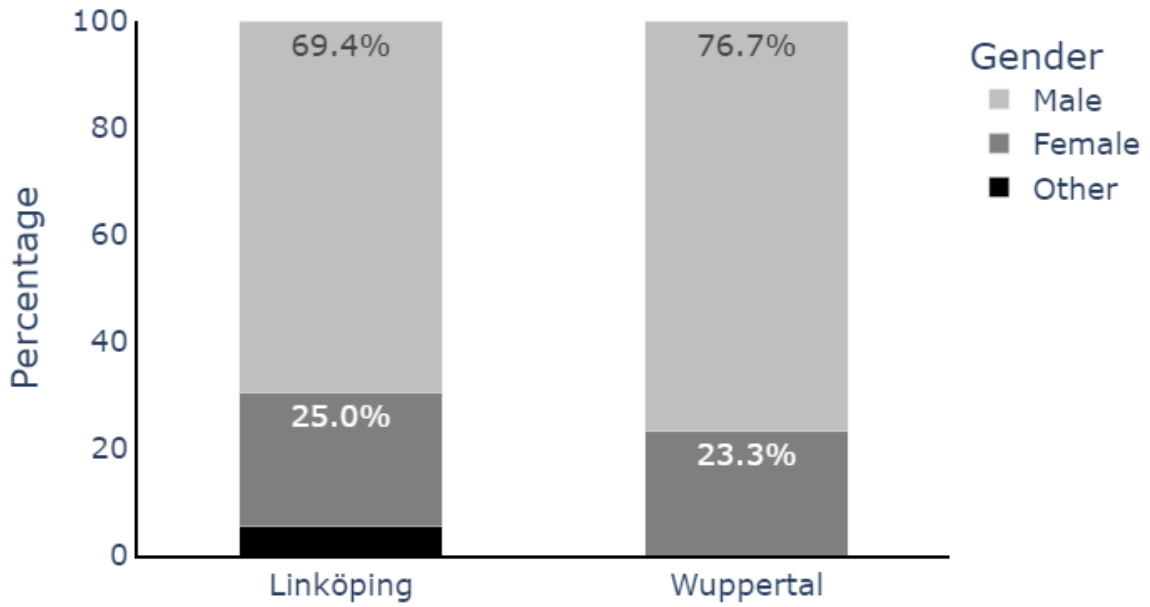
Linköping: 36 participants

- People who commute regularly by bicycle.

Wuppertal: 30 participants

- People with moderate-high physical fitness.





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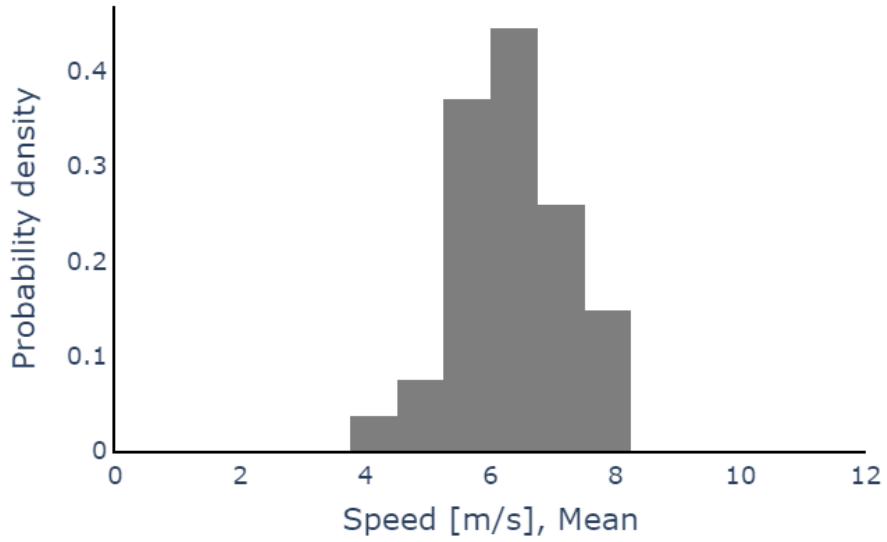
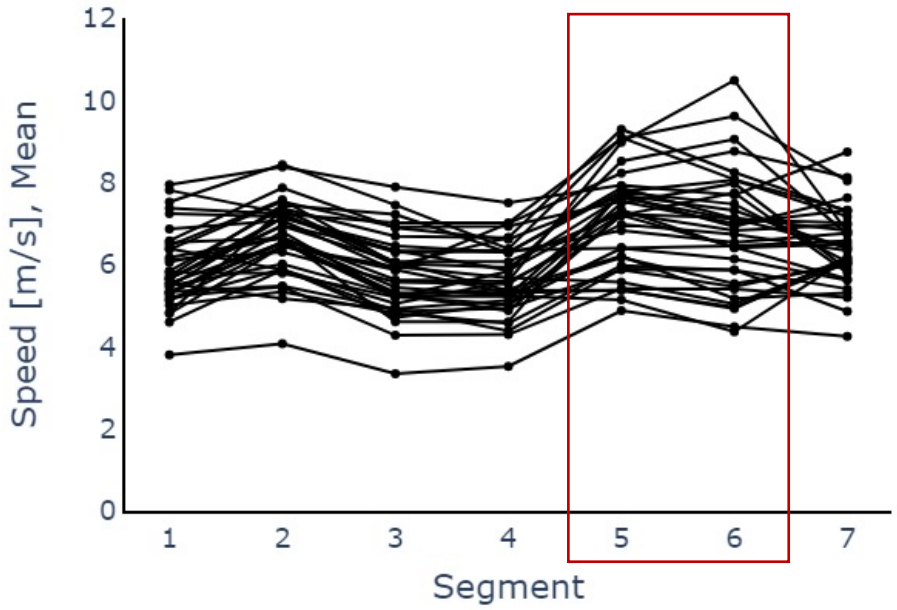
Unconstrained speed

Linköping: **36** participants

- (7) Flat and straight segments.





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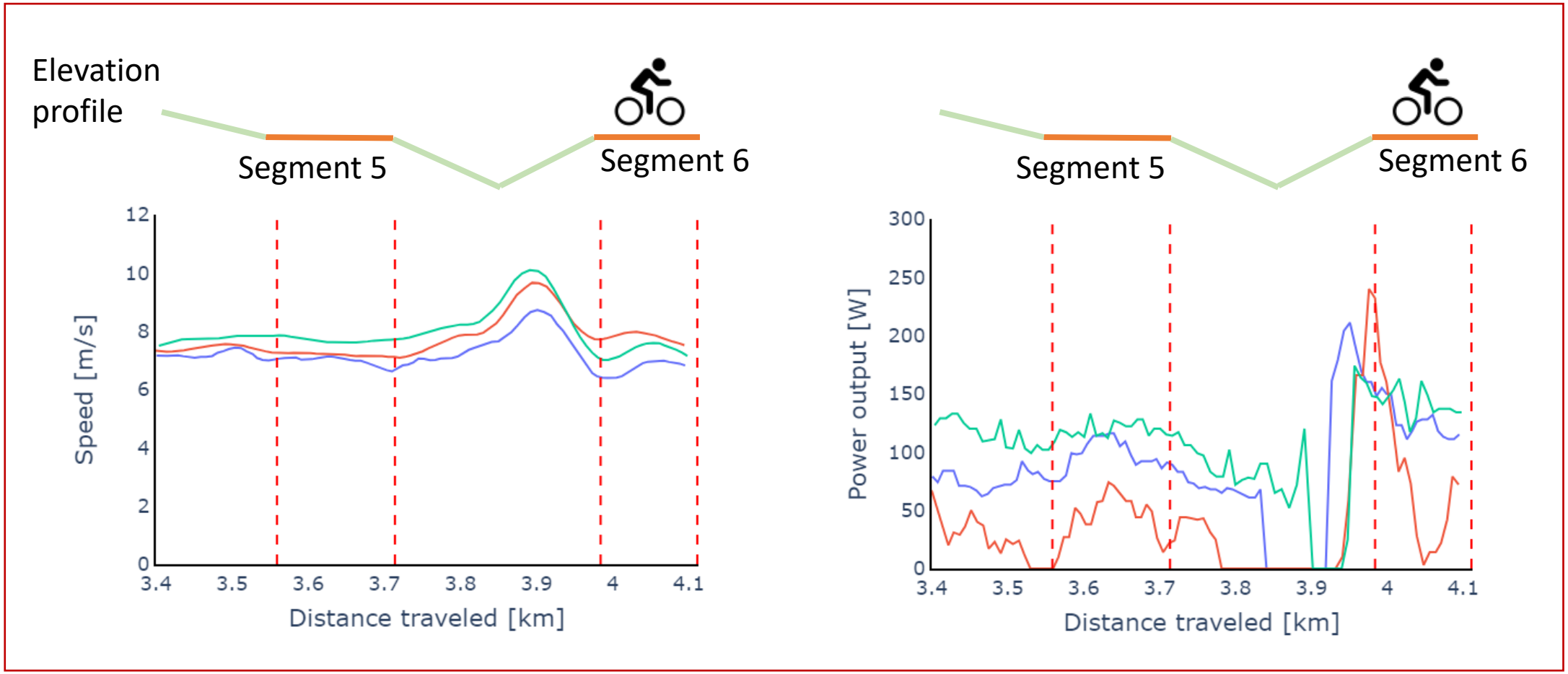
Speed/power output adaptation



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Gradient effects

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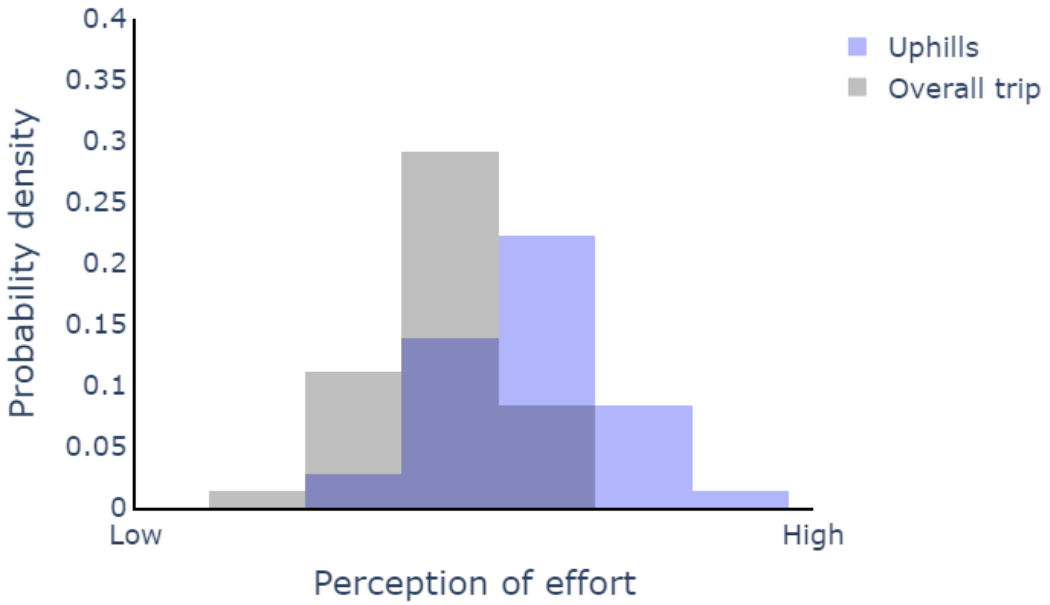
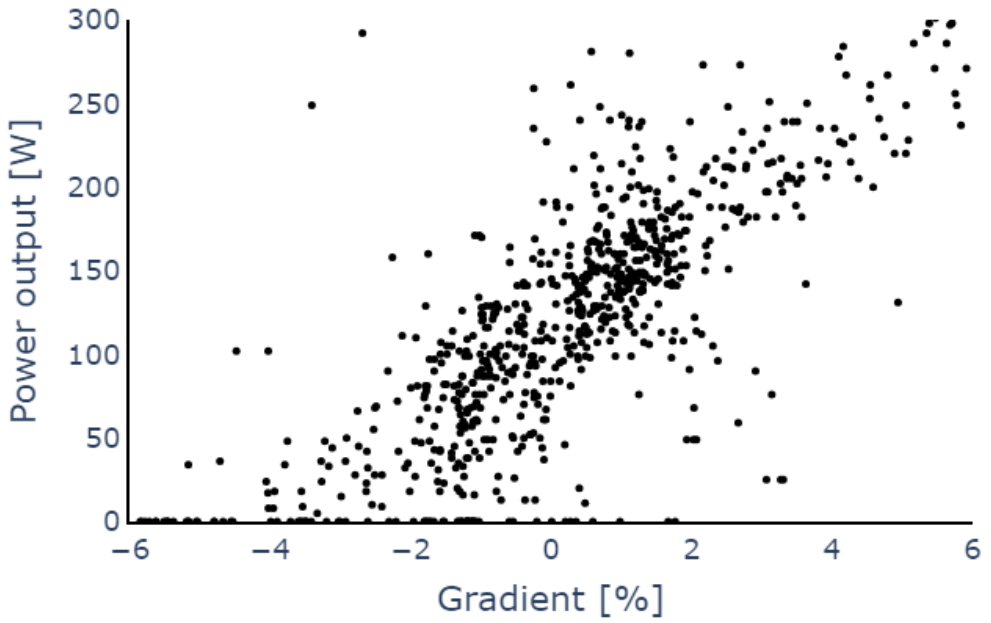


Single participant:



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Wind effects

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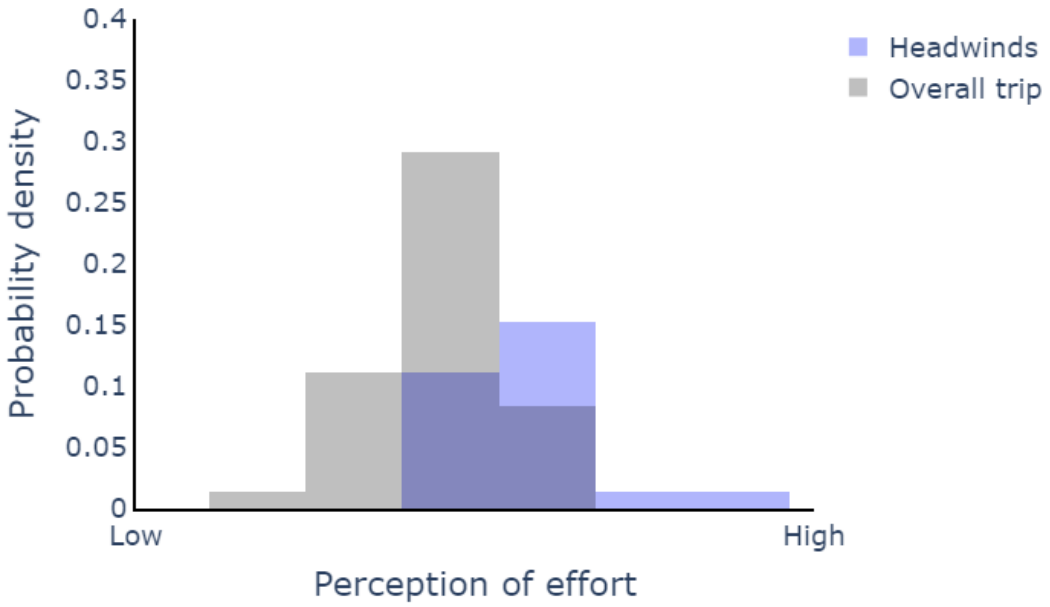
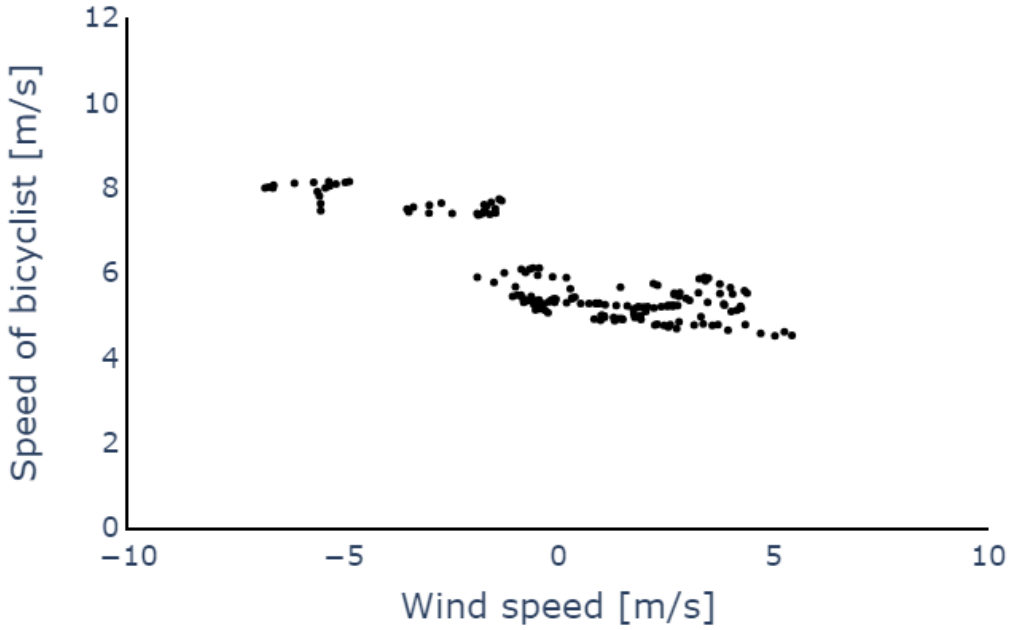


Single participant:



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Insights

- Speed choice of bicyclists is highly context-dependent.
  - Alignment (vertical/horizontal), and wind.
  - Temporal and spatial correlation.
  - A manifestation of preferred effort.
    - Possibility to model through power output.

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Thanks

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