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Measuring and Modeling Cyclists' Comfort and Stress Levels

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Measuring and modeling cyclists' comfort and stress levels

Presenter: Miguel Figliozzi

Professor of Civil and Environmental Engineering

PSU Friday Seminar, Fri. March 11th, 2016

Motivation

- Recent interest to study cyclists' levels of traffic stress, e.g. Furth and Mekuria 2013.

- HCM Bicycle LOS

- Other "stress" or "comfort" measures

Terminology

The term "stress" is commonly understood as the opposite of "comfort"

One definition of "comfortable" is "free from stress or tension"

Merrian-Webster online dictionary

Outline

1. Modeling data collected utilizing a smartphone app called ORcycle

2. Real-world, on-road measurements of physiological stress

3. Discussion, policy implications and next steps

ORcycle Project

- Smartphone app to collect cyclists data

- *Available for iOS and Android*

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5

ORcycle Project Goals

- Pilot a cheaper and easier method to collect bicycle data

- Understand impacts of riding skills and personal characteristics on choices

- *Quantify the underreporting of safety data (crashes &. near-misses)*

- *Learn where cyclists travel and their level of traffic and cycling stress*

ORcycle: 4 basic parts

- Record Trips

- Report Safety Issues
  - Crash or near-miss
  - Safety problem (e.g. uneven pavement)

- User Data
  - Biking habits and socio-demographic (optional)

- Links to maps and to report to ODOT

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Trip Questions

Questions after completing a trip:

- Purpose

- *Frequency*

- *Route choice factors*

- *Comfort level*

- *Safety concerns? (optional)*
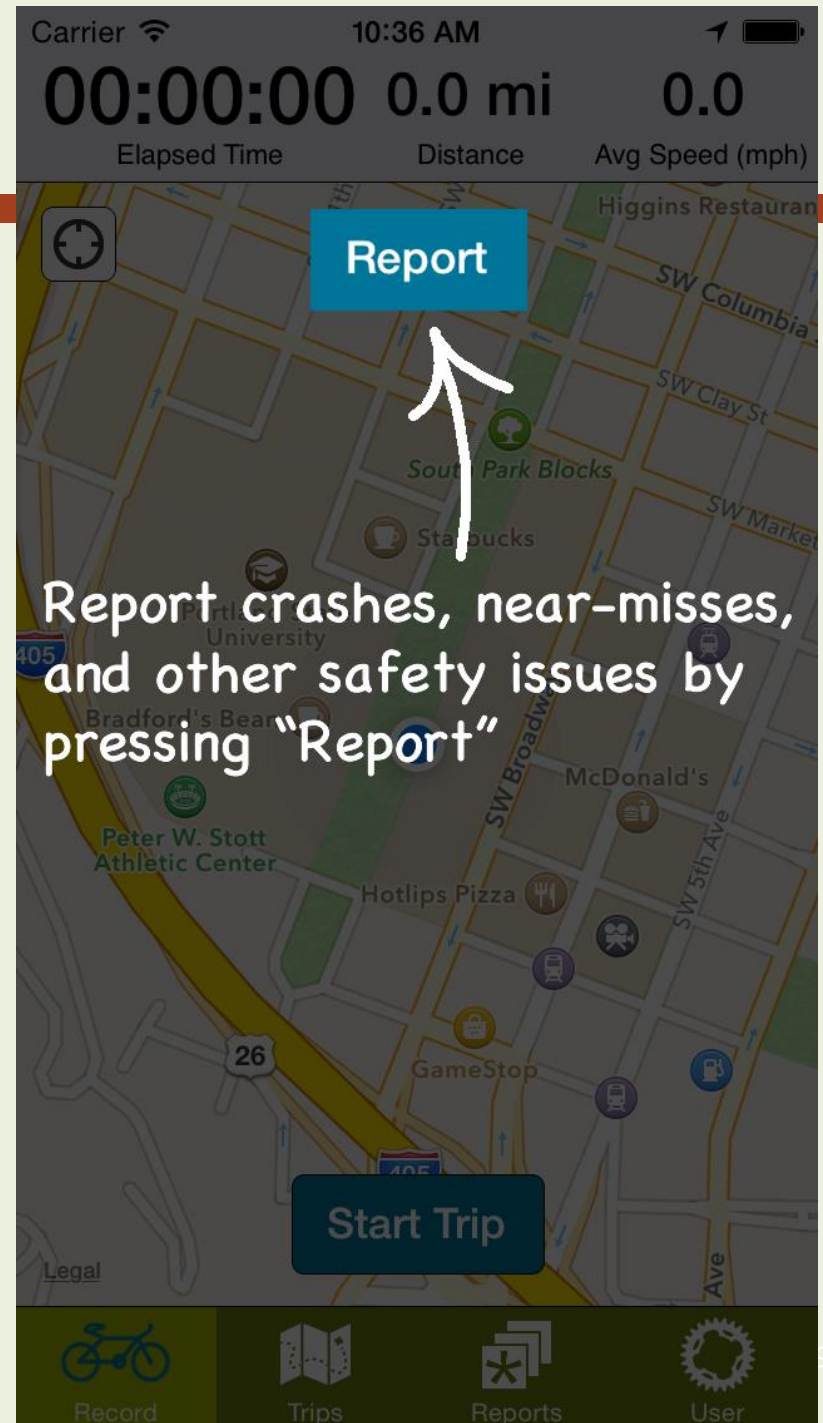
- *Additional comments?* (optional)
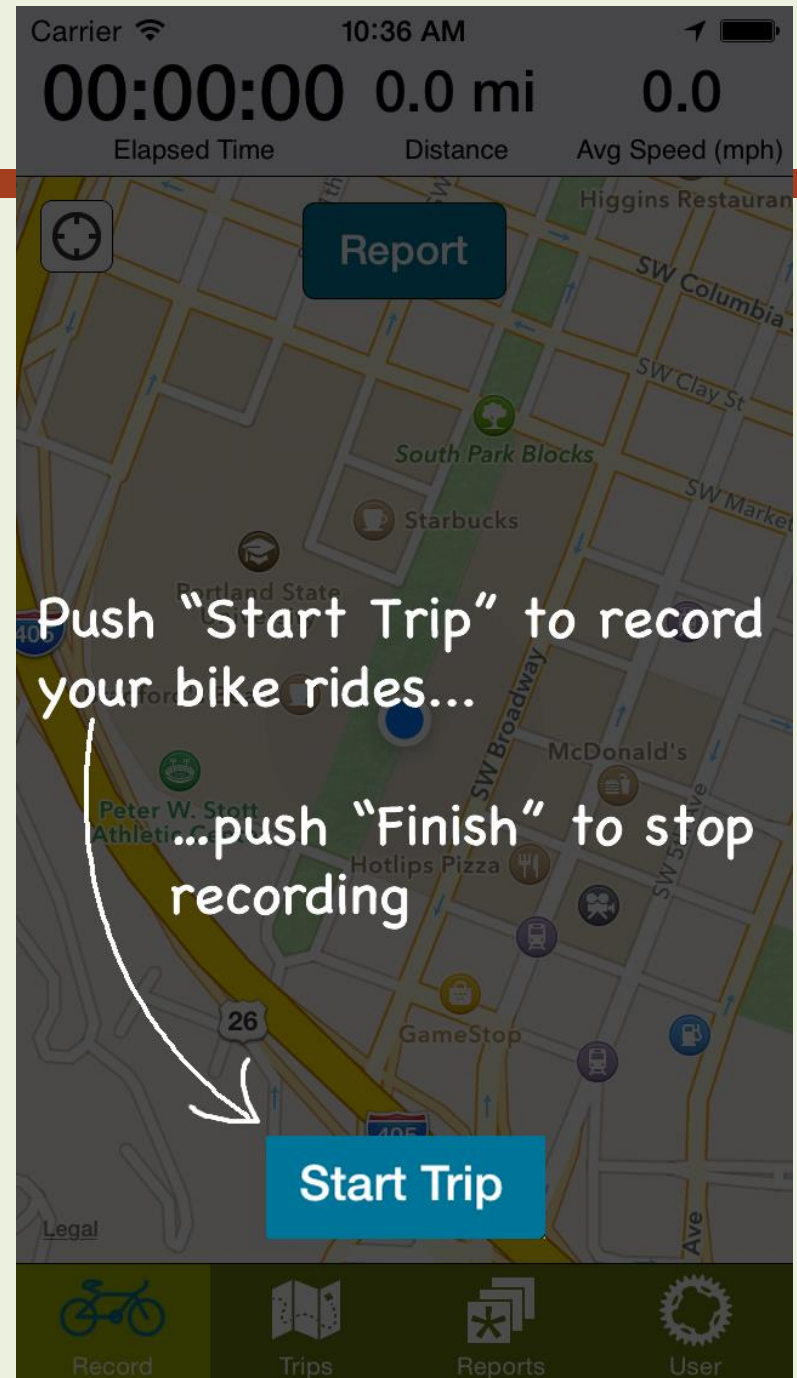
Report Questions

Questions after completing a crash report:

- Severity
- Object (vehicle)
- Actions that led to the event
- What contributed to the event
- Date
- Additional comments?

Questions after completing a safety report:

- Urgency
- Type of problem
- Date
- Additional comments?

Safety reports & AskODOT

Since Nov. 2015 users can email safety reports to

ODOT using the app

- AskODOT receives the email with safety report

  data and a link to google maps

- Plus photos and comments

- Commitment to respond within 5 business days

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Safety reports & AskODOT

ORcycle bicycle app improves reporting capabilities

http://www.oregon.gov/ODOT/COMM/Pages/nr15111801.aspx

ODOT News

Nov. 18, 2015

For more information: Professor Miguel Figliozzi, Portland State University, (503) 725-2836 or Shelley M. Snow, ODOT Communications, (503) 881-5362

Reports can now be shared with road authorities

SALEM — The ORcycle application for smartphones is getting an update, and safety advocates hope it will encourage riders to send in reports about problems on the transportation system so the proper road authorities can investigate and fix, if warranted. When the app was launched this time last year, users voluntarily submitted data only to researchers at Portland State University. With this update, users will have a "report safety issue" option and they can voluntarily send that report directly to the Ask ODOT Citizens Representative Office during a one year pilot program. Ask ODOT will send the safety report to the appropriate ODOT District or, if it is not a state facility, to the local road authorities.

With the new update, ODOT will receive the GPS coordinates of the safety report along with a link to Google maps and even a photo of the safety issue if the user wants to include one. There are several options for describing the type of safety issue the user is reporting, such as "narrow bike lane," "pavement condition" or "no crossing button." The app follows a strict privacy policy and does not ask for a name or address, and users have control over the data they are sharing.

Researchers at PSU will continue to receive the information voluntarily provided by users of the app, including reports of "crashes or near-misses." These reports give planners valuable data about route usage, crashes and near-misses, infrastructure issues and more.

Created by the Transportation Technology and People (TTP) lab at Portland State University in partnership with ODOT, the ORcycle app has been used regularly over the past year by several hundred participants. The data submitted by users have already been used to better understand cyclists' use of the transportation system. Additional information about the app and research outputs at http://www.pdx.edu/transportation-lab/orcycle. The ORcycle app is free and can be downloaded from the App Store or Google Play.

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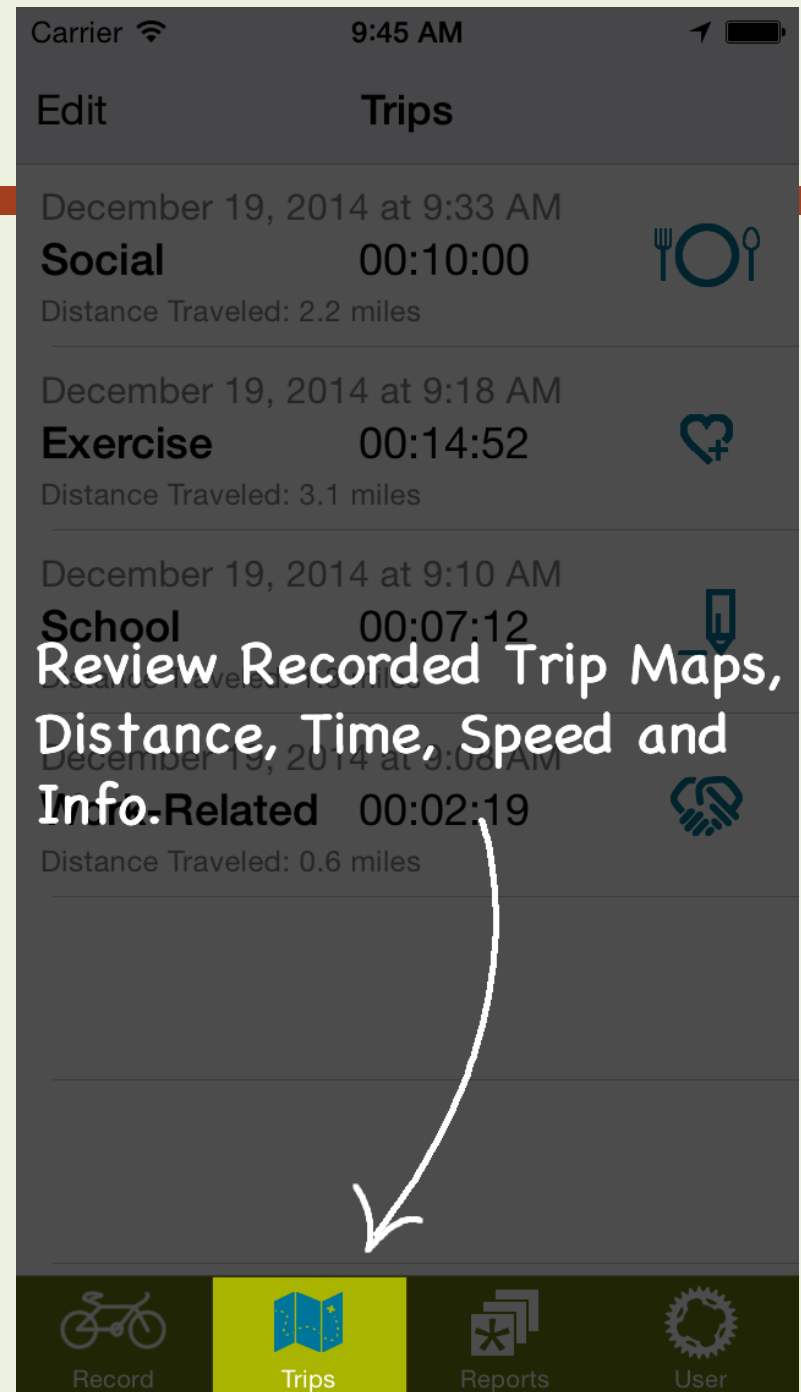
Recorded Trips

User can review trips:
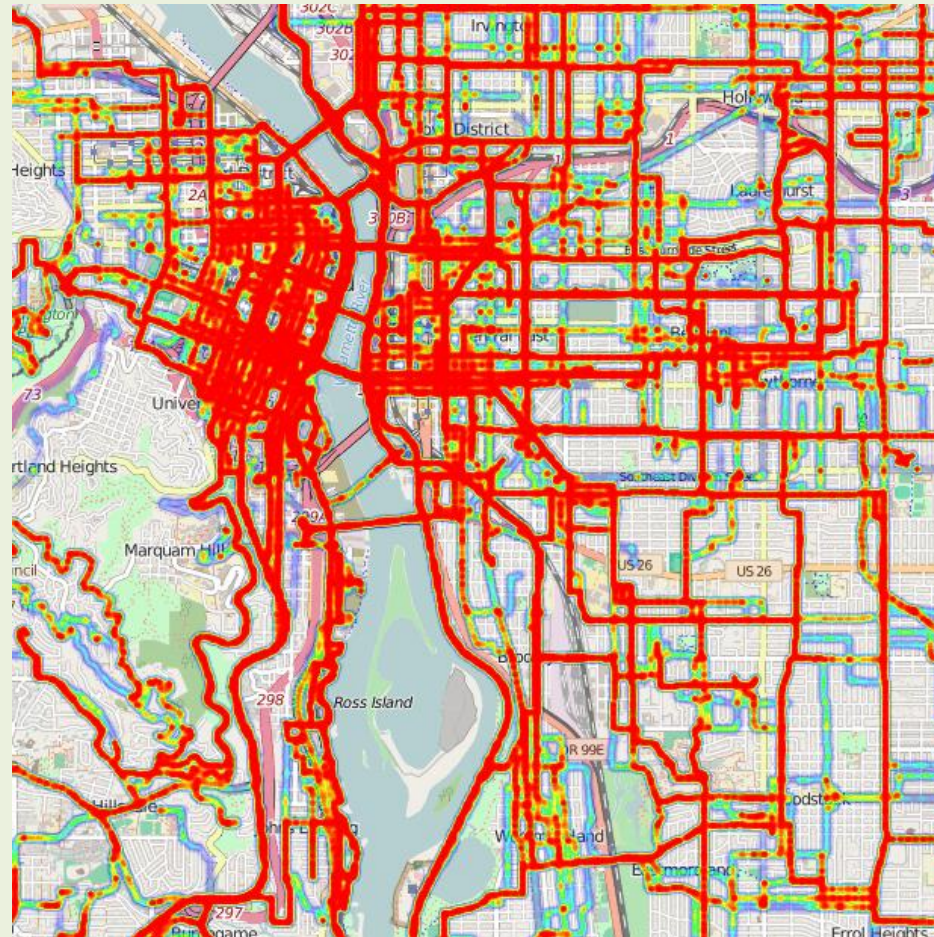- Map
- Time, distance
- Questionnaire

And more features…

Trips

Edit

December 19, 2014 at 9:33 AM
Social   00:10:00
Distance Traveled: 2.2 miles

December 19, 2014 at 9:18 AM
Exercise   00:14:52
Distance Traveled: 3.1 miles

December 19, 2014 at 9:10 AM
School   00:07:12

December 19, 2014 at 9:08 AM
Related   00:02:19
Distance Traveled: 0.6 miles

Record   Trips   Reports   User

Review Recorded Trip Maps, Distance, Time, Speed and Info.

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GPS coordinates*

*Heatmap, not adjusted by trip frequency

Exploratory route comfort study

Each trip rated on a 1 to 5 scale

Ordinal Logistic Regression

Route Comfort as Dependent Variable

One independent variable at the time

Trip Details   Save

HOW OFTEN DO YOU RIDE THIS ROUTE?

Several times per month

IN TERMS OF COMFORT, THIS ROUTE IS...

Choose one

I CHOSE THIS ROUTE BECAUSE... (CAN SELECT MORE THAN ONE)

It is enjoyable/has nice scenery

Cancel   **Route Comfort**   Done

Very Good (even for families/children)

Good (for most riders)

Average

Bad (only for confident riders)

Very Bad (unacceptable for most riders)

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Single variable model results

Why did you choose this route?

… It has good bicycle facilities (+)

… It has nice scenery (+)

… It has low traffic speeds (+)

… It has few busy intersections (+)

… It is good for families + kids (+)

… I do not know another route (-)

… It is direct + fast   (--)

Not significant: I found it on my phone/online, It is good for a workout, It has other riders/people
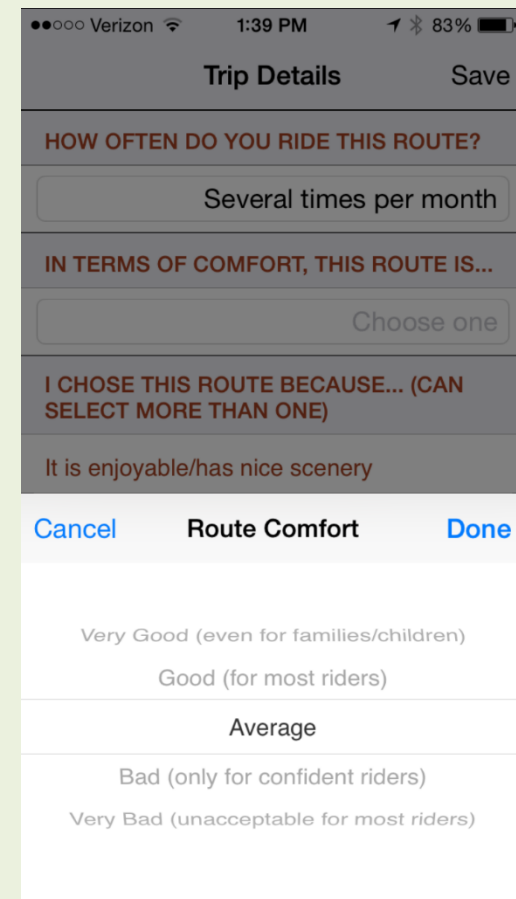
Single variable model results

Along this route, you are concerned about conflicts/crashes with…
… NOT concerned (++)
… Auto traffic (-)
… Other cyclists (-)
… Large commercial vehicles (trucks) (--)

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16

Single variable model results

Average Trip Speed of Cyclist (-)
Trip Distance (-)
Weekday Trip (-)

Trip Purpose: Exercise (+)
Trip Purpose: Shopping/Errands (+)

No bike facility, primary arterial (-)
No bike facility, other (-)
Bike lane, primary arterial (-)
Bike lane, minor arterial (-)
Separated path (+)

Pooled model – distance based

Final Model - Relative importance	Sign	Relative Score*
Stressed by large commercial vehicles	(-)	100%
Arterial (with and without bike lane)	(-)	85%
Stressed by auto traffic on route	(-)	85%
Separated path	(+)	84%
Trip purpose: Shopping/errands	(+)	82%
Stressed by "other cyclists" on route	(+)	80%
Trip purpose: Exercise	(+)	80%
Not concerned about stressors on route	(+)	79%
Greenways (aka bike boulevards)	(+)	76%
Greenways (aka bike boulevards) (squared)		76%

* Log-Likelihood change when removing one variable *Ceteris Paribus*

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Linear plus Square Contributions

Comfort rating (y-axis) vs Greenway distance (x-axis)

Linear

Linear + square
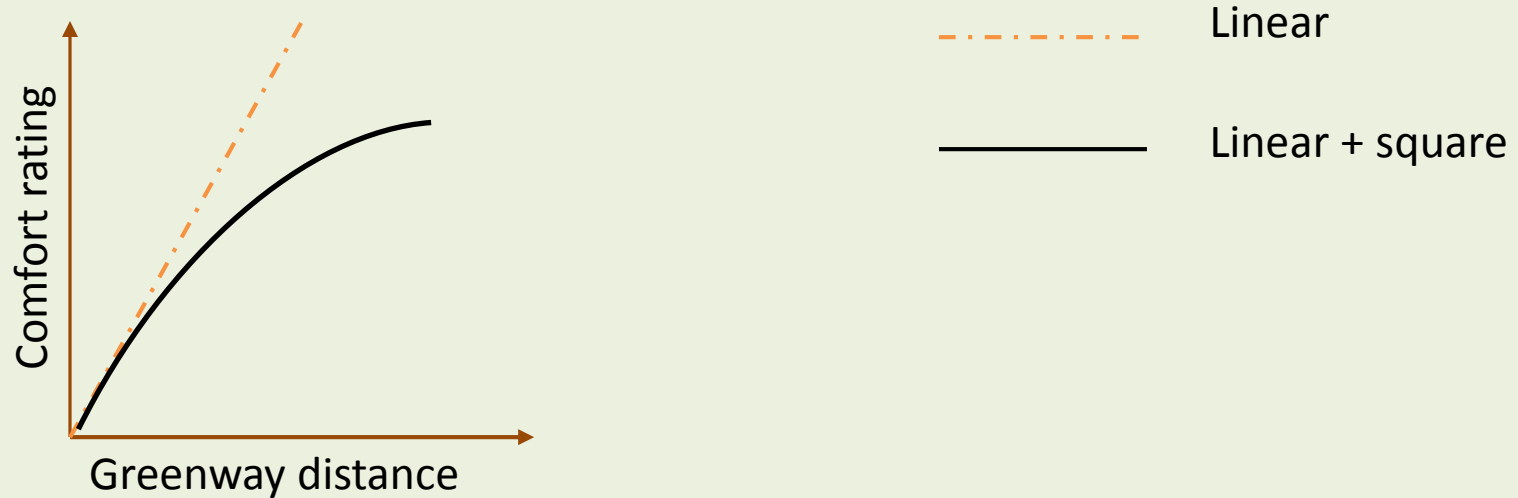
Pooled model – % based

Final Model - Relative importance	Sign	Relative Score*
Stressed by large commercial vehicles	(-)	100%
Separated path	(+)	87%
Stressed by auto traffic on route	(-)	85%
Trip purpose: Shopping/errands	(+)	83%
Trip purpose: Exercise	(+)	82%
Arterial (with and without bike lane)	(-)	81%
Total trip distance	(-)	81%
Total trip distance (squared)		81%
Stressed by "other cyclists" on route	(+)	80%
Not concerned about stressors on route	(+)	80%

* Log-Likelihood change when removing one variable _Ceteris Paribus_

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Linear plus Square Contributions

Linear — · — · — · —

Linear + square ———

Comfort rating

Greenway distance

+

Comfort rating

Trip distance

-
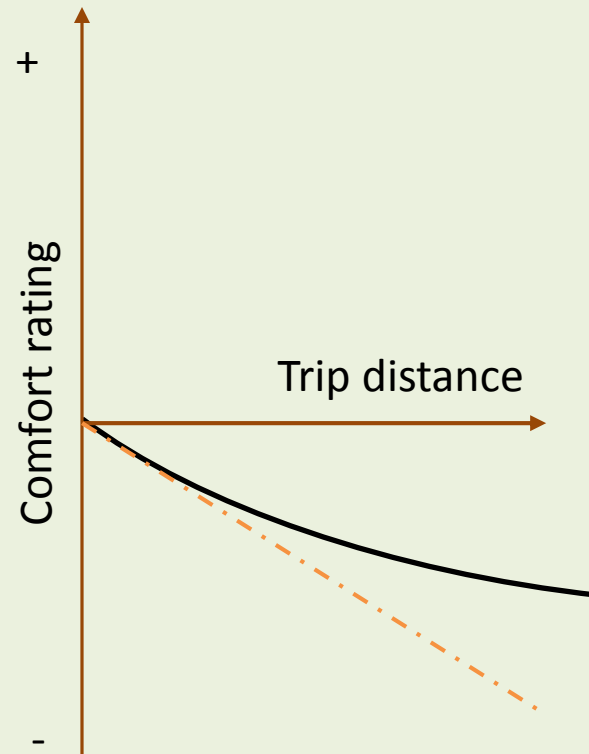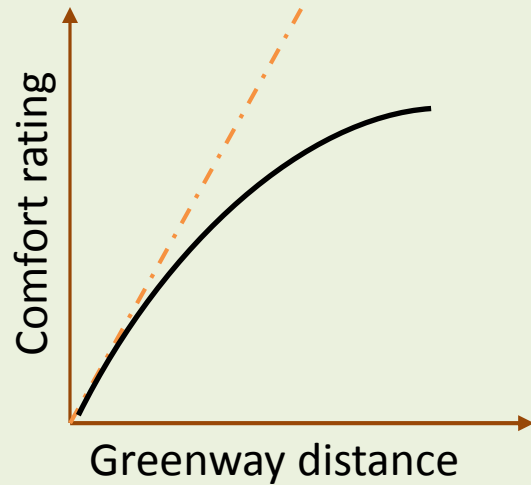
Key insights to increase comfort

- Avoid routes with commercial vehicles

- Less traffic

- Shorter routes (or distance effect?)

- More bike paths or separated facilities

- Commuter trip comfort levels are not the same as exercise or shopping trip comfort levels (confounded factors?)

Measuring stress levels for real-world on-road cyclists: do bicycle facilities, intersections, and traffic levels affect cyclists' stress?
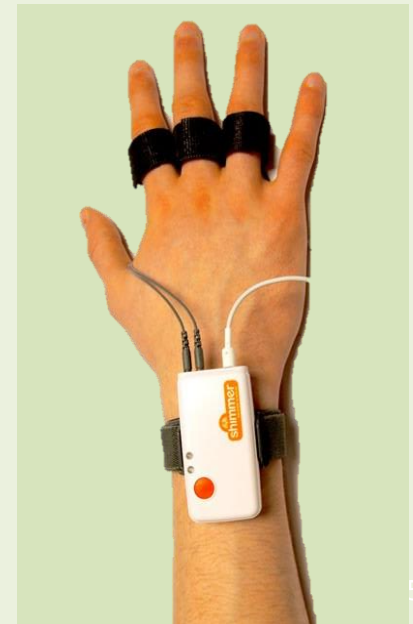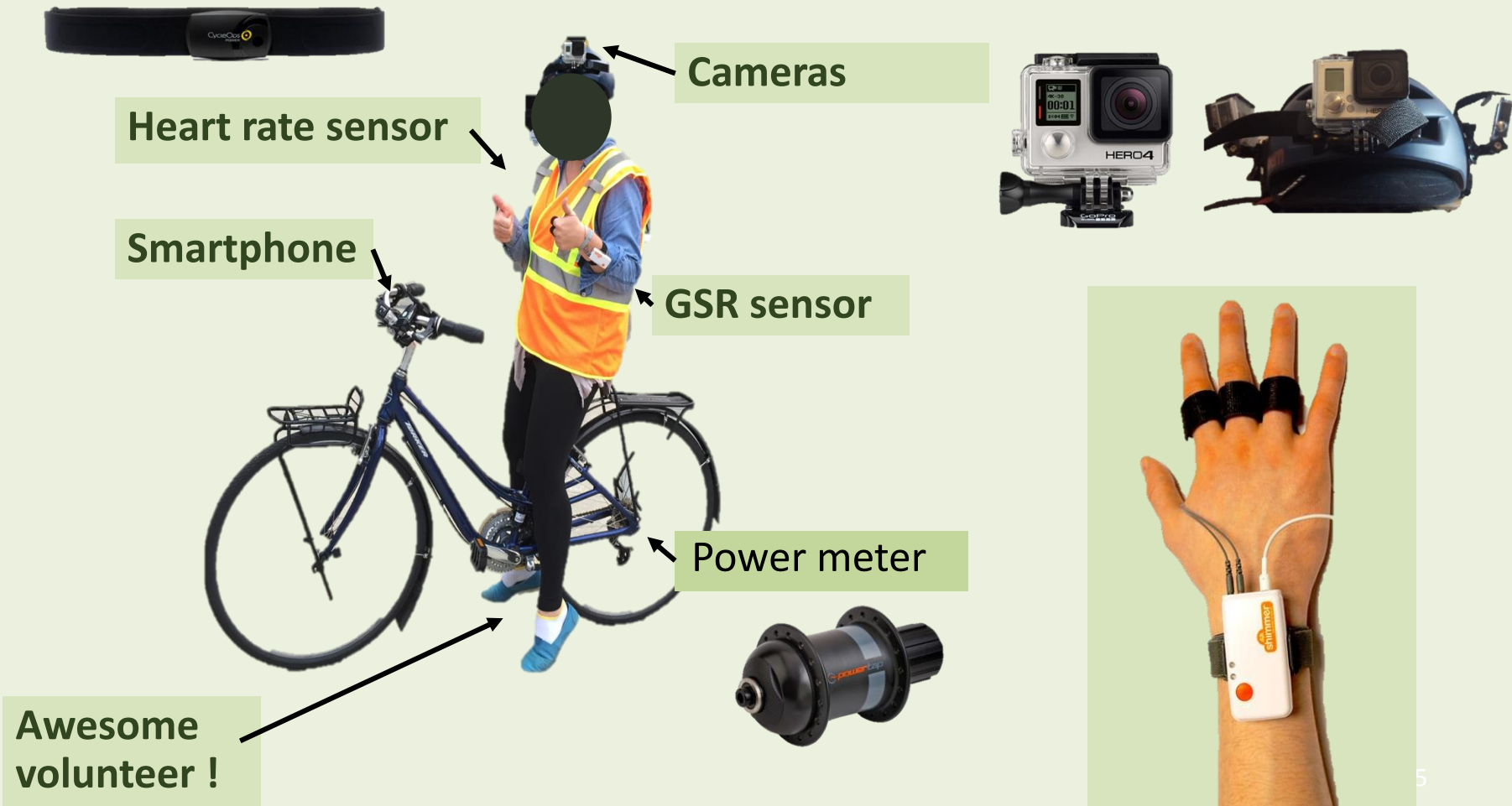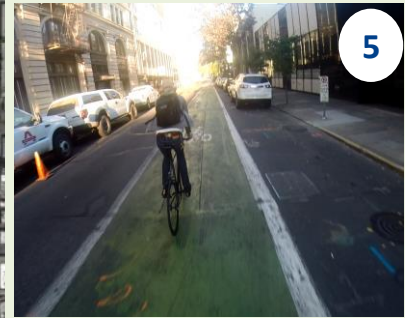
Galvanic Skin Response (GSR)
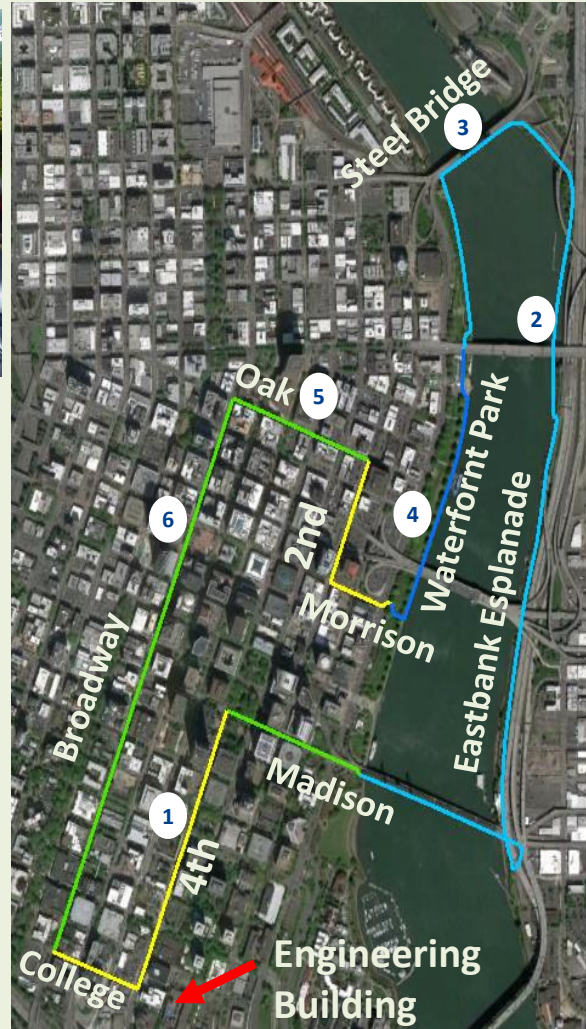
- GSR has been utilized by many research studies in fields ranging from psychology to sports medicine.

- GSR is a robust non-invasive way to measure stress.

- The resistance of the skin changes with the activity of the sweat gland and small changes in resistance that can be measured accurately.

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Many ingredients…

Cameras

Heart rate sensor

Smartphone

GSR sensor

Power meter

Awesome volunteer !

Facility types: mixed traffic, off-street, wide bike lane, and standard bike lane

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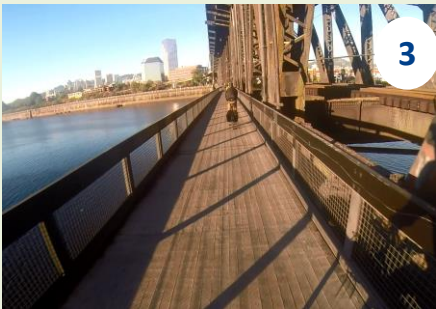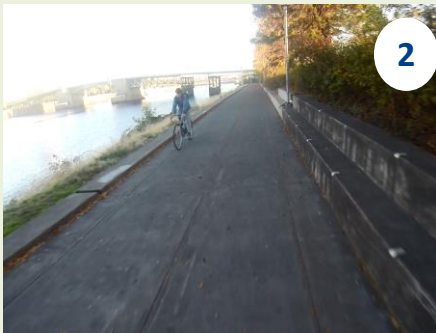
Some findings

Does peak traffic impact stress levels? YES
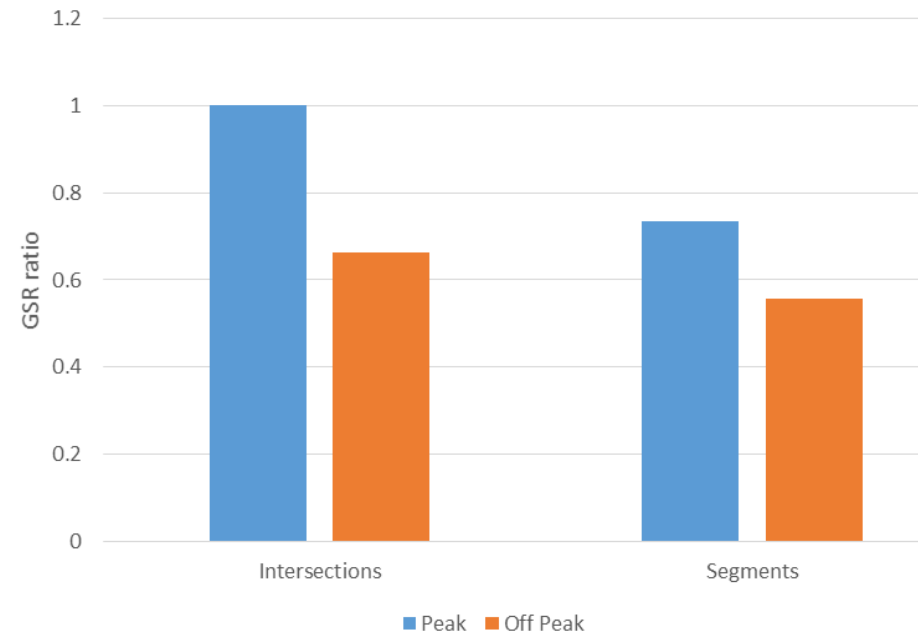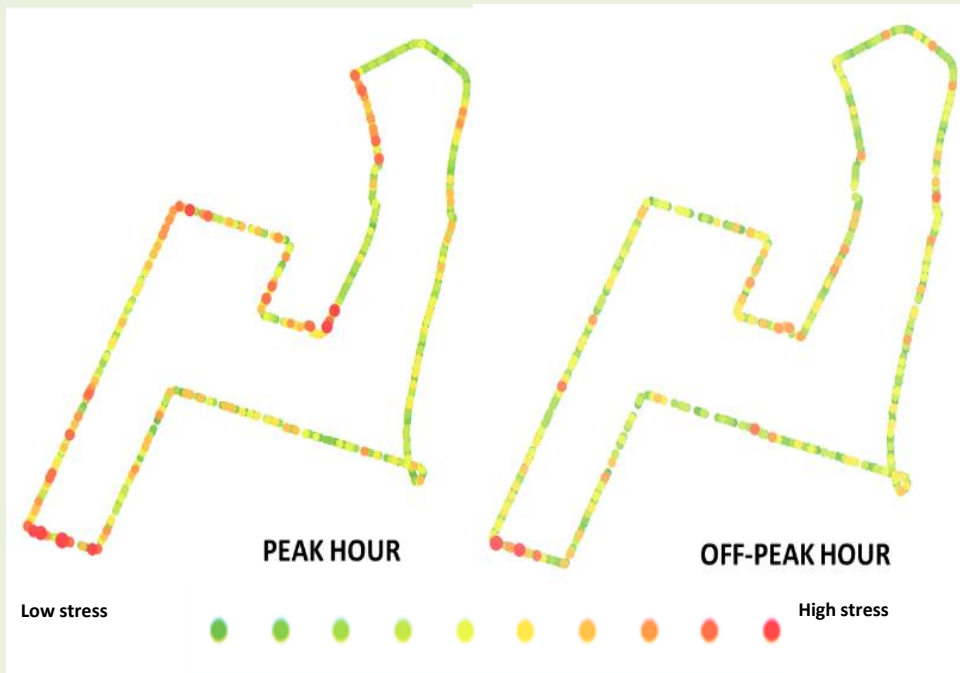
Do intersections impact stress levels? YES

Some findings

What about facility types?
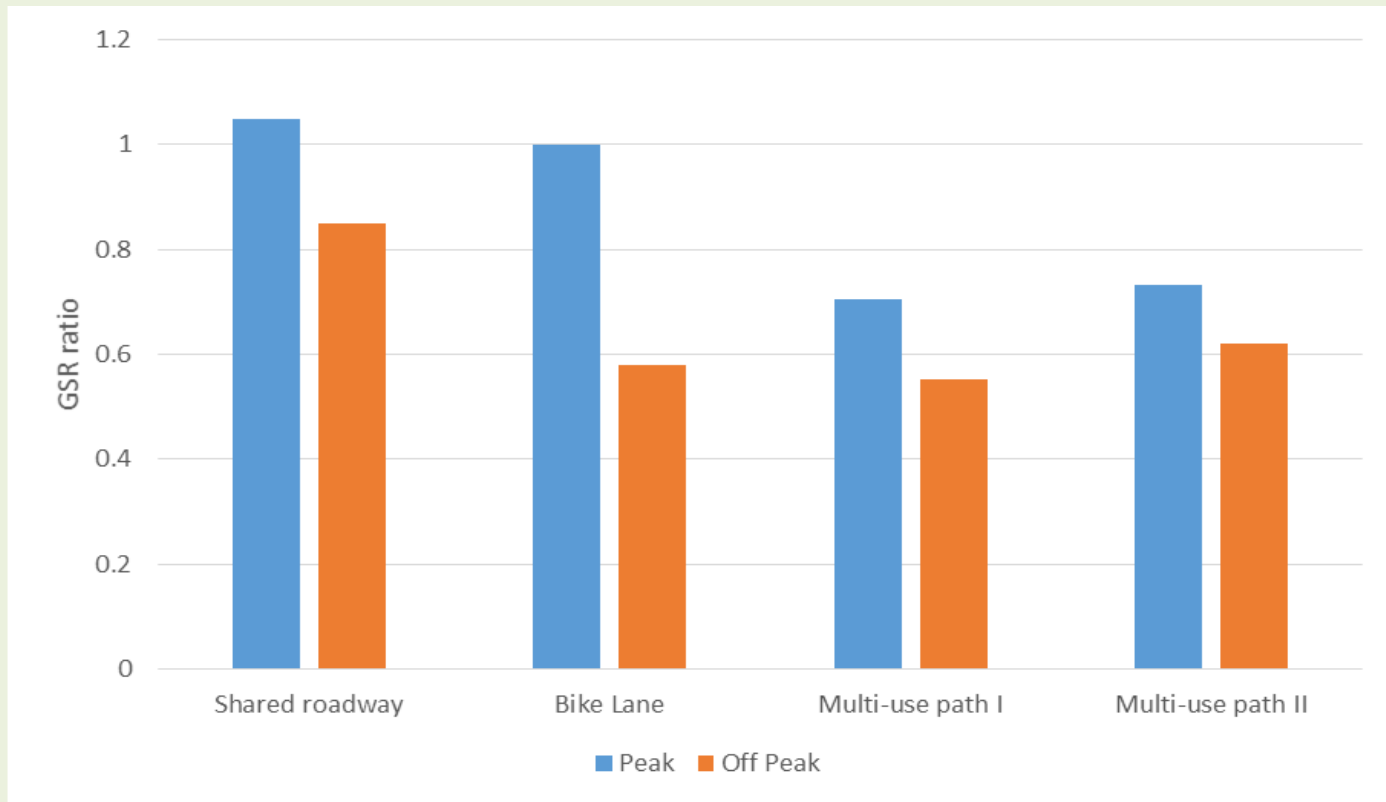
Multi-use path I: Waterfront park (westside)
Multi-use path II: Eastbank esplanade (more eastside)

What else can we learn?
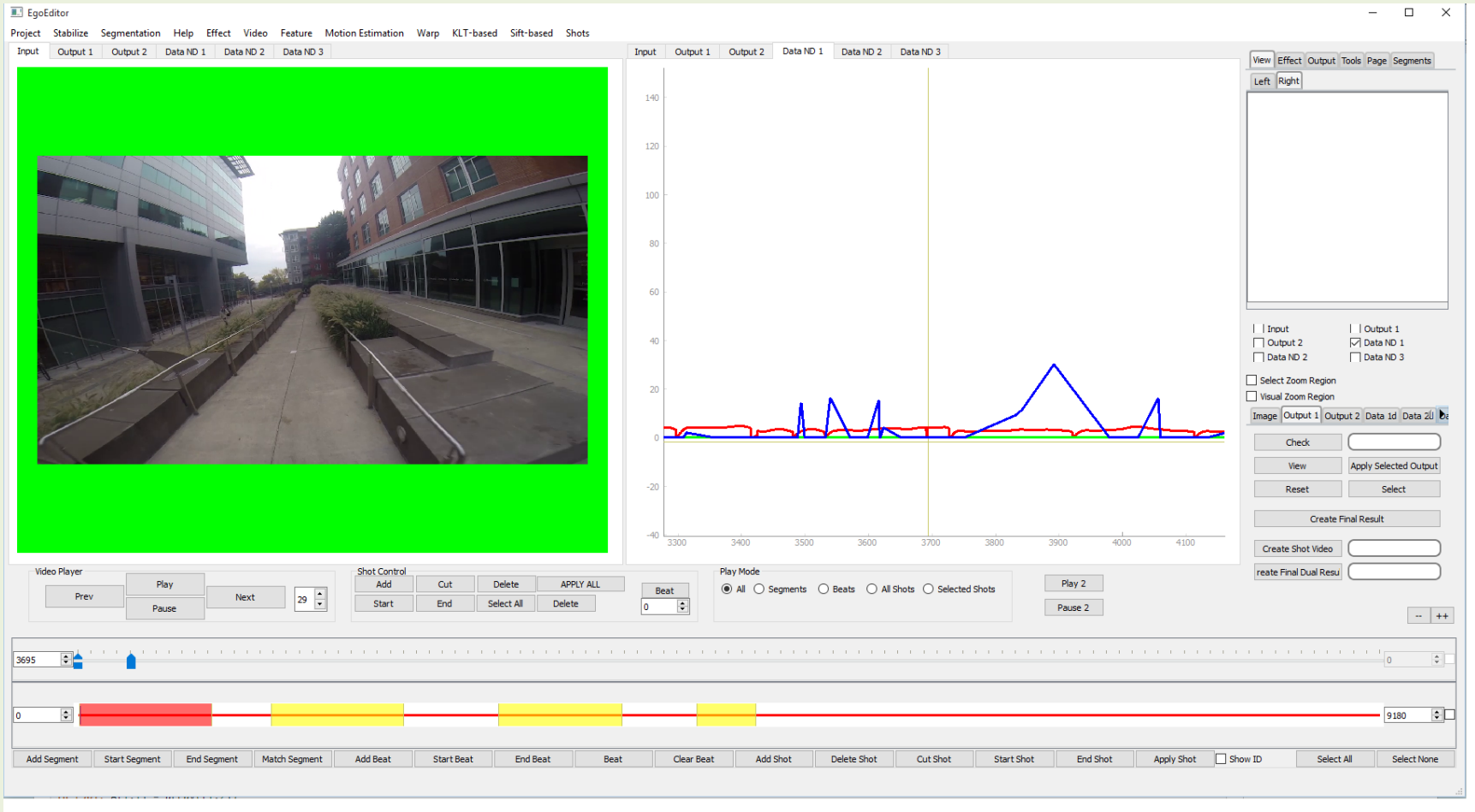
A lot, video analysis of peaks and lows…

More details ?

Do you want to know more about measuring real-world on-road stress levels?

30 minute presentation on Monday 14th, Oregon Active Transportation Summit, 2pm

Final comments

Early work but results are very promising

Data complementarities

- General policy insights: revealed data + questions
- Very specific stress measurements for a facility, e.g.
  - compare paths or intersections
  - before/after

Collaborators

Modeling and ORcycle:

Bryan Blanc (*)

Bikram Maharjan (**)

Robin Murray (**)

(*) Department of Civil and Environmental Engineering, PSU
(**) Department of Computer Science, PSU

Collaborators

Modeling and measuring _real-world_ _on-road_ Stress

Alvaro Caviedes (*)
Robin Murray (**)
Hoang Le (**)
Feng Liu (**)
Wu-chi Feng (**)

(*) Department of Civil and Environmental Engineering, PSU
(**) Department of Computer Science, PSU

Learn more…

About the project
http://www.pdx.edu/transportation-lab/orcycle

Download the app, for iOS or Android
Search "ORcycle" in the iTunes App Store or in Google Play

Send safety reports to AskODOT using ORcycle

Email us at: ttplab@pdx.edu

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Learn more... Related Papers and Reports

1. Blanc, B., & Figliozzi, M. (2016a). Modeling the Impacts of Facility Type, Trip Characteristics, and Trip Stressors on Cyclists' Comfort Levels Utilizing Crowdsourced Data. Forthcoming 2016 Transportation Research Record.
2. Blanc, B., Figliozzi, M, Clifton, K. (2016b). How Representative of Bicycling Populations are Smartphone Application Surveys of Travel Behavior, Forthcoming 2016 Transportation Research Record
3. Figliozzi, M.A., (2015). Evaluating the use of crowdsourcing as a data collection method for bicycle performance measures and identification of facility improvement needs, Final Report SPR 768, ODOT, http://www.oregon.gov/ODOT/TD/TP_RES/pages/researchreports.aspx
4. Caviedes, A. & Figliozzi, M. (2016) Measuring stress levels for real-world on-road cyclists: do bicycle facilities, intersections, and traffic levels affect cyclists' stress? Presented at 2016 Transportation Research Board Annual Meeting, Washington DC.
5. More papers under review...

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35

THANK YOU

Questions? Comments…

Visit our webpage :

http://www.pdx.edu/transportation-lab

Email us at: ttplab@pdx.edu

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