Rider-centric Approach to Micromobility Safety

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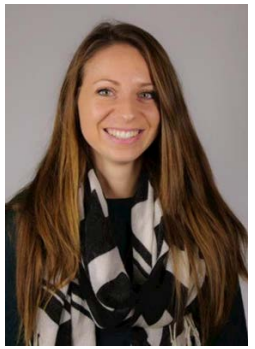
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Plus Shuxin Zhong, Zhiying Zhu, Kelcie Ralph, Evan Bregenzer

Research motivation

- Micromobility and active travel is more sustainable compared with driving.
- Yet, the adoption rate remain **LOW** in the U.S.
- Enhanced understanding of **subjective travel experiences/perceived safety** plays a key role in promoting micromobility and active travel

  - fearful, unsafe, stressful, vulnerable, discomfort
  - Cheerful, refreshing, exciting

How to measure subjective experiences?

Self-Report Survey

Directly ask respondents to rate the travel stress level

*Gold standard

Heart Rate Tracker

Collect heartbeat data to calculate metrics to evaluate stress level

*Most frequently used in active travel stress literature

EDA (GSR)

Collect skin conductivity data to evaluate stress level

*Widely used in active travel stress literature

** motion and humidity sensitive

Eye Trackers

Collect eye gaze behaviors to understand traveler's workload

*Emerging and inconclusive

** weather and eye constraints

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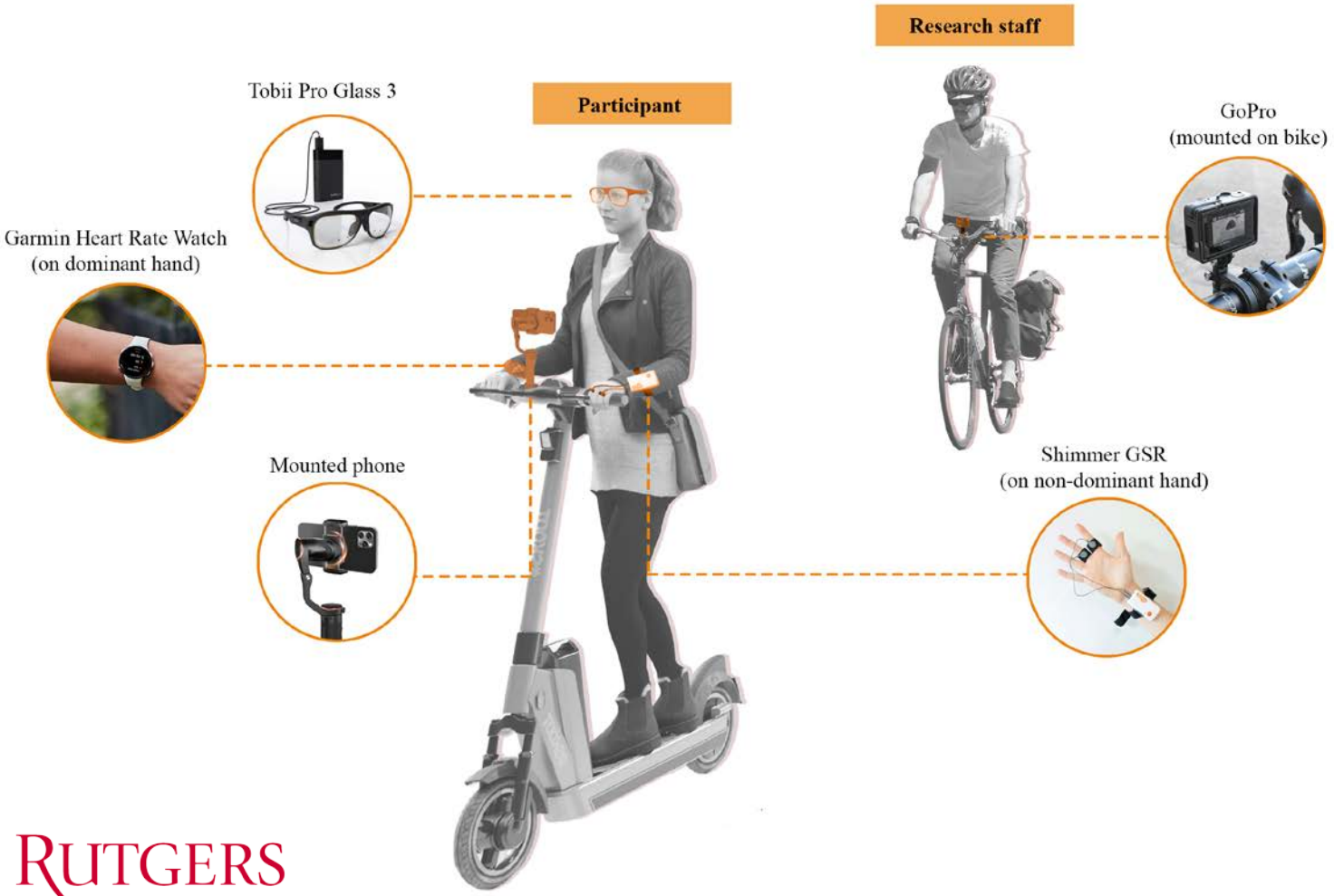
Semi-naturalistic E-scooter Riding Experiment



Biometrics Sensors

- Eye Tracking Glass
- Galvanic Skin Response (GSR) Sensor
- Heart Rate Monitor

GPS Sensor

Phone

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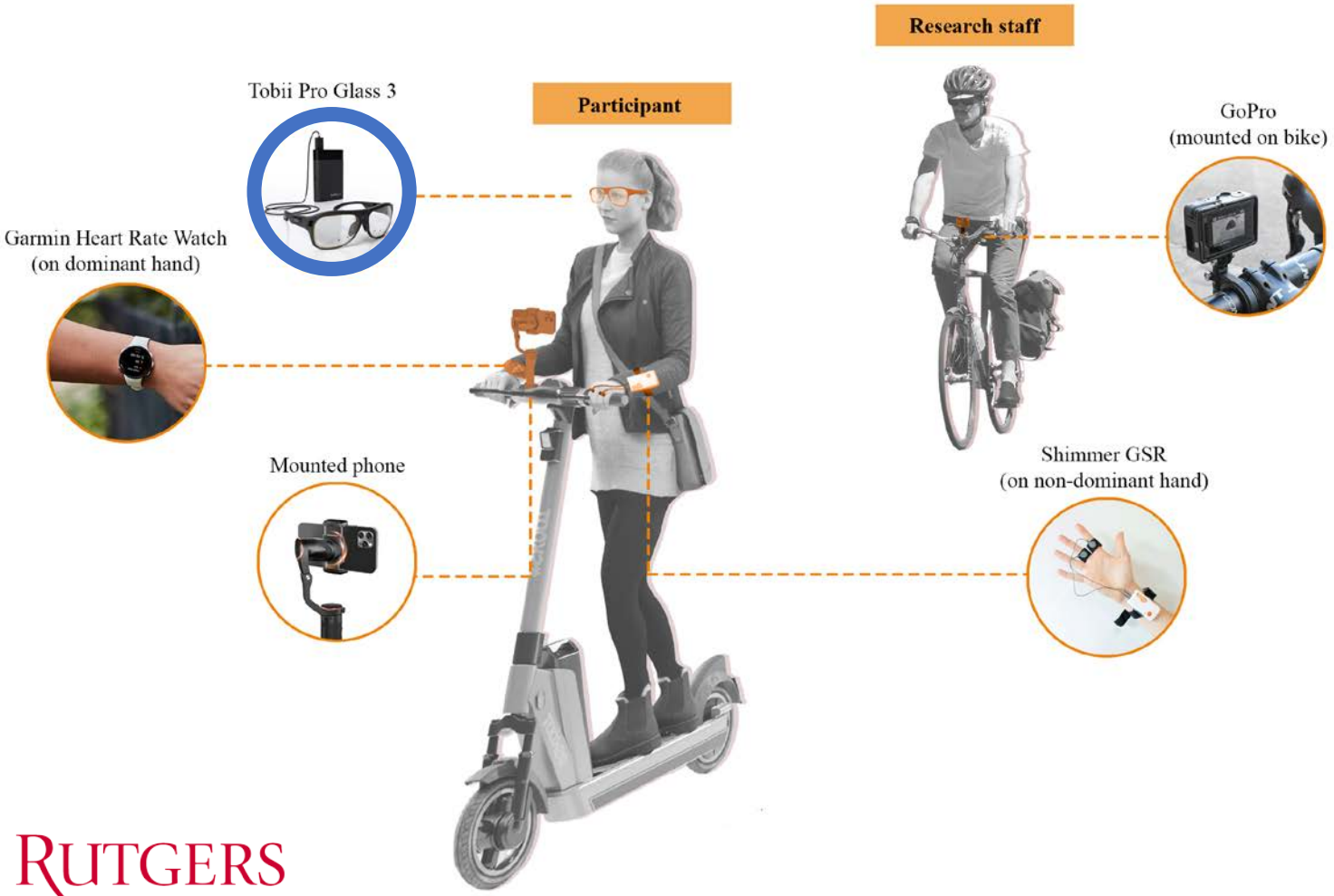
Semi-naturalistic E-scooter Riding Experiment



Eye Tracking Glass

Data Collected

- World View Video
- Eye Fixation Point
- Pupil Dilation

Measurements

- Gaze patterns
- Gaze metrics-based stress level measurement

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Semi-naturalistic E-scooter Riding Experiment

Galvanic Skin Response (GSR) Sensor

Data Collected

- Skin Conductance Level

Measurements

- Emotion arousal (sad, anger, excitement, scared)

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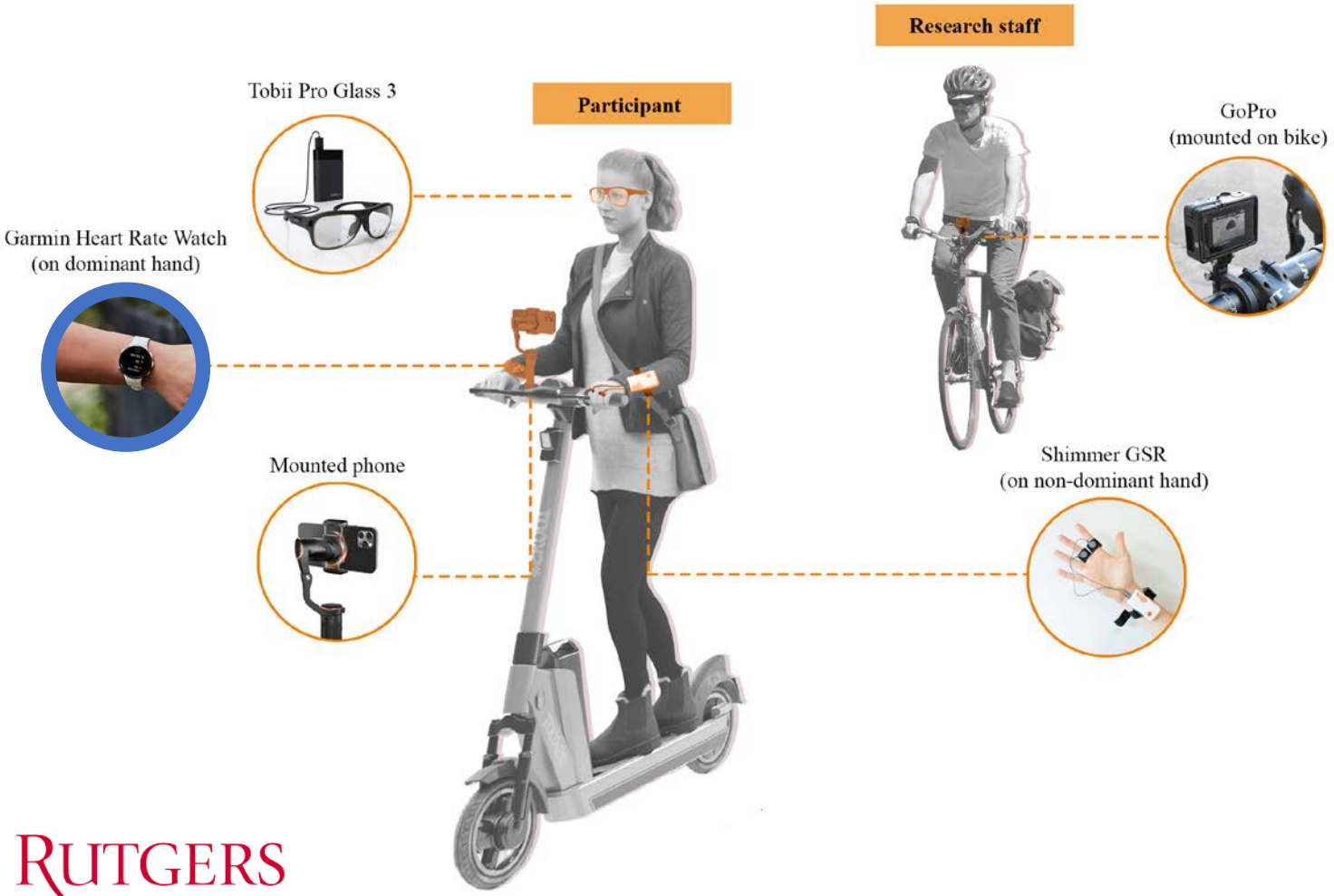
Semi-naturalistic E-scooter Riding Experiment



Heart Rate Monitor

Data Collected

- Heart Rate Beat to Beat Time

Measurements

- Heart Rate Variability (HRV) to measure stress level

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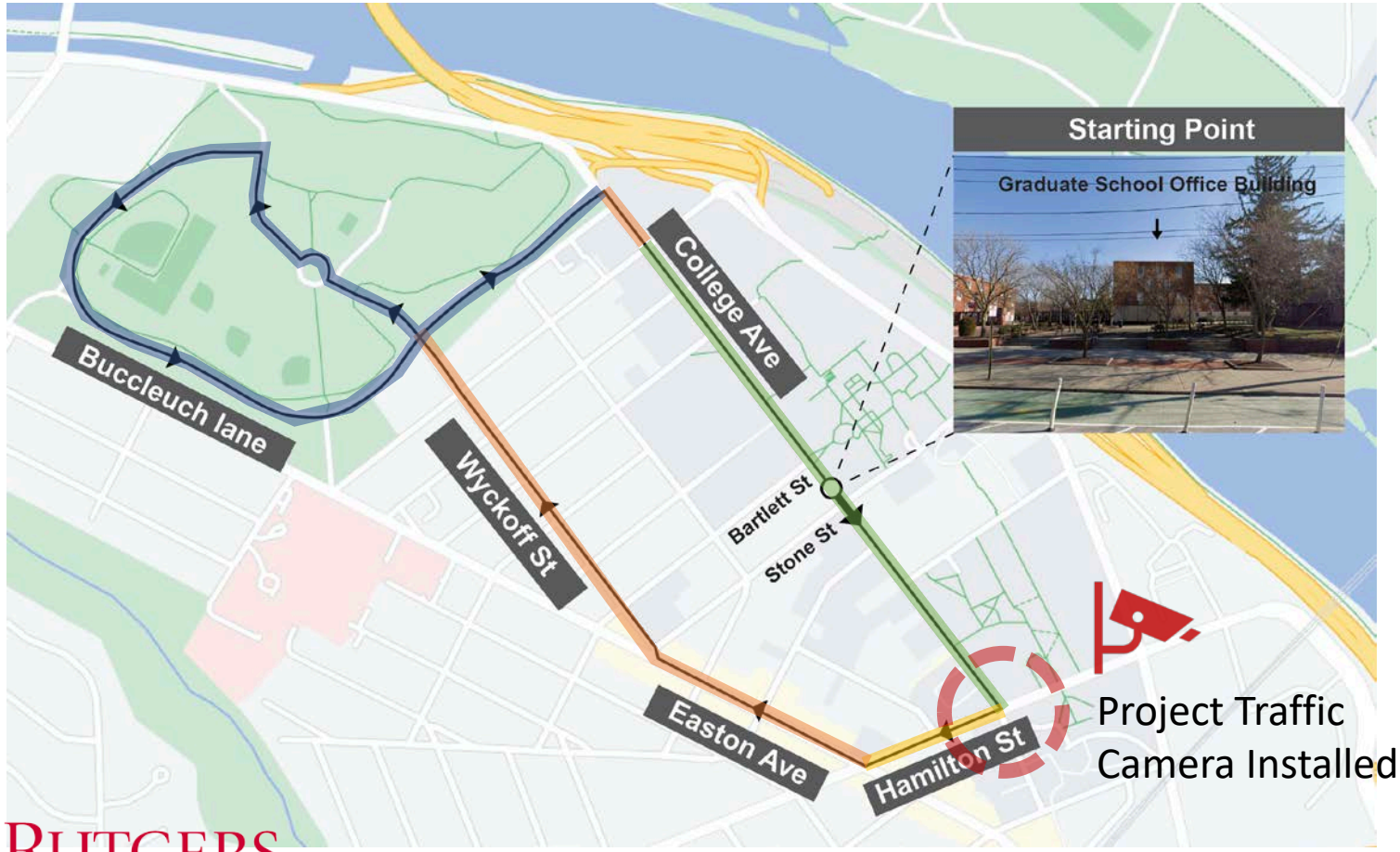
Semi-naturalistic E-scooter Riding Experiment



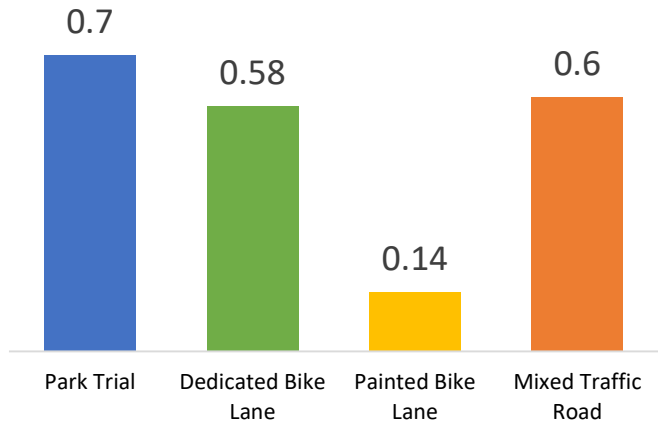
Park Trial

Dedicated Bike Lane

Painted Bike Lane

Mixed Traffic

Total 2 mi, ~15-min ride



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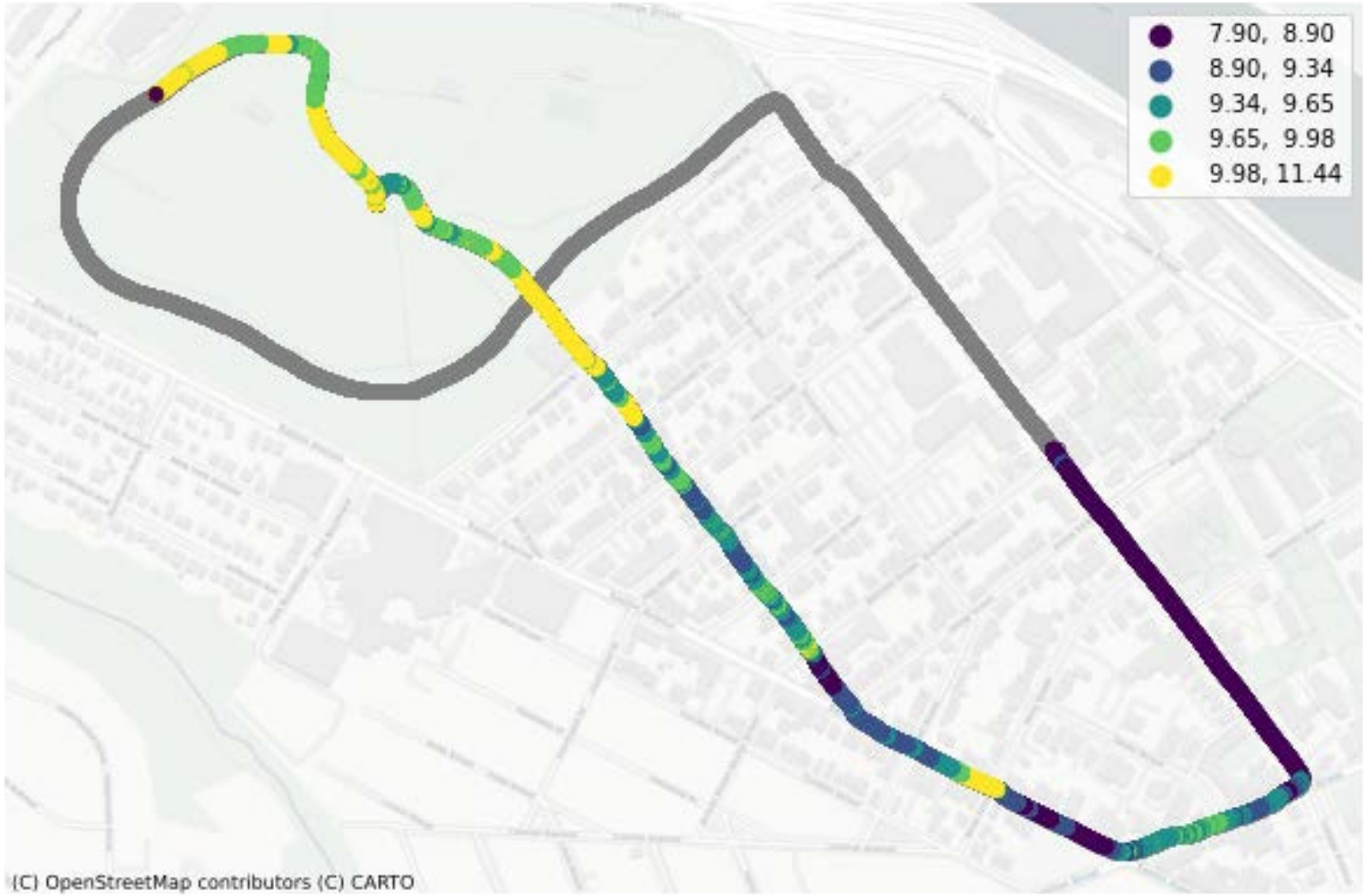
Stress Level

- Sensor dropped in park due to uneven pavement

GSR, Skin Conductance Level (μs)



*Quantile color scheme

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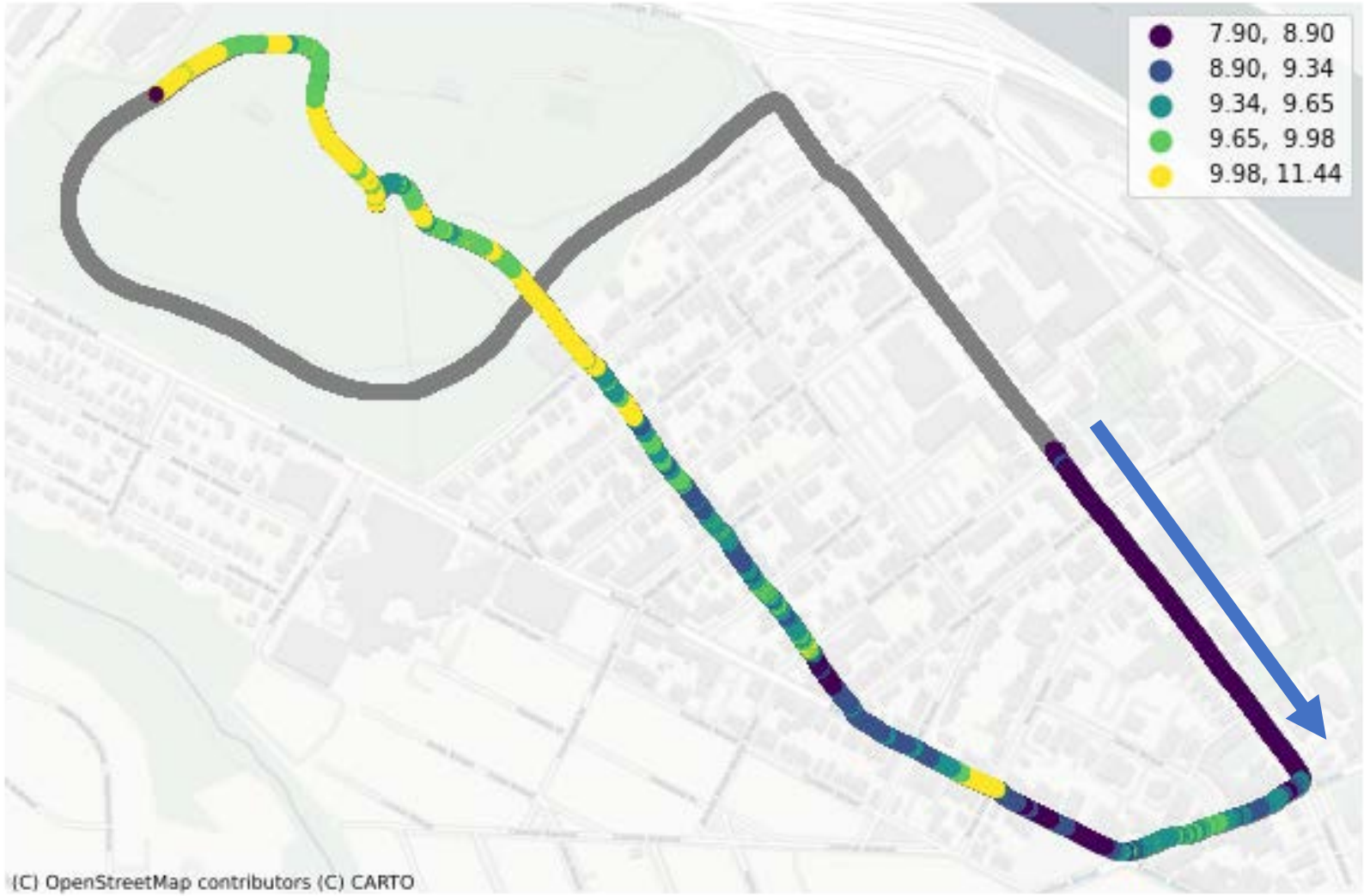
Stress Level

- Sensor dropped in park due to uneven pavement
- Lowest when there is dedicated bike lane

GSR, Skin Conductance Level (μs)



*Quantile color scheme

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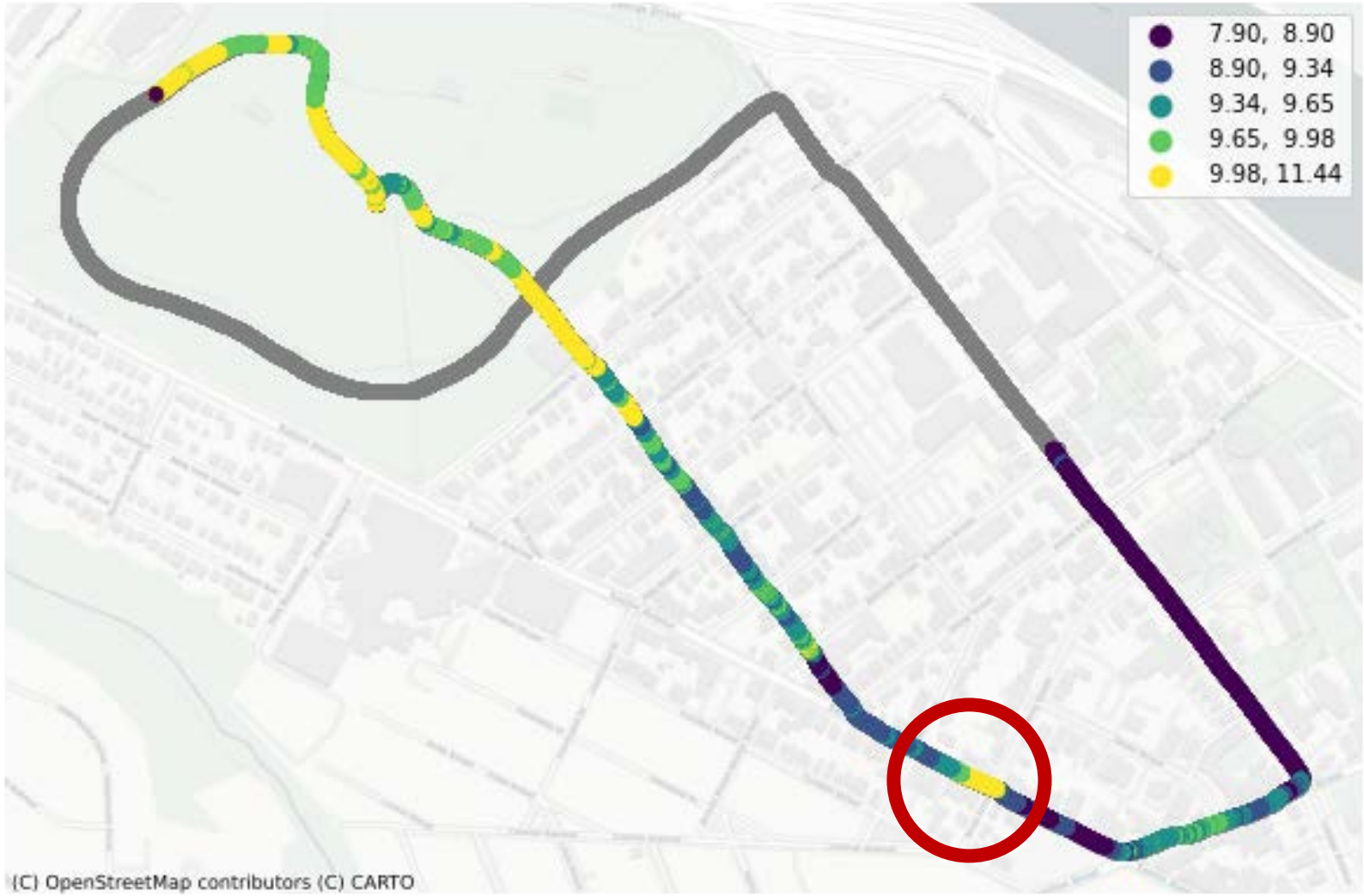
Stress Level

- Sensor dropped in park due to uneven pavement
- Lowest when there is dedicated bike lane
- Captured a **near-miss** event Easton & Mine Street
- High in the park due to bad pavement condition

GSR, Skin Conductance Level (μs)



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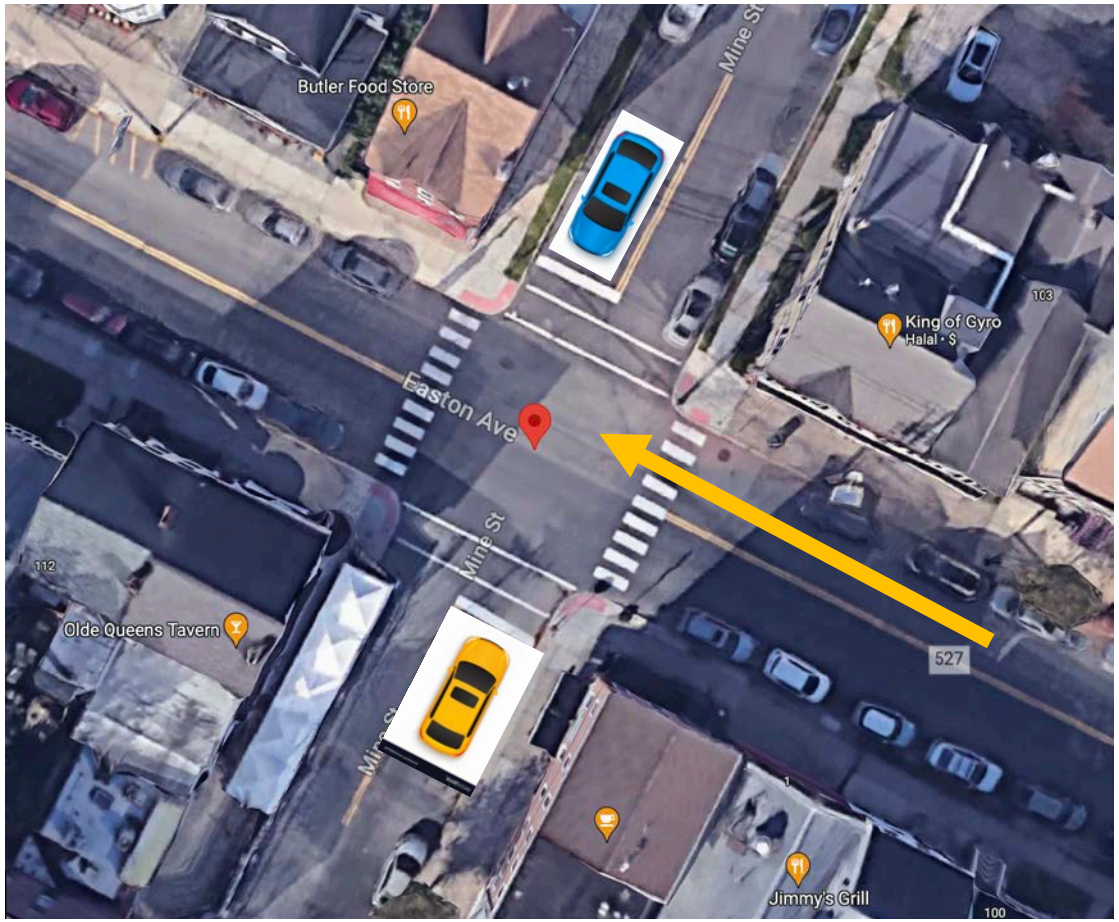
Near Miss Event



- Non-signalized intersection with Stop Sign on Mine St.
- E-scooter traveling on Easton Ave
- One vehicle (yellow car) traveling from west bound Mine Street, yielded to e-scooter
- One vehicle traveling from the east bound Mine Street, fail to yield

While we are still collecting more e-scooter data,
We have completed our WALKING experiment data collection.

Walking Experiment

Apparatus

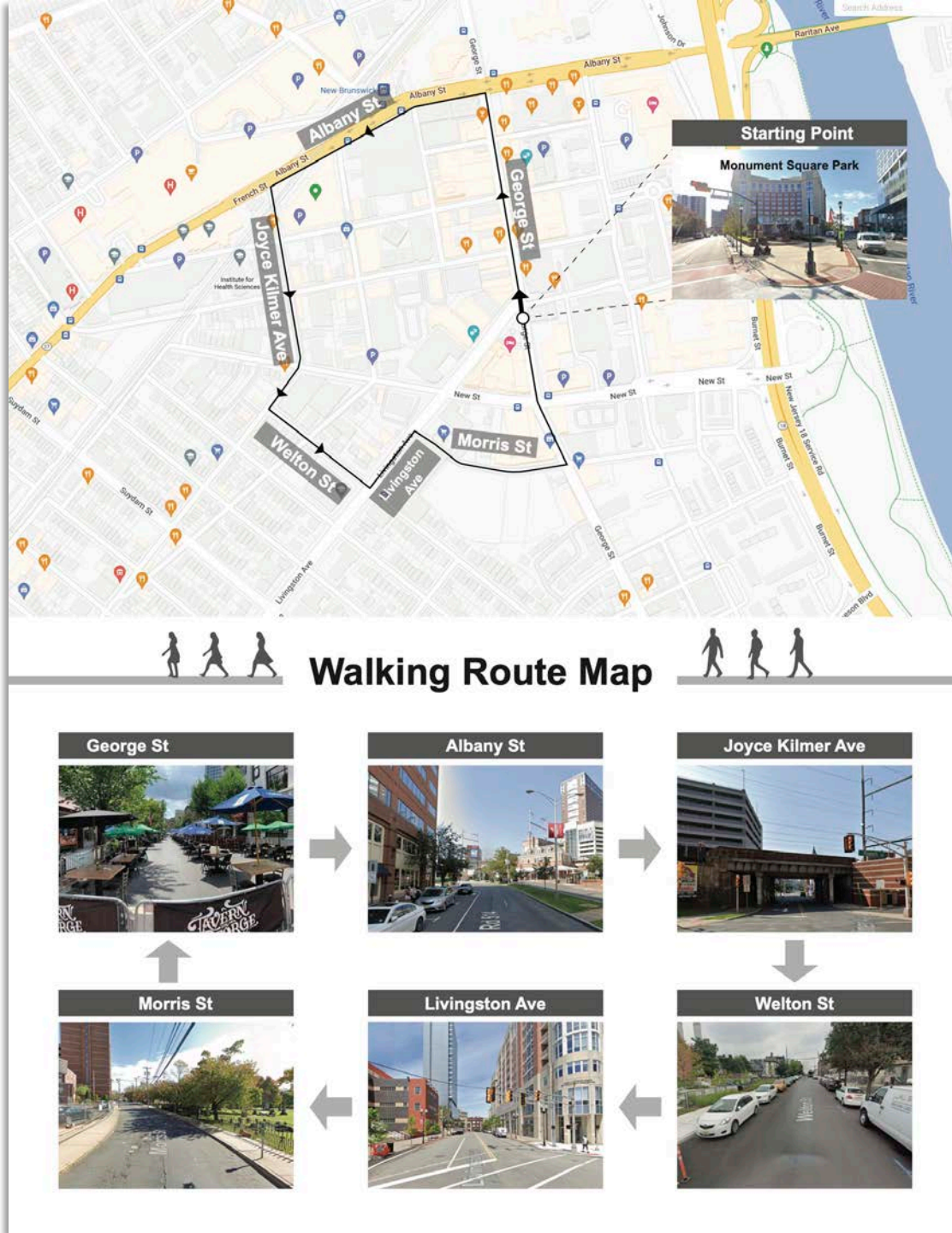
- Shimmer 3 (GSR)
- Garmin Watch (HR, GPS)
- Tobii Pro 3 (Eye movement)

1.2 Miles (~25 minutes) Route

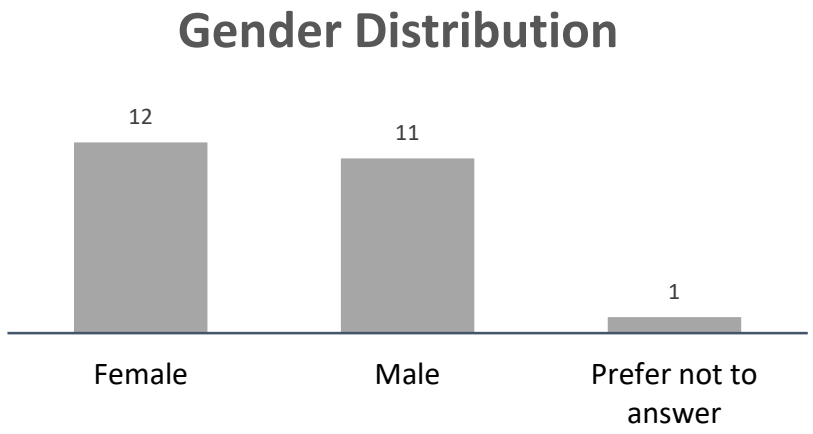
Surveys

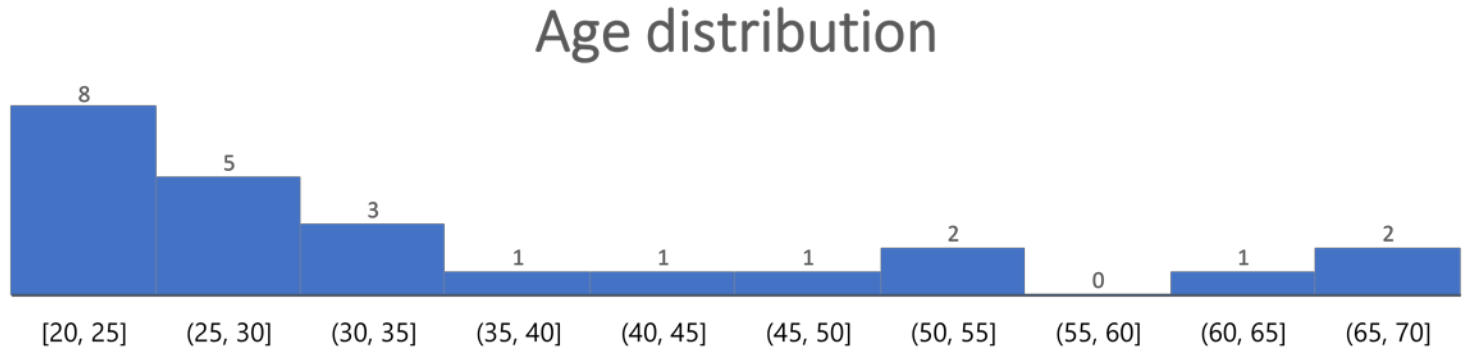
- Pre-experiment: eligibility criteria
- Post-experiment: trip perception, travel behavior, demographics

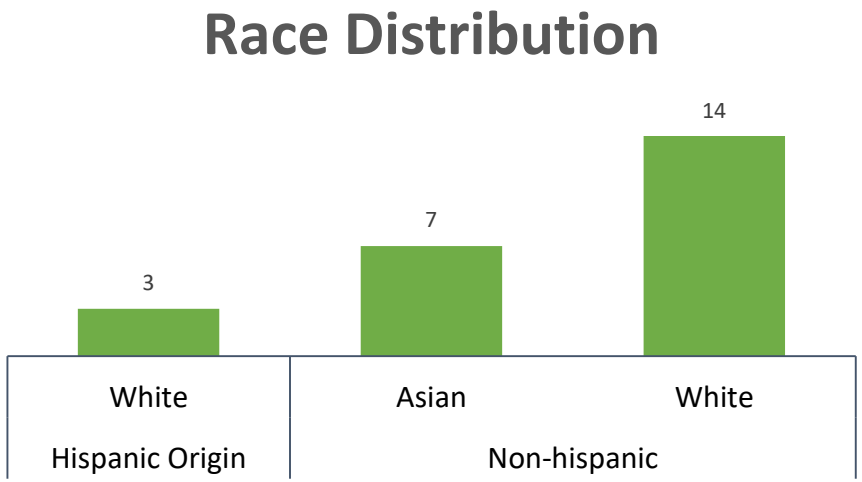
* Bicycle and e-scootering experiments are on the way

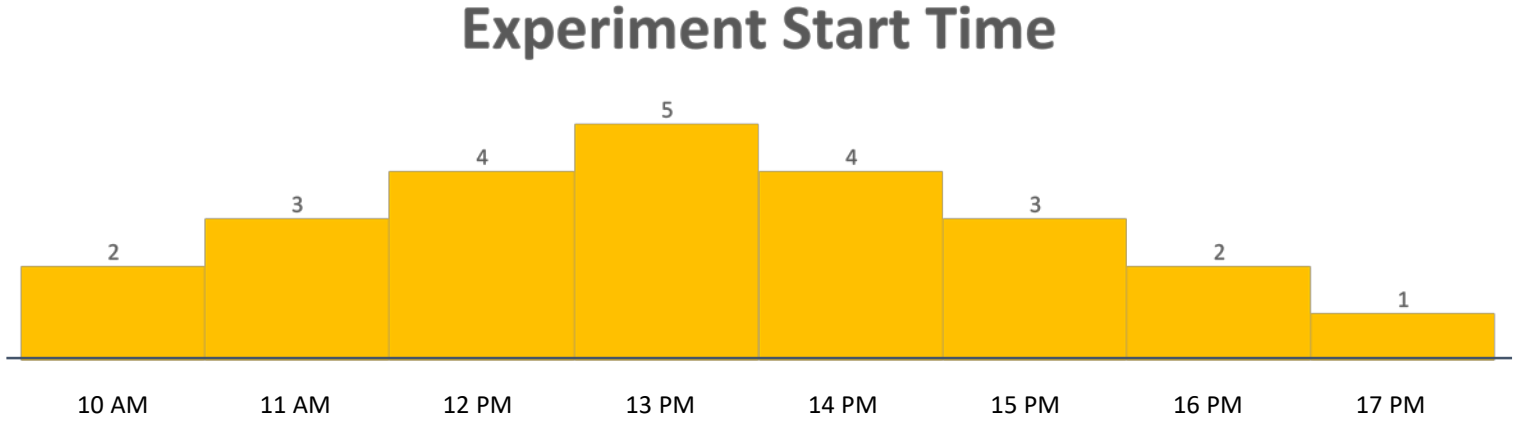


Participant recruitment result： 24 volunteers



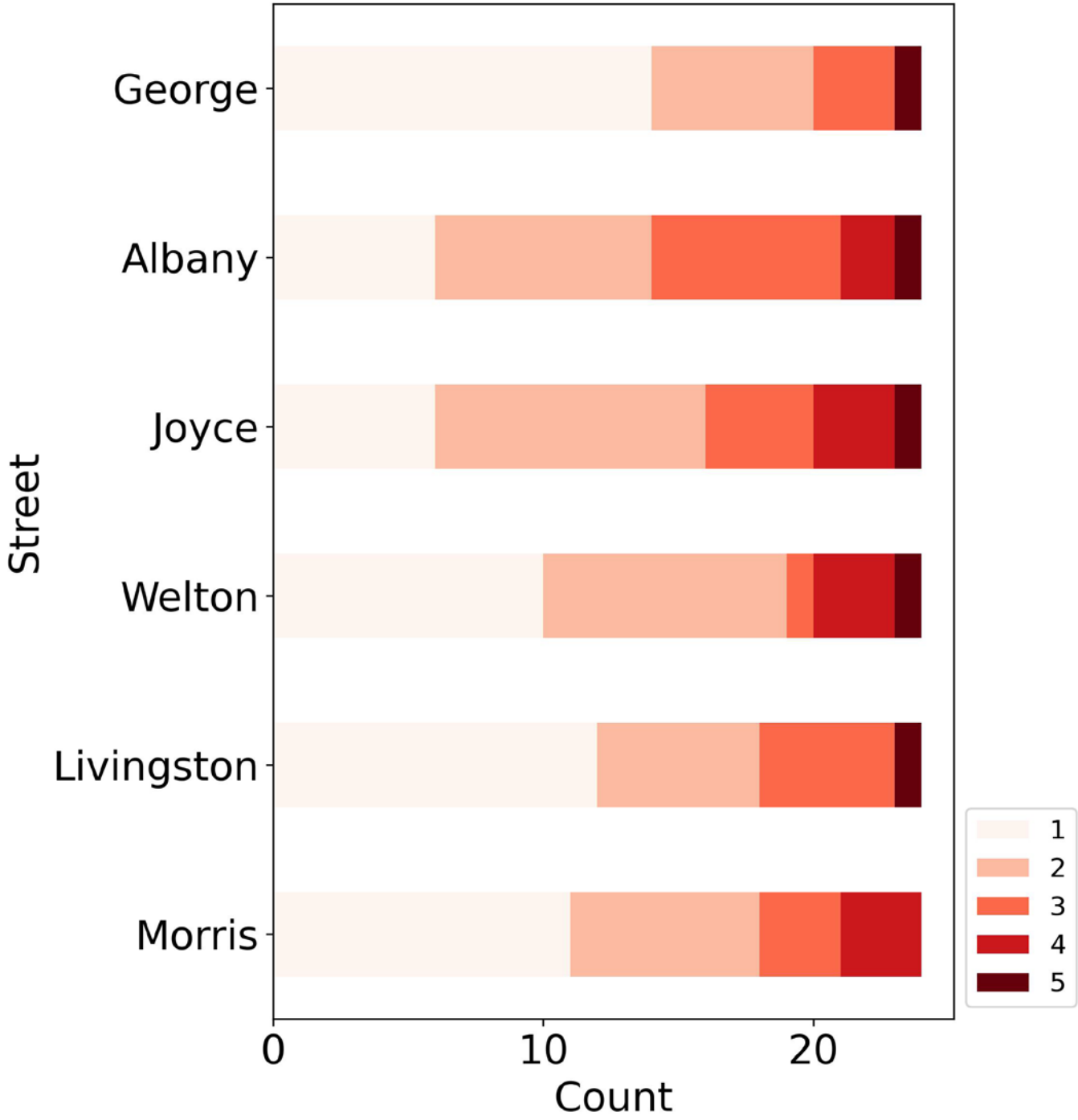






Survey Results

- George street is considered as most relaxing
- Most people feel stressful on Albany and Joyce Kilmer streets

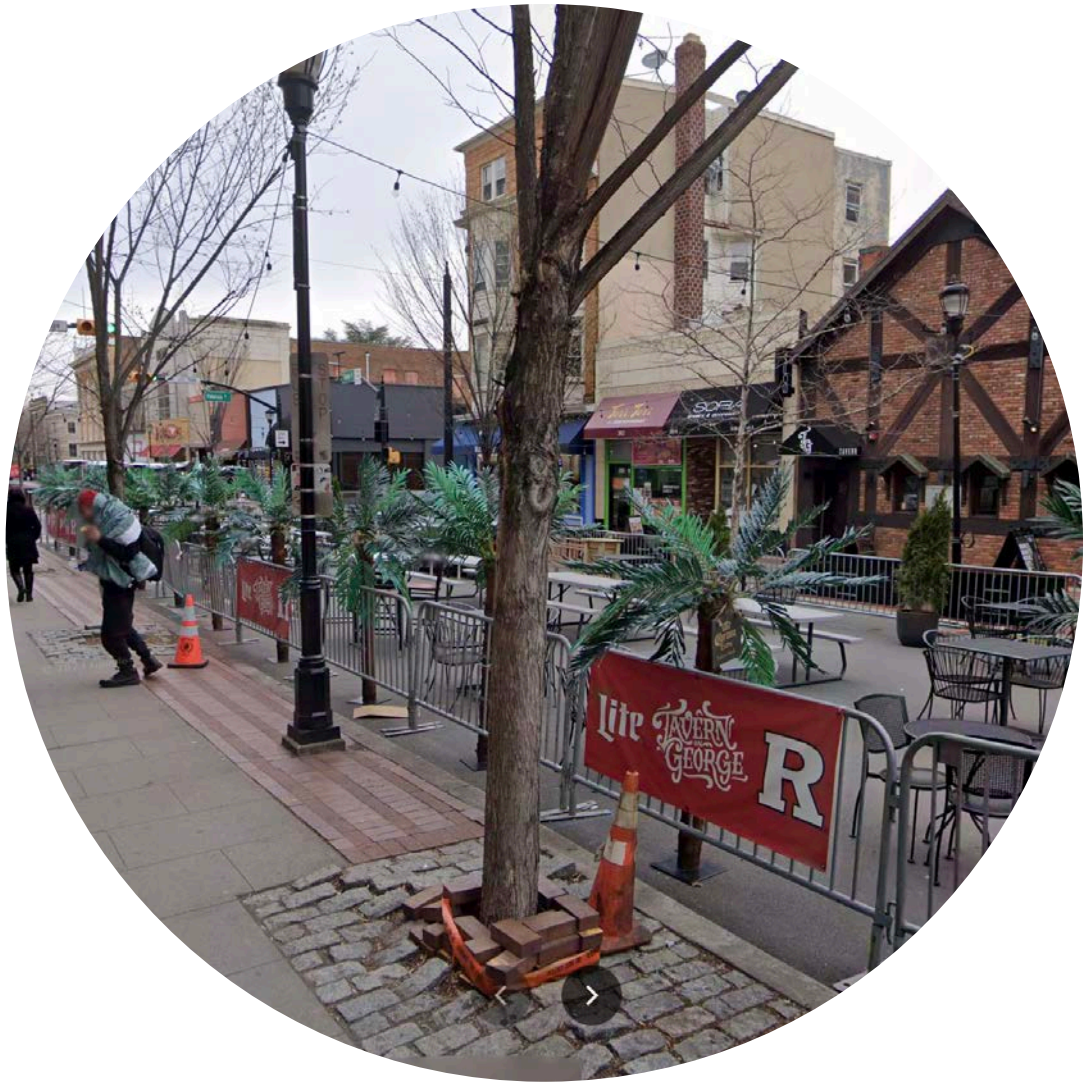


Survey Results

- George street is considered as most relaxing

  - I like that there are **no cars** and a lot of **business** and **people** hanging out
  - specialty shops, food **places**, little markets
  - **nice ambience**

  - sometimes **cars** go on red from the cross streets since george st is closed. they assume pedestrians don't matter
  - busy sidewalk, **confusing** temporary barriers
  - a little **crowded**
  - Very high **police presence**

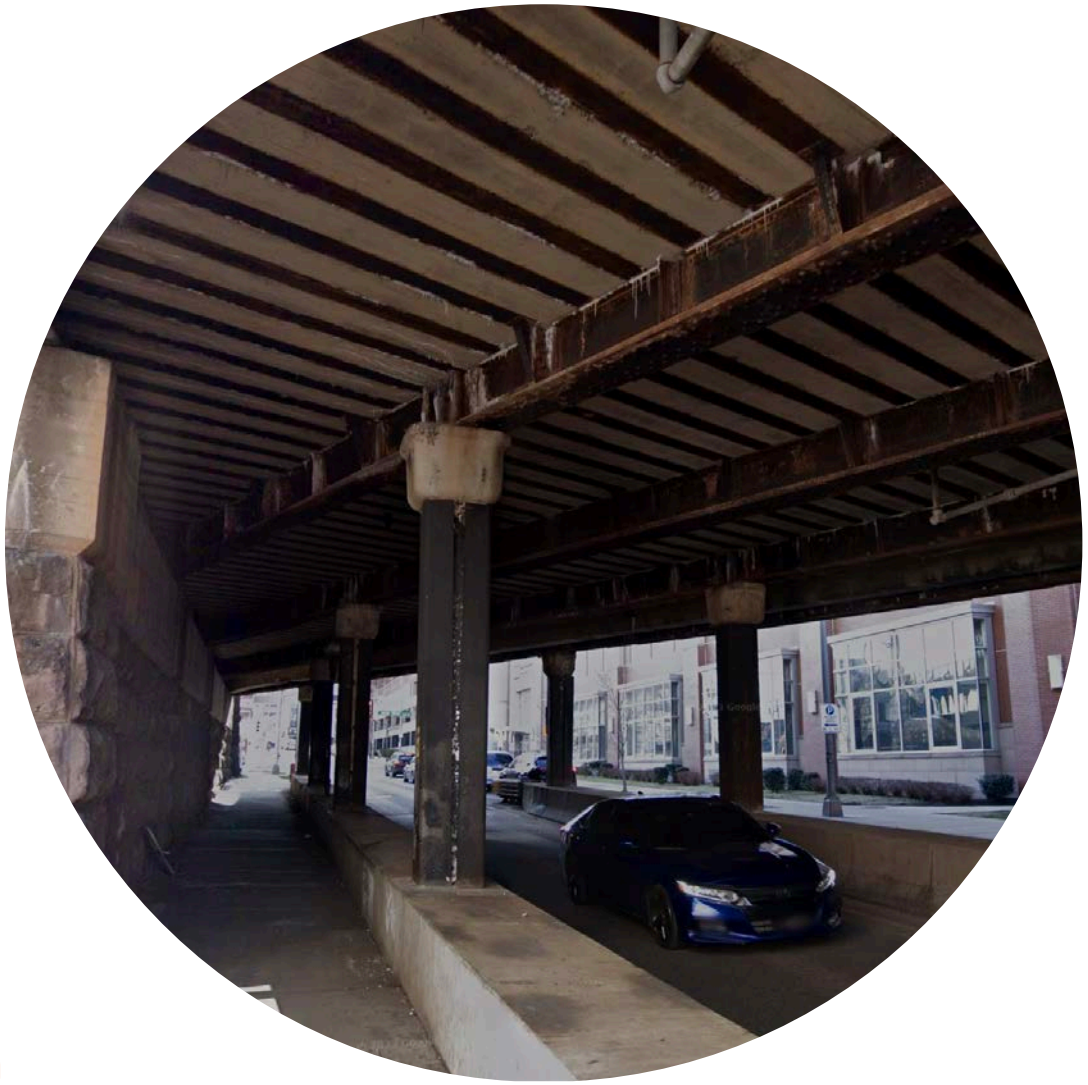


Survey Results

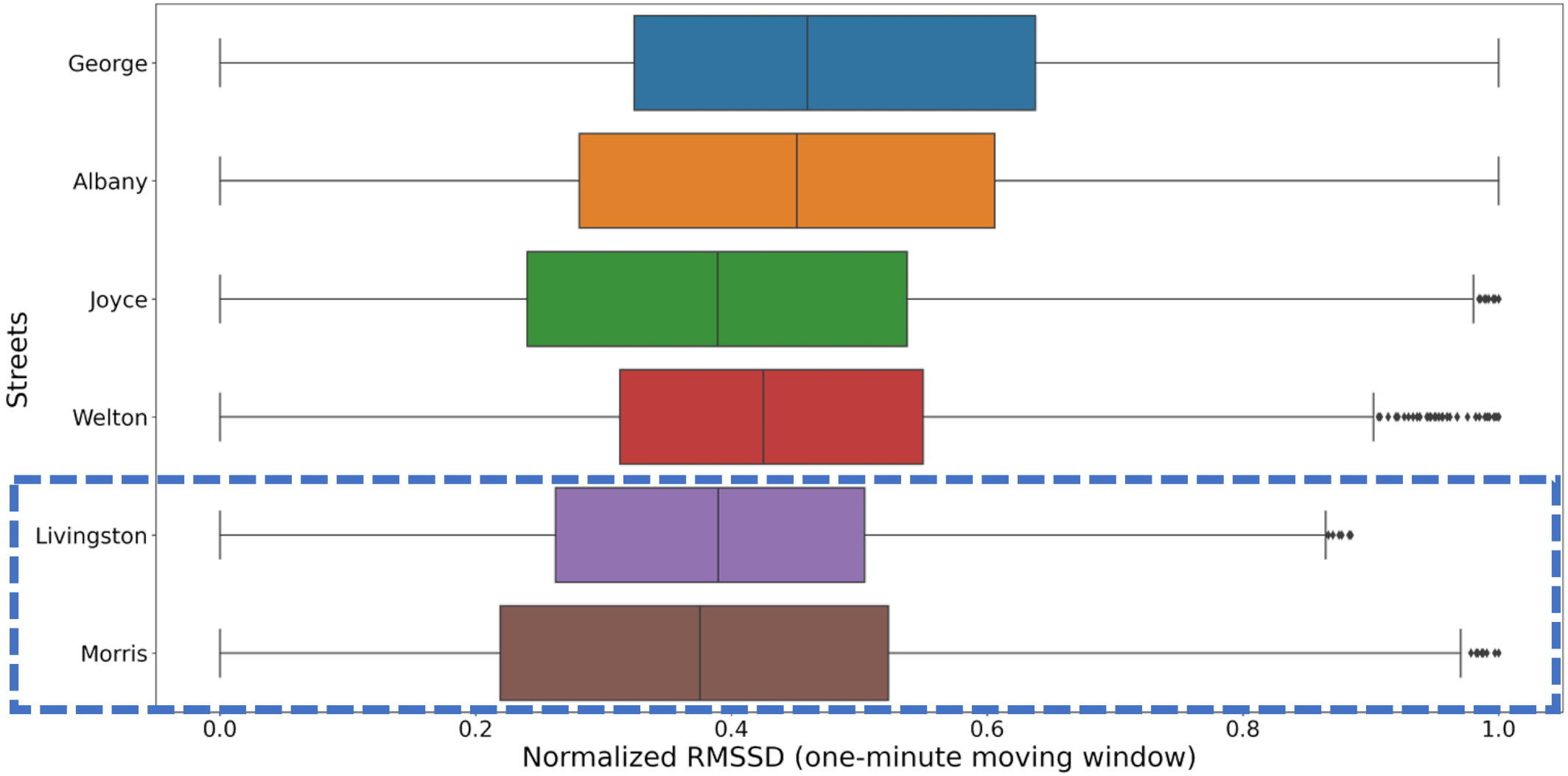
- Albany and Joyce is considered as most stressful

  - **wide sidewalks** sometimes
  - long sight lines**, train tracks**

  - **too many cars** and trucks. **intersection** w/ easton is bad
  - **Not enough green** here too much traffic
  - **High police presence**. **water dripping** from overpasses
  - cars honking, car parked on crosswalk, people stranded in the median, **driver yelling**

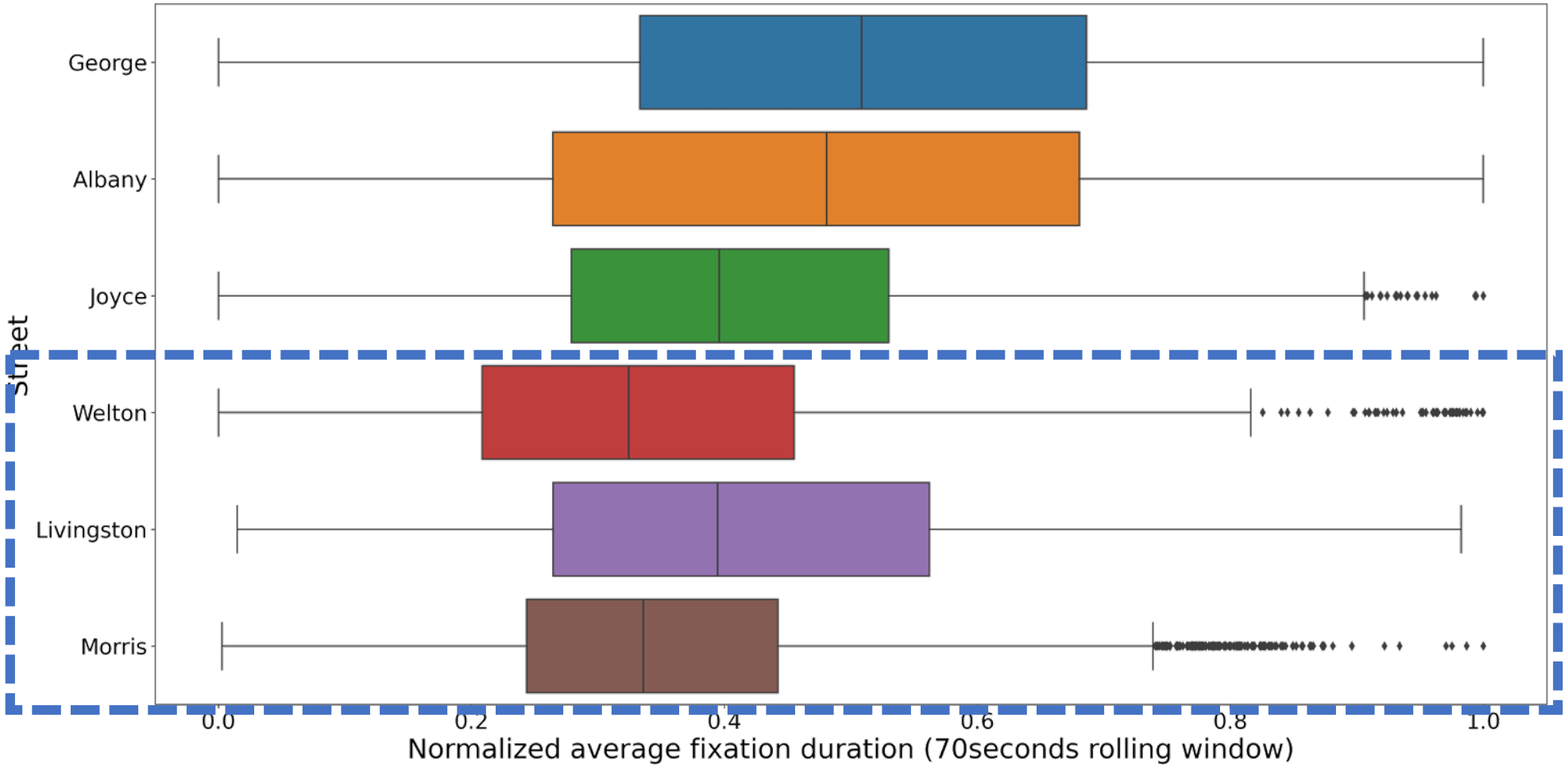


Heart Rate Variability



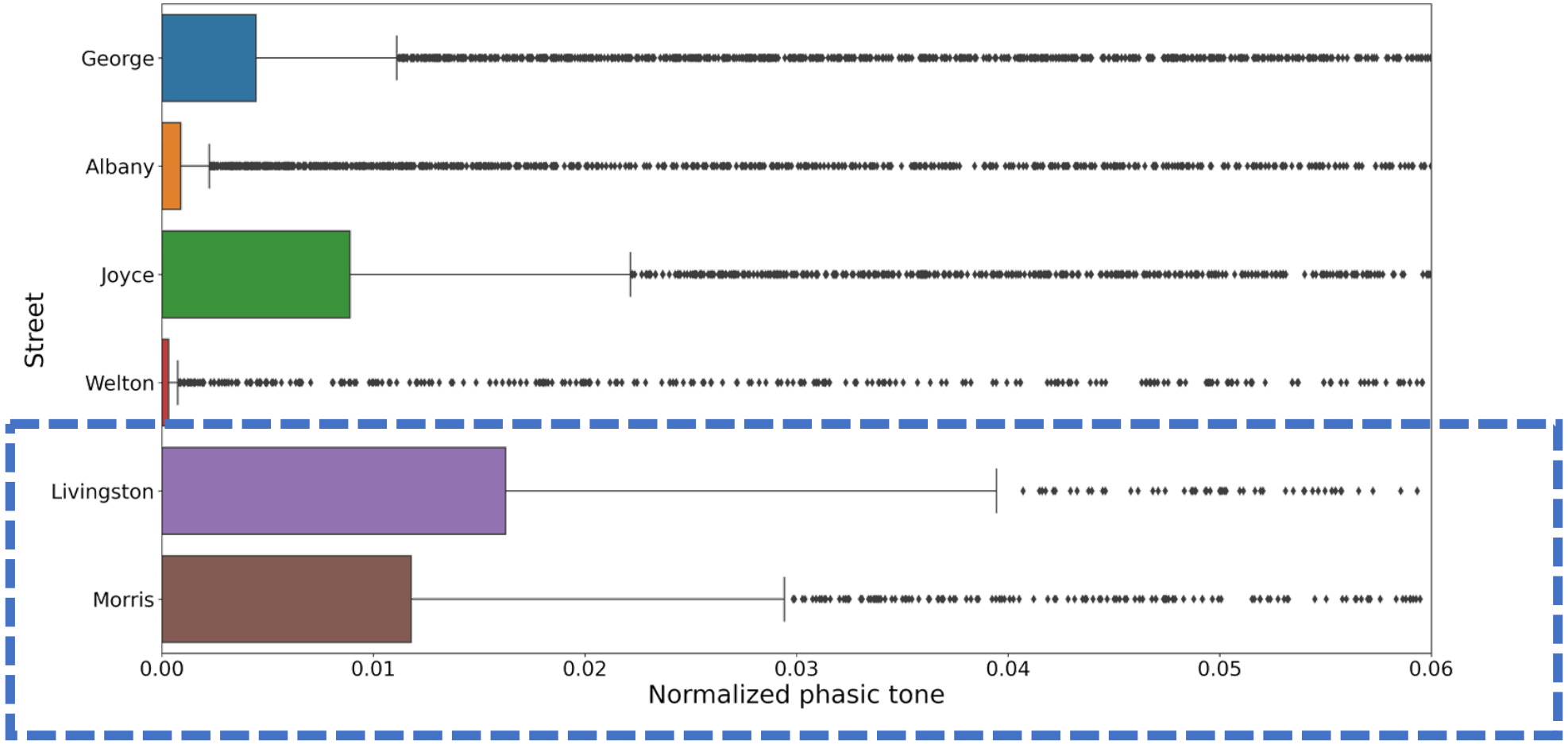
Eye tracking – Average Fixation Duration

+ Some observation periods are removed due to low eye tracking rates, especially on Albany Street when walking towards the sun.



Preliminary GSR Results

- Still exploring various GSR data preprocessing and phasic tones extraction algorithms

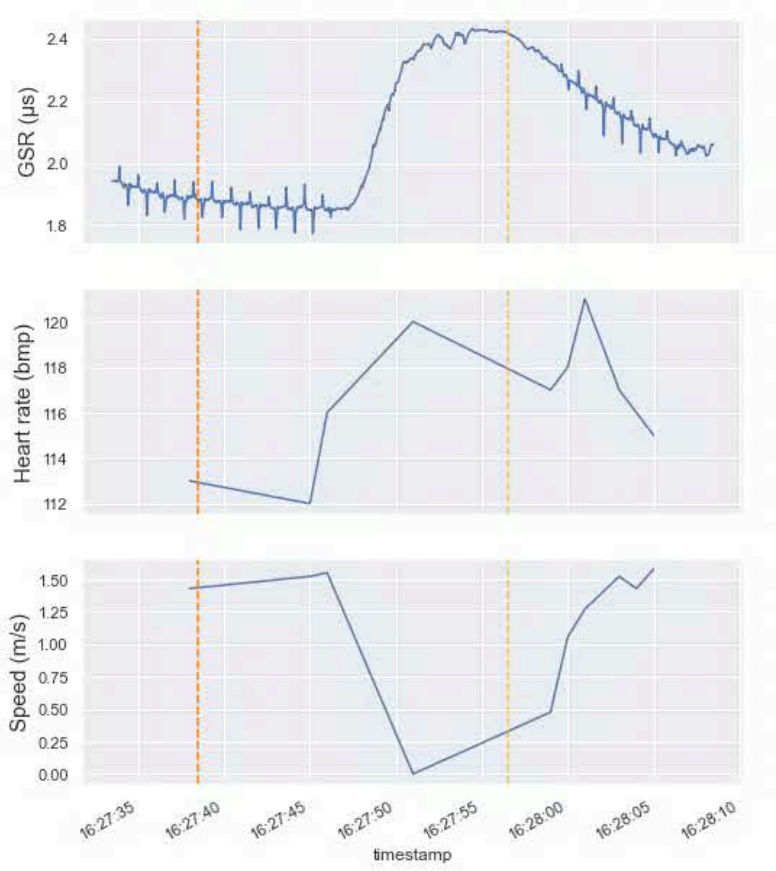


Livingston & Morris Intersection

- Survey comments
  - “Crossing Livingston intersection to morris is **stressful**”
  - “The intersection **needs signal**”

GSR does capture stress level in real-time

GSR also captures positive feelings



Navigation Patterns

- Area of Interest (AoI) analysis
- Deep learning image segmentation
- Automatically classifies images into over 40 categories

Video Image

PSPNet Segmented Video Image

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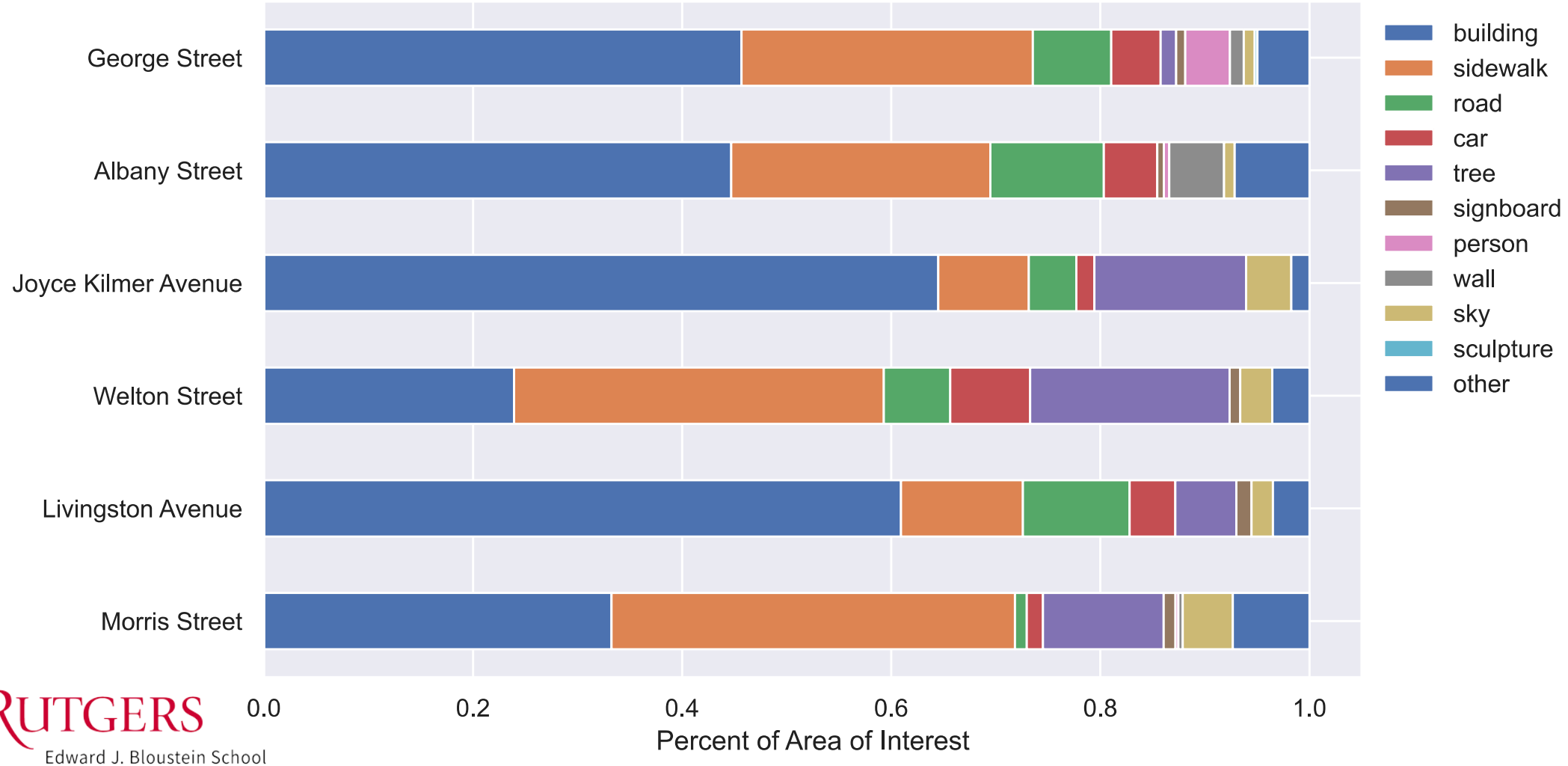
Navigation Patterns



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Next Steps

- Collect more sample data
- Develop descriptive statistics and models to explore the association between perceived environment and physical environment, and perceived environment and stress level
- Explore heterogeneity in risk perception (by gender, age)

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Thank you!

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