VTTI's Older Driver Research Program: Initial Naturalistic Study

Sponsor:

National Surface Transportation Safety Center for Excellence (NSTSCE)

VTTI Naturalistic Driving Symposium

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Driving Transportation with Technology

Virginia Tech Transportation Institute

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Our Older Participant Volunteers!

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Presentation Outline

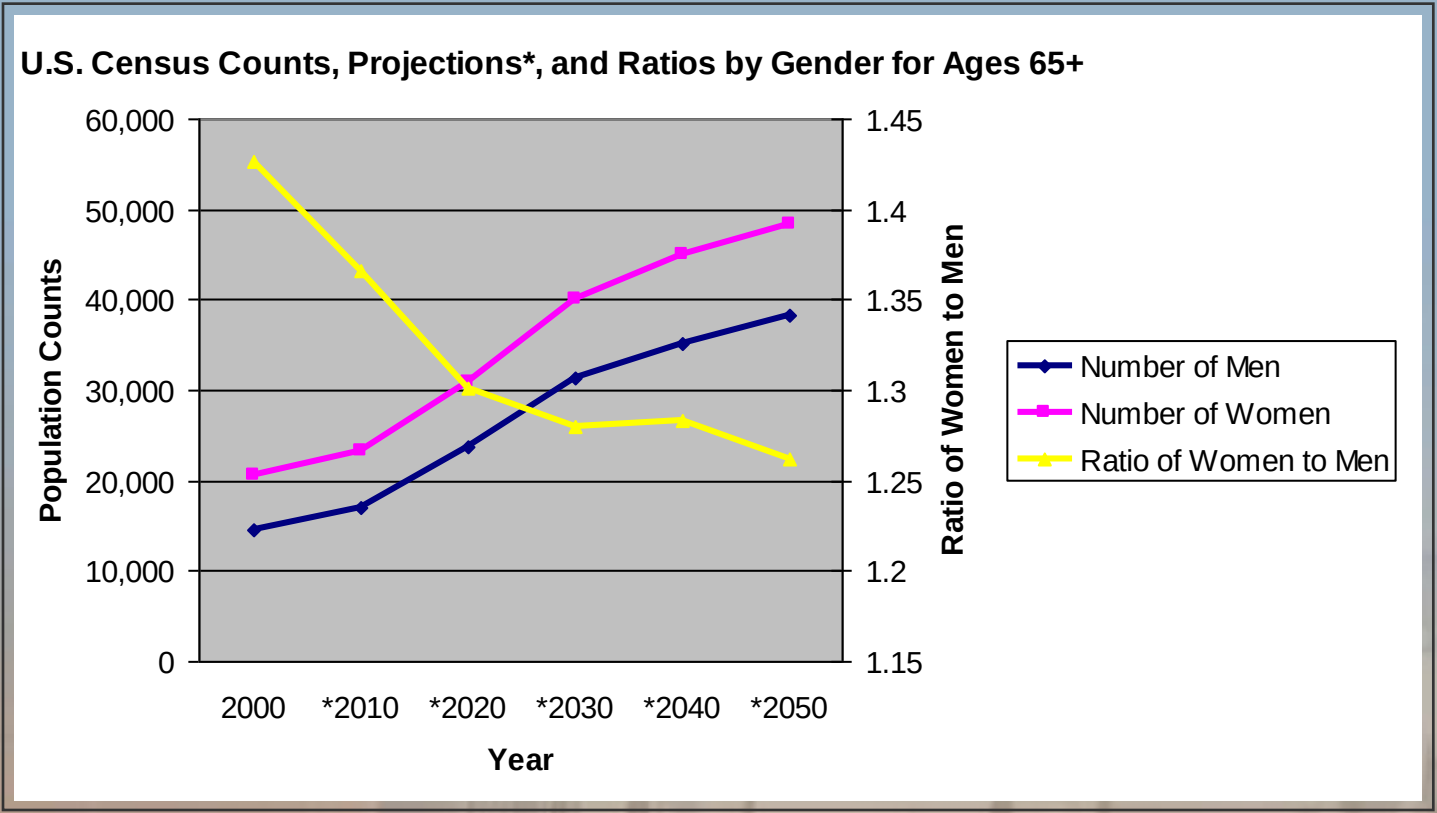
- Background and Motivation
- Objectives
- Methods
- Status
- Results
- Early Conclusions
- Future Directions

Traffic Injury Prevention
Current Special Issue on Older Drivers

- Licensing Authorities' Options (e.g., Eberhard)
- Medical Impairments (e.g., Marshall)
- Cognitive Impairments (e.g., Adler & Silverstein)
- Vision Testing (e.g., Bohensky, Charlton, Odell, & Keeffe)
- Self Regulation (e.g., Molnar & Eby)
- Driver Assessment and Rehabilitation (e.g., Langford; Wheatley & Di Stefano)
- Prolonged Mobility (Oxley & Whelan)
- Future Vision (Fildes)

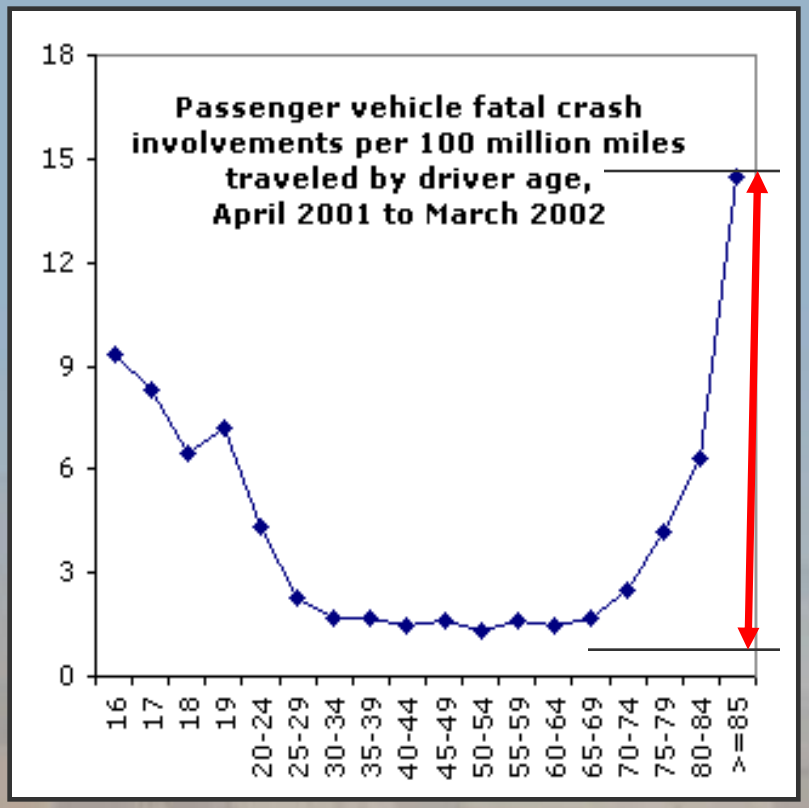
More Older Drivers

- **Census Projections Indisputable** - there will be millions more older drivers and a much greater proportion of same in the coming decades



High Fatality Risk

- Fatality Risk > all other age groups except teens, when controlling for exposure



IIHS (2004)

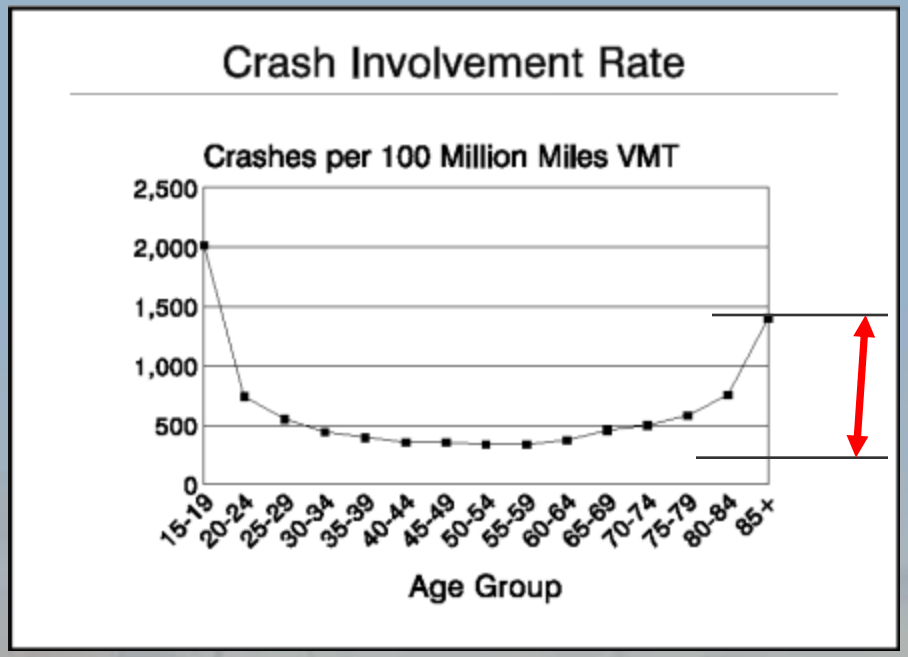
Greater Fragility

- Older drivers are more likely to suffer fatal and other serious injuries in a crash.

NHTSA (2006)

High Crash Risk

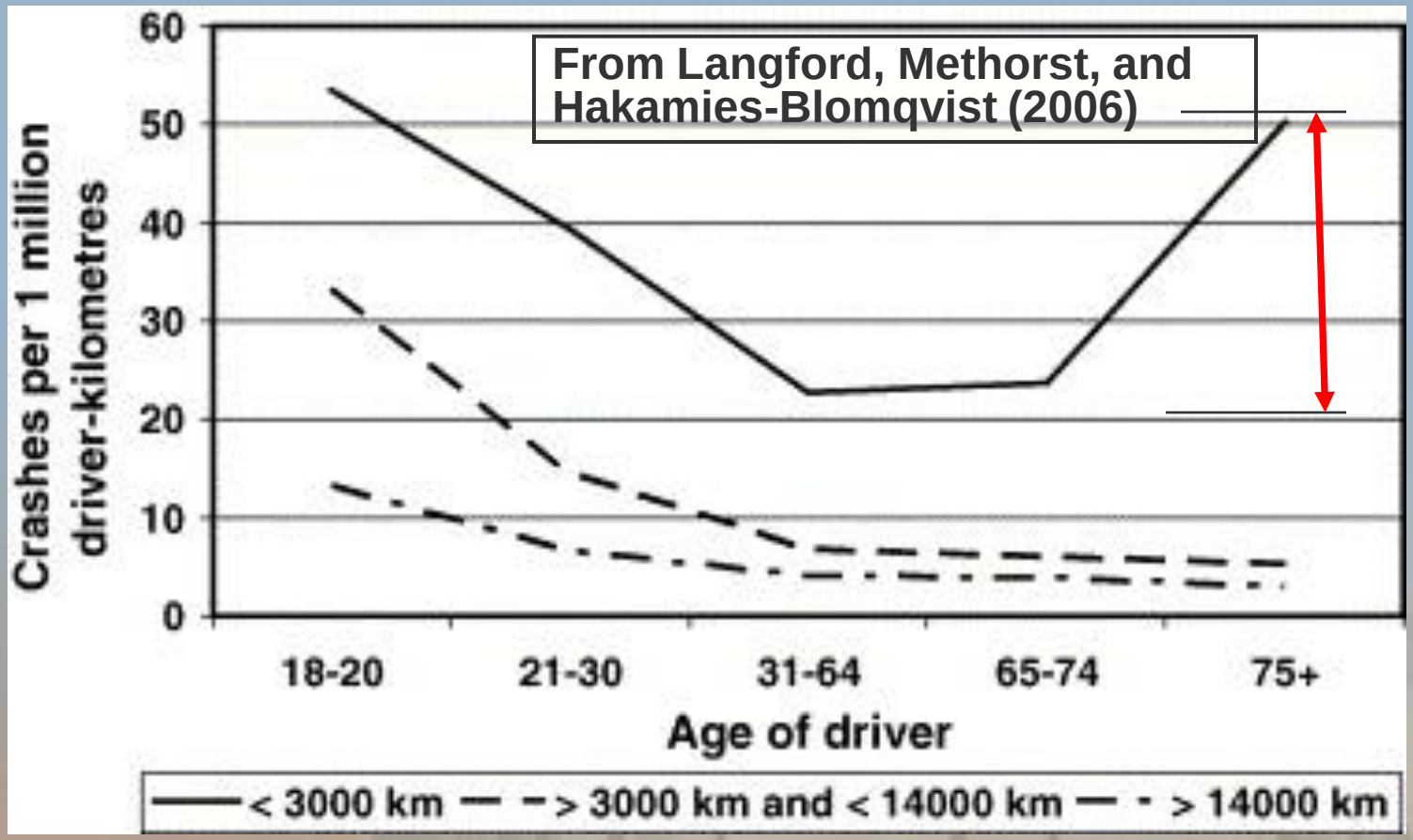
- Crash Risk > all other age groups except teens, when controlling for exposure



NHTSA (2006)

High Crash & Fatality Risk

- Crash & Fatality Risk mediated by total mileage
- Due to: roadway type or impairment?



Functional Impairment

- Strong tendency for older drivers to experience decrements in:
  - Vision
  - Cognition (including dementia)
  - Psychomotor skill and flexibility
  - General Health (often requiring many more medications)
- Each of these can increase crash risk (Marshall, 2008)

Objectives

1. ***Naturalistic Driving:*** Instrument 20 older (75+, 65+) drivers' vehicles for 12 months each to better understand:
   - behavior and driving performance
   - the situations and contributing factors that lead to crashes
   - crash injury data for use in biomechanical crash injury modeling
     - Advanced Accelerometer Assembly
       - Sampling Frequency: 1kHz (x, y, z)
       - Range: -100g to +100g
       - Accuracy/Sensitivity: 0.1g

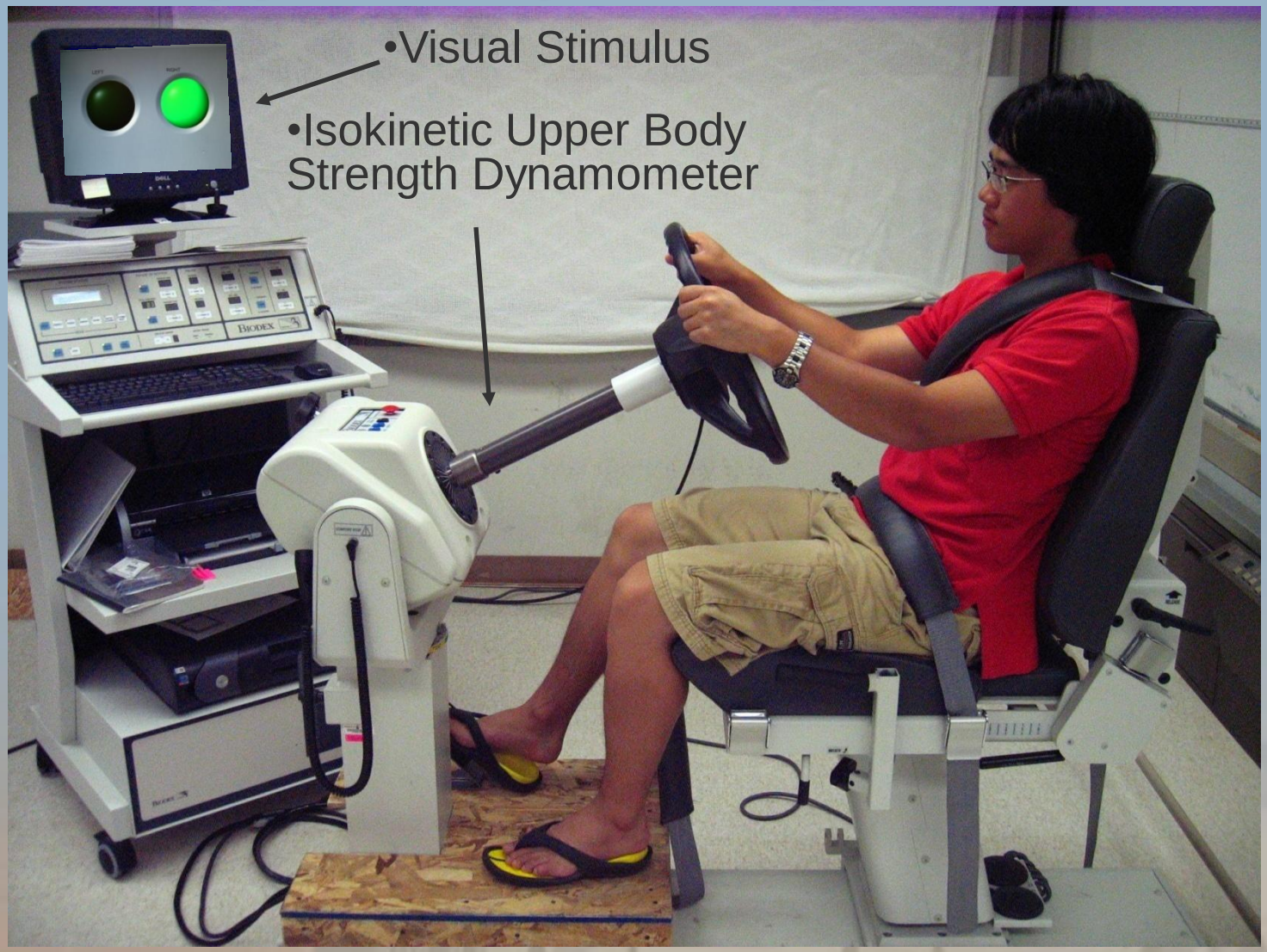
Objectives

2. ***Determine Older Driver Impairment Profiles*** across a wide variety of dimensions
   - ***Correlate impairment profiles*** against the driving behavior and safety outcome data for patterns that may lead to:
     - Intervention
     - Training
     - Cessation protocols
3. ***Determine Older <u>Non-Driver</u> Impairment Profiles***
   - Compare Impairment profiles of the drivers to the non-drivers
   - Learn more about why older individuals choose to give up driving

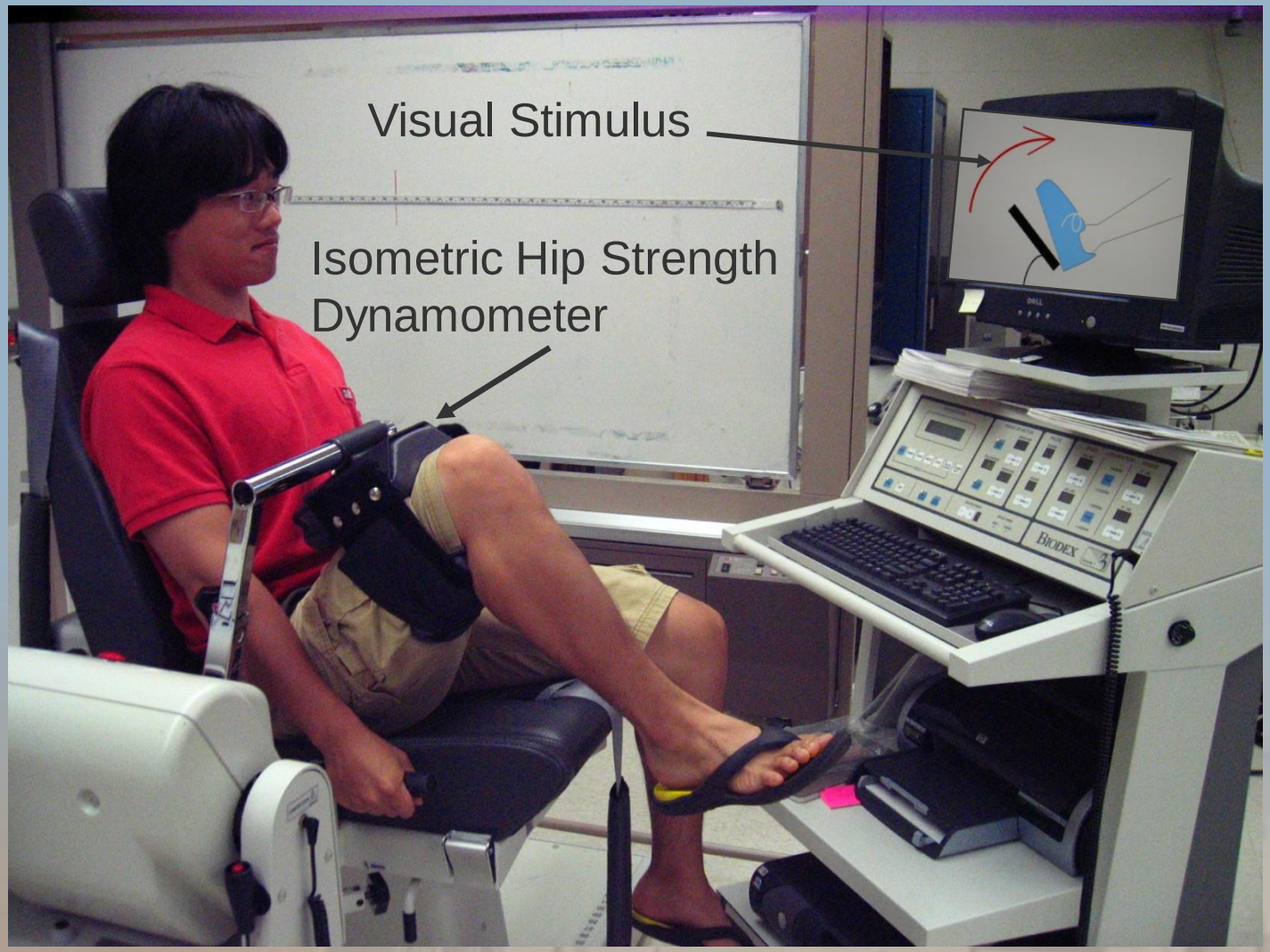
Assessments

- **Physical**
  - upper and lower body strength & RT
  - head-neck-torso flexibility
- **Visual**
  - static and dynamic visual acuity
  - glare sensitivity
  - accommodation
- **Dementia**
- **Visual-Cognitive**
  - divided and selective visual attention
  - useful field of view
  - visual closure

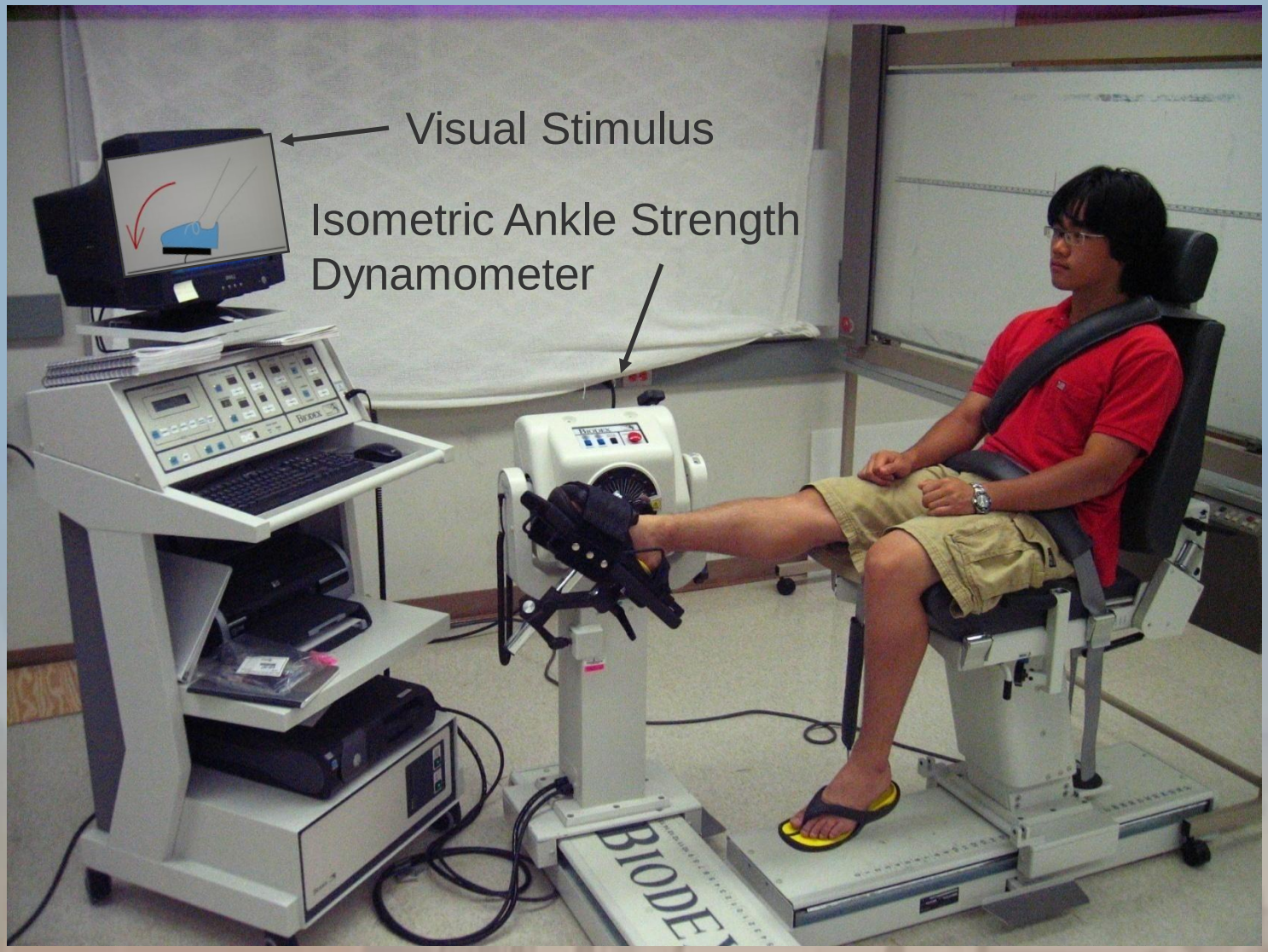
Upper Body Strength & RT



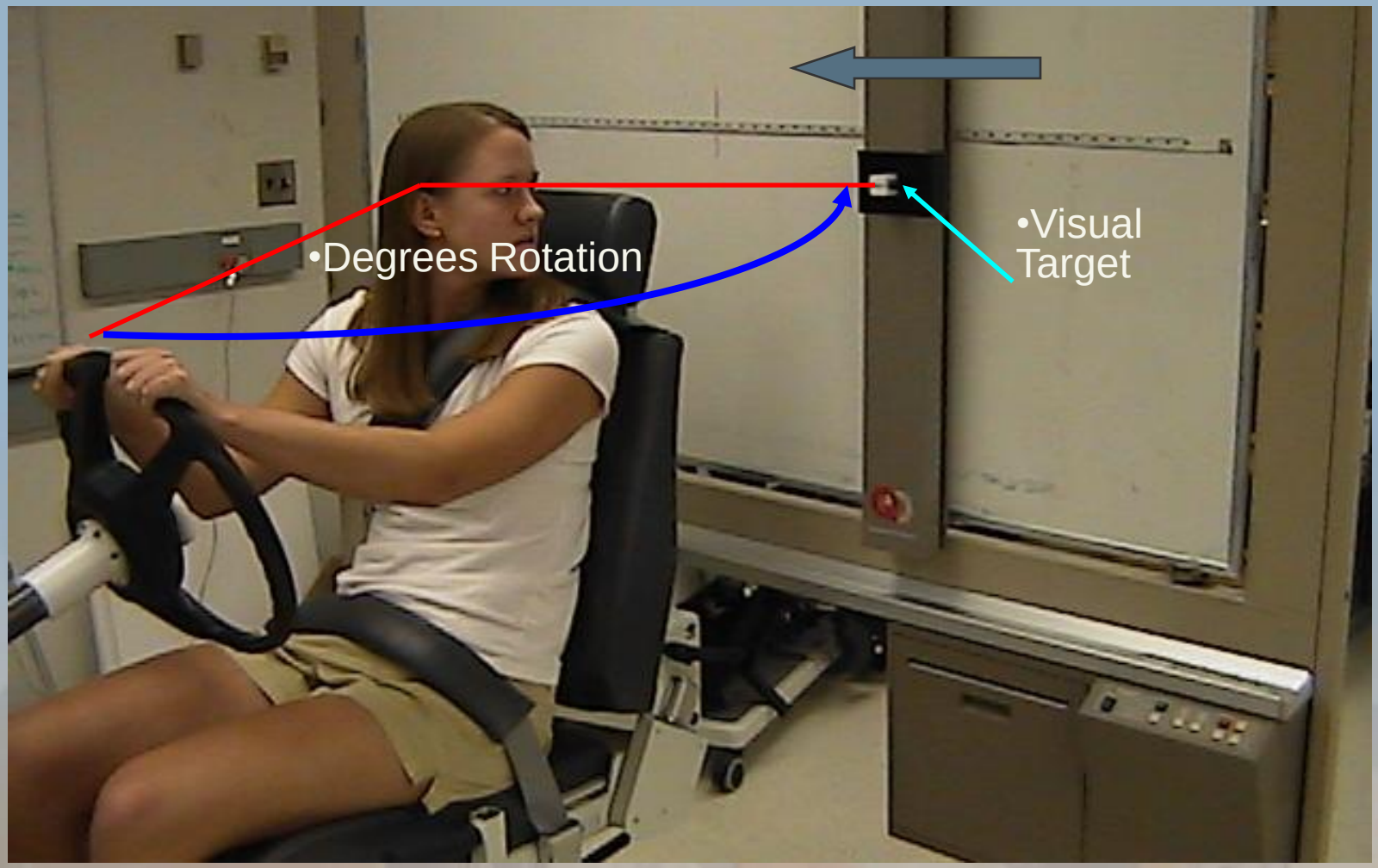
Hip Strength & RT



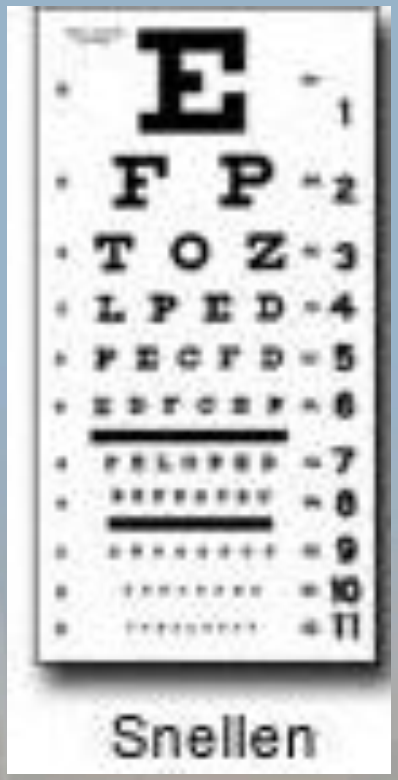
Ankle Strength & RT



Head-Neck-Torso Flexibility

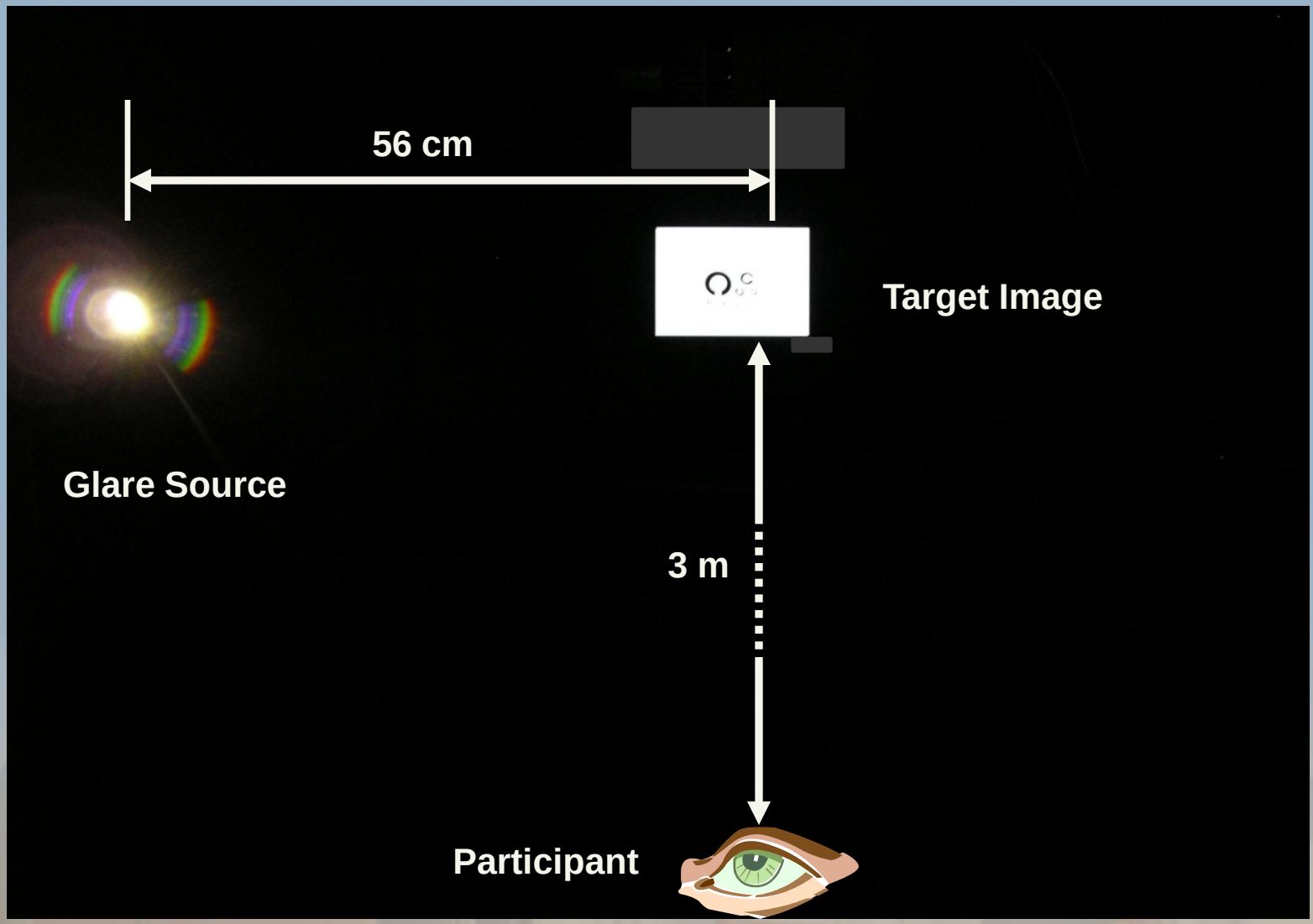


Visual Acuity & Contrast Sensitivity

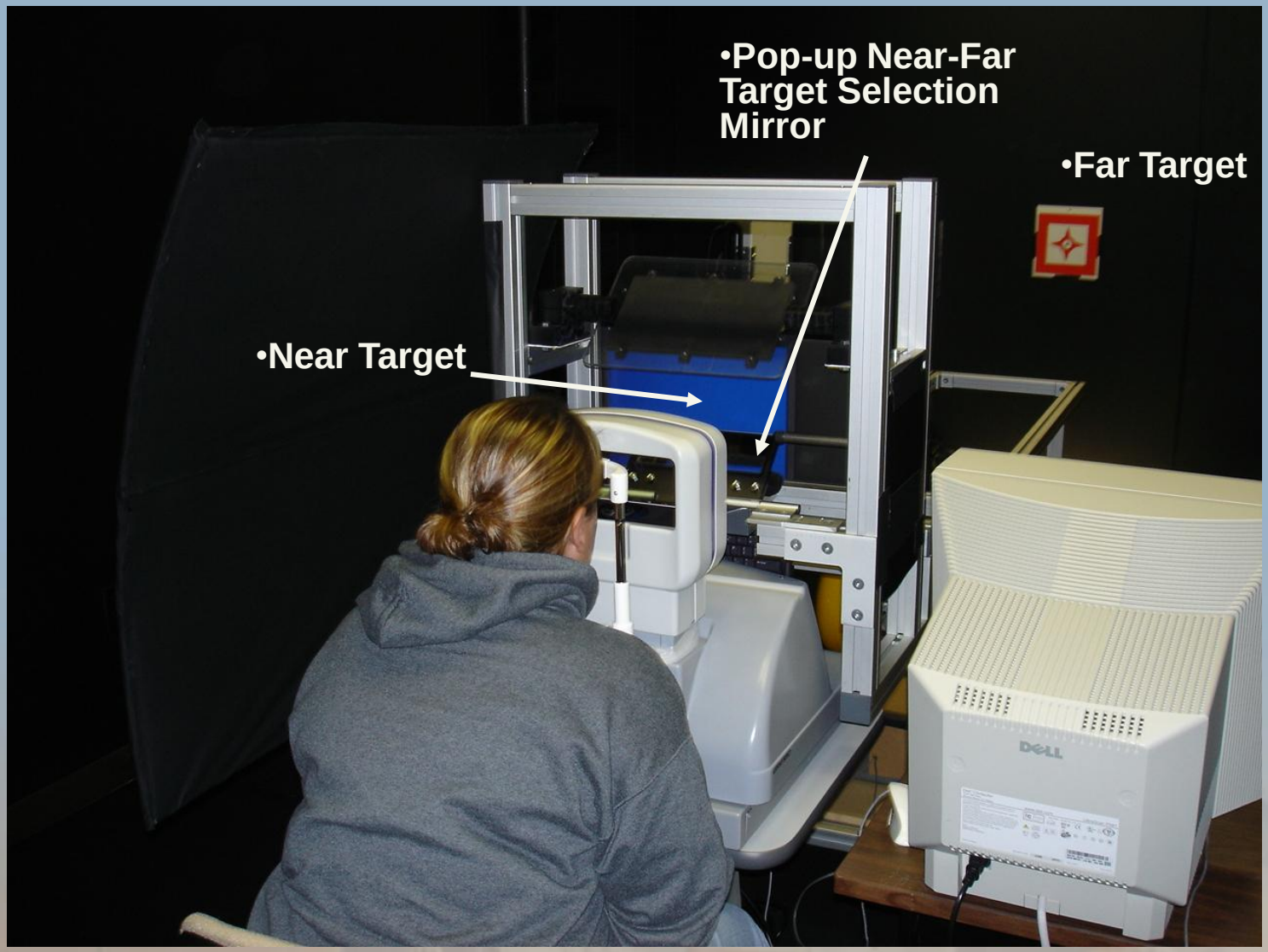


Snellen

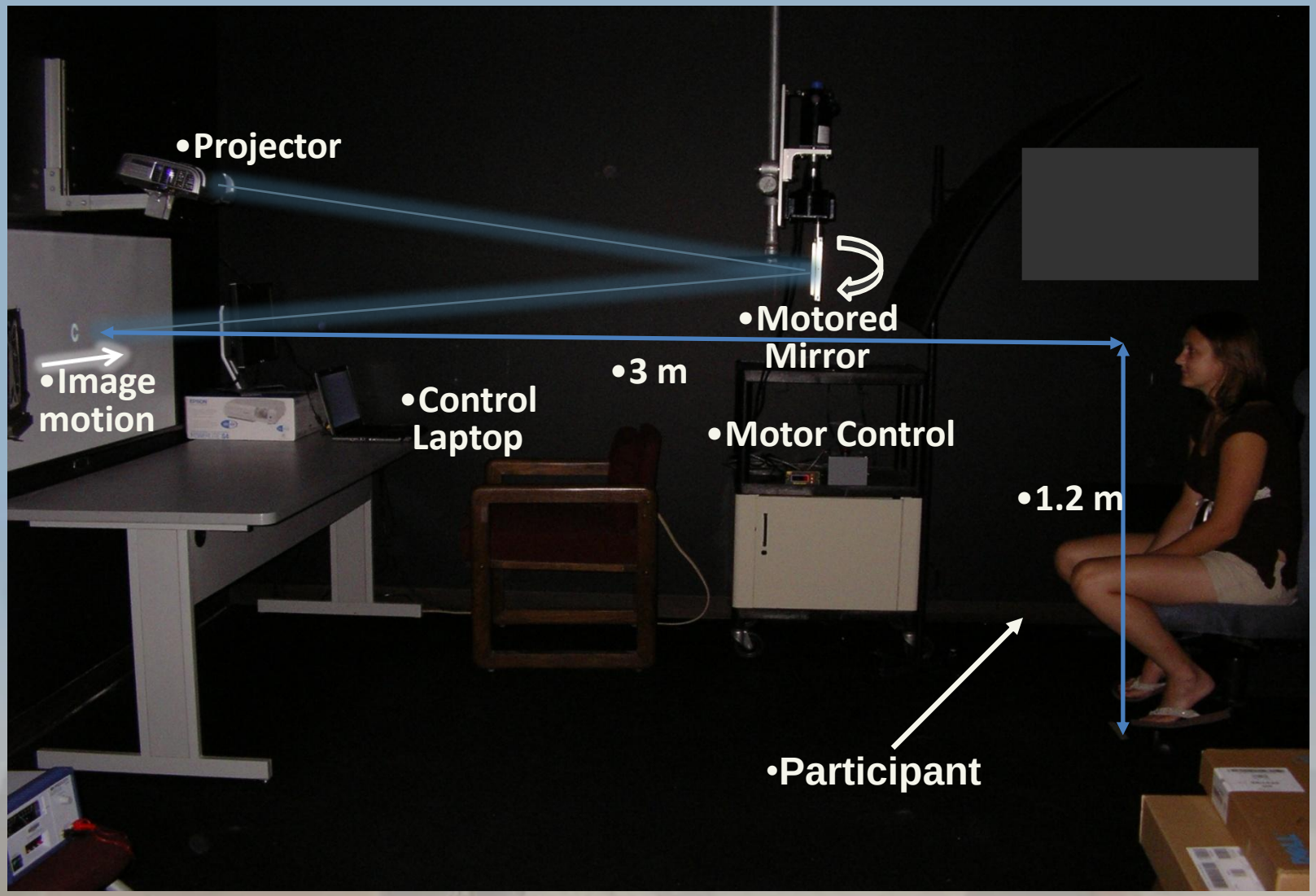
Glare Sensitivity Apparatus



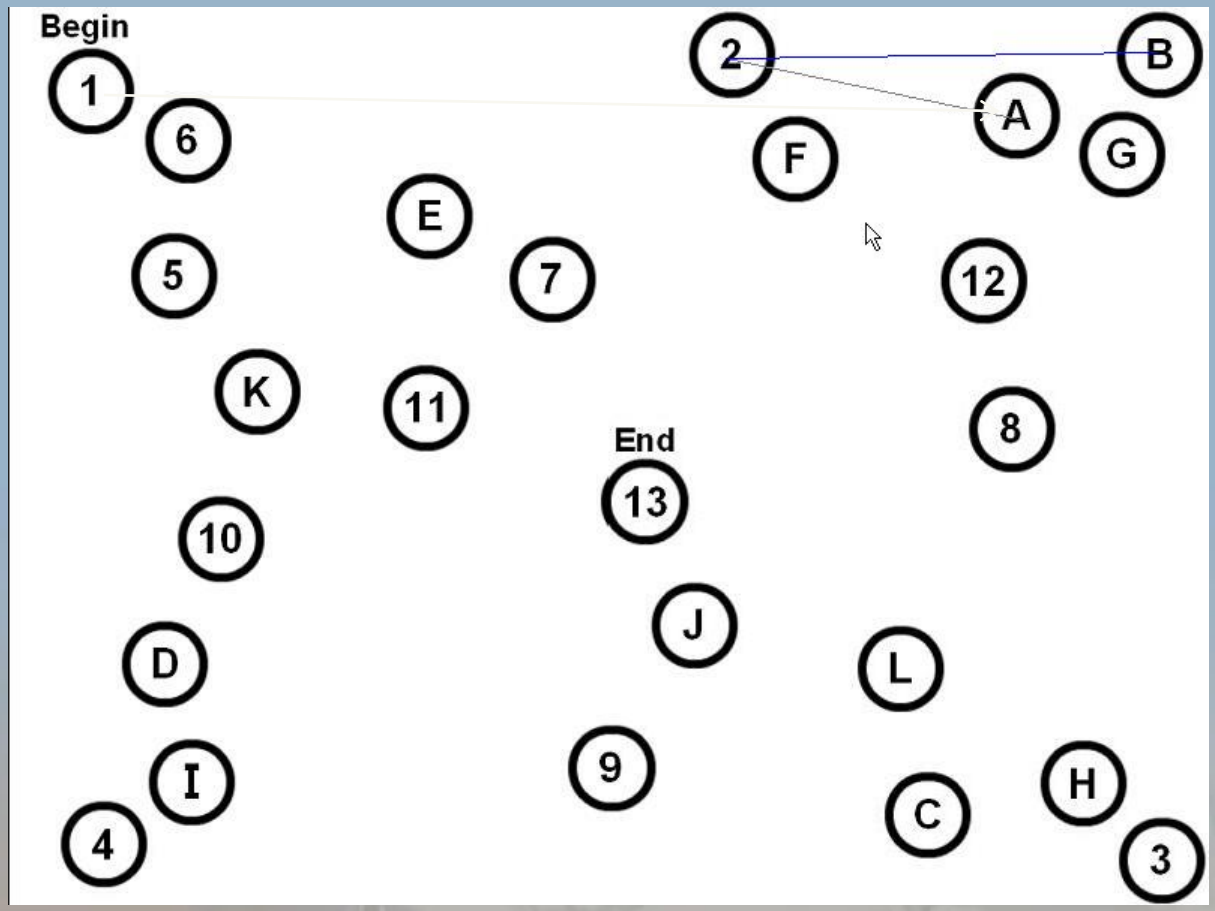
Accommodation Metrics Apparatus



Dynamic Visual Acuity Tester



Trail Making Test B in DrivingHealth Inventory



Onboard Data Acquisition System (DAS)

- Unobtrusive DAS records continuous, high frequency data on the following:
  - longitudinal and lateral acceleration
  - yaw rate
  - GPS-based location and speed
  - machine vision-based lane tracking
  - selected controls (e.g., turn signals and brake lights)
  - cameras will show:
    - driver's face
    - interaction with the center stack (e.g., radio)
    - forward and rear roadway views

4-Channel Composite Synched Video

•Driver's Face

•Forward Roadway

•Data Synch

•Rear View

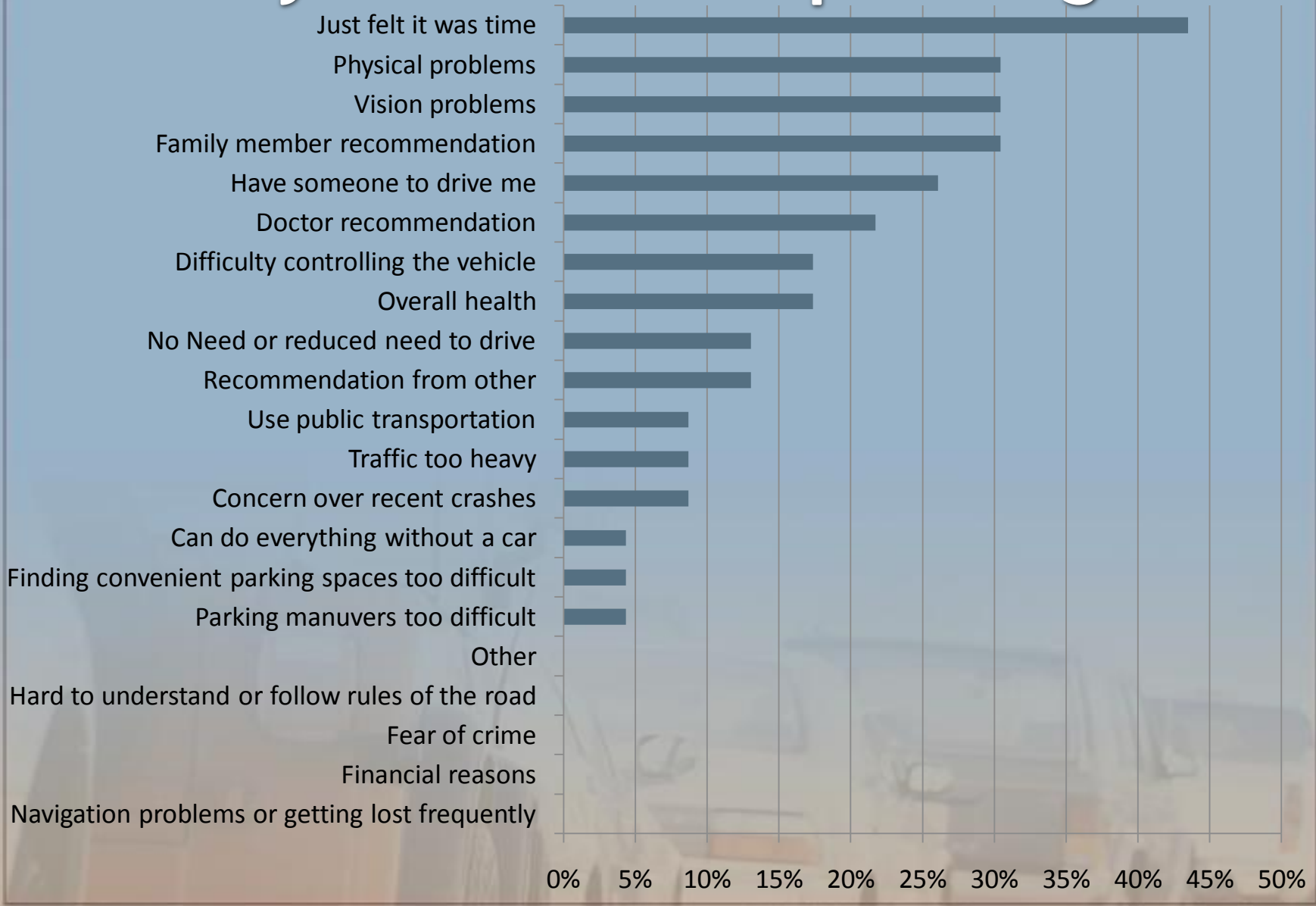
•Over the Driver's Shoulder / Center Stack Interaction

Status

- 15 vehicles currently instrumented, on road, and gathering data; 5 are in queue, meaning all 20 drivers should be on the road in the next couple of months
- All assessment data gathered
  - Drivers: 14 male; 12 female (age range: 70-85)
  - Non-Drivers: 11 male; 12 female (age range: 65-93)

	Driver Age (s.d.)	Non-Driver Age (s.d.)
Male	77 (4.6)	79 (7.7)
Female	79 (4.3)	82 (6.7)

Why Did You Give Up Driving?



Results: Physical & Psychomotor

Variable	Driver Mean	Non-Driver Mean	t Value	Pr > |t|
Ankle Torque Max - Plantar (N-m)	33.531	22.620	2.52	0.0159
Ankle Torque Max – Dorsi (N-m)	30.650	17.084	3.66	0.0008
Upper Body Torque Max Left (N-m)	25.140	16.396	3.69	0.0007
Upper Body Torque Max Right (N-m)	25.101	16.207	4.17	0.0002
Ankle Initial Reaction Time (s)	2.438	2.860	-2.90	0.0061
Ankle Peak Reaction Time (s)	2.940	3.640	-4.23	0.0001
Hip Initial Reaction Time (s)	2.363	2.994	-3.53	0.0011
Hip Peak Reaction Time (s)	2.743	3.679	-4.93	<.0001
Upper Body Initial Reaction Time (s)	2.218	2.622	-2.48	0.0179
Upper Body Peak Reaction Time (s)	2.460	3.024	-2.93	0.0058

α = .05

Results: Perceptual

Variable	Driver Mean	Non-Driver Mean	t Value	Pr > |t|
Dynamic Visual Acuity (2 RPM)	0.4043	0.3313	2.48	0.0179
Dynamic Visual Acuity (4 RPM)	0.3304	0.1222	6.23	<.0001
Dynamic Visual Acuity (6 RPM)	0.1391	0.0444	4.71	<.0001
Glare Contrast Sensitivity (16 cycles/degree)	*3.913*	*4.6316*	*-2.86*	*0.0067*
Snellen Acuity	25.192	41.522	-4.23	0.0001
Contrast Sensitivity Left (1.5 cycles/degree)	5.1154	4.3478	2.50	0.0158
Contrast Sensitivity Left (3 cycles/degree)	5.5769	4.8696	2.33	0.0243
Contrast Sensitivity Left (6 cycles/degree)	4.1923	3.5652	2.22	0.0311

α = .05

Results: Other

Variable	Driver	Non-Driver	t Value	Pr > |t|
# of Health Problems	2.6923	5.6957	-3.86	0.0003
Years Driving	59.692	53.75	2.12	0.0393
Trail Making (s)	114.3	191.59	-4.35	0.0001

α = .05

Early Conclusions

- Recruitment Issues Male ND and Female D
- Almost all sig differences favored drivers
- Accommodation may play a role: YD vs. OD
- Emerging factors to differentiate D & ND:
  - Health
  - Physical strength
  - Reaction time
  - Acuity
    - Static & Dynamic
      - $r_{(2, 4, 6)}$ = 0.14824, 0.44879, 0.27923
  - Visual attention
- Reasons for Giving up driving
  - Physical, visual, family rec., felt it was time

Future Directions

- Develop logistic regression model to Classify Drivers / Non-Drivers
- Add advanced accelerometer assembly and implement in as many vehicles as feasible
- Validate driver glance behavior model for this population
- Attempt to put an additional 20 vehicles on the road

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