NATIONAL ACADEMIES *Sciences Engineering Medicine*

TRB TRANSPORTATION RESEARCH BOARD

TRB Webinar: Can You See Me? Testing Pedestrian and Bicycle Conspicuity Assumptions

September 14, 2023

1:00 – 2:30 PM

PDH Certification Information

1.5 Professional Development Hours (PDH) – see follow-up email

You must attend the entire webinar.

Questions? Contact Andie Pitchford at TRBwebinar@nas.edu

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Program. Credit earned on completion of this program will be reported to RCEP at RCEP.net. A certificate of completion will be issued to each participant. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

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AICP Credit Information

1.5 American Institute of Certified Planners Certification Maintenance Credits

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Log into the American Planning Association website to claim your credits

Contact AICP, not TRB, with questions

Purpose Statement

This webinar will discuss what is known and undetermined about the conditions that might interfere with vulnerable-road-user conspicuity for a safe system to work. Presenters will highlight state-of-the-art pedestrian and bicycle simulator technologies including virtual reality, multi-projection, and simultaneous simulation. Presenters will also explore other data sources that can be used to measure conspicuity.

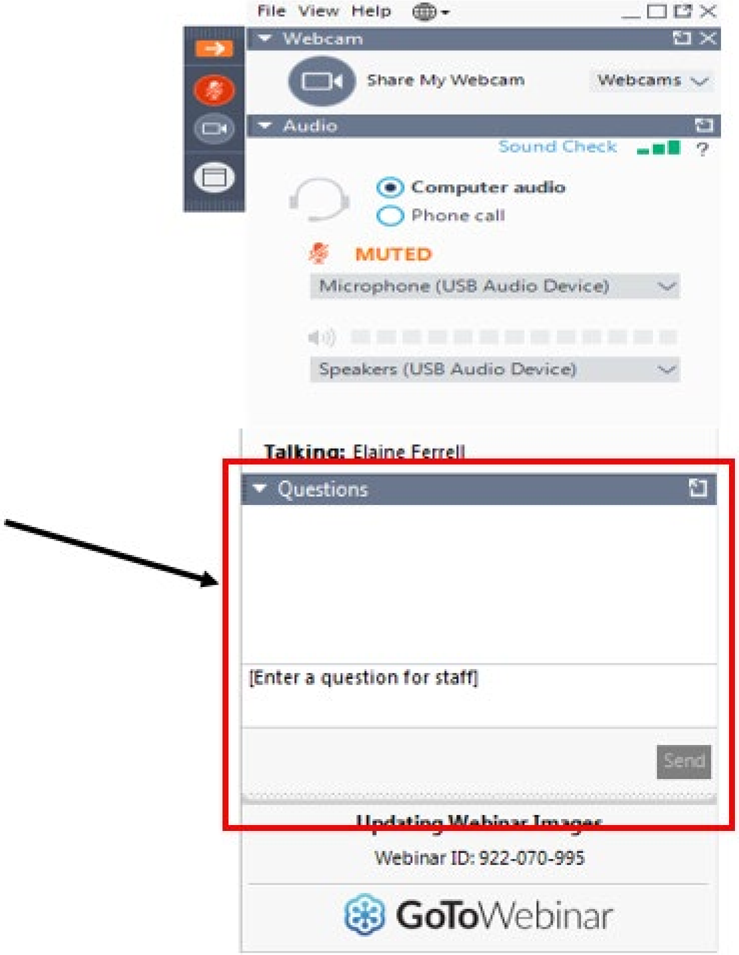
Learning Objectives

At the end of this webinar, you will be able to:

- Understand the available research regarding the limitations of vulnerable-user conspicuity in day and night settings
- Identify the possibilities and challenges in incorporating a pedestrian or bicycle into a simulator environment
- Recognize the potential and limitations for new data sources to contribute to pedestrian conspicuity research

Questions and Answers

- Please type your questions into your webinar control panel
- We will read your questions out loud, and answer as many as time allows



Today's presenters

Barb Chamberlain
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David Hurwitz
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Patricia Tice
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ProFound Insights, Inc.

Chris Schwartz
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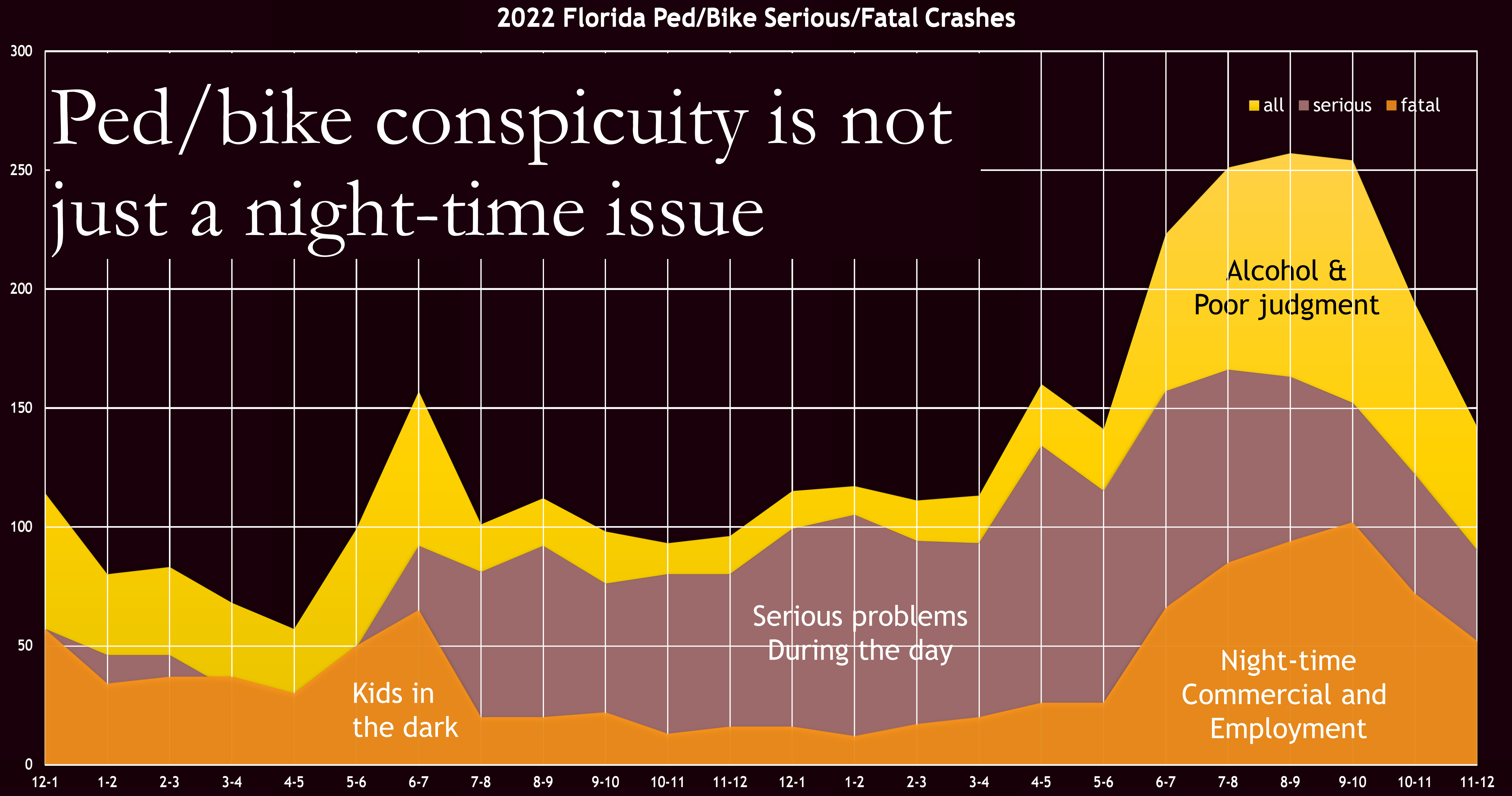
Can you see me?

Surprises in Pedestrian and Bicycle Conspicuity

Dr. Patricia Tice, PhD, PE, AICP

Ped/bike conspicuity is not just a night-time issue



Performance vs. Behavior

Driver behavior, not just performance

- SHRP2 NDS Video Tabulations
- SHRP2 Speed, acceleration, jerk
- Is a person there?

Psych Theory

What impacts whether a person can be seen?

Perceptual Narrowing

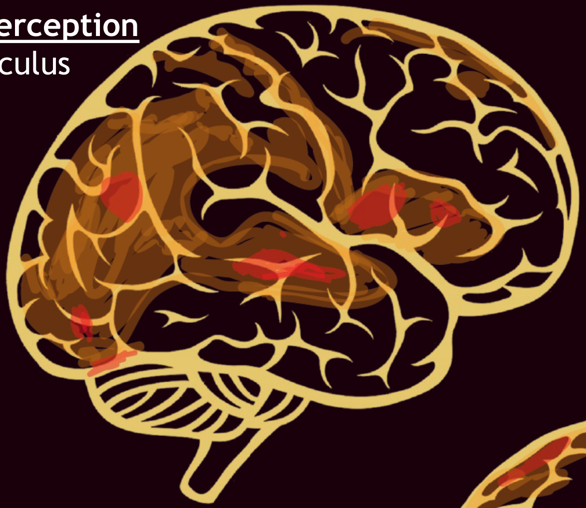
Rogers, Kadar, & Costall (2005). "Gaze patterns in the visual control of straight-road driving and braking as a function of speed and expertise." Ecological Psychology **17(1): 19-38.**

DWA: Driving Without Awareness

- Once we learn, we quit watching ourselves drive
- **We are conscious, just not very…**
- Automatic systems prioritize seeing people

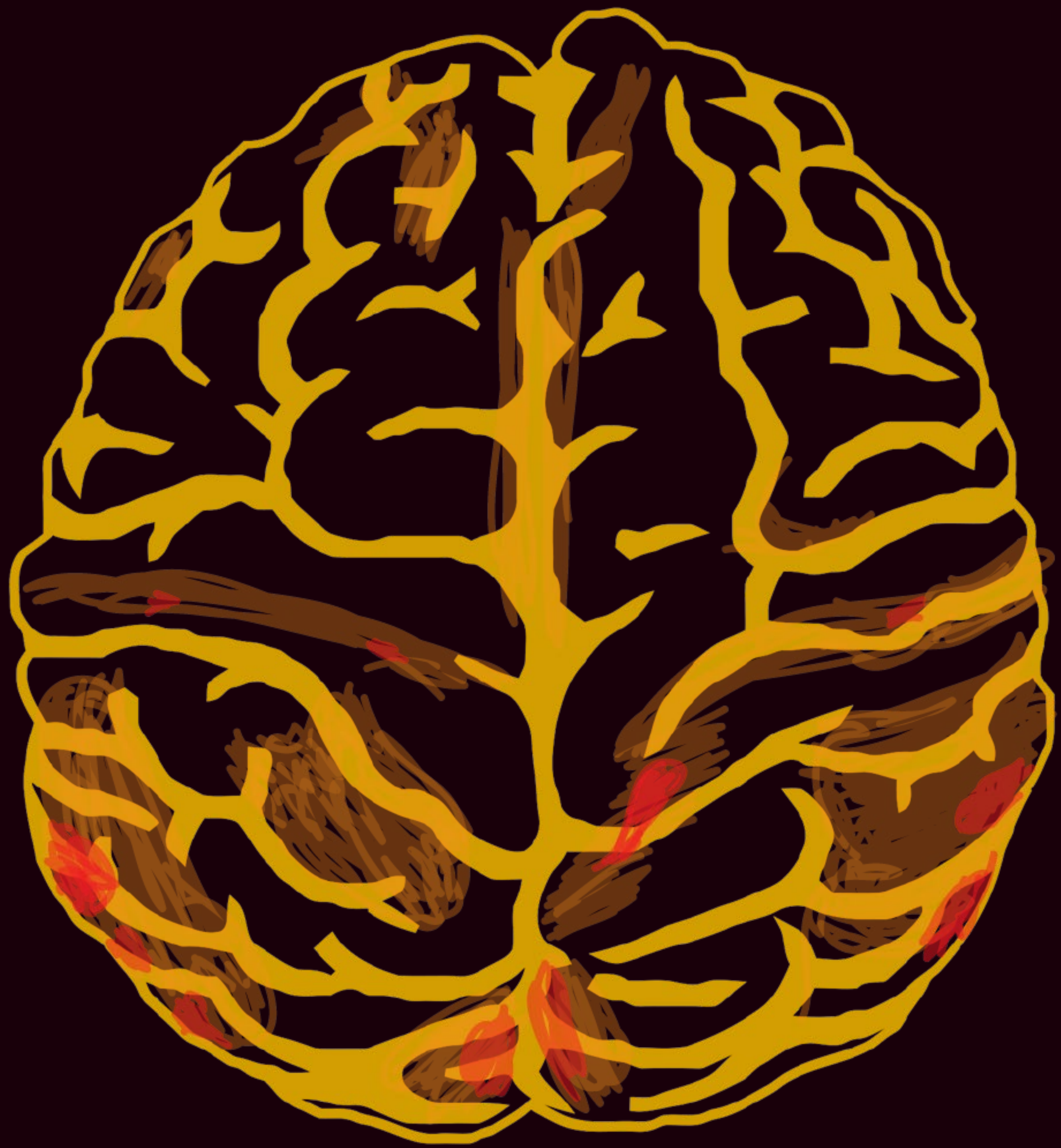
People on the brain

Reflex-like perception
Superior Colliculus
Pulvinar
Striatum
Amygdala



Visual Perception
Lateral occipital cortex
Superior temporal sulcus
Intraparietal lobule
Fusiform gyrus
Amygdala
Premotor Cortext

Body awareness (mirroring)
Insula
Somatasensory cortex
Anterior Cingulate cortex
Ventromedial prefrontal cortex



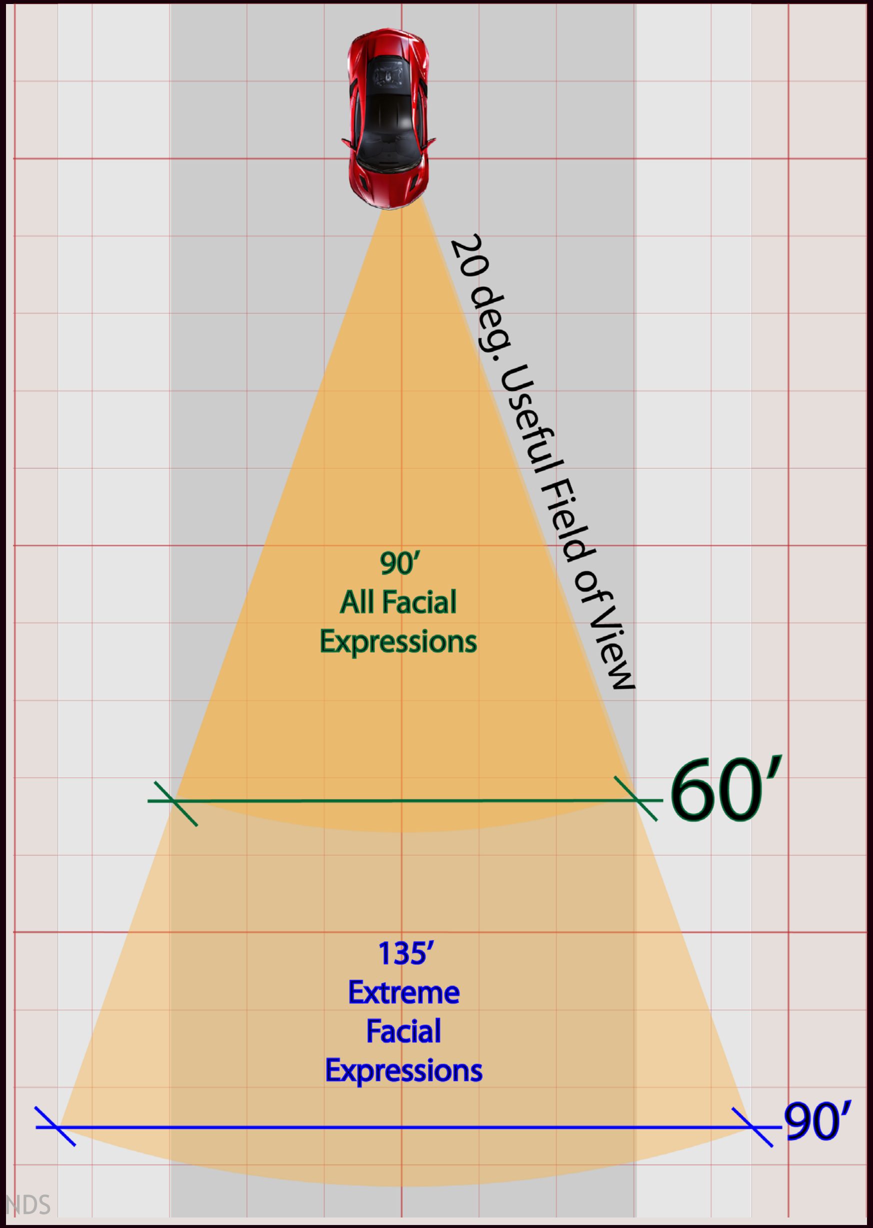
Engell, A. D., & McCarthy, G. (2014). Face, eye, and body selective responses in fusiform gyrus and adjacent cortex: an intracranial EEG study. *Frontiers in human neuroscience*, *8*, 642.
Tipper, C. M., Signorini, G., & Grafton, S. T. (2015). Body language in the brain: constructing meaning from expressive movement. Frontiers in human neuroscience, 9, 450.
De Gelder, B. (2006). Towards the neurobiology of emotional body language. Nature Reviews Neuroscience, 7(3), 242-249.

Limitations:

Plan view:

- Interaction Possibilities:
  - 90-135 feet
- Driver uses a 16-20 degree view

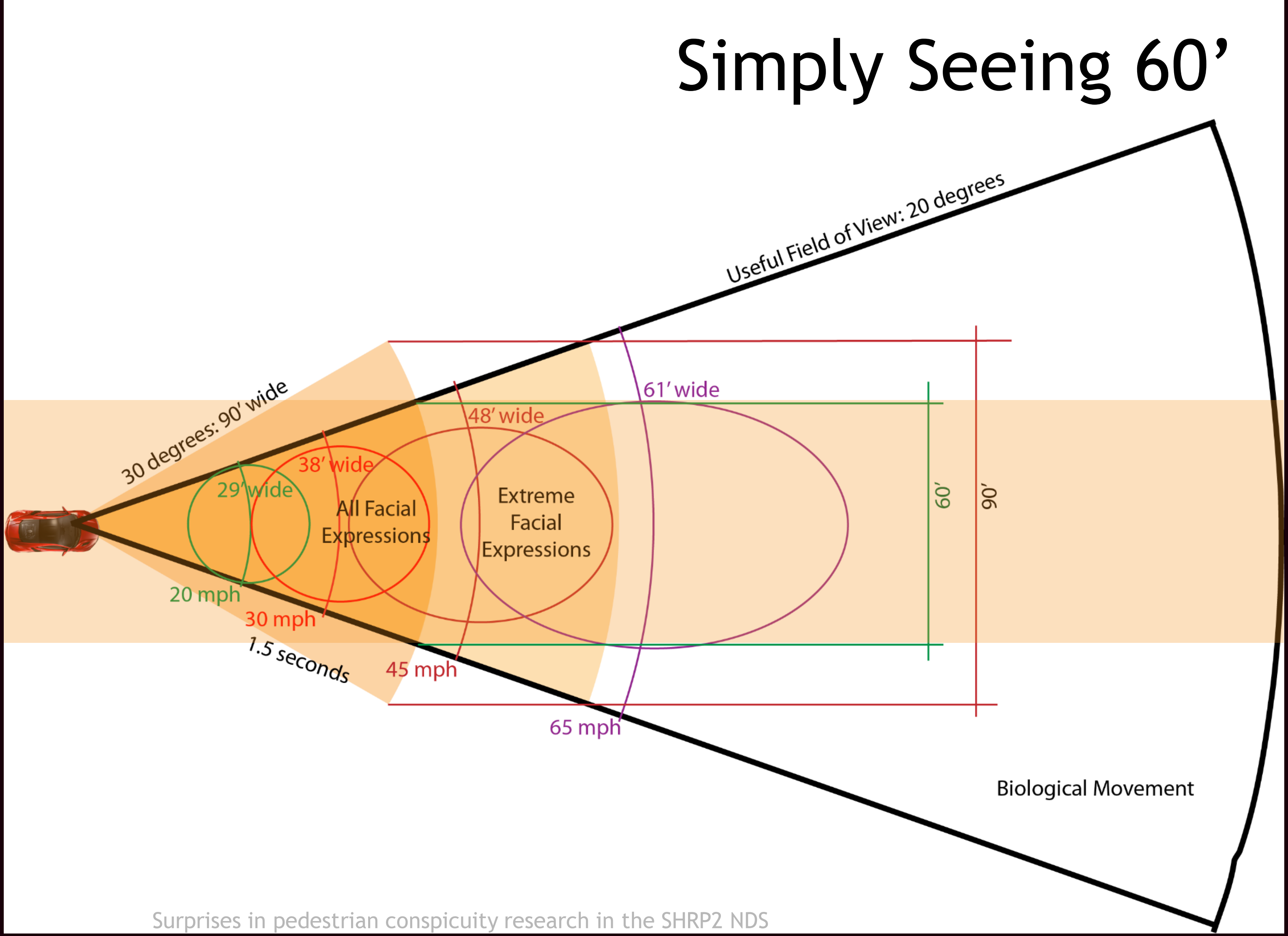
➢**Yields a 60-90’ wide corridor**



Perceptual Narrowing

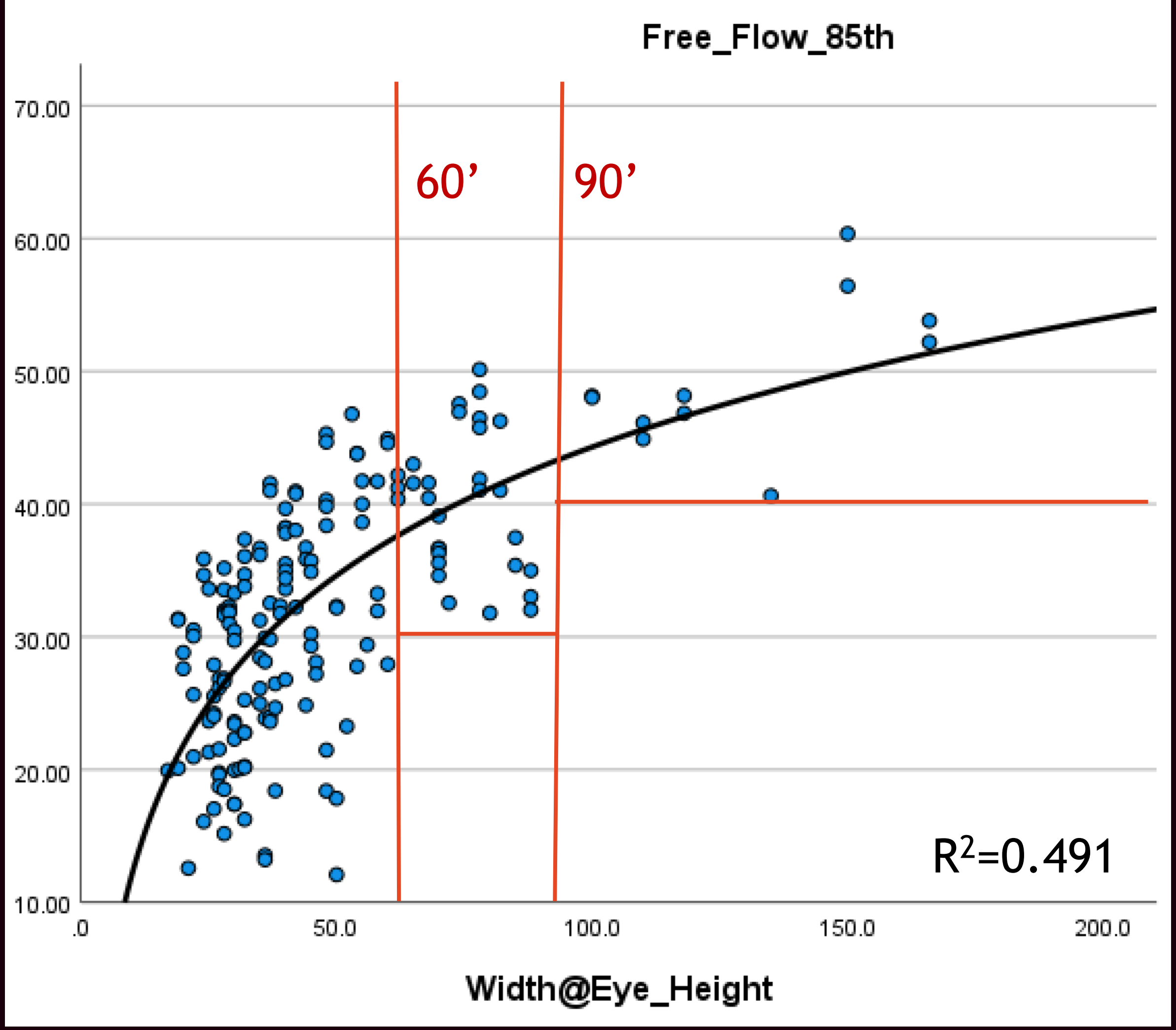
Rogers, Kadar, & Costall (2005). "Gaze patterns in the visual control of straight-road driving and braking as a function of speed and expertise." Ecological Psychology **17(1): 19-38.**

Perceptual Narrowing



Width at eye height
Visual Width of the Corridor

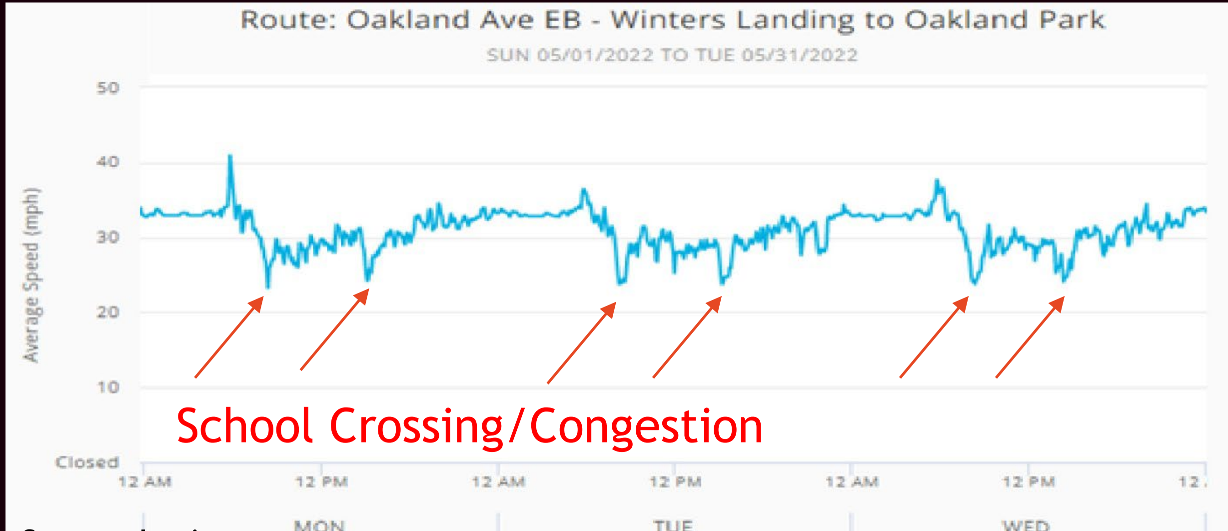
Visual Corridor Width



People vs. none

Prediction with all variables

Prediction w/o doorway density

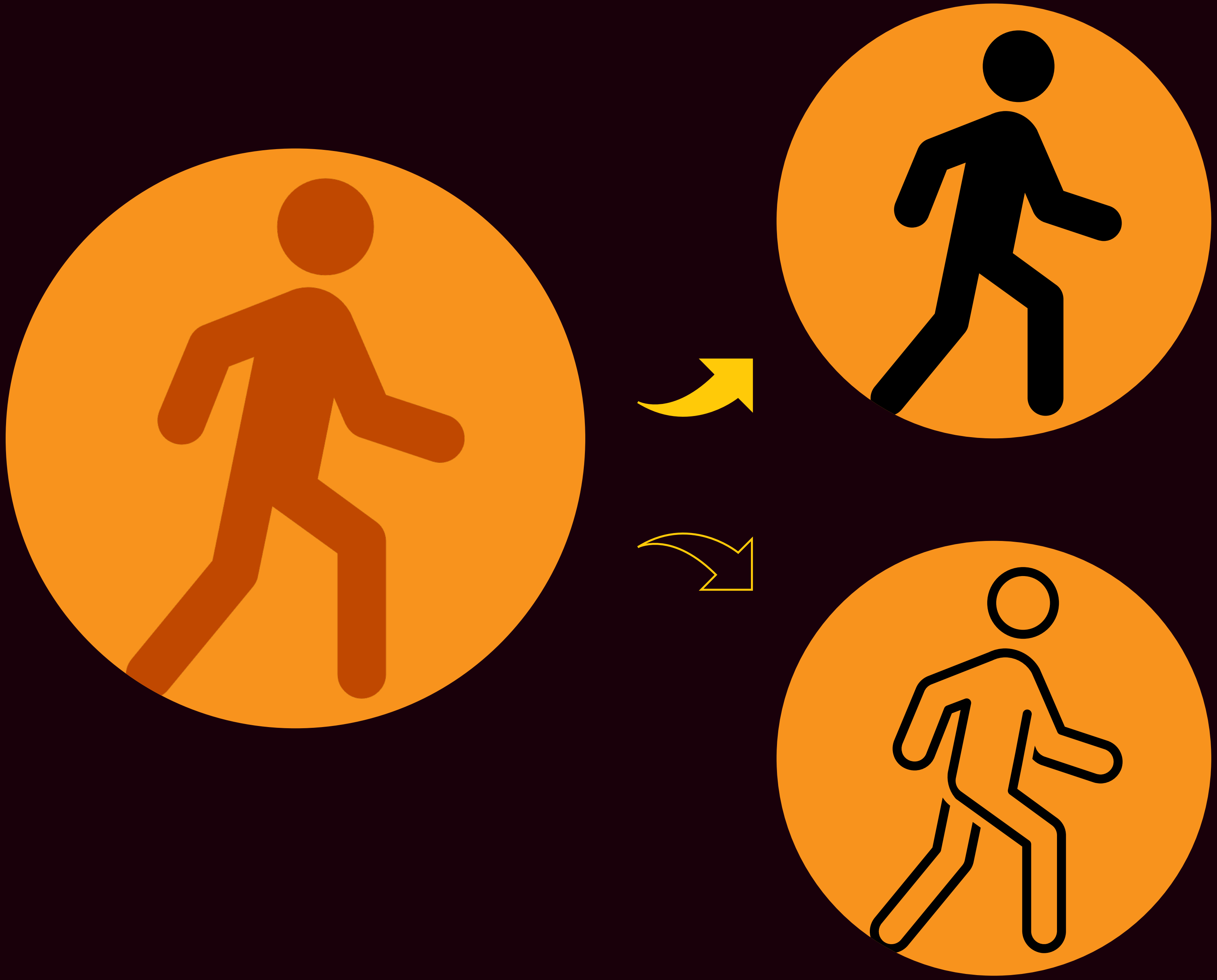


Source: Iteris

Seen or not?

Was there a pedestrian there?

Did they get seen?

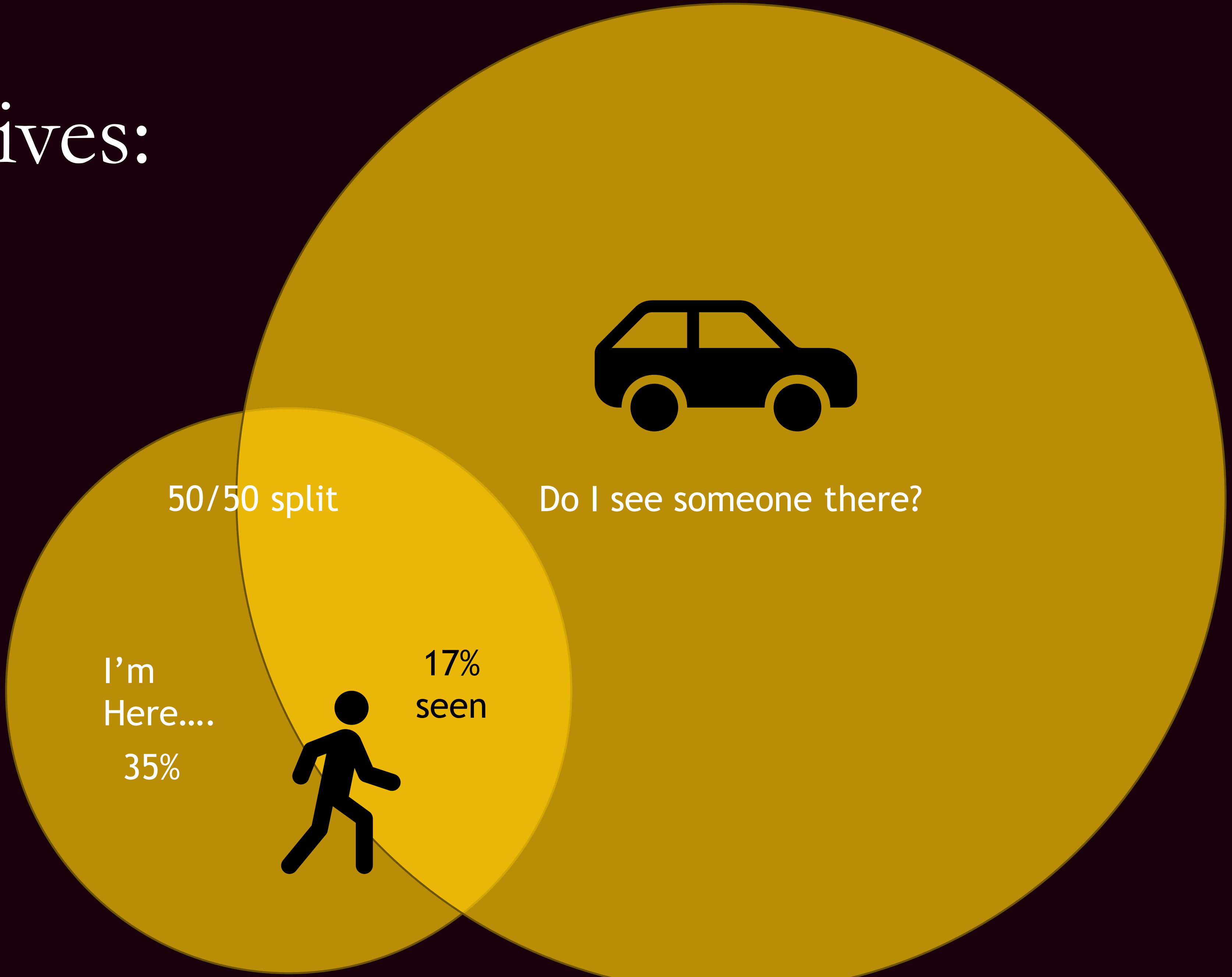


Two Perspectives:

VRU's were present about 35% of the time

If they were there, they were seen about half of that time.

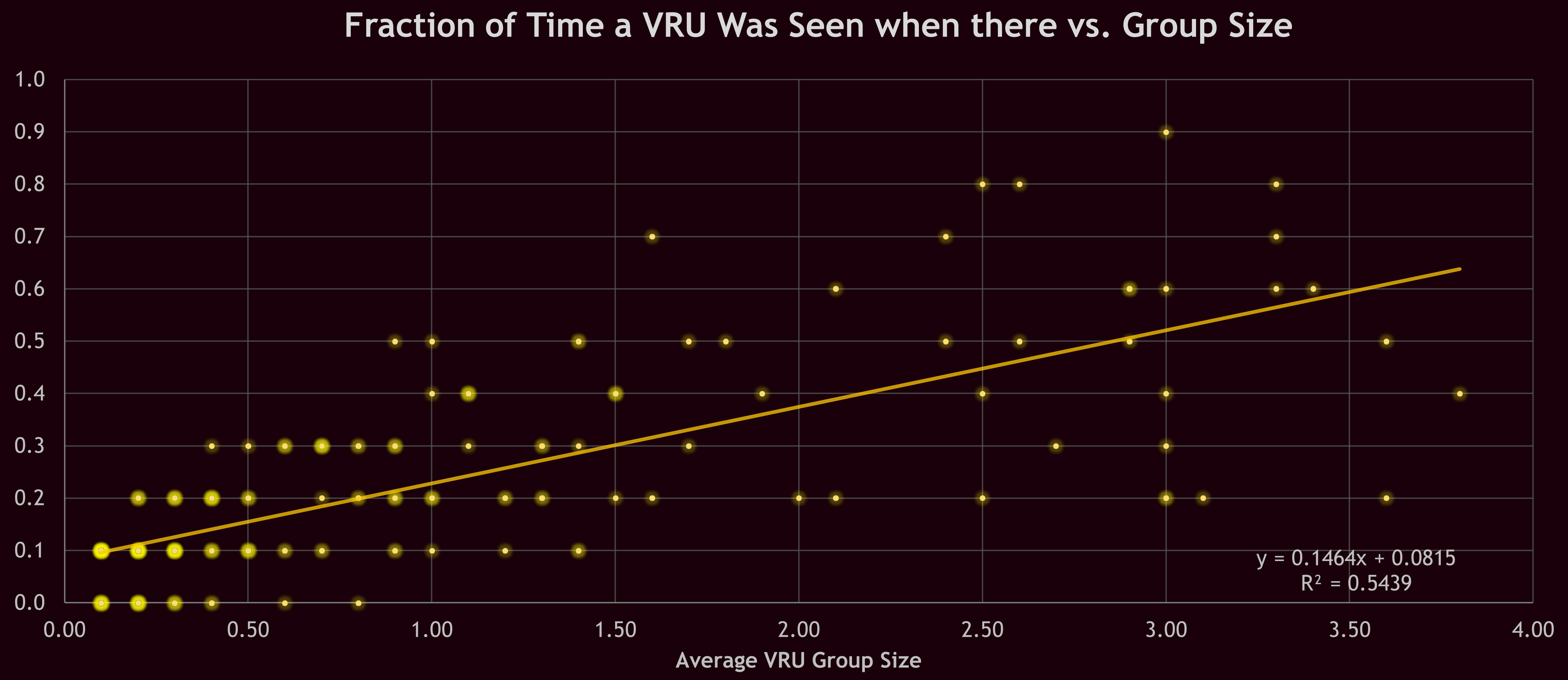
Which means that from the driver's perspective, they only saw a VRU about 17% of the time.



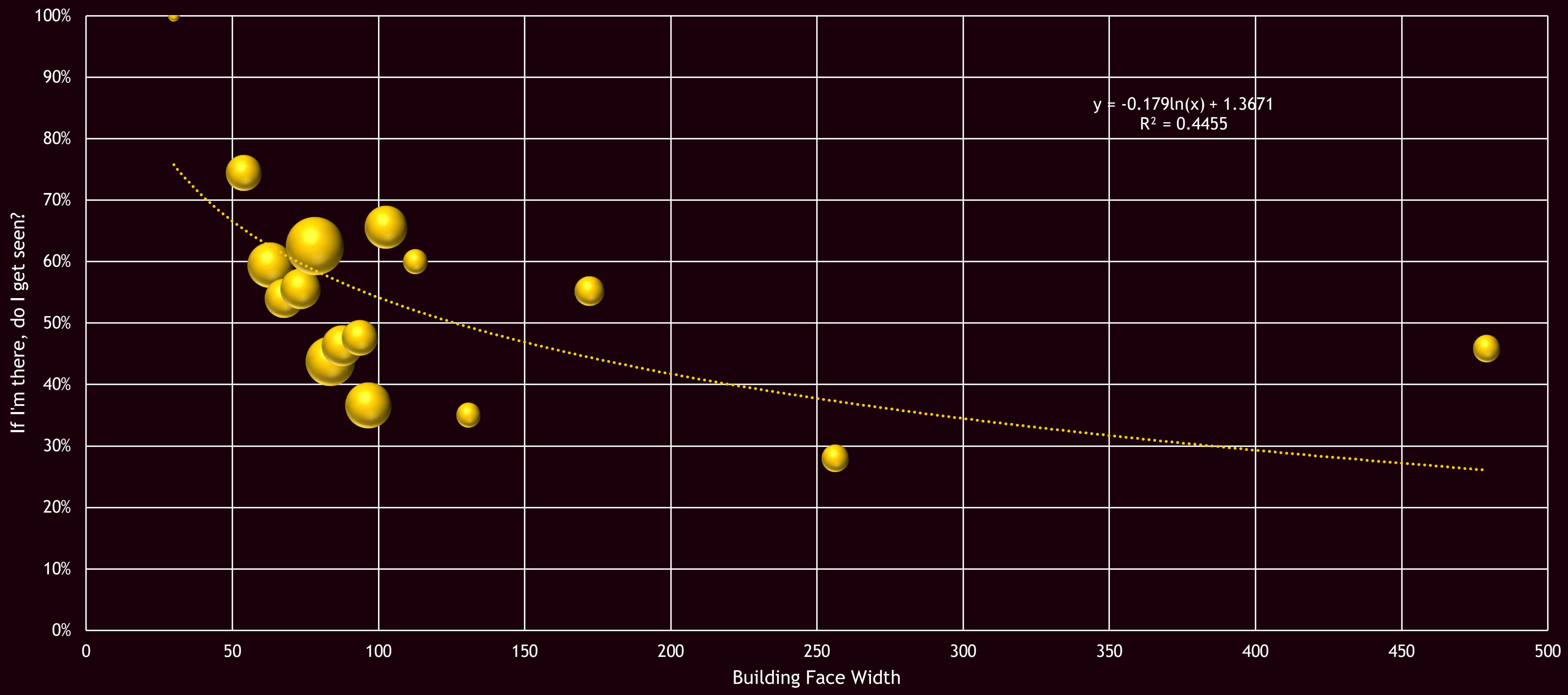
Pedestrian point of view

If I'm there, do I get seen?

Critical mass



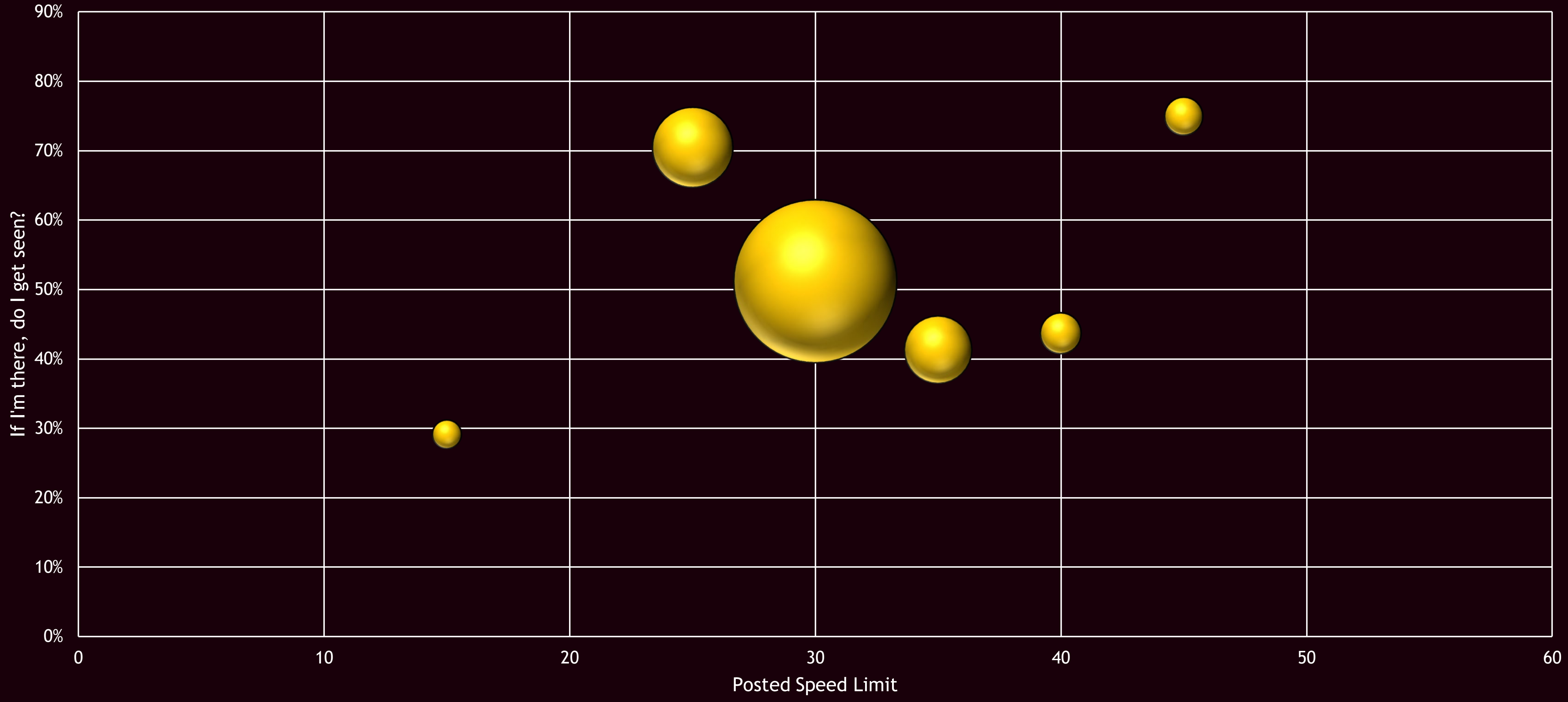
Building face width



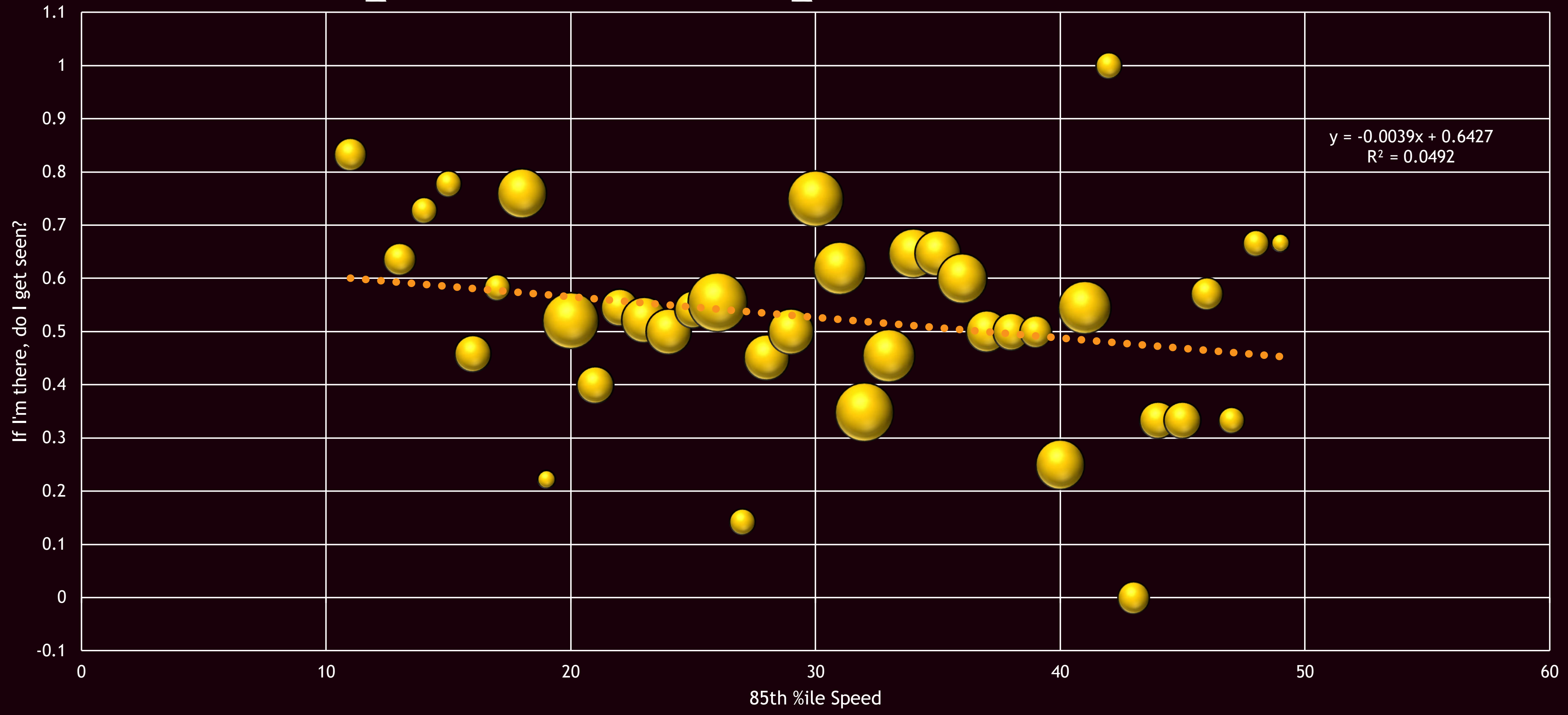
Other variables that matter:

- Sidewalk type
    - Most conspicuous was right next to the road, but the risks there are also highest
    - Really wide sidewalks dropped the ability to be seen
- LOS
    - Busier meant less visible

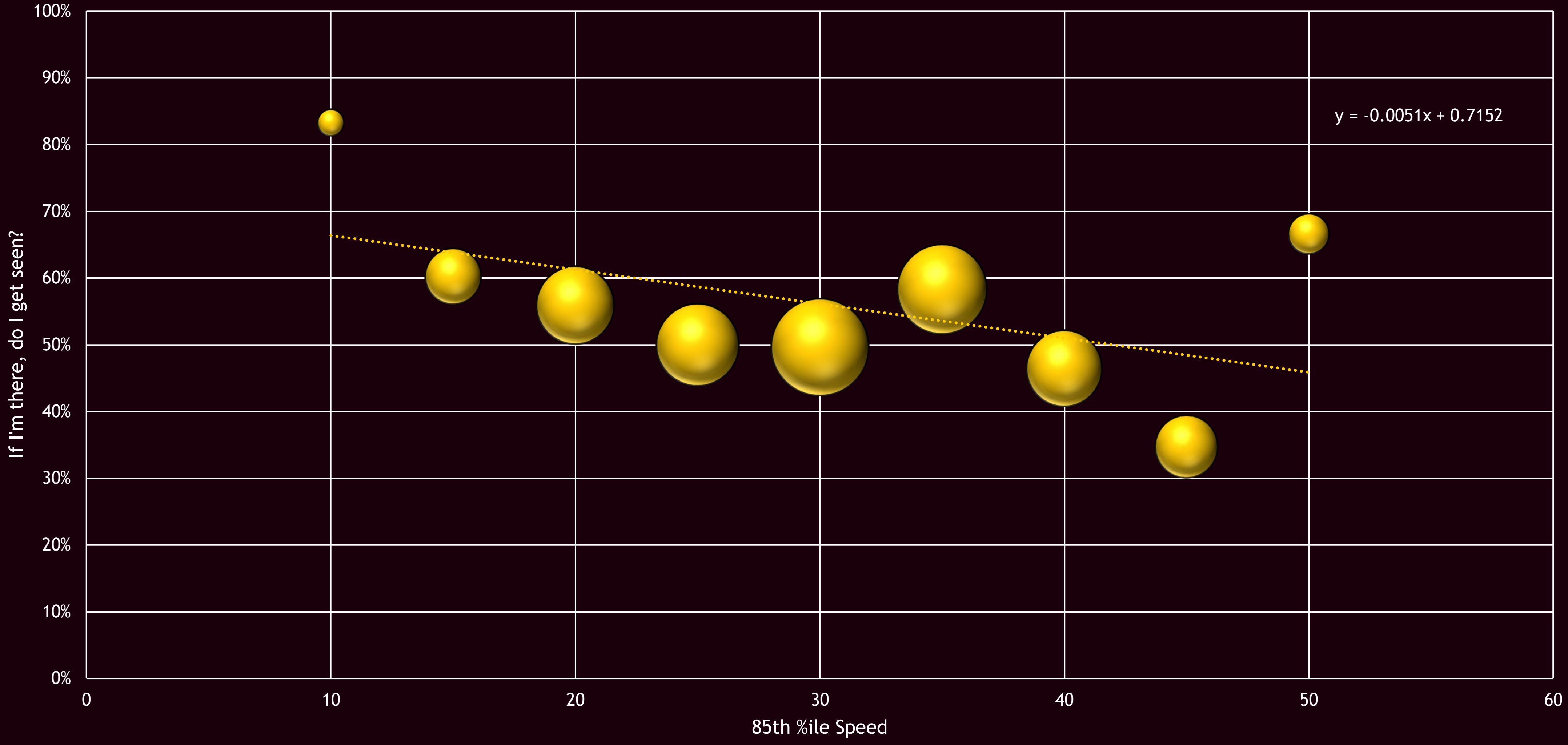
Speed Limit:
From the pedestrian's point of view:



Speed:
From the pedestrian's point of view:



Speed:
From the pedestrian's point of view:

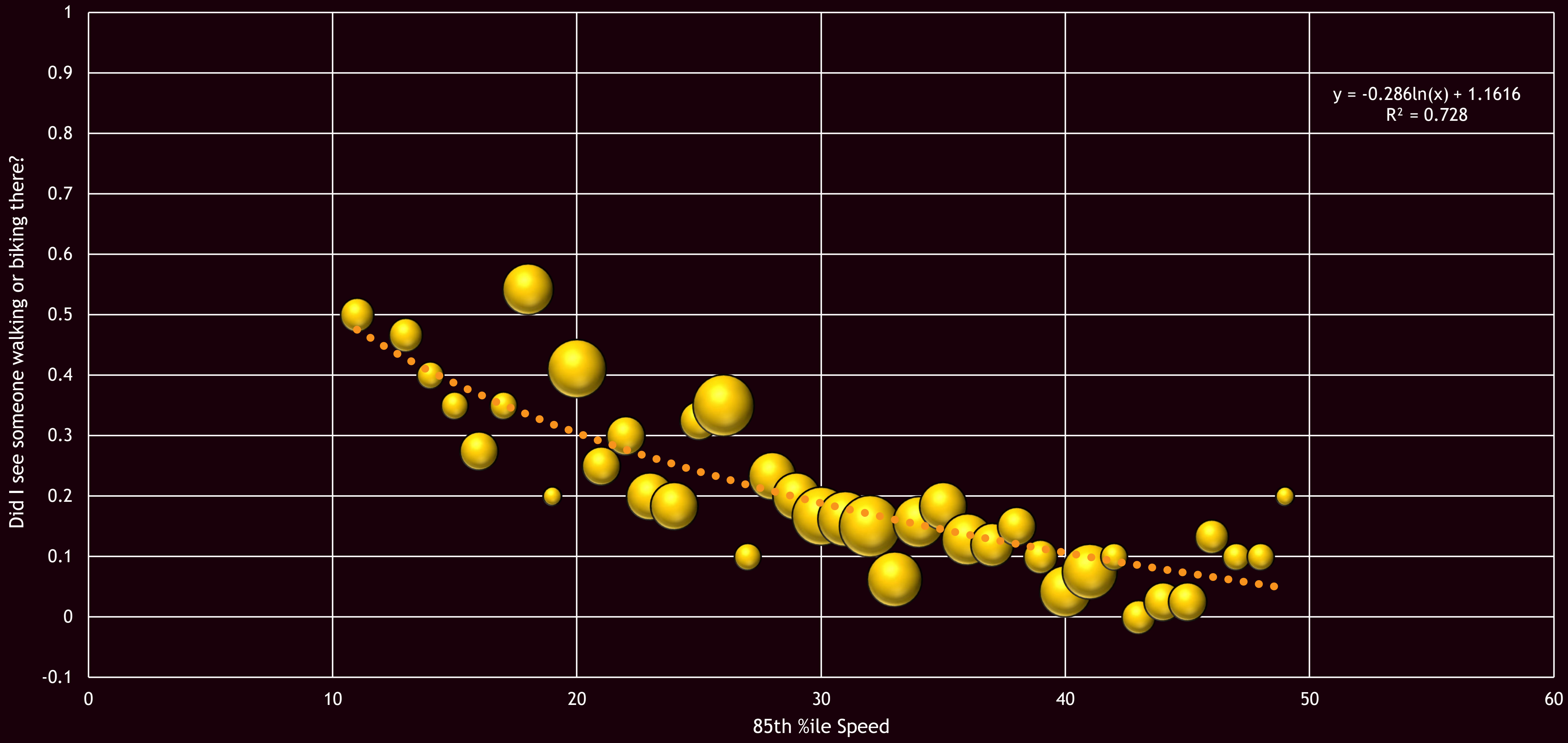


Driver's point of view

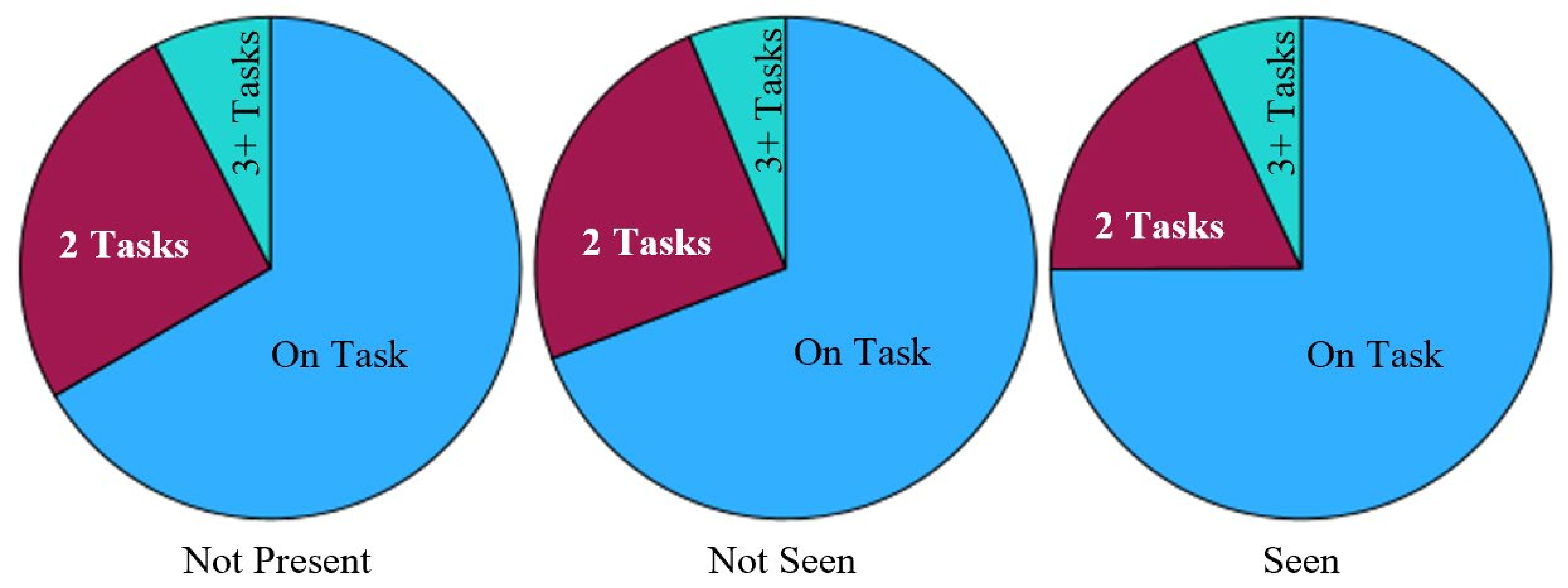
Am I going to see anyone there?

Speed:

From the driver's point of view



Multitasking:
From the driver's point of view



Questions:

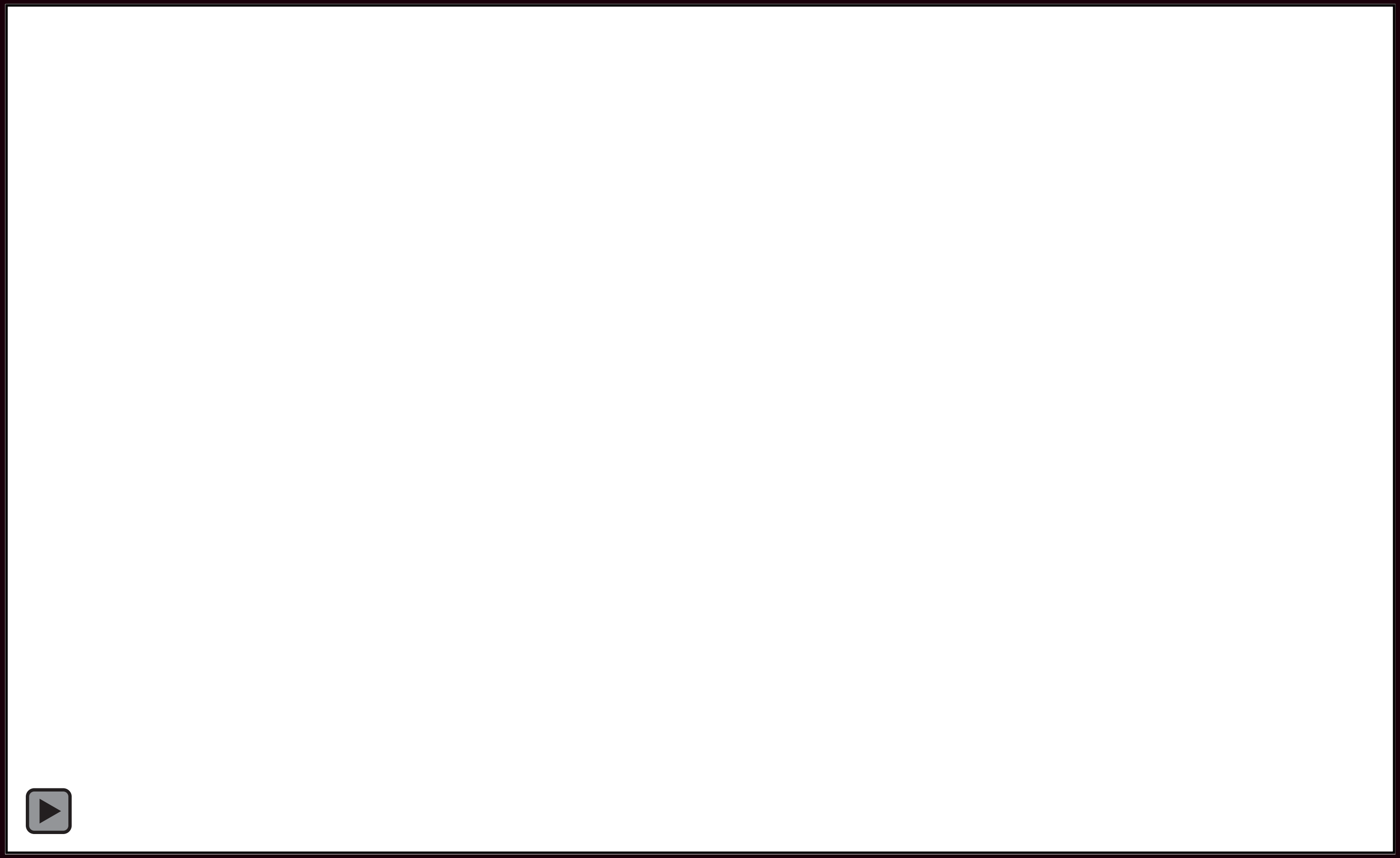
- What else matters?
- What are the distance limits?
- What are the speed limits?
- How can we make pedestrians more conspicuous, day and night?
- What are the daytime vulnerabilities?
- What's going on under the hood?

Simulation?

- What can we do in a simulator?
- How accurate does the face and gait need to be?

Other data streams:

- (New) NDS
- CAV video
- Point light walkers



Video: Jeff Kelly, https://www.youtube.com/watch?v=w7nRBRoMfWM

Shameless plug:

- Still looking for presenters, researchers, and potential funding sources

Can You See Me?: Vulnerable Road User Conspicuity Research Plan

Sunday, January 7, 2024, 9:00 AM-12:00 PM, Convention Center
Sponsored by Standing Committee on Human Factors of Infrastructure Design and Operations; Standing Committee on Pedestrians; Standing Committee on Bicycle Transportation; Standing Committee on Road User Measurement and Evaluation; and Standing Committee on Visualization in Transportation

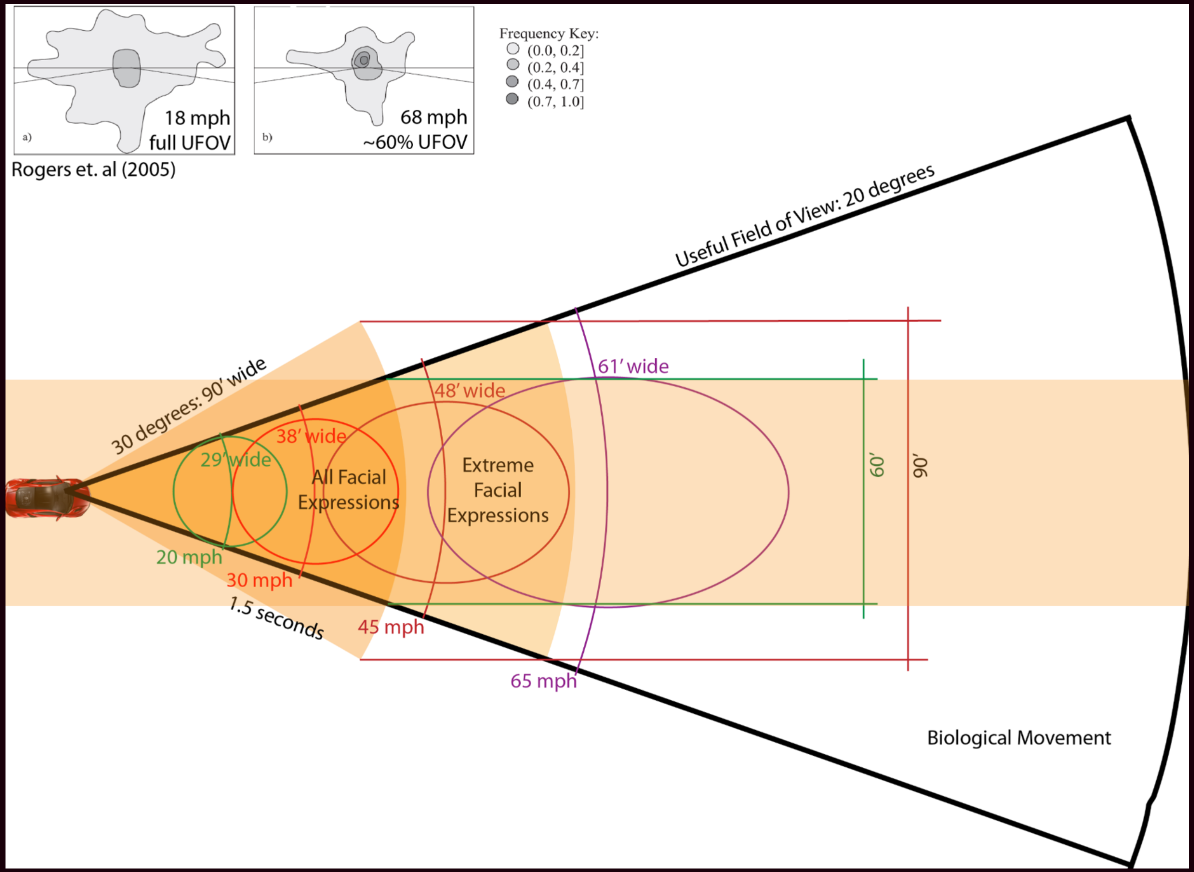
It is assumed pedestrians and cyclists can be seen by drivers, but there are few studies that delineate these perceptual limitations in vivo. Beside the obvious safety issues, seeing a road user directly impacts driver behavior, framing the scale of urban space. The goal of this workshop is to collaboratively examine this topic to identify the critical research questions, explore "pedestrian in the simulator" technologies, and identify other data sources to address this safe systems topic.

Many thanks to FDOT and the UCF

Transportation Econometric Modeling Group

DeWayne Carver

Dr. Naveen Eluru



Dr. Peter Hancock

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Pedestrian Simulators in Traffic Safety Research

Chris Schwarz, Ph.D.

Driving Safety Research Institute

The University of Iowa

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Learning Objectives

- How have pedestrian simulators been used in traffic safety research?
- What are the opportunities and benefits if this approach?
- What are the challenges and limitations of this approach?

Pedestrian Safety

- 7,388 pedestrians killed in 2021, up 12.5% from 2020
  - Highest number since 1981
- 60,577 pedestrians injured in traffic crashes in 2021, up 11% from 2020
- On average, a pedestrian was killed every 71 minutes and injured every 9 minutes in traffic crashes in 2021

Some Existing Pedestrian Simulators

Name/Location	Type
Ben-Gurion University of the Negev, Israel	Semi-Dome
IFSTTAR Pedestrian Simulator, Versailles, France	CAVE
Hank Virtual Environments Laboratory, University of Iowa	CAVE, HMD
Highly Immersive Kinematic Experimental Research (HIKER) Pedestrian Lab, University of Leeds	CAVE
Driving Safety Research Institute, University of Iowa	HMD
VR Lab, Turner-Fairbank Highway Research Center	HMD
University of Guelph, Ontario	HMD
Omni-Reality and Cognition Lab (ORCL), University of Virginia	HMD
Technical University of Munich	HMD
CARISSMA, Ingolstadt, Germany	HMD
OnFoot, Universities of Calgary & Manitoba	HMD

- CAVE – Cave Automatic Virtual Environment
- HMD – Head Mounted Display, also Virtual Reality (VR)

Hank Lab CAVE

It’s still early days…

- More pedestrian simulators are appearing due to better and cheaper technology
  - Games and movies drive the technology
- Previous methods involved less realistic ‘shout’ protocols
  - Pedestrian shouts or presses a button on intent to go
- CAVE and HMD simulators allow study of dynamic pedestrian behaviors
- Connected simulators that link multiple participants allow study of realistic road user interactions
  - Capture cascading chains of stimulus and response

Meta Quest 2

Pedestrian Simulator Research Topics

- Pedestrian crossing behaviors
  - Adults vs. children vs. elderly
  - Crossing alone vs. crossing together
  - With different vehicle speeds
  - In traffic: gap choice, start delay
  - Daytime vs. nighttime
- Distraction from devices, texting
- Efficacy of warning systems
- Interaction with automated vehicles
  - New external lights
- Vehicle-to-pedestrian (V2P) communication
- Road lighting, adaptive headlamps

Field of View

- Field of view (FOV) is the angular cone perceived by the pedestrian at a particular instant in time
- Field of regard (FOR) is the total area accessible to the pedestrian in the simulator
- FOV is constrained in HMDs by the small displays
- FOR is constrained in CAVES because they often leave out the ceiling and one wall

	CAVE	HMD
FOV	↑	↓
FOR	↓	↑

Case Study: Nighttime Conspicuity

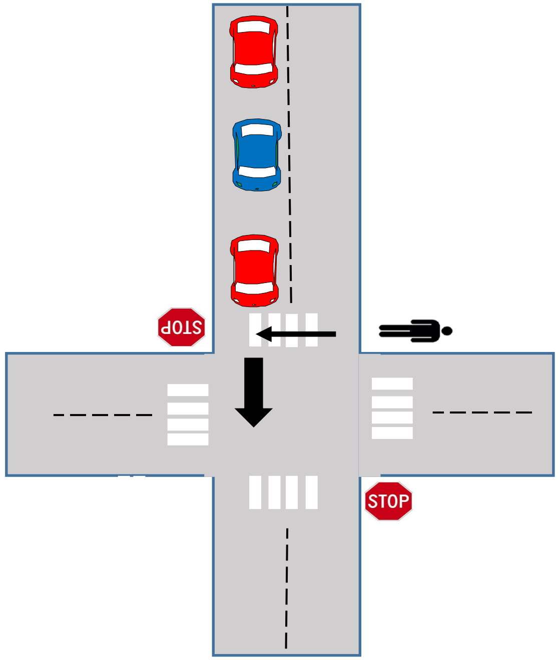
- Ran separate studies for drivers and pedestrians
  - “Can I see you?”
  - “Can you see me?”
- Investigated benefits of adaptive headlamp features
- Agent = computer controlled object
- Avatar = computer representation of human
- Driver’s perspective
  - Driver avatar
  - Pedestrian agent
- Pedestrian’s perspective
  - Driver agent
  - Pedestrian avatar

Driver’s perspective

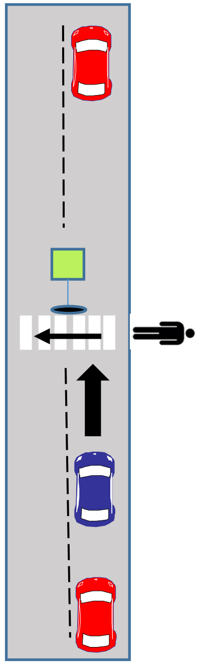
Pedestrian’s Perspective

Case Study: Connected simulator experiment

- Studied pedestrian vehicle interactions at junctions with stop signs as well as mid-block zebra crossings
- Mixed interactions between agents and avatars for drivers and pedestrians



Junction



Mid-block

Apparatus

NADS-1 motion base driving simulator

Participant Behaviors

Simulator versus Reality

Simulator

- Safe
- Controlled, repeatable
- Can observe detailed behavior
- Can study variables that affect specific crash situations

Reality

- Captures complexity of real life
- Can observe large numbers of people
- Can identify crash causation factors

Simulator Validity

- We aim for these types of validity:
  - Face, behavioral, relative
- Simulators usually cannot achieve:
  - Absolute validity

Single versus Connected

Single Simulator

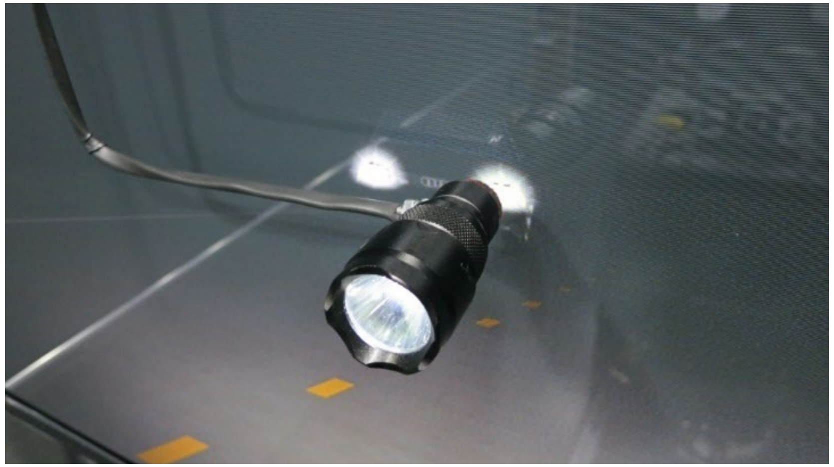
- Good for measuring go/no-go decisions, gap acceptance
- Agents only have simple, pre-programmed behaviors
- Scenarios are simpler to program

Connected Simulators

- Good for measuring dynamic interactions between humans
- Can render gestures and glances between avatars
- Can produce complex chains of responses
- Scenarios are more complicated
- Data analysis is more complicated
- Experiment design and execution are more complicated
- Still less complicated than real life!

Conspicuity

- Conspicuity can be tuned to some degree in order to match detection distances
- It is difficult to accurately render lighting, reflectivity, and glare
  - True glare may not be achievable without the addition of a separate glare source
- Preferred luminance for HMDs is lower than for other displays
- We're attuned to detecting bio-motion
  - Make agent movements as realistic as possible
  - Simulated environments can be too 'sterile', lacking ambient motion and visual clutter



Glare Source

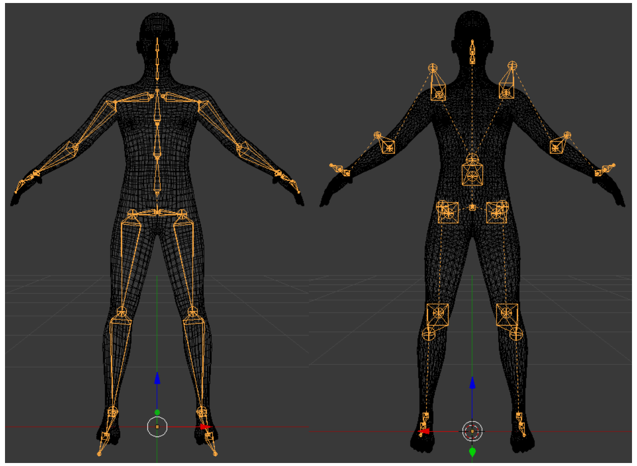
Headlight Glare

Mobility

- Walking space is limited by CAVE size, lab space, cable lengths
- An omni-treadmill can provide unlimited mobility but walking ‘feels’ different
  - Hard to stop on a dime or quickly change direction
- Disparity between visual and physical motion can cause simulator sickness
- Kinematic awareness
  - In a CAVE you see your own body, but others won’t see your avatar
  - In an HMD you do not see your own body, only your avatar
  - Animating an avatar requires trackers, a human model, and inverse kinematics - still a hard problem

Virtuix Omni

Credit: Wikipedia



Human Model

October is pedestrian safety month

Today’s presenters

Barb Chamberlain
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David Hurwitz
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Oregon State University

Patricia Tice
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ProFound Insights, Inc.

Chris Schwartz
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University of Iowa

Upcoming events for you

September 19, 2023

TRB Webinar: Maximizing the Power of the Research in Progress (RIP) Database

November 13-15, 2023

TRB's Transportation Resilience 2023

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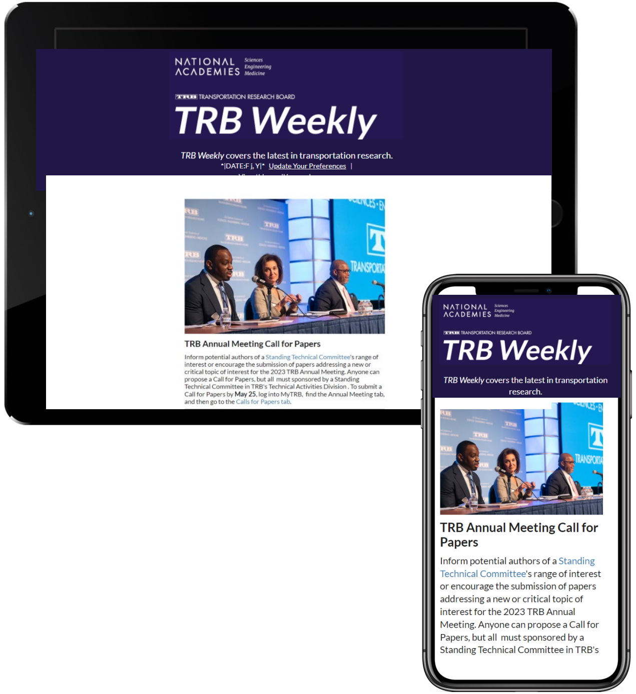

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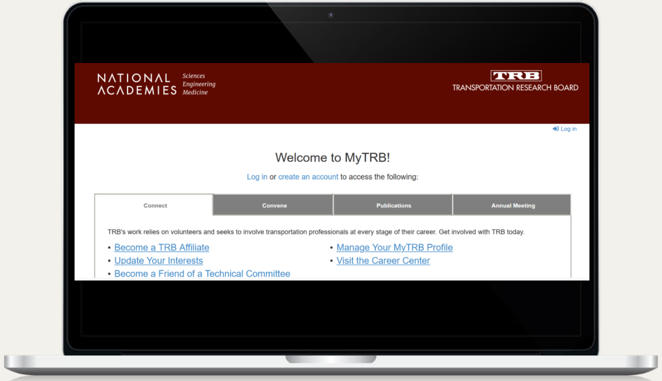

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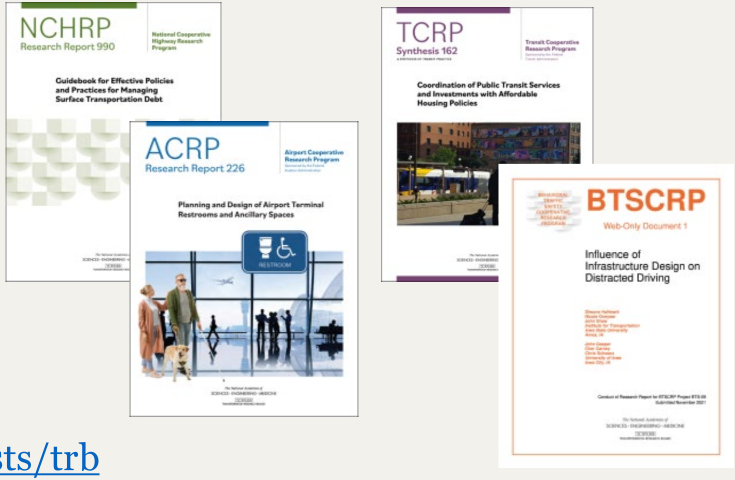

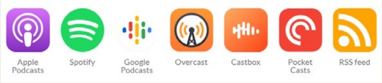

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