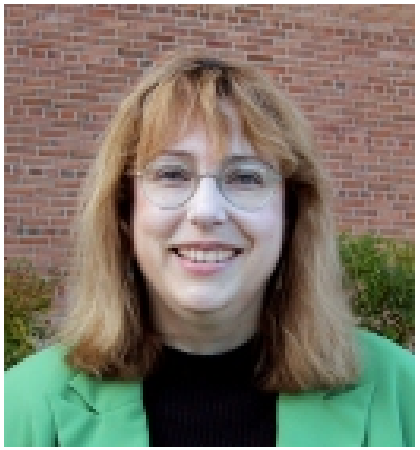
Webinar Series: Working Hours, Sleep and Fatigue

Fatigue and Automation: Black Swans and Lumberjacks Redux

September 26, 2018



Moderators:

Naomi Swanson, Branch Chief

Division of Applied Research and Technology, NIOSH

Ted Hitchcock, Deputy Branch Chief

Division of Applied Research and Technology, NIOSH

Featured Presenter:

Don Fisher, Principal Technical Advisor

Safety Transportation Human Factors

US Department of Transportation, Volpe Center

Housekeeping

Audio

- Please make sure your volume is turned up computer speakers or earphones

Technical Issues

- Adobe Connect meeting support: 1-800-422-3623

Live captions are available for this meeting at the bottom of your screen

- If you are watching the recorded version, please email: twh@cdc.gov to request the unedited transcript

Housekeeping

Interventions and Promising Practices in the Aging Workplace.pptx

TOTAL WORKER HEALTH

NIOSH TOTAL WORKER HEALTH®
Webinar Series

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

Interventions and Promising Practices in the Aging Workplace

September 28, 2017

The findings and conclusions in this presentation have not been formally disseminated by the National Institute for Occupational Safety and Health, and should not be construed to represent any agency determination or policy.

Notes for Attendees

To access live streaming captions, visit:
http://fedrcc.us/Enter.aspx?EventID=33925118&CustomerID=321

What to use the Q&A box (below) for:
1) You are having a technical difficulty that you believe is originating from our end.
2) You have a question for the presenters. During the Q&A session at the close of today's webinar, we will read aloud questions from the queue and discuss.
Please note: You will only be able to see your own questions and those that have been answered by the presenters directly within the Q&A box.

Unable to hear audio? Please try the following solutions:
1. Check that your computer speakers are on. All audio for this meeting will come from your computer speakers or headphones. Make sure that they are on and the volume is set to a comfortable level.
2. Within Adobe Connect, you can also check your audio settings by 1) ensuring that your

Q & A

Closed Caption Viewer

12 pt | White (B) | No Captions

Everybody throw in, and sort of say where you are.
people know that they can fill out the RCP forms here or send them to us, or get on with relay customer service.
And fill it out on line.
>>Carol: A glad to hear that.
I have another question for Shelley.
Have you gotten any video clips?
>>Shelley: No, I haven't.

Live

Downloads

Name	Size
WD2335 TCEO Instructions - Basi	18 KB
Interventions and Promising Prac	3 MB
WC2335 TCEO Instructions - Basi	18 KB

Download File(s)

Notes for Attendees provides important information for:

- Tech support
- Link for live closed captioning

Q&A Box: You may type questions and interact with presenters/hosts.

File Downloads: Select file and click download button for a copy of today's presentations.

Closed Caption Viewer will stream live captions during presentation.

Thank you!

NSwanson@cdc.gov
EHitchcock@cdc.gov

Presentation information:

https://www.cdc.gov/niosh/topics/workschedules/webinars

Fatigue and Automation in Transportation: Black Swans and Lumberjacks Redux

Sleep and Fatigue
September 26, 2018

Donald L. Fisher, Ph.D. and Stephen Popkin, Ph.D.
Volpe National Transportation Systems Center

The National Transportation Systems Center

Advancing transportation innovation for the public good

U.S. Department of Transportation
Office of the Secretary of Transportation
John A. Volpe National Transportation Systems Center

Part I

Fatigue

Fatigue

Fatigue is *MORE THAN* sleepiness and its effects are more than falling asleep.

1999 U.S. DOT Operational Definition

Symptoms: Fatigue is a complex state characterized by a lack of alertness and reduced mental and physical performance, often accompanied by drowsiness.

Causes: Fatigue may be caused or exacerbated by any or all of the following: lack of sleep, disruptive work/ rest cycles, neurological conditions, excess mental or physical workload, exposure to extreme physical conditions, emotional stress, the use of drugs or alcohol, illness, and/or monotony.

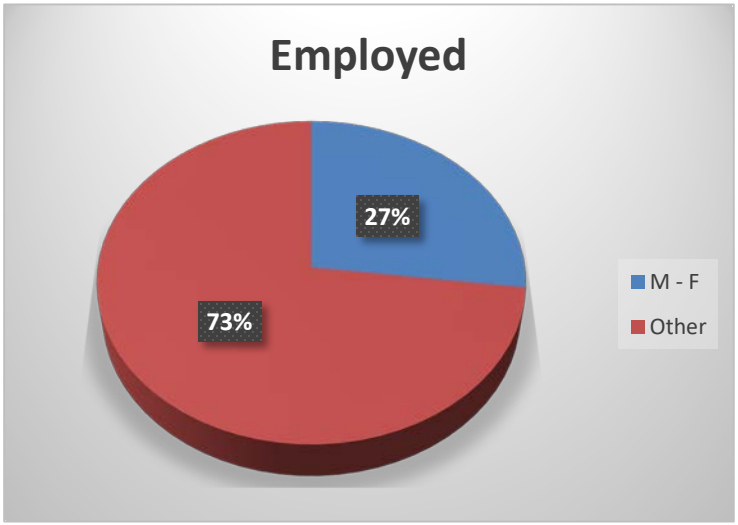
What is the Cost of Fatigue?

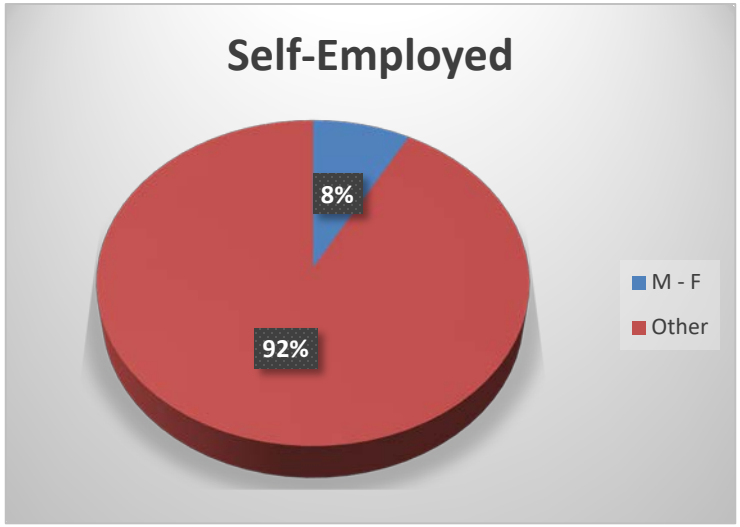
- 1990: $77 billion per year in U.S.[1]
- 2004: $200 billion in U.S.[2] due to:
  - Lost productivity ($79.7 billion)
  - Healthcare costs ($28.3 billion)
  - Absenteeism ($50.4 billion)
  - Turnover ($39.1 billion)
  - Accidents ($8.5 billion)
- $8,577 per employee in extended hours operation

[1]Institute for Circadian Physiology, 1990; [2]Circadian Intnl, 2004)

What are effects of drowsiness on driving?

- Fatal crashes
  - 2.5% of fatal crashes (NHTSA, 2018)
  - 21% of fatal crashes (Tefft, 2012)
- Drowsy driving prevalence
- Shiftwork (other)





DLF

Costa et al. (2004)

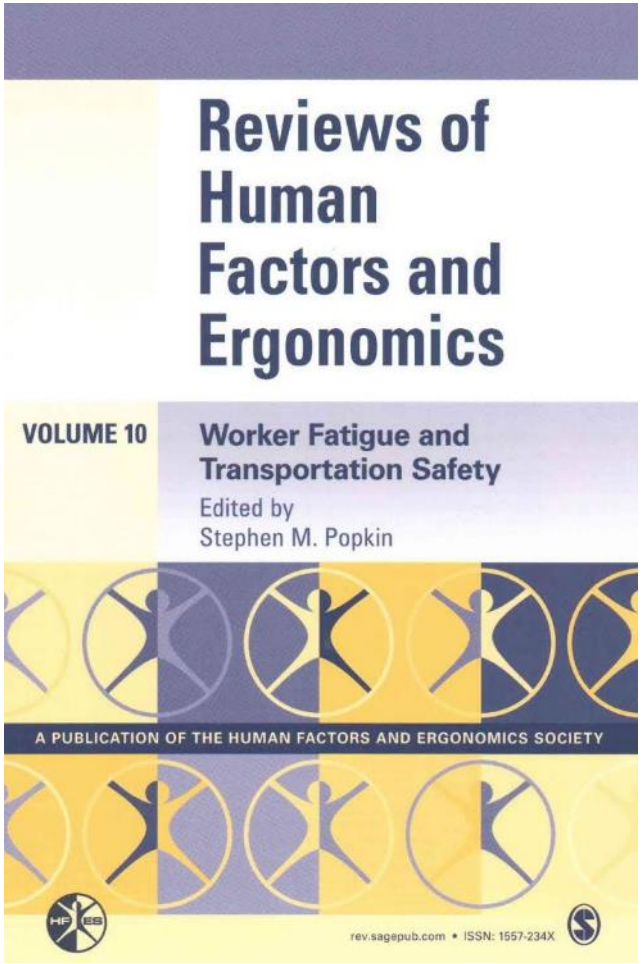
Primary Skills and Abilities

	Skill or Ability	Bus Operator	Taxi Driver	Truck Driver	Truck Dispatcher	Pipeline Controller
Skills	Operation & Control	✓	✓	✓		✓
	Operation Monitoring	✓	✓	✓		✓
	Critical Thinking	✓	✓		✓	
	Judgment & Decision Making			✓	✓	
	Complex Problem Solving			✓	✓	✓
	[illegible]	✓	✓	✓	✓	✓
	[illegible]trol Precision	✓	✓	✓		
	Deductive Reasoning		✓	✓	✓	

FATIGUE TARGETS WORKERS' SKILLS & ABILITIES

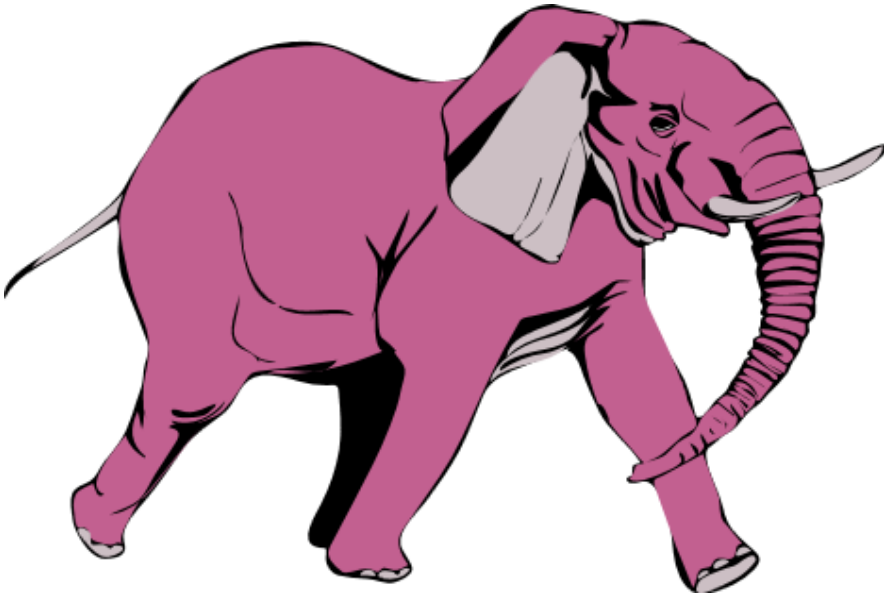
*Reference: Occupational Information Network (O*NET)*

What has been done to address fatigue?



Popkin, 2015

Then why does fatigue persist?



Credit: openclipart, Anarres

- It's economically convenient for both the staff and the companies
- There have been long histories of collecting bargaining that make it difficult to get the elephant out of the room
- There is a lack of awareness and appreciation about the elephant itself

So, what's a person to do?

Cartoon by Ahmedfani; URL in notes

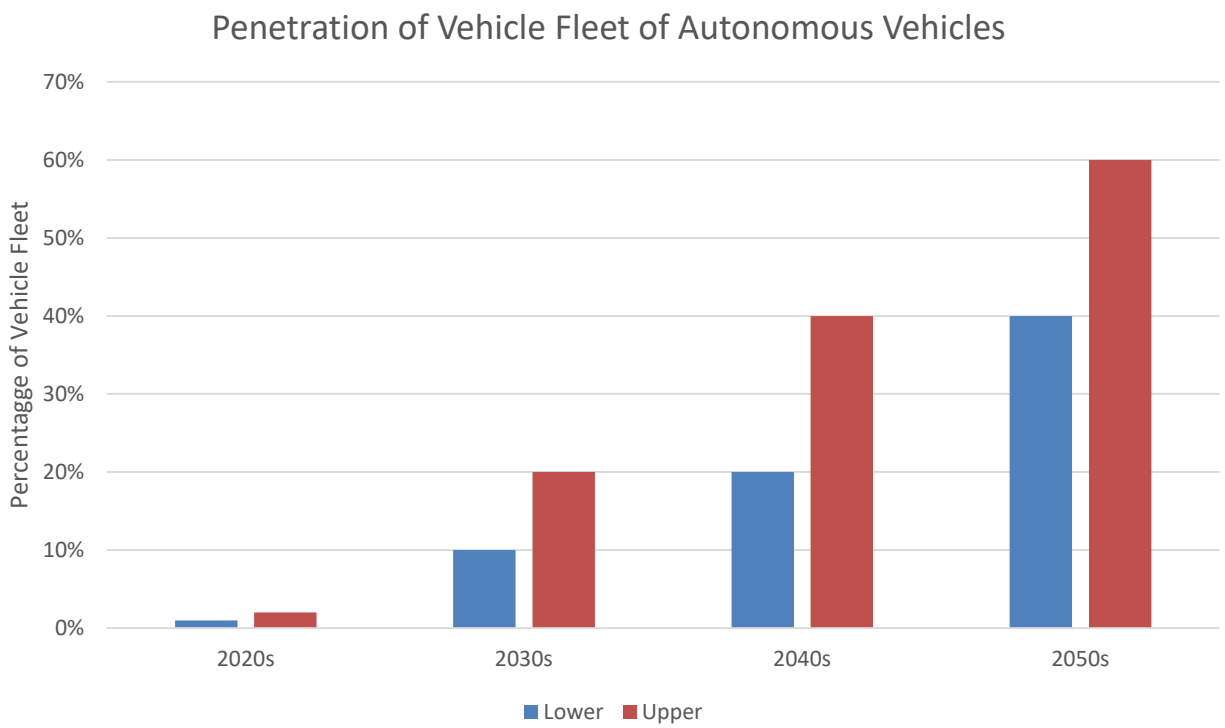
Fatigue, Automation and Transportation

Credit: openclipart, DG-RA

Automated vehicle

Credit: Google images, noncommercial reuse

Automation will be a long time coming

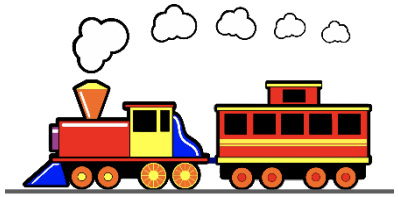


DLF

Litman, 2018

Transportation Problems of the Future

- Cross Modal

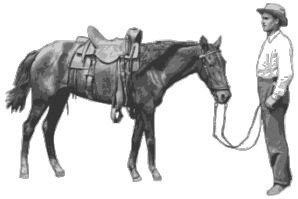


Openclipart: ElectronicRU; JayNick

- Cross Functional Impairment

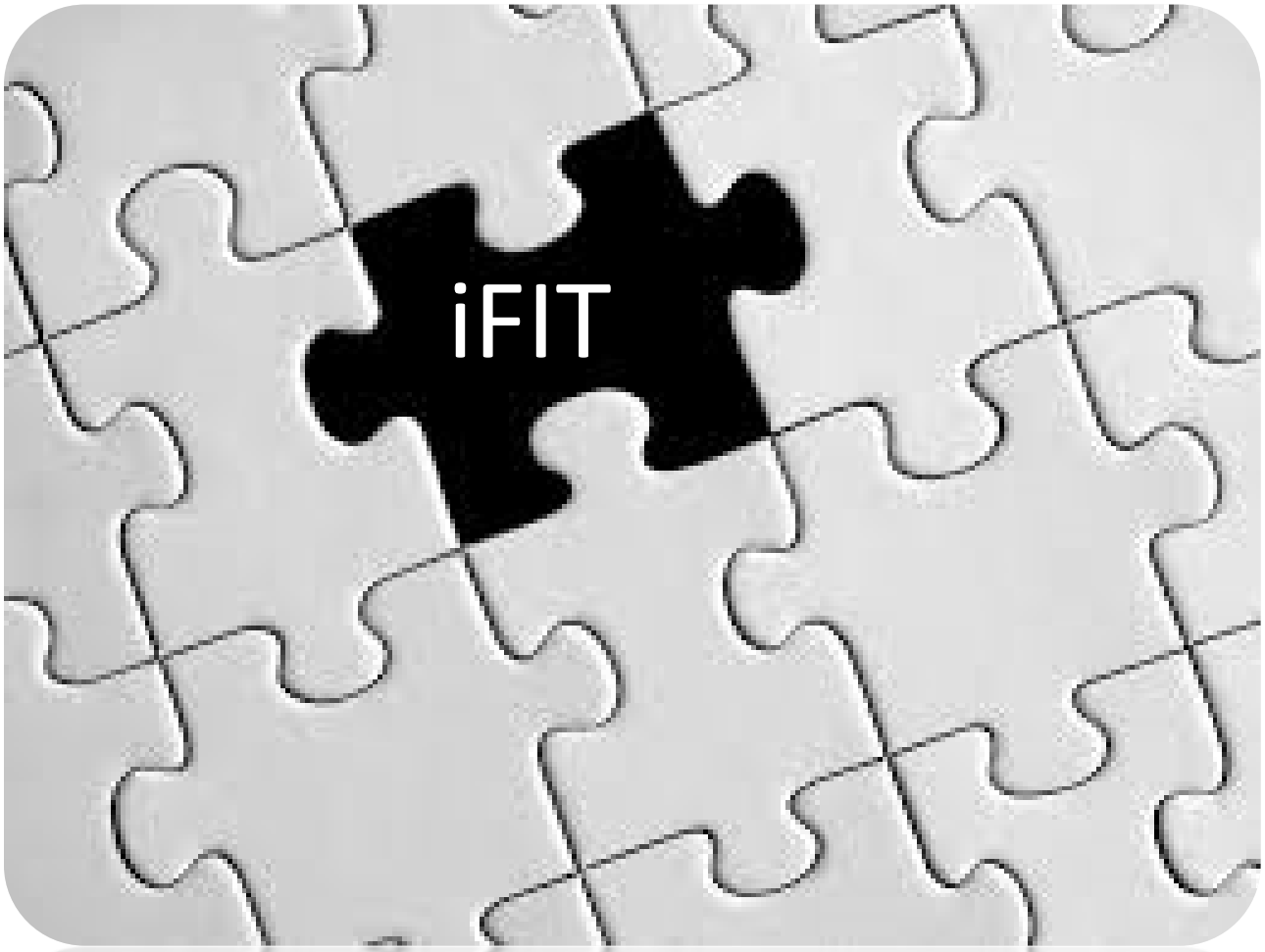
Openclipart: Johny_Automatic; svk-ab

- Cross Level of Automation



Openclipart: j4p4n; Merlin2525

Institute for Functional Impairment in Transportation

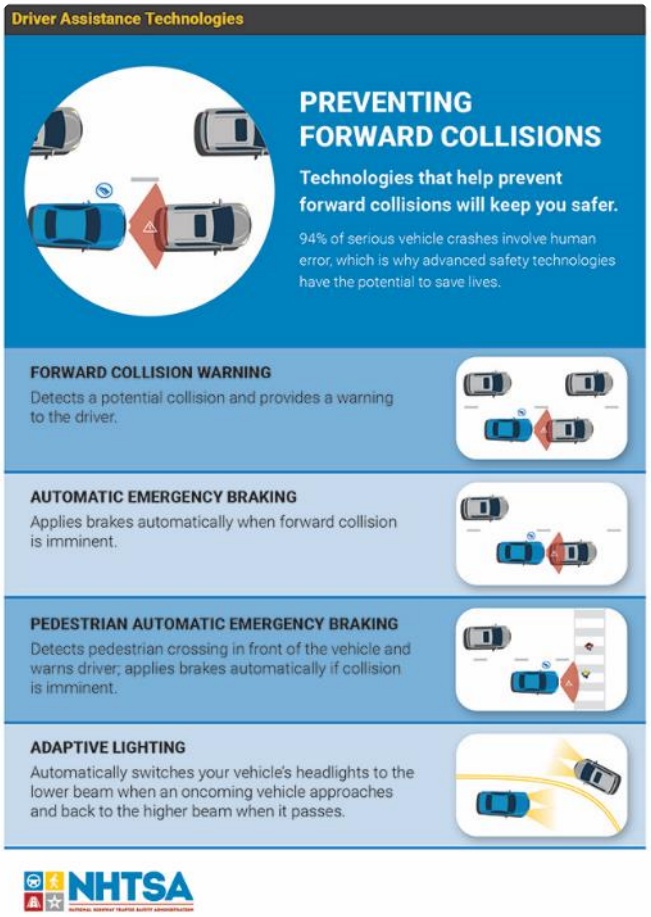


Credit: Google images, noncommercial reuse

Part II

Automation

Advanced driver assistance systems (ADAS)



Automated driving systems (ADS)

Levels of automation: Definition

FCW

ACC

Longitudinal &
Lateral Control

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Copyright © 2014 SAE International. The summary table may be freely copied and distributed provided SAE International and J3016 are acknowledged as the source and must be reproduced AS-IS.

Levels of automation: Definition

FCW

ACC

Longitudinal & Lateral Control

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Copyright © 2014 SAE International. The summary table may be freely copied and distributed provided SAE International and J3016 are acknowledged as the source and must be reproduced AS-IS.

Levels 0, 1, 2, 3

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes

Level 0

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a

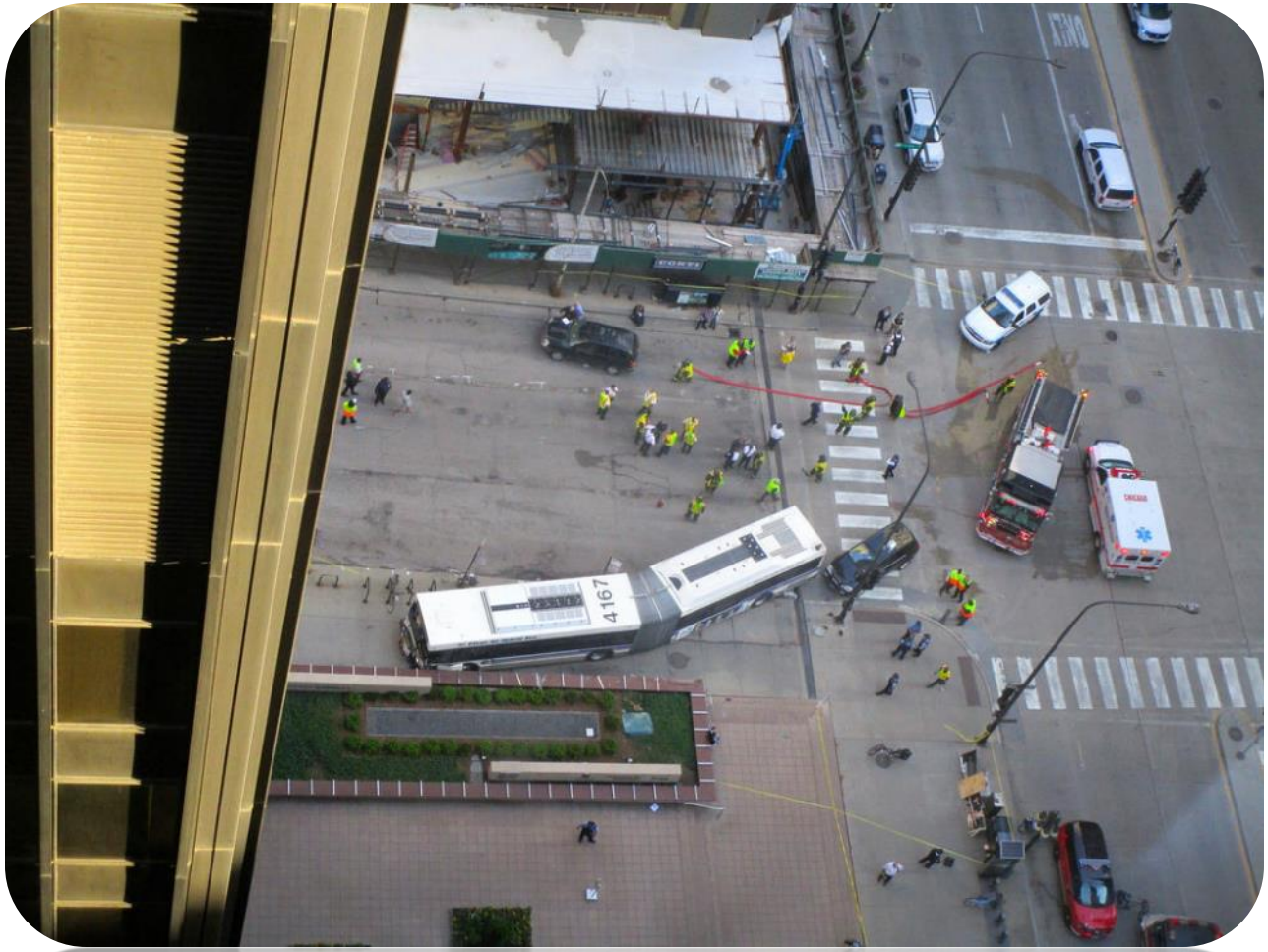
Pedestrian collision warning systems

Credit: Google images, noncommercial reuse

Pedestrian fatalities involving buses

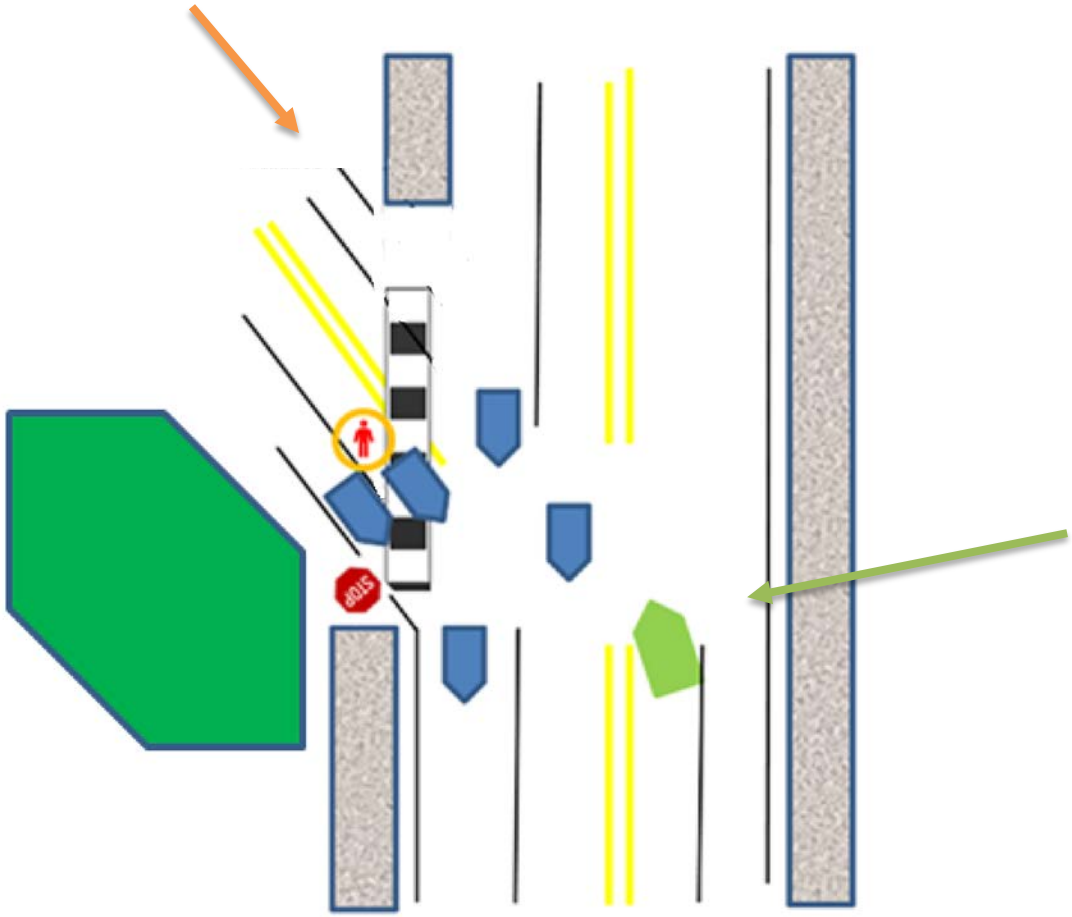
Credit: Google images, noncommercial reuse

Intersections

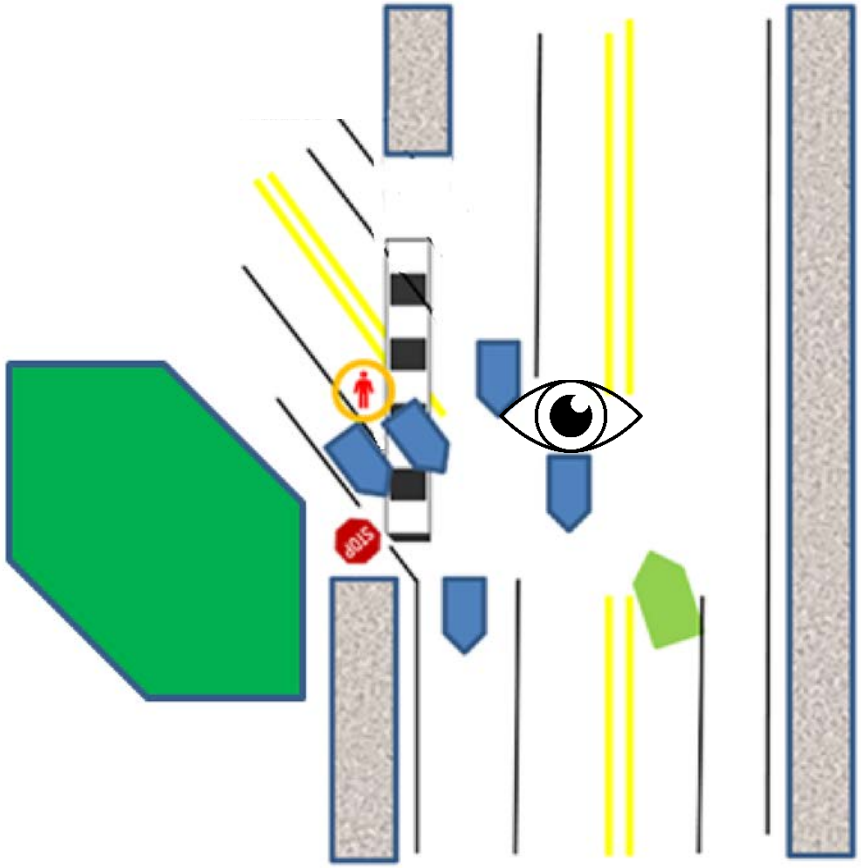


Credit: Google images, noncommercial reuse

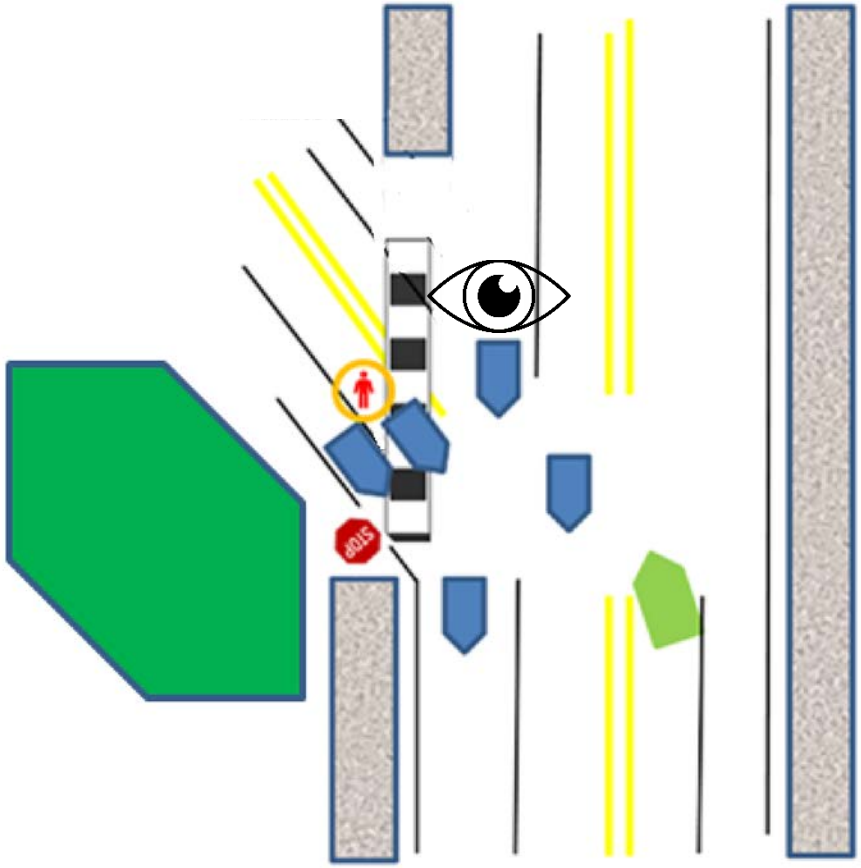
Y-Intersection - I



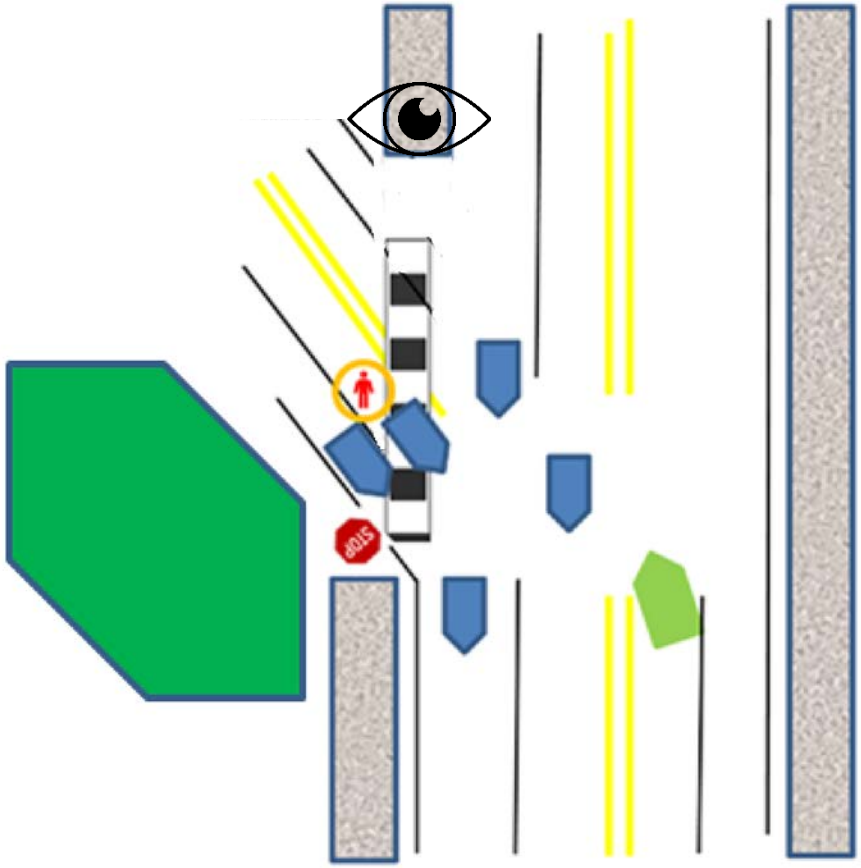
Y-Intersection - 2



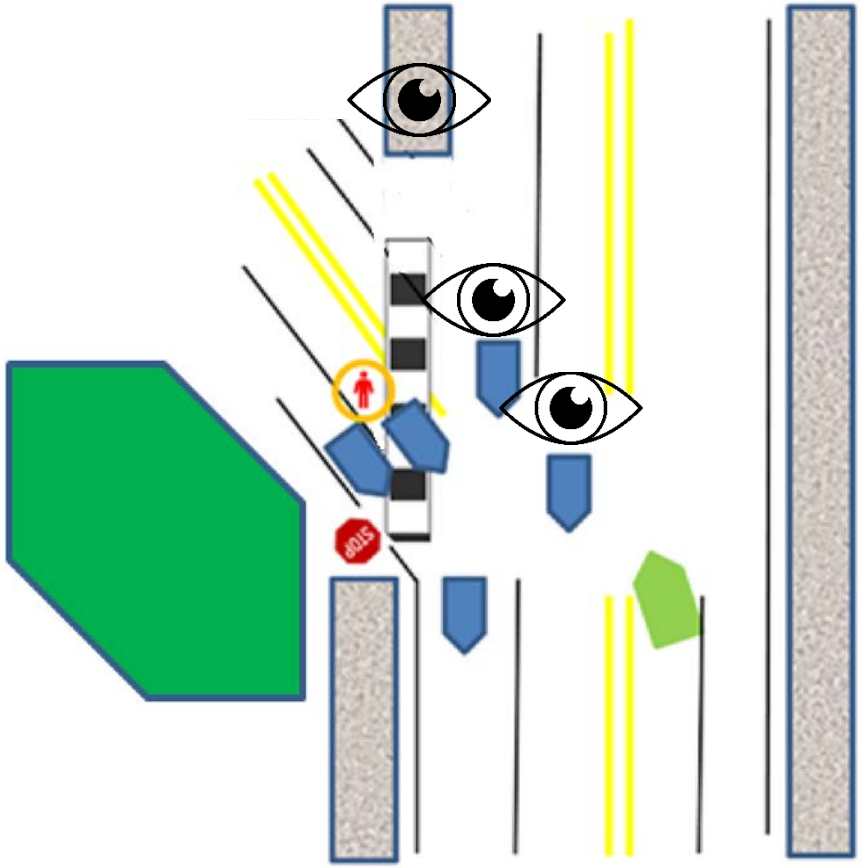
Y-Intersection - 3



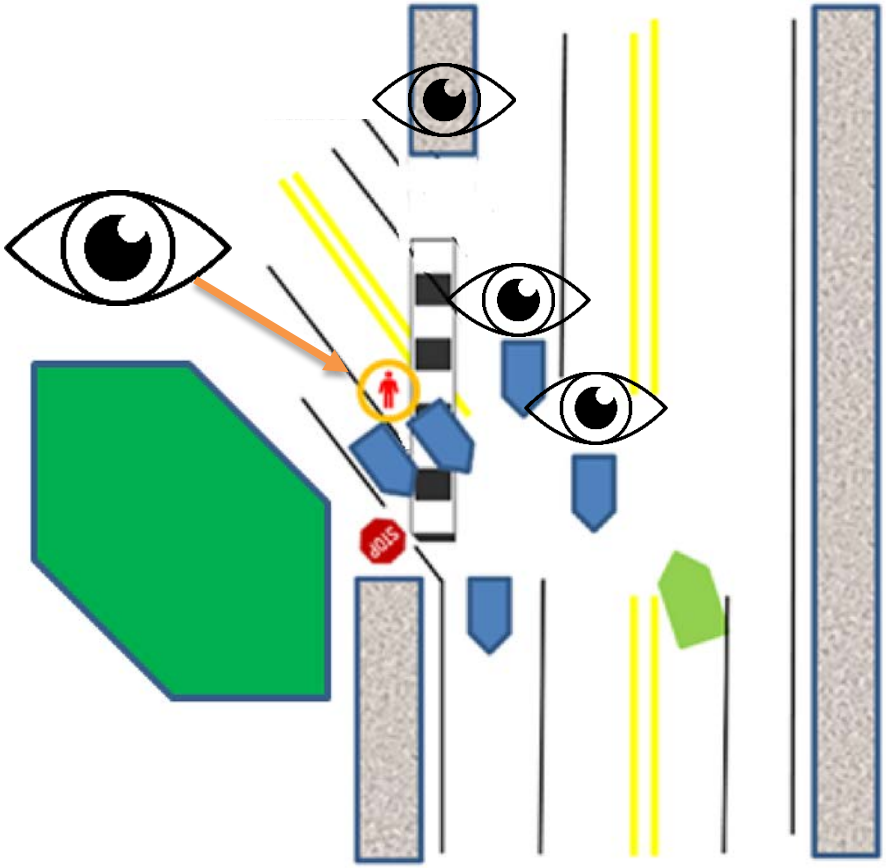
Y-Intersection - 4



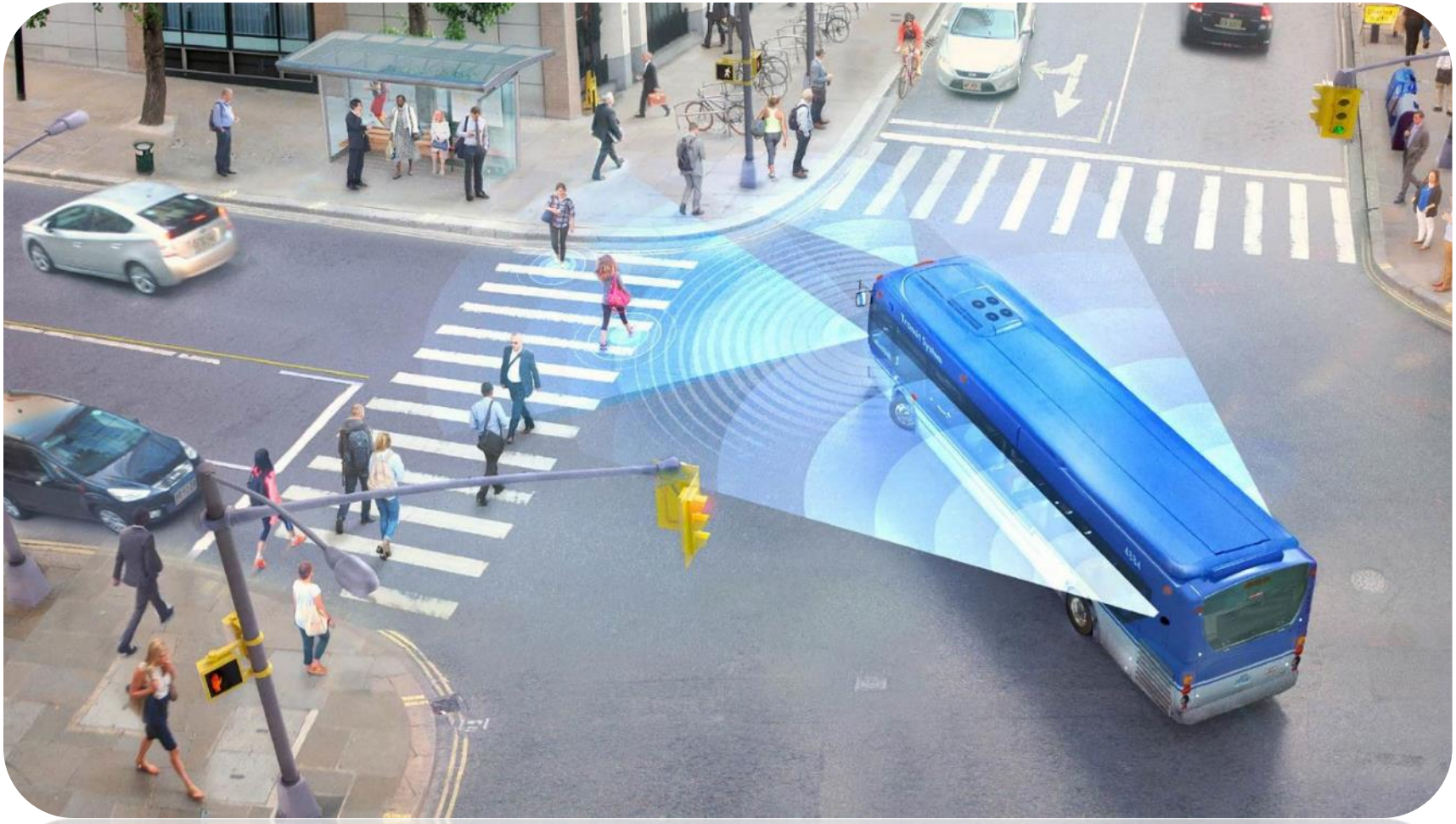
Y-Intersection - 5



Y-Intersection - 6

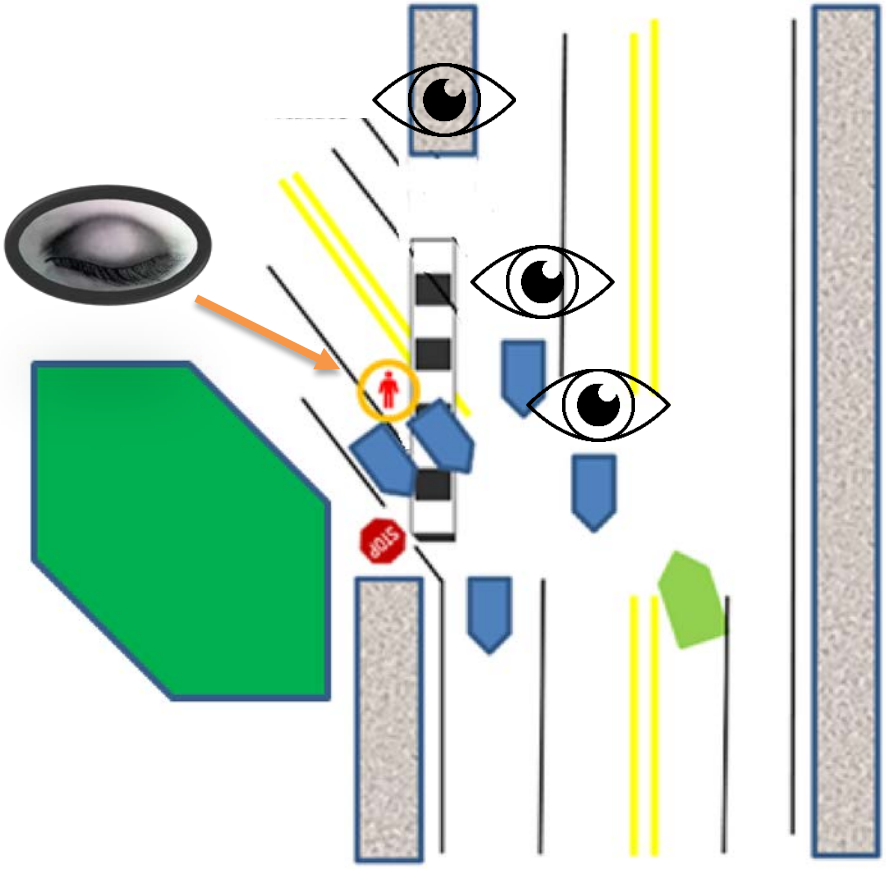


Pedestrian Collision Warning Systems



Credit: Mobileye

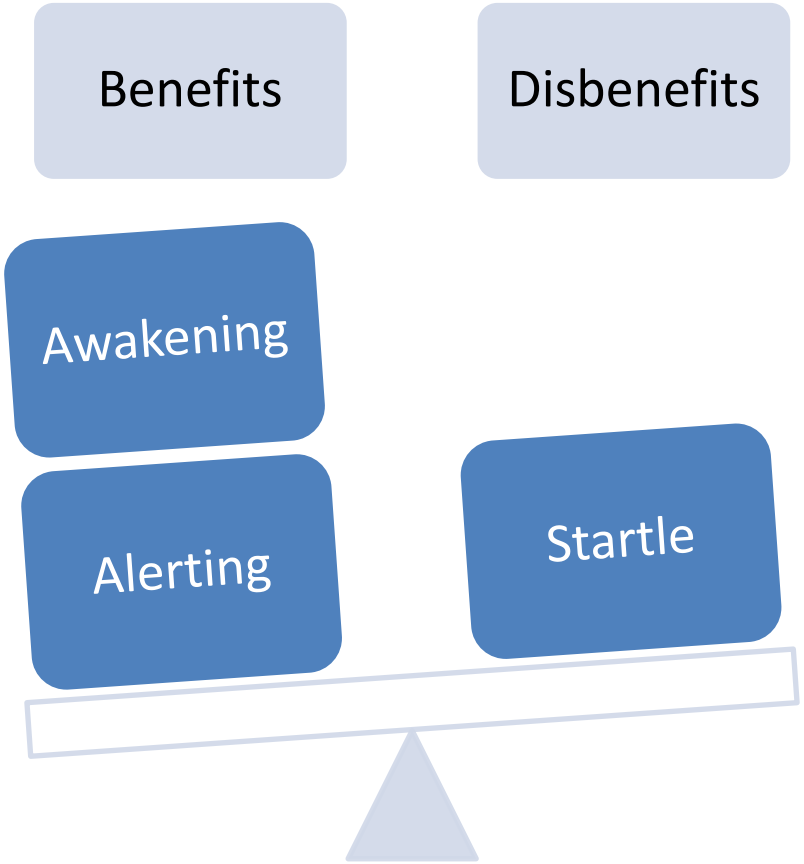
Level 0: Pedestrian Collision Warnings and Fatigued Drivers



Vehicle crash: Marked midblock crosswalk

https://www.youtube.com/watch?v=6WTVf8s72Mg

Level 0: Benefits and Disbenefits



Pedestrian Detected by PCW

Evidence-based research

Credit: Google images, noncommercial reuse

Experiment on NADS

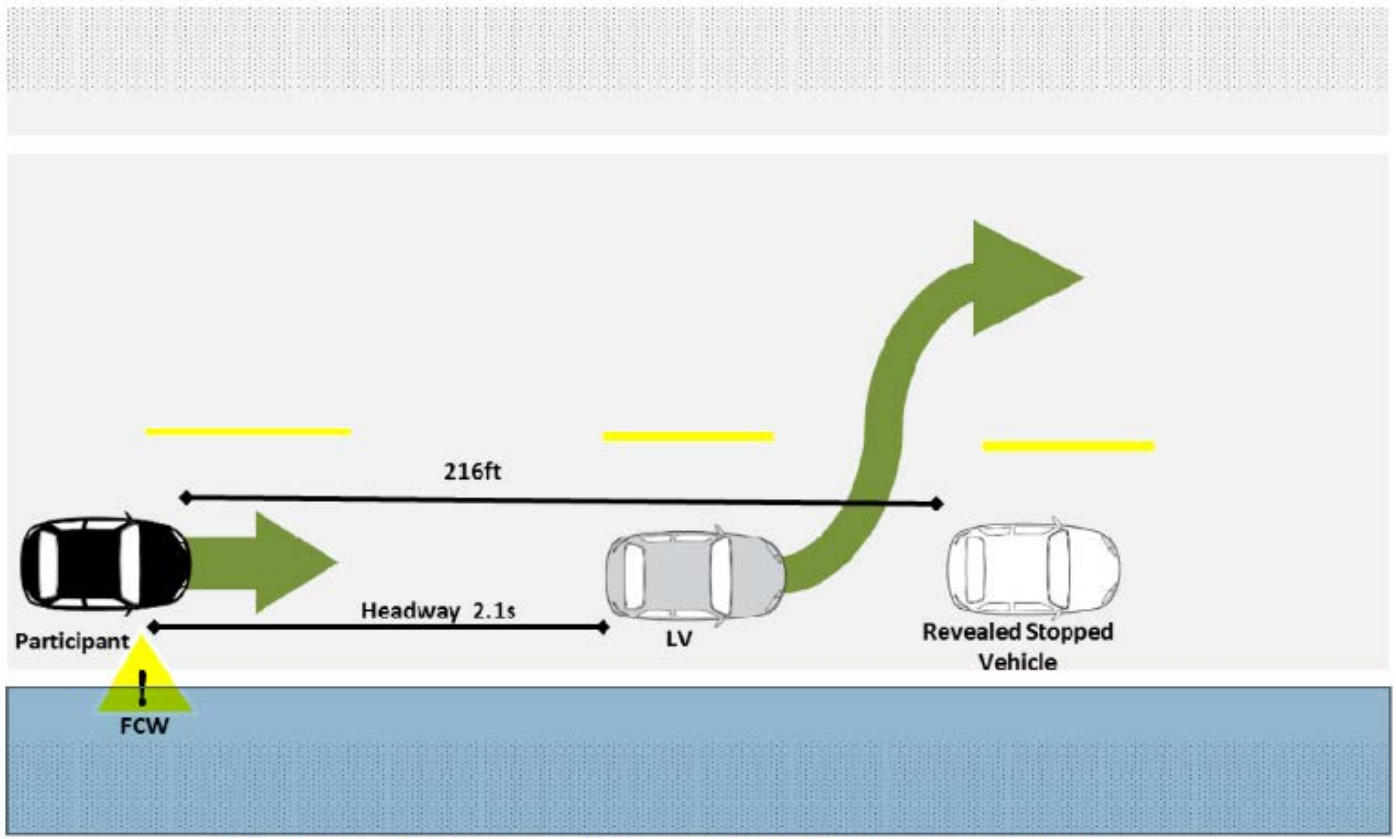
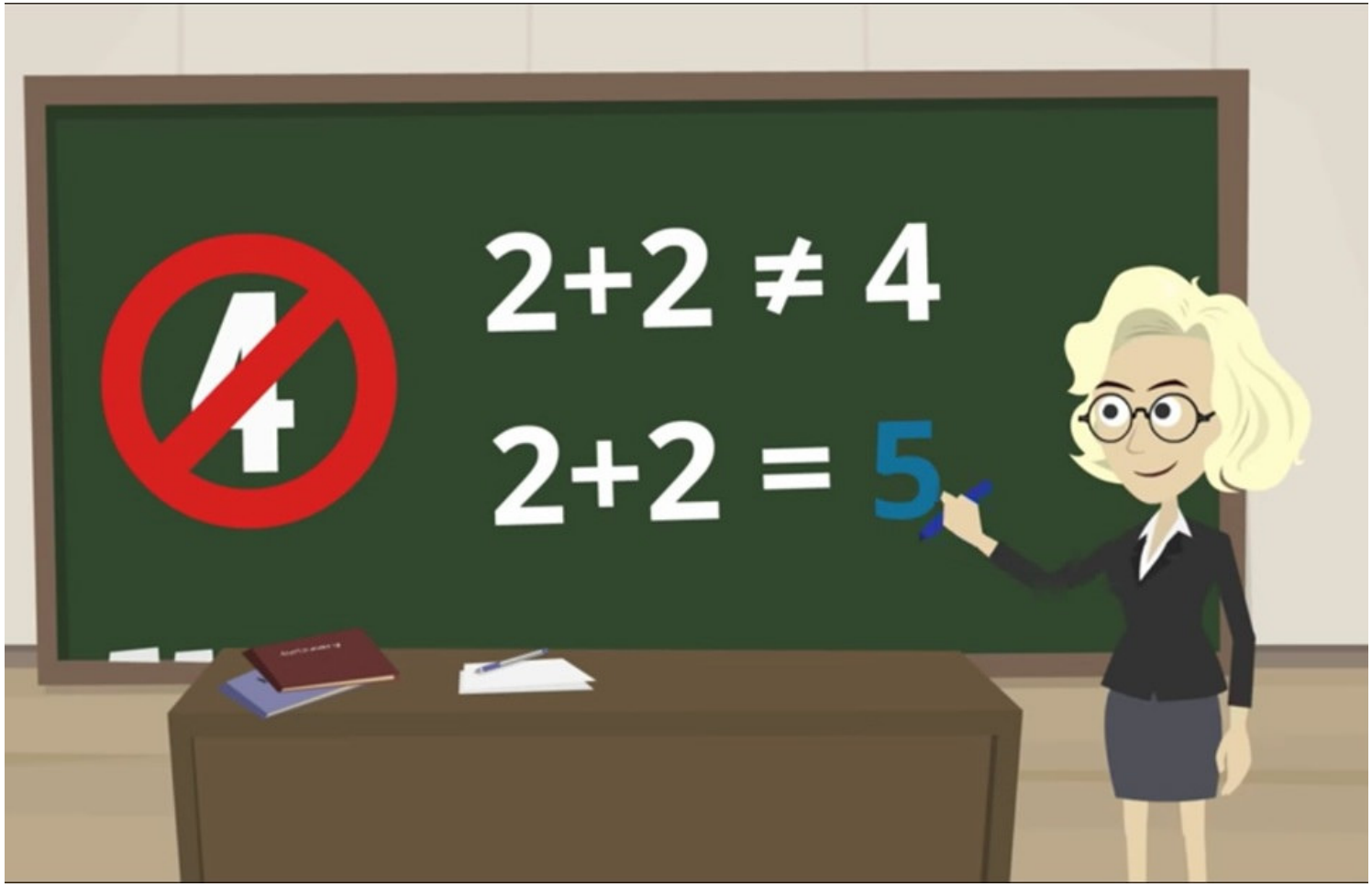


Figure 1. Diagram of the lead vehicle reveal event

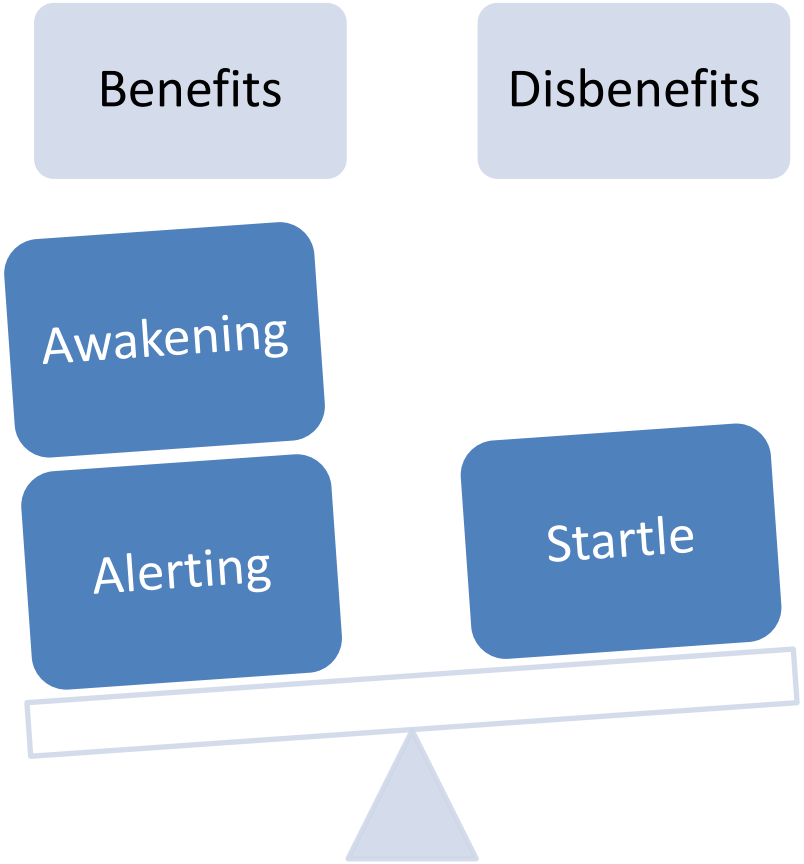
Gaspar et al., 2017

No effect on response times



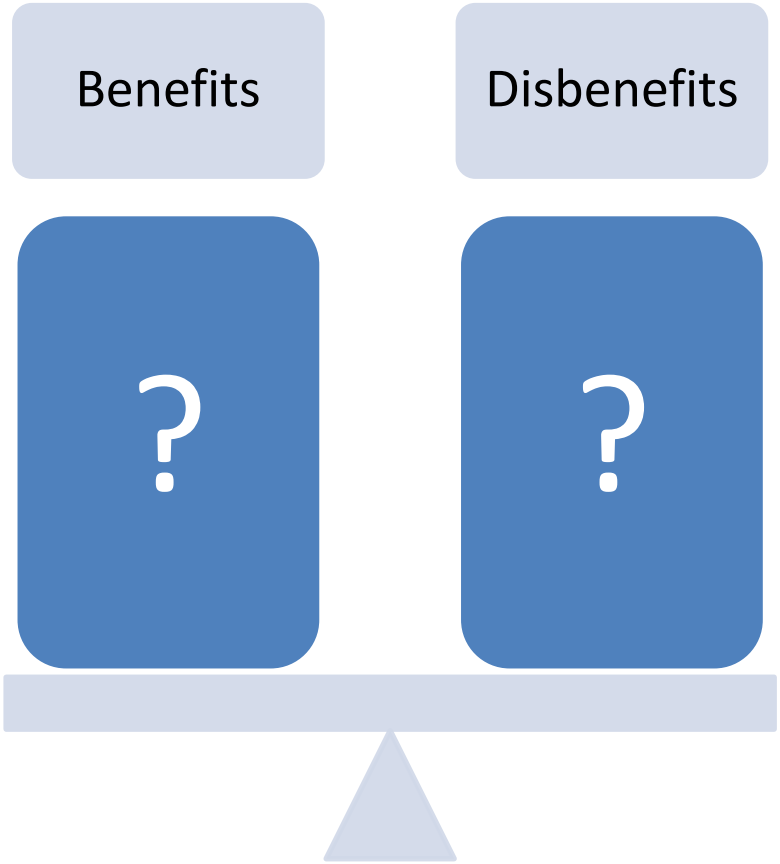
Credit: Google images, noncommercial reuse

Level 0: Benefits and Disbenefits



Pedestrian Detected by PCW

Level 0: More research



Pedestrian Detected by PCW

Level 1

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes

Level 1: Adaptive Cruise Control

Mehler et al., 2014

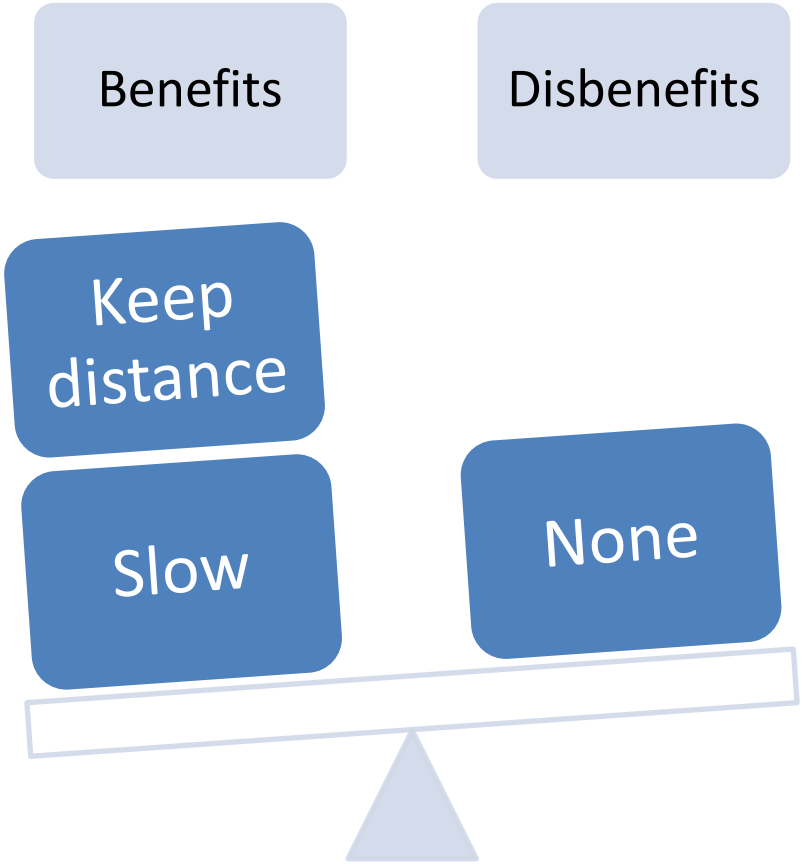
Benefits of ACC

Perception → Comprehension → Prediction

Perception → Comprehension → Prediction

Credit: Google images, noncommercial reuse

Level 1: Benefits and Disbenefits



ACC Engaged

Caveat 1: Mind wandering

Wandering mind not a happy mind

About 47% of waking hours spent thinking about what isn't going on

Credit: Google images, noncommercial reuse

Study: Mind wandering in low and high workload scenarios

Credit: Google images, noncommercial reuse

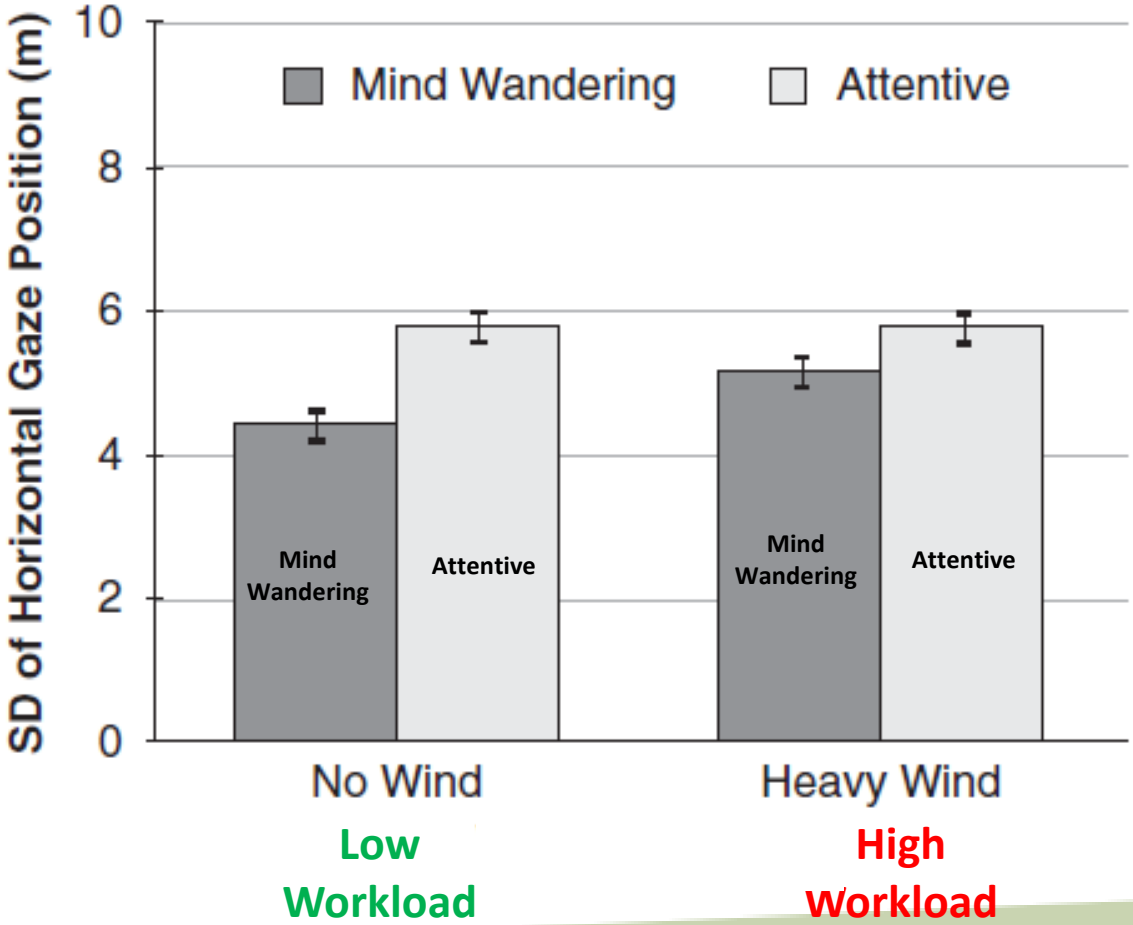
Eye tracking

Eye Tracker

Standard deviation of horizontal gaze position

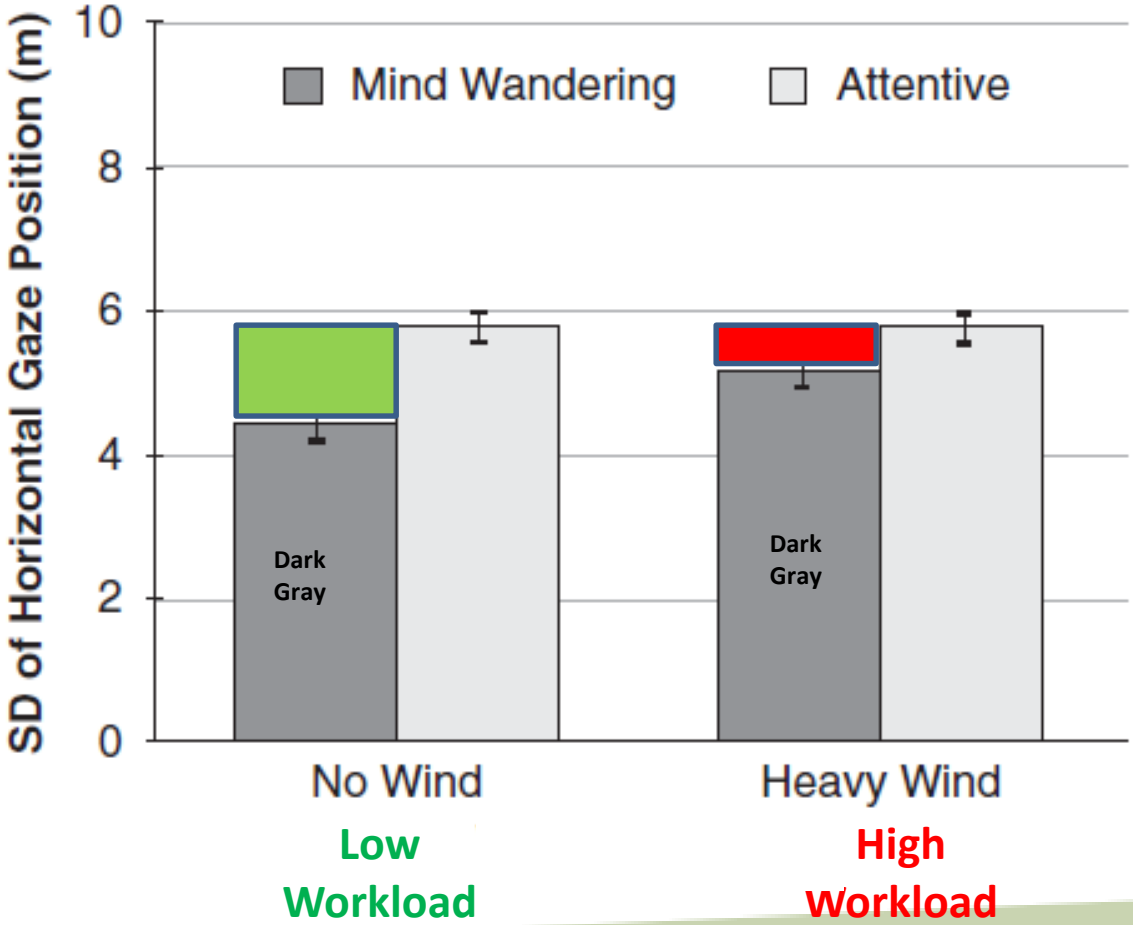
DLF

Findings: Glance behavior



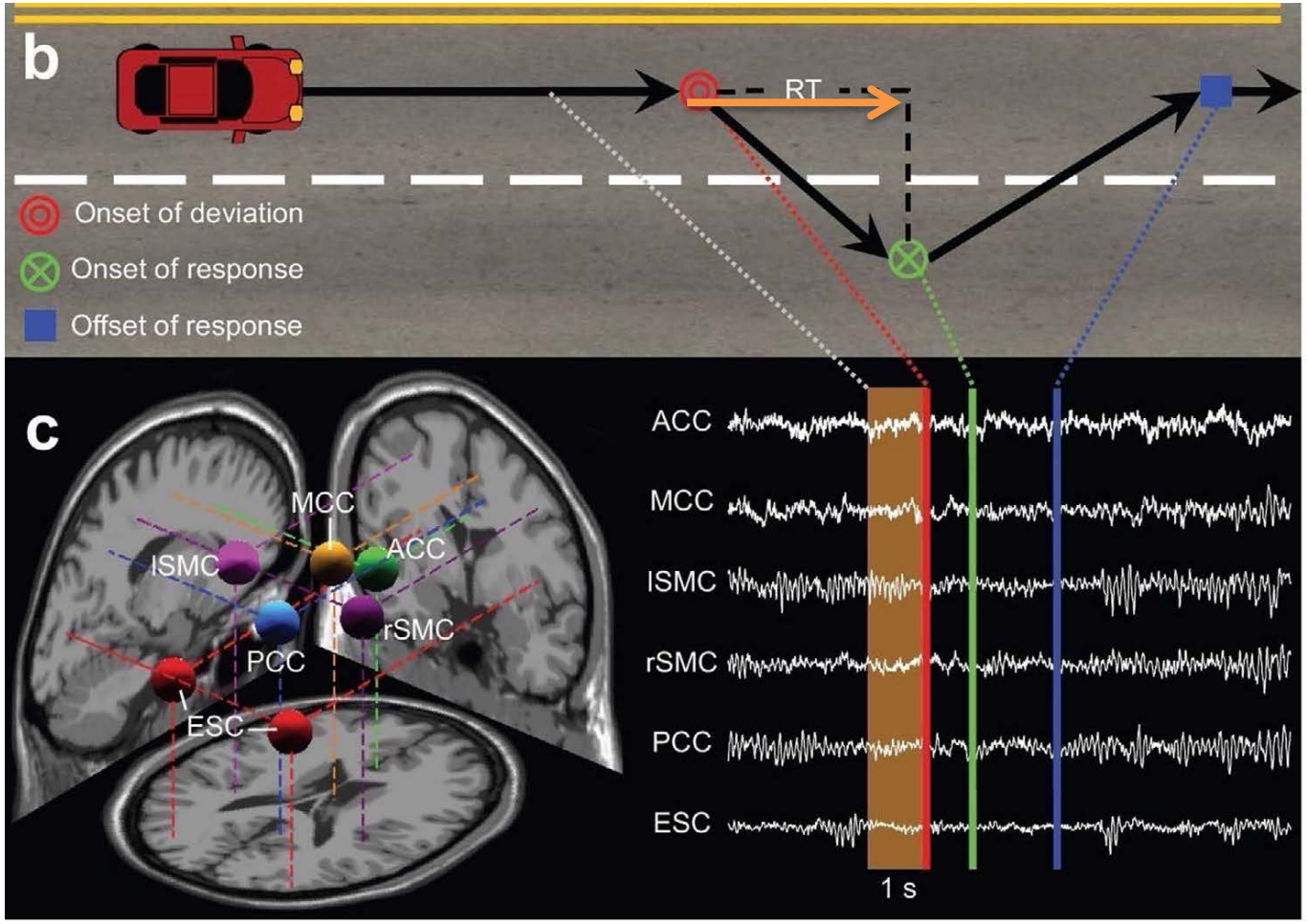
He, Becic, Lee, and McCarley, 2011

Findings: Glance behavior



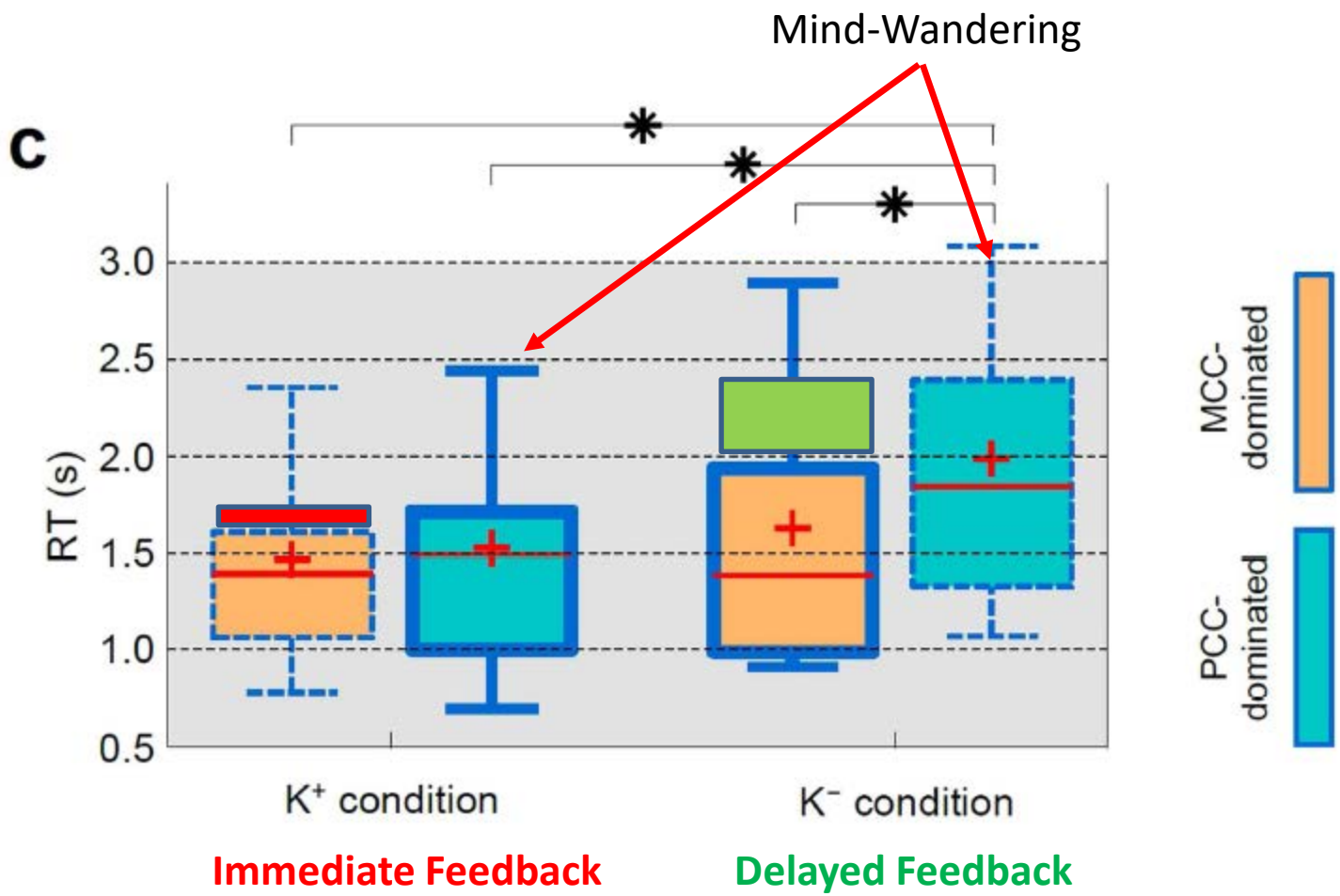
He, Becic, Lee, and McCarley, 2011

Study: Mind wandering in delayed and immediate feedback scenarios



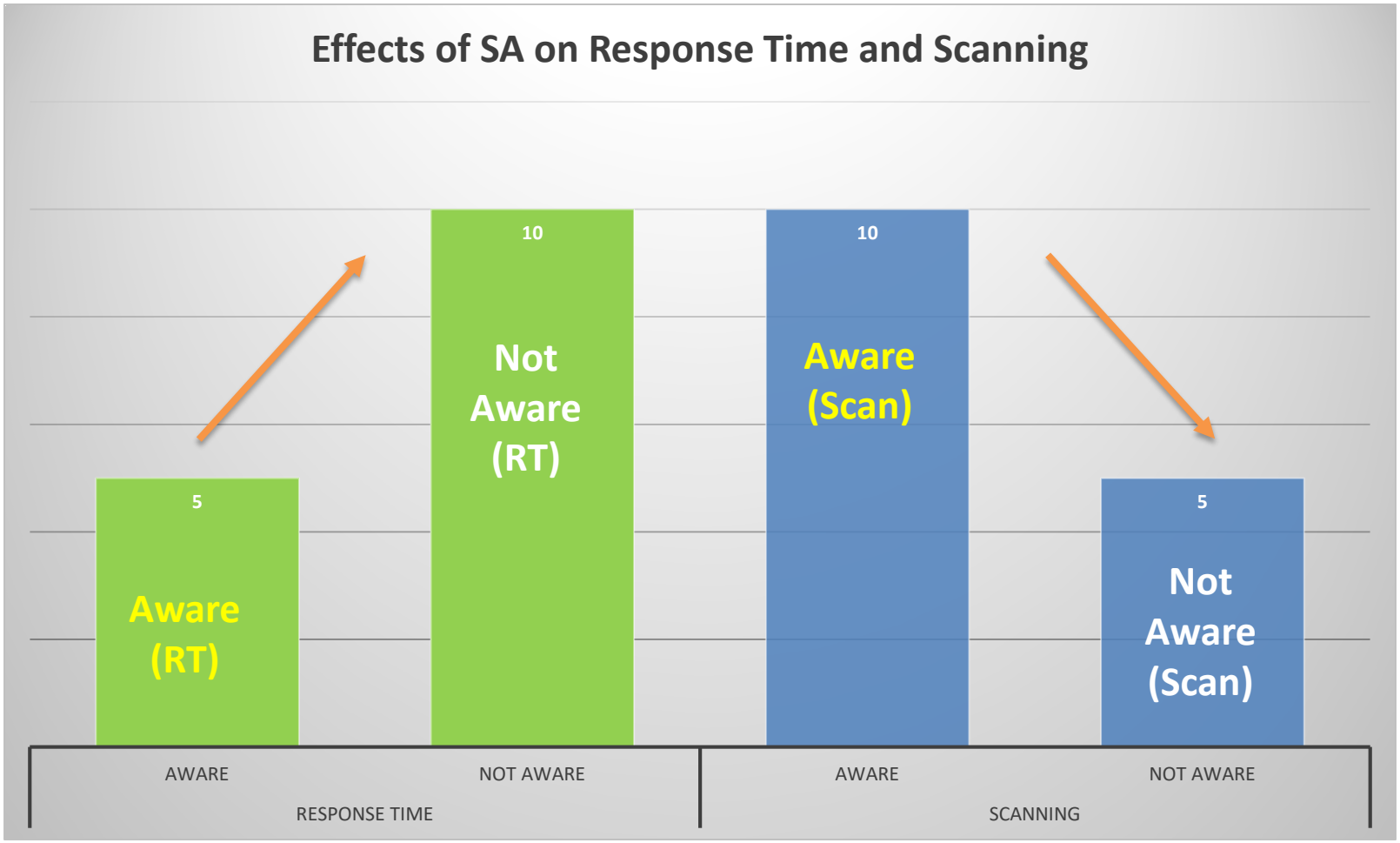
Lin et al., 2015

Findings: Response times



Lin et al., 2015

Caveat 1. Situation awareness

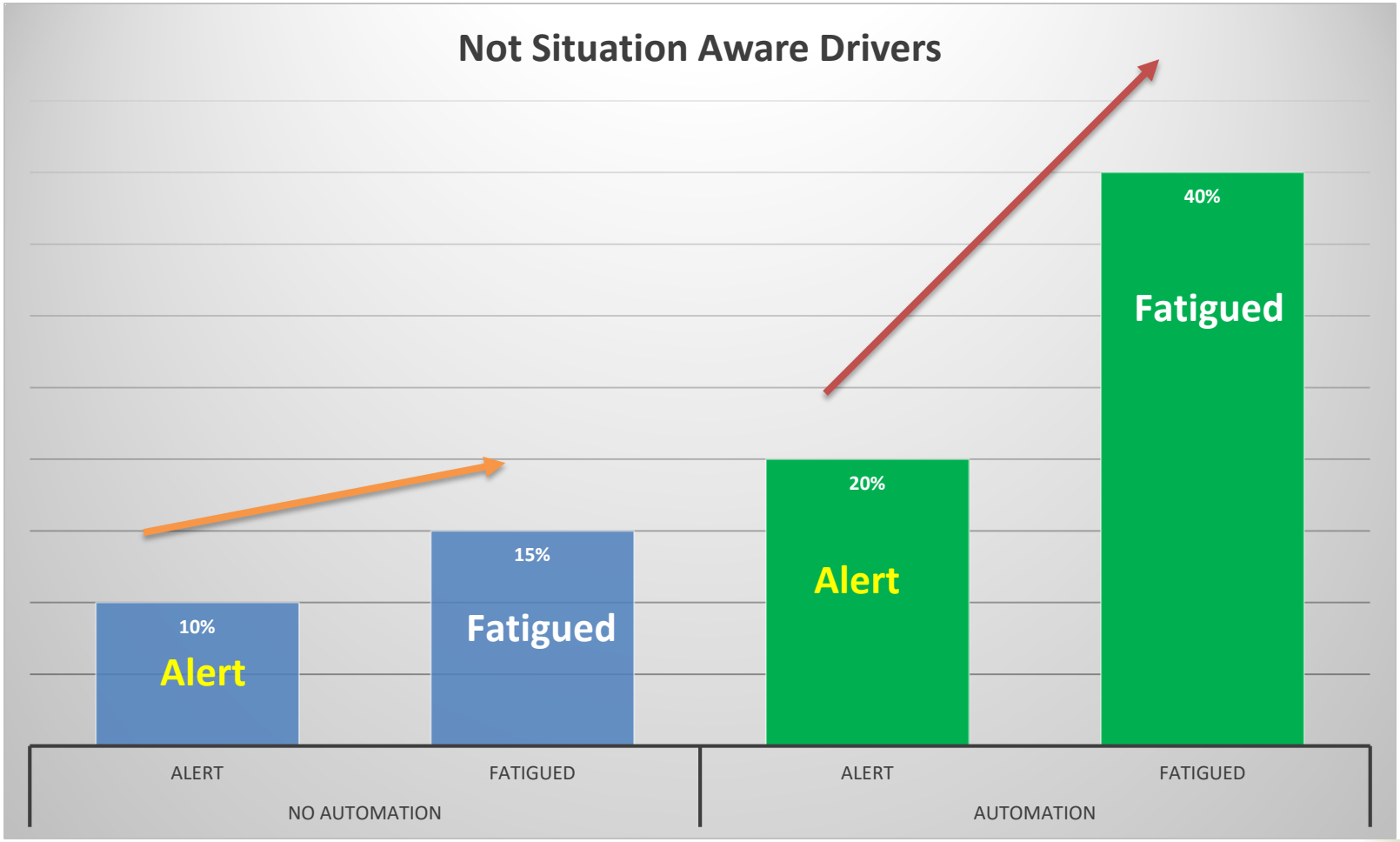


He et al.,2011

Lin et al,2015;
Thomas et al., 2016

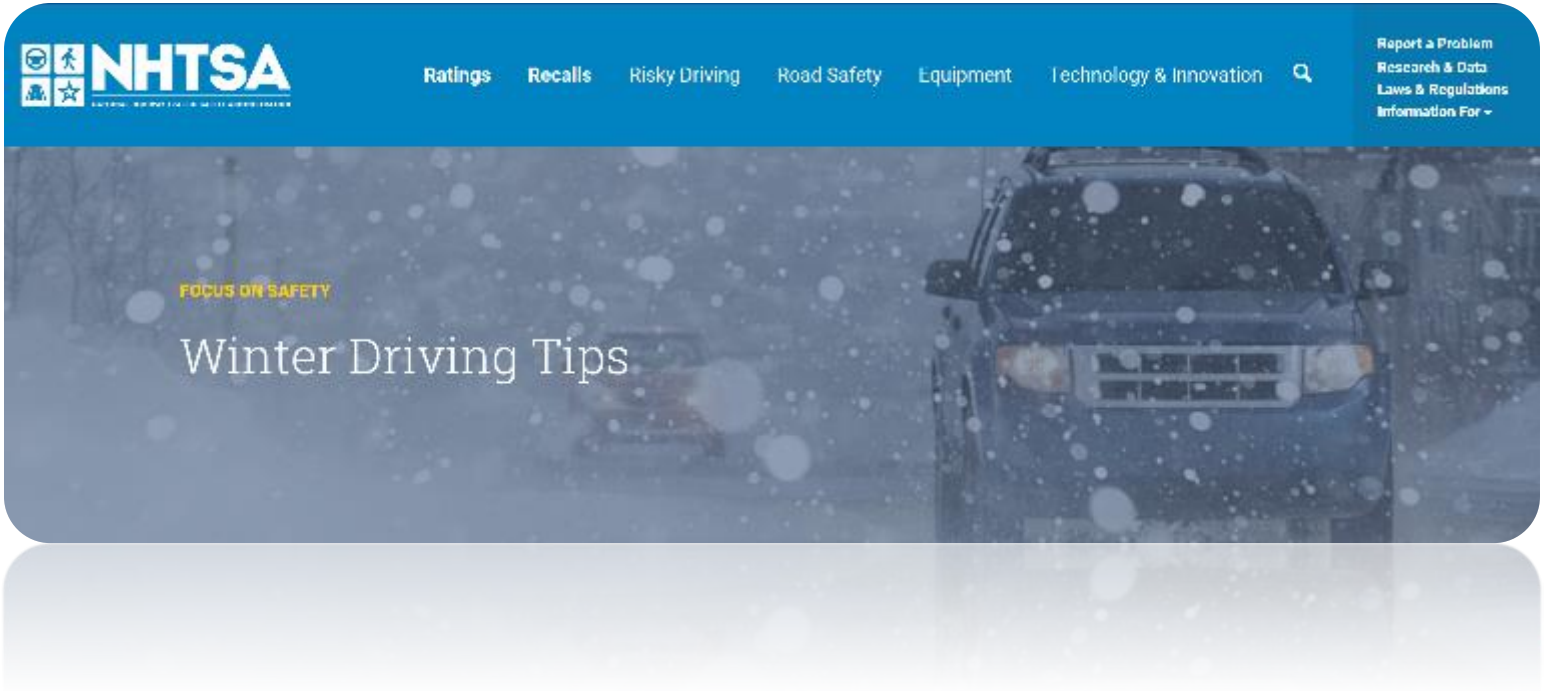
DLF

Multiplier effect: Fatigue and automation

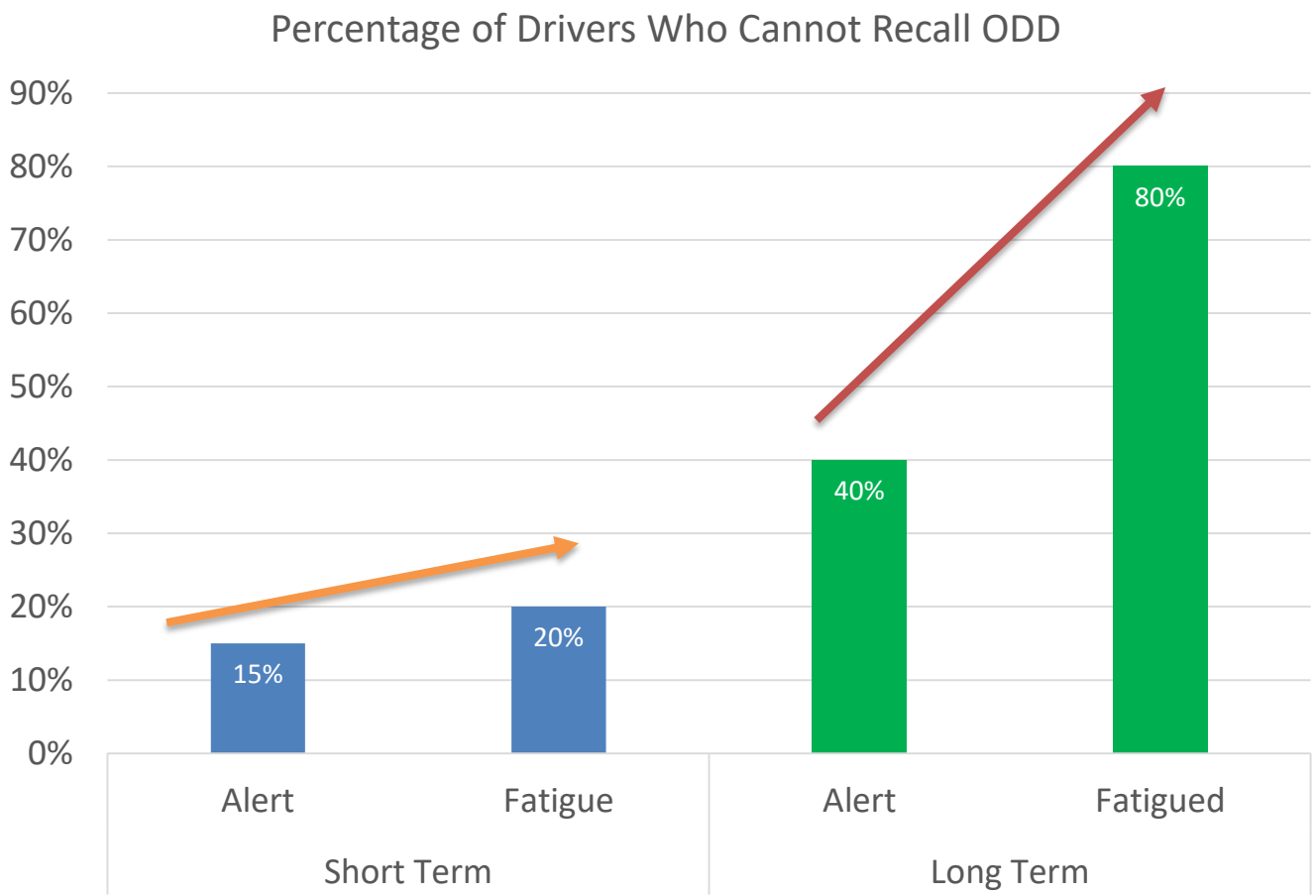


DLF

Caveat 2: Operational Design Domain

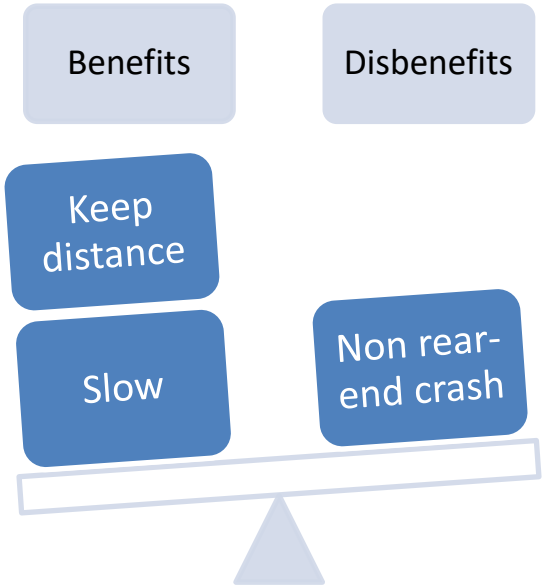


Fatigue and Operational Design Domain



Level 1: Benefits and Disbenefits for Fatigued Drivers

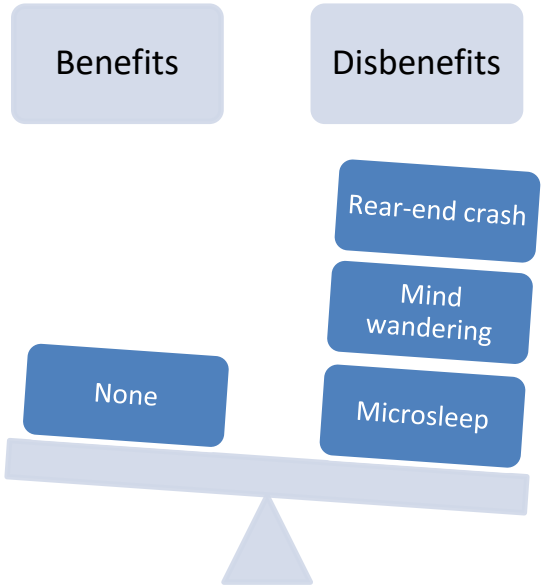
ACC Engaged



Targeted Crashes

Not Targeted Crashes

ACC Disengaged



All Crashes

Level 2

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes

Level 2: Longitudinal and Lateral Control

Credit: Los Angeles Times

Credit: Google images, noncommercial reuse

Caveat 1: Loss of situation awareness

Credit: Google images, noncommercial reuse

Level 2: Alert Drivers

Tesla update forces you to keep your hands on the wheel... or else

by BRYAN CLARK — 10 months ago in ARTIFICIAL INTELLIGENCE

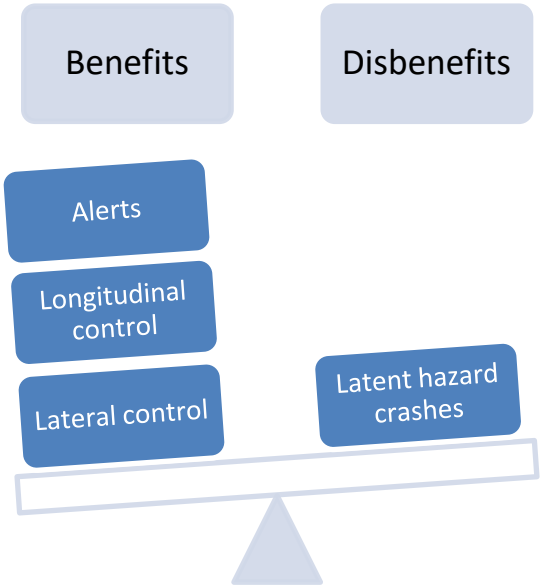
Caveat 2: Operational Design Domain

To prevent serious injury or death, be alert and pay special attention when passing freeway exits and entrances with Super Cruise, and be ready to take control of the vehicle when necessary. Changes in lane markings around freeway exits and entrances can momentarily cause Super Cruise to not detect the correct lane. If this occurs, Super Cruise may attempt steering inputs to bring the vehicle back into the correct lane and, in rare circumstances, could over-correct and cause the vehicle to momentarily cross into a lane next to your vehicle unless you manually steer to maintain your lane position.

Credit: Cadillac CT6 Owners' Manual

Level 2: Benefits and Disbenefits for Fatigued Drivers

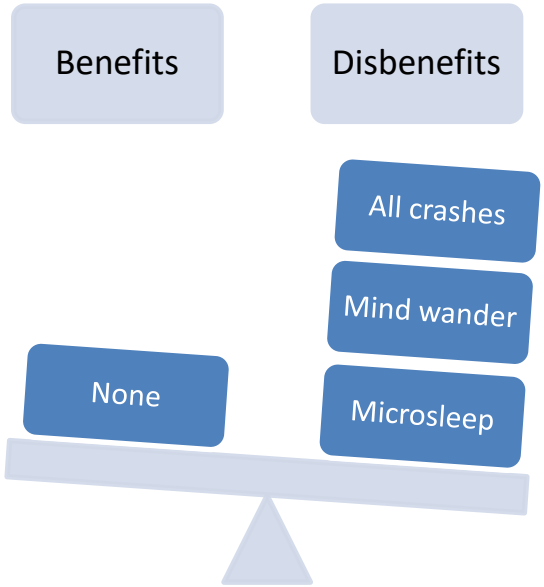
L2 Engaged



Targeted Crashes

Not Targeted Crashes

L2 Disengaged



All Crashes

Samuel and Fisher, 2018

Level 3

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes

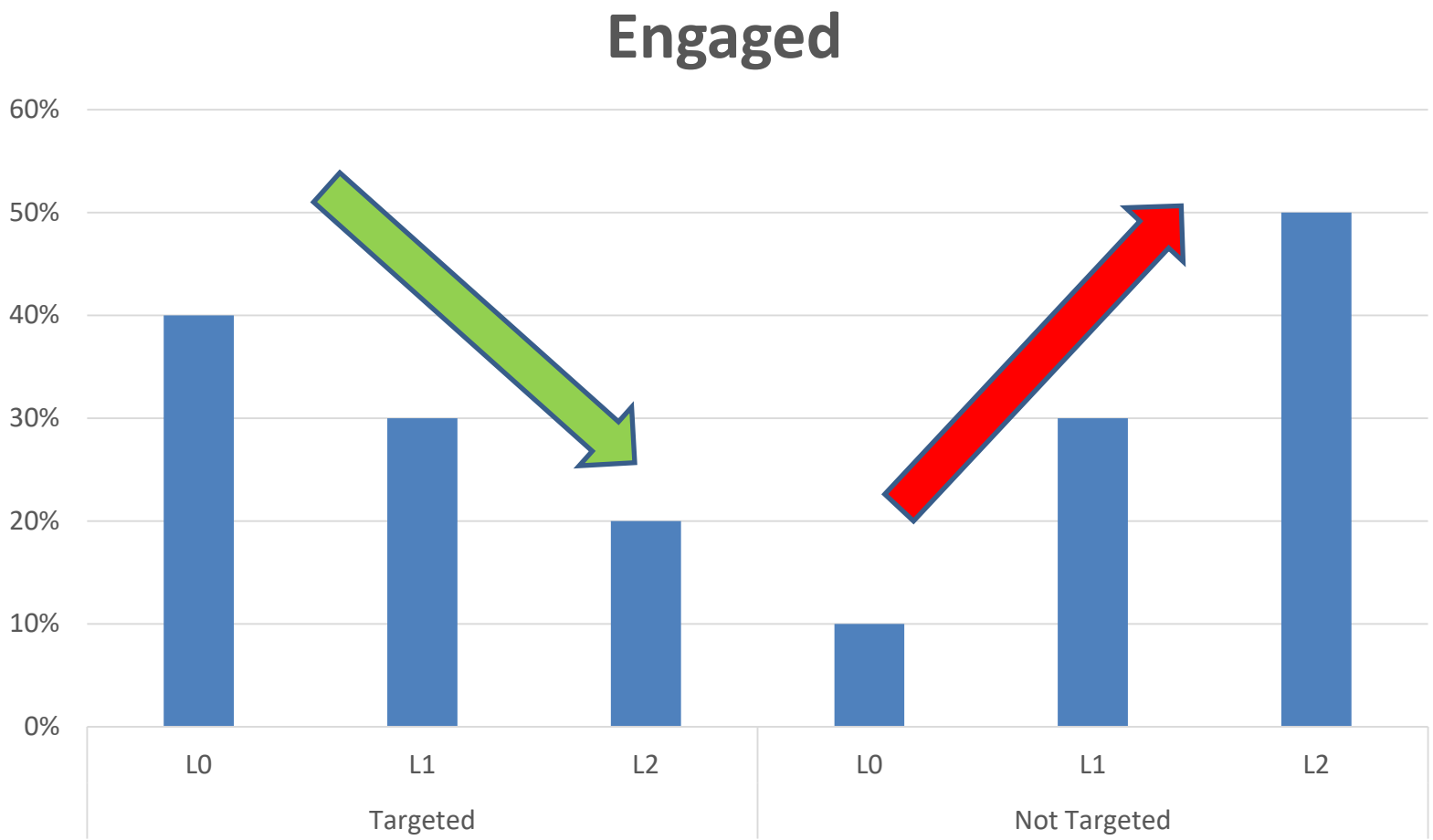
What does the driver do?

Transfer of control: Alert drivers

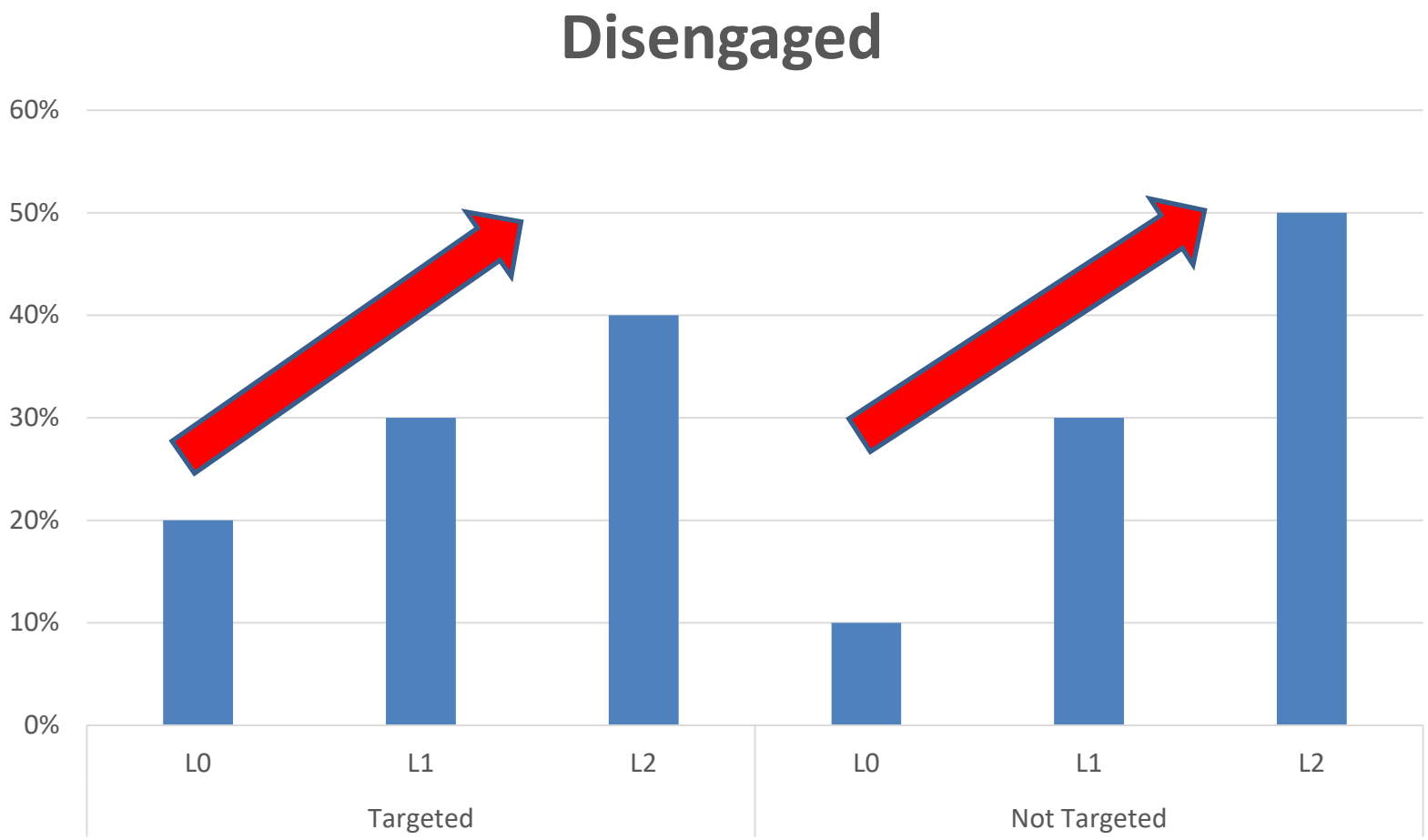
Transfer of control: Fatigued drivers

Credit: Google images, noncommercial reuse

Lessons Learned: Fatigue and Automation



Lessons Learned: Fatigue and Automation



Lessons Learned: Functional Impairment and Automation

$$P(Crash|No\ Automation)$$

$$\gg$$

$$P(Crash|\ Automation)$$

$$P(Crash|\ Automation) =$$

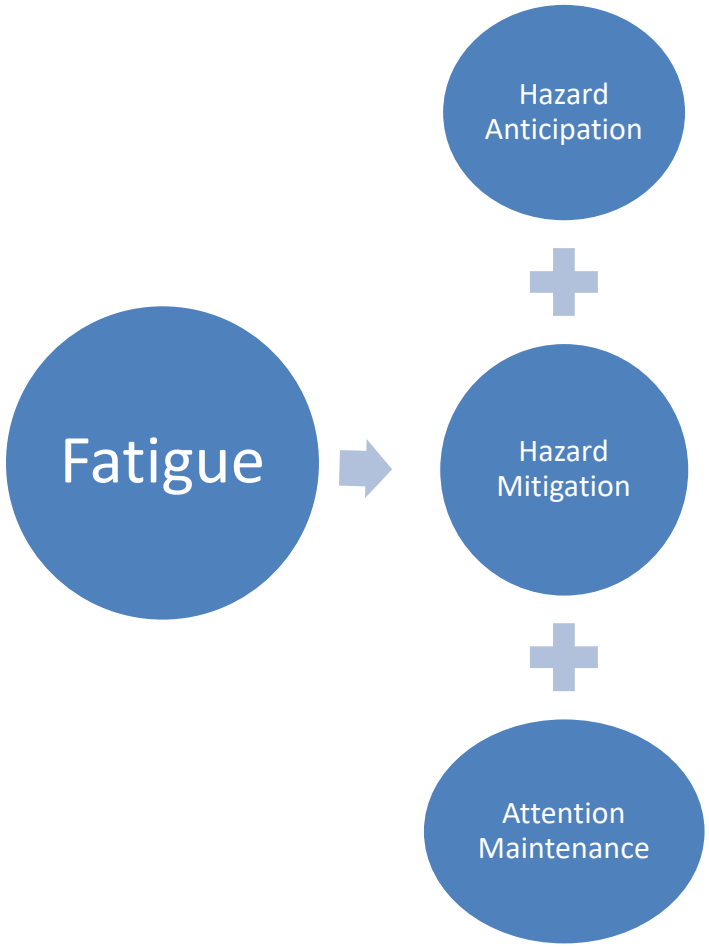
$$P(Crash|Engaged)P(Engaged) + P(Crash|Not\ Engaged)P(Not\ Engaged)$$

Part III

Functional Impairments

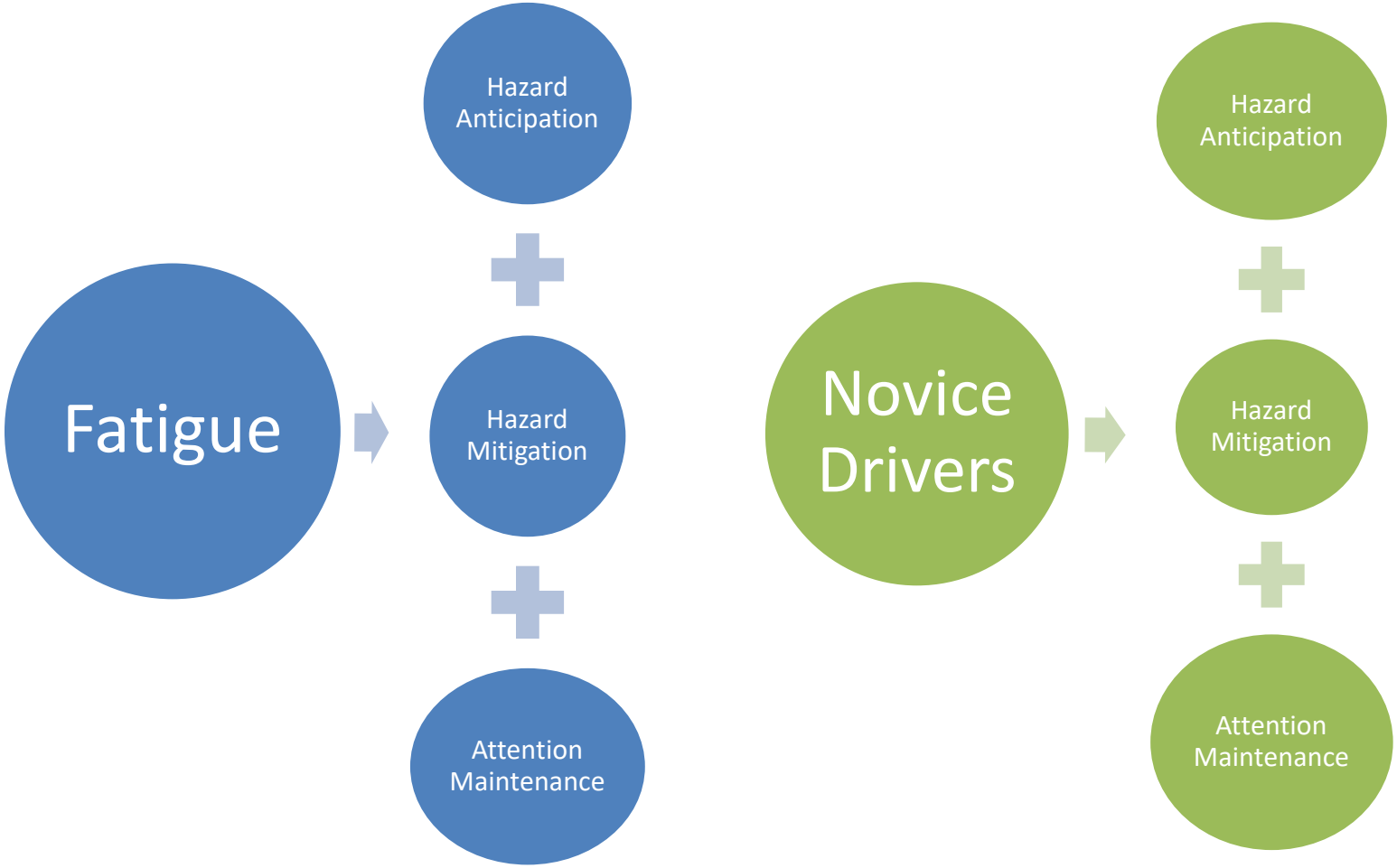
Fatigue and Lifespan

Fatigue, Driving Skills, Lifespan, Training



Hamid, 2013; Samuel et al., 2014

Fatigue, Driving Skills, Lifespan, Training



Fisher et al., 2017

Training experiment

- Participants
  - 36 licensed student nurses, 18 – 45 years old
- Experimental design
  - Evaluation (morning)
    - Driving simulator
    - Eye tracker
  - Sleep questionnaires (morning)
  - Training (morning)
    - SAFE-T
    - Placebo
  - Evaluation (evening – 12 hours after morning evaluation)
    - Driving simulator
    - Eye tracker
  - Sleep questionnaires (evening)

Hamid 2013; Samuel et al., 2014

Latent Hazard Anticipation: Definition

DLF

Hazard Anticipation: Evaluation

DLF

Video 1

Truck crosswalk unsafe

Video 2

Truck crosswalk safe

Hazard Anticipation: Training

Hamid, 2013

Hazard Anticipation: Results

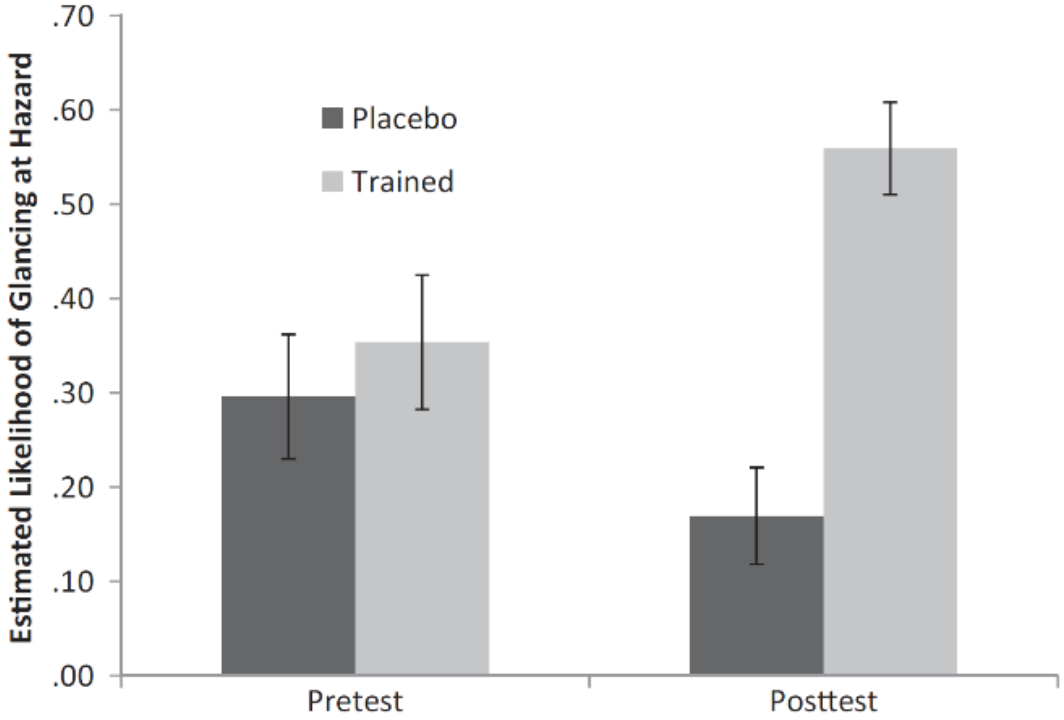


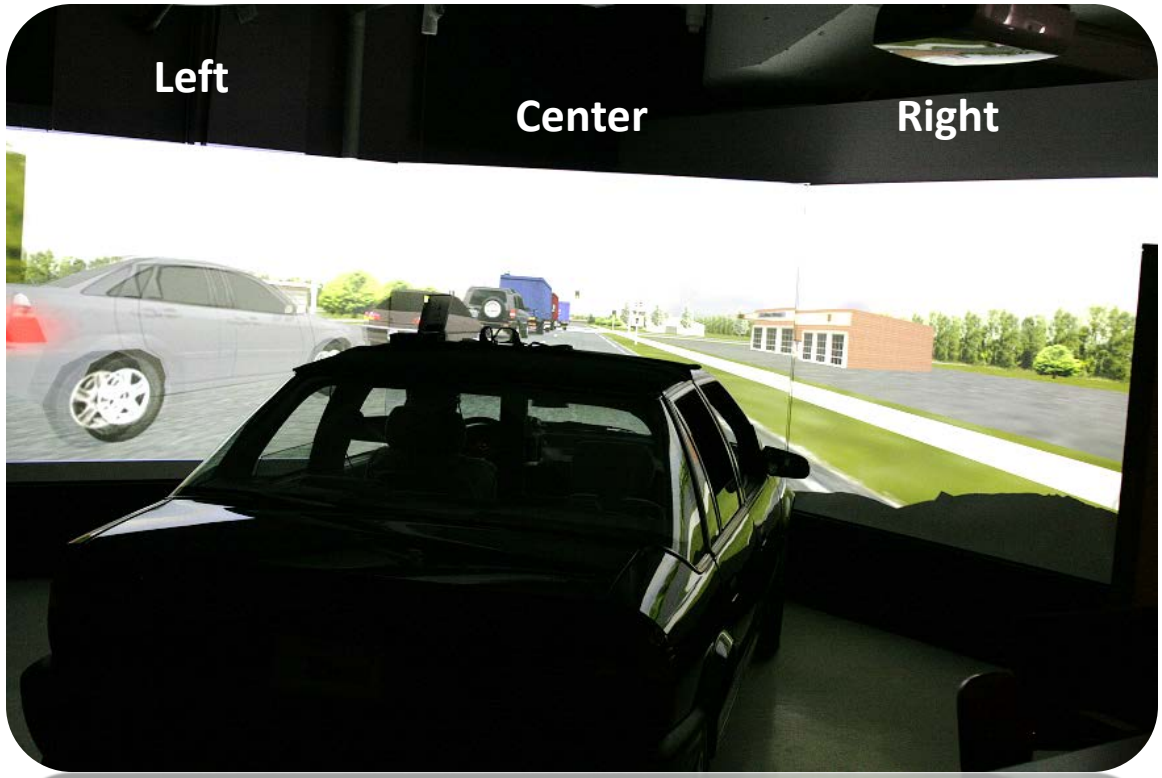
FIGURE 1 Hazard anticipation: summary of interaction between group of drivers and pre–post test.

Hamid, 2013

Hazard mitigation: Definition

DLF

Hazard Mitigation: Evaluation

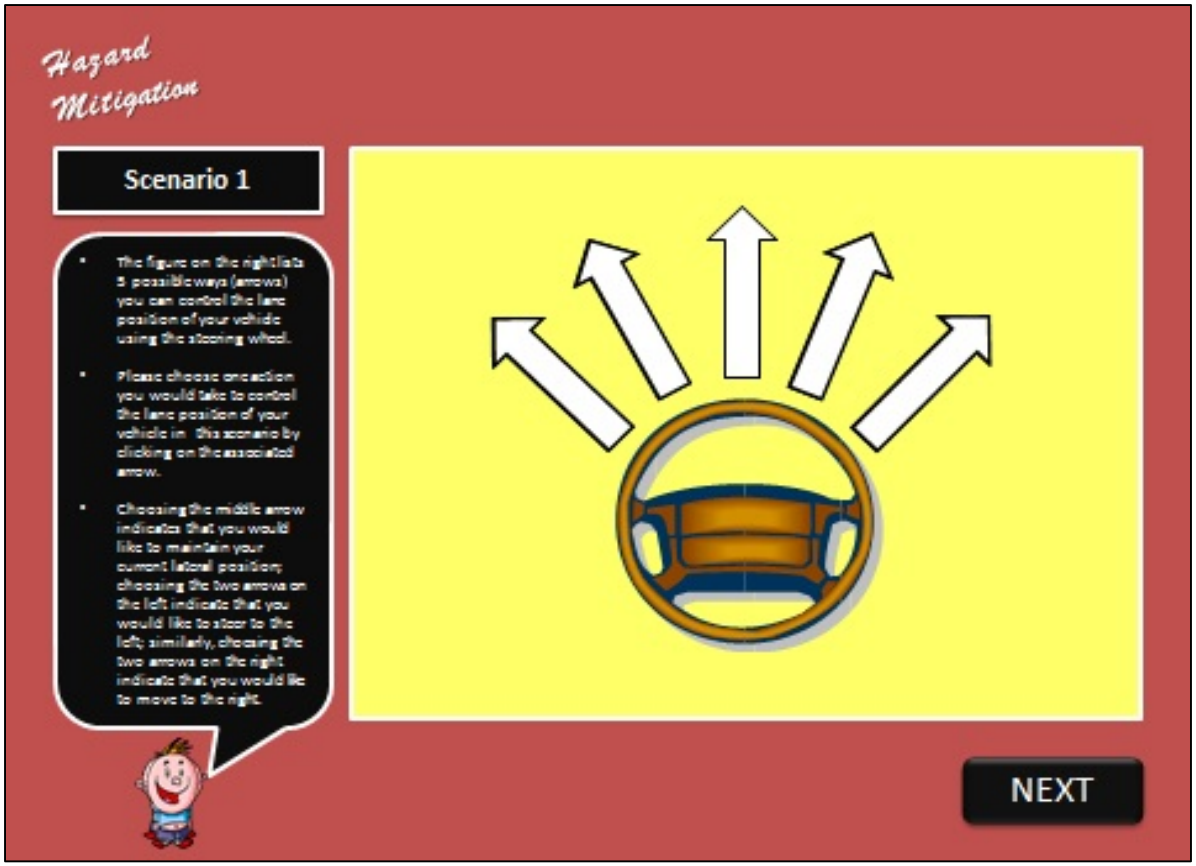


DLF

Hazard Mitigation: Training

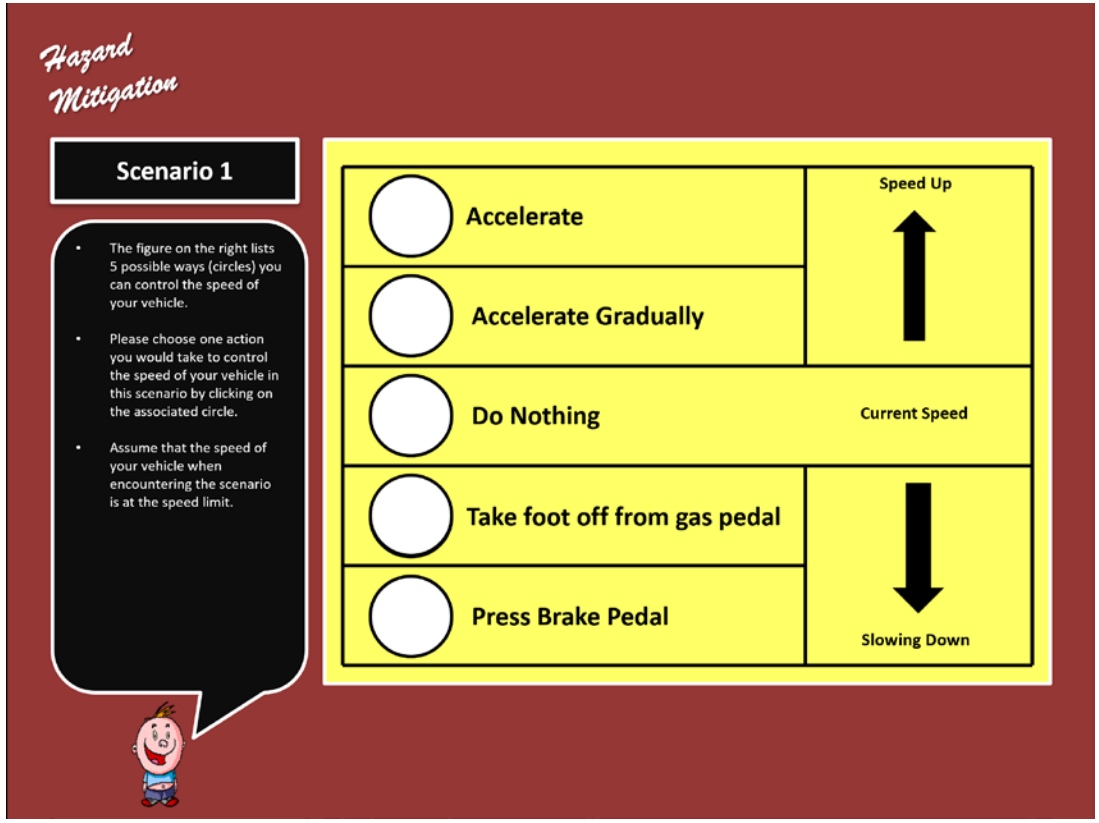
Hamid, 2013

Hazard Mitigation: Training (Position)



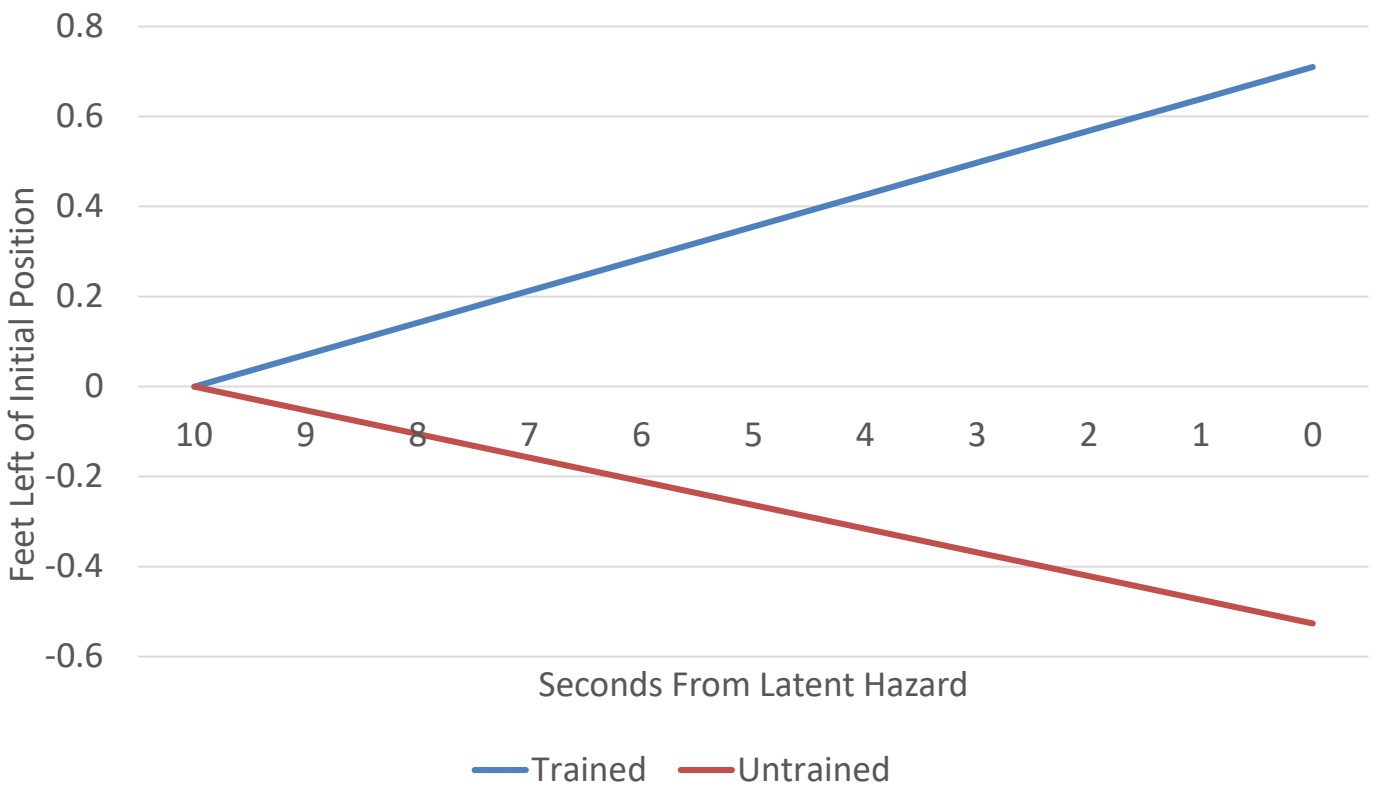
Hamid, 2013

Hazard Mitigation: Training (Velocity)



Hamid, 2013

Hazard Mitigation: Results



Hamid, 2013

Attention maintenance: Definition

Video (Distractology 101)

Credit Arbella Insurance Foundation

Attention maintenance: Evaluation

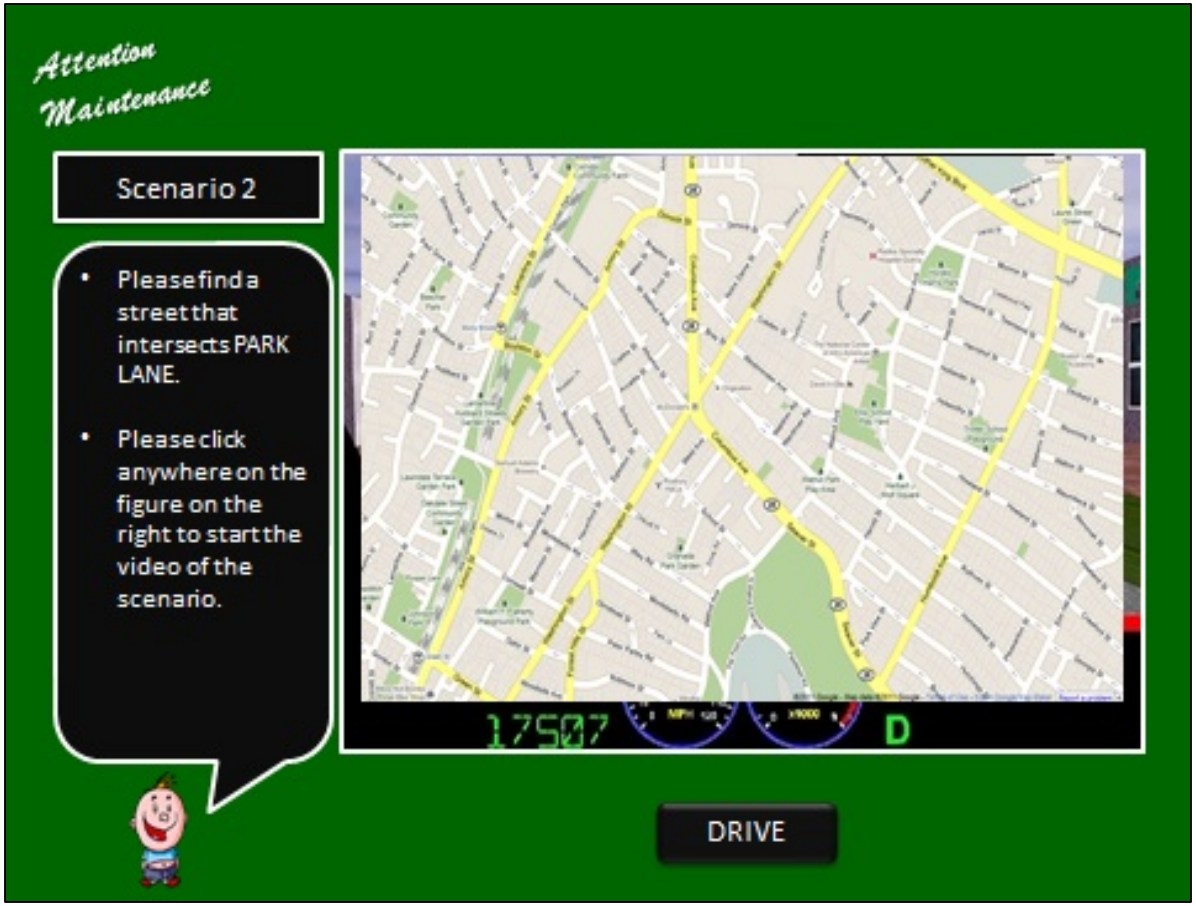
DLF

Video (iPod)

Attention Maintenance: Training (1)

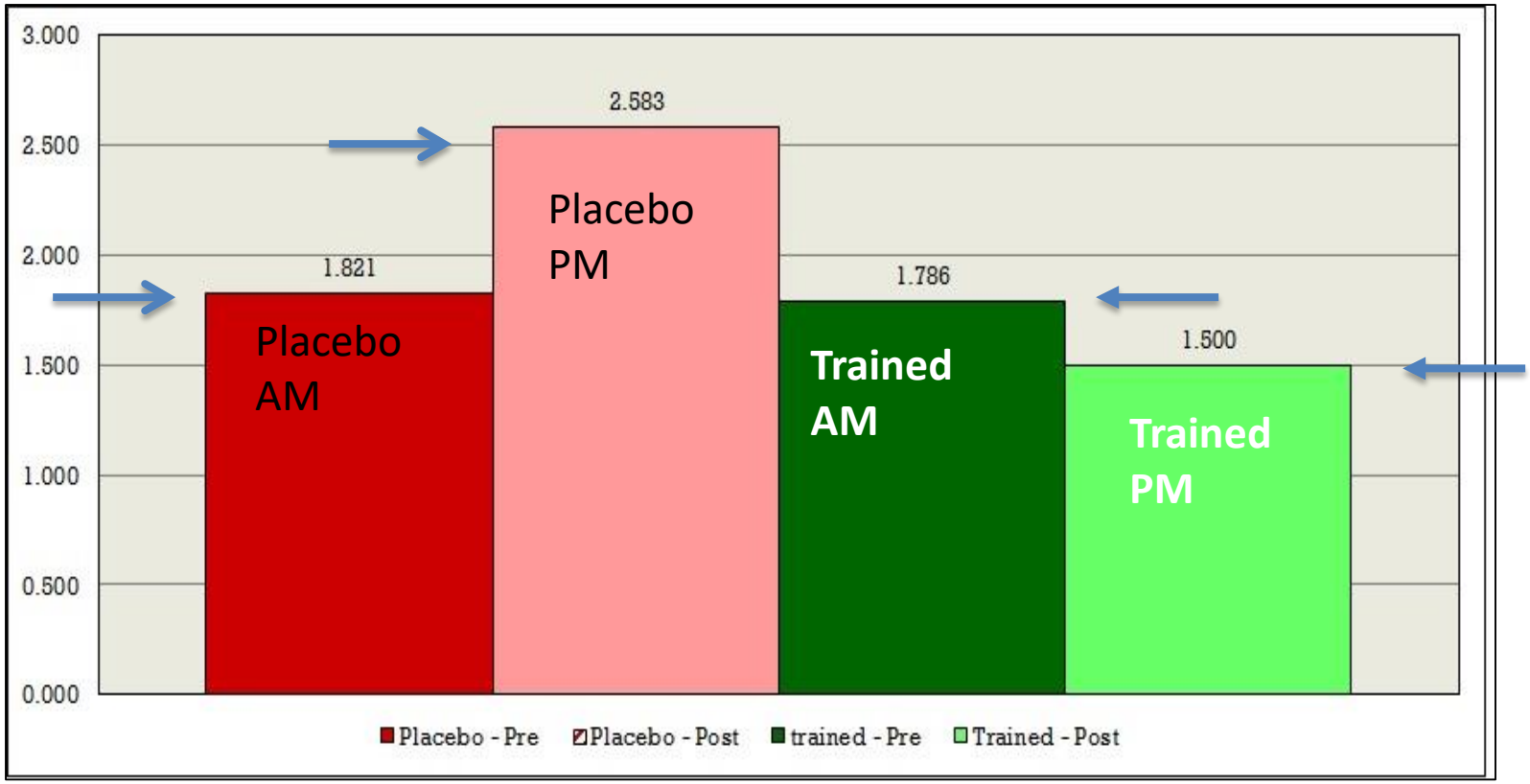
Hamid, 2013

Attention Maintenance: Training (2)



Hamid, 2013

Attention Maintenance: Results



Hamid, 2013

Lessons Learned: Fatigue and Lifespan

Credit: Google images, noncommercial reuse

Part IV

Cross Modal

Microsleeps

Credit: Google images, noncommercial reuse

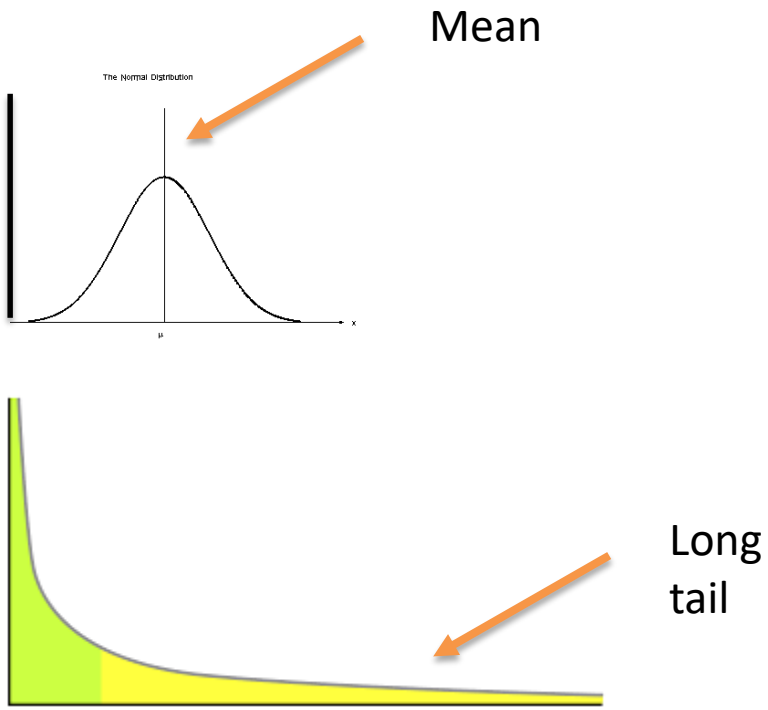
Three steps

Credit: Google images, noncommercial reuse

GPS

Credit: Google images, noncommercial reuse

The mean and the distribution



Credit: Google images, noncommercial reuse

Why especially long glances inside the vehicle are dangerous

- Glance durations inside the vehicle
  - Naturalistic studies (Klauer et al., 2006).
  - Simulator studies (Horrey & Wickens, 2007).

- Does limiting the maximum duration of in-vehicle glances solve the distraction problem?

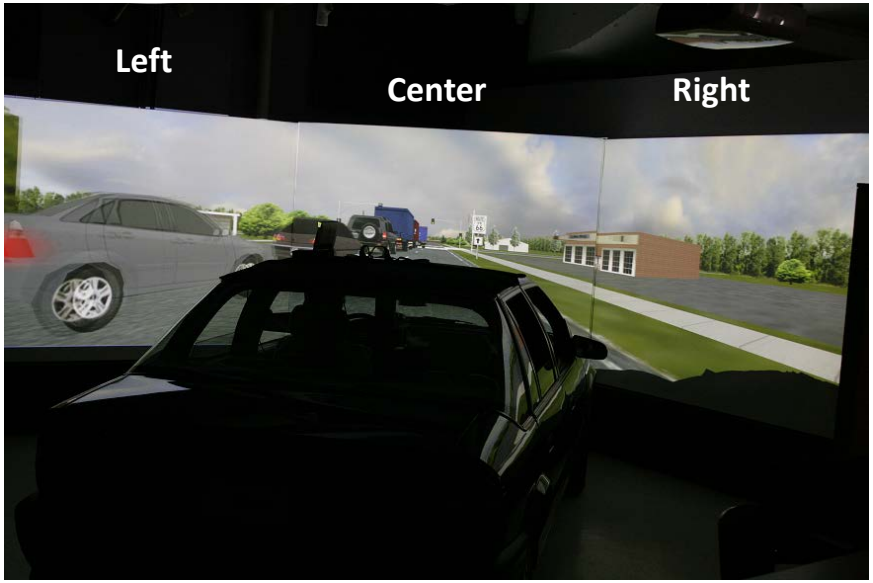
Credit: Google images, noncommercial reuse

We also need to know the minimum glance on the forward roadway

- Glances On the Forward Roadway
  - Excessively short glances a problem
  - Minimum duration (threshold duration) ≥ ???

Treatments: Continuous condition

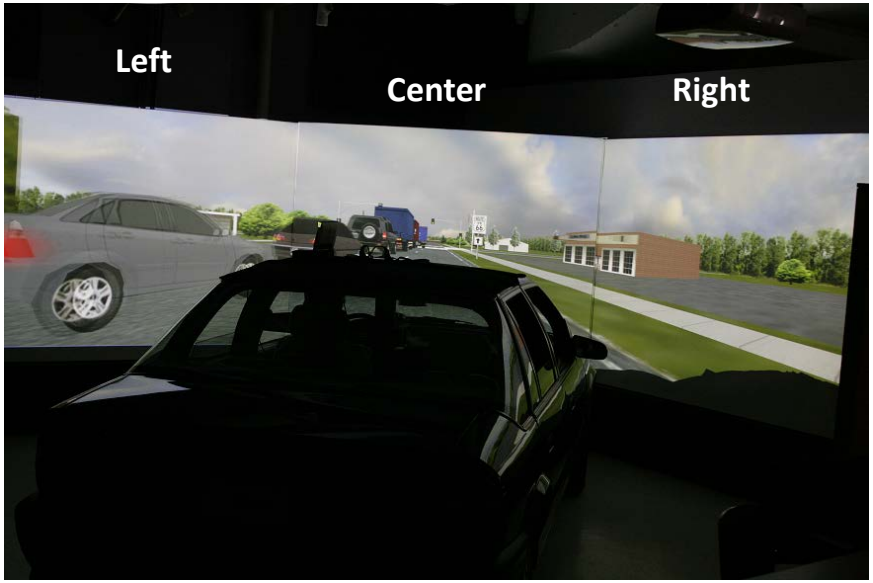
Control (Continuous) Condition



DLF

Treatments: Unloaded condition

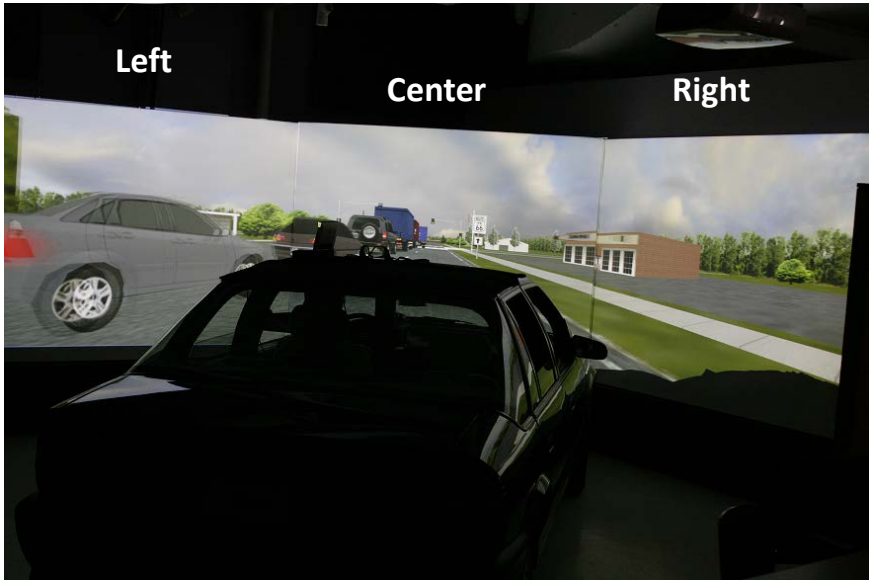
Alternating Baseline Condition (Unloaded)

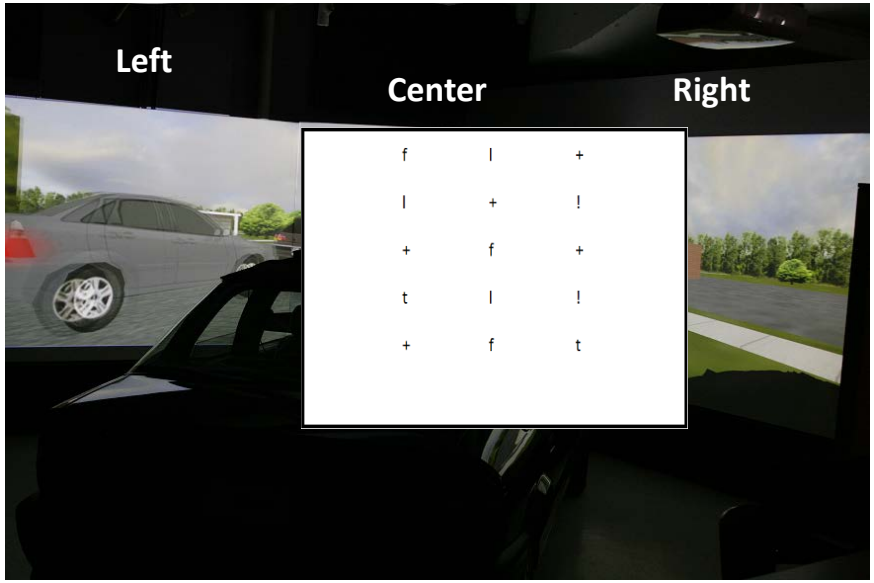


DLF

Treatments: Loaded condition

Alternating Experimental Condition (Loaded)



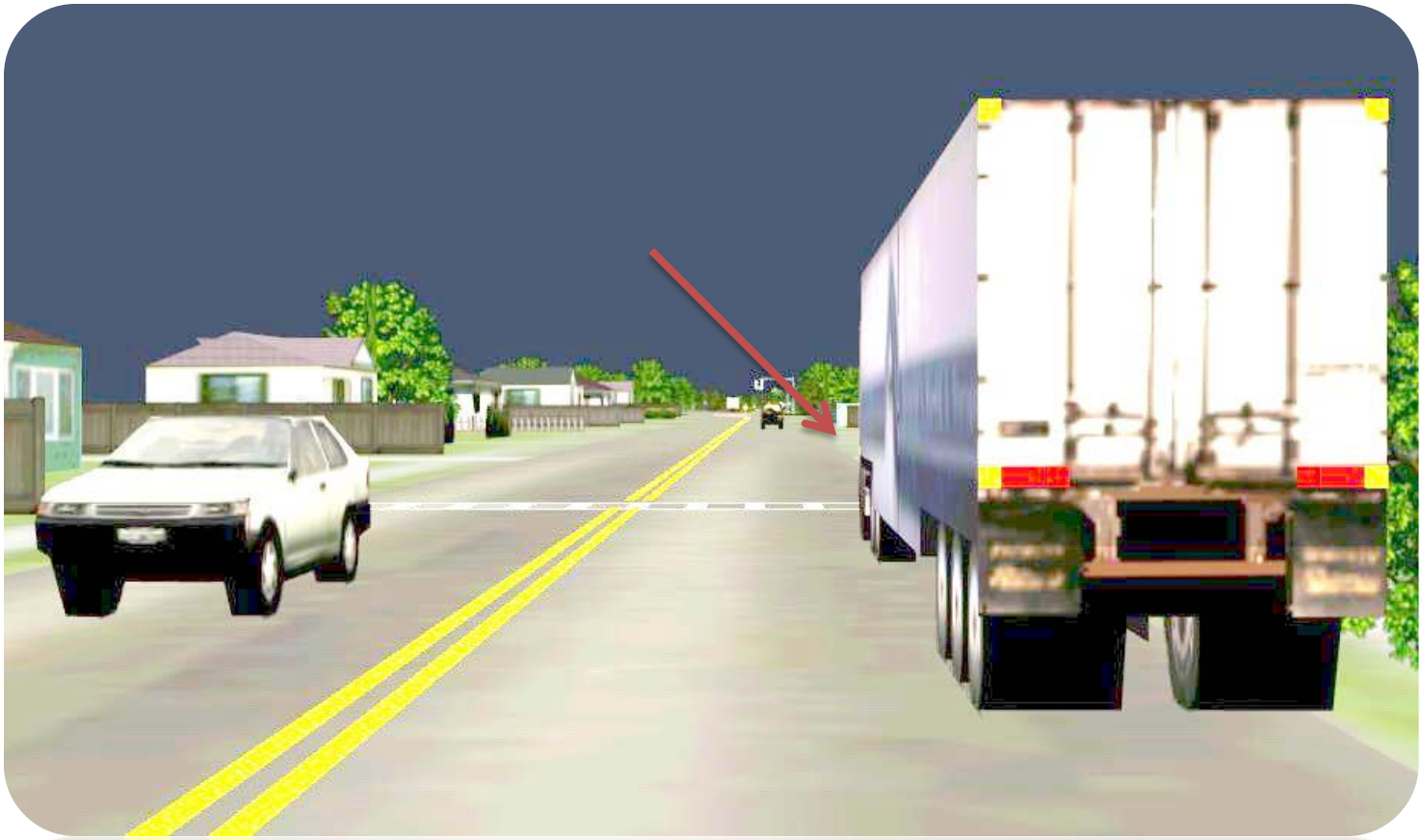


DLF

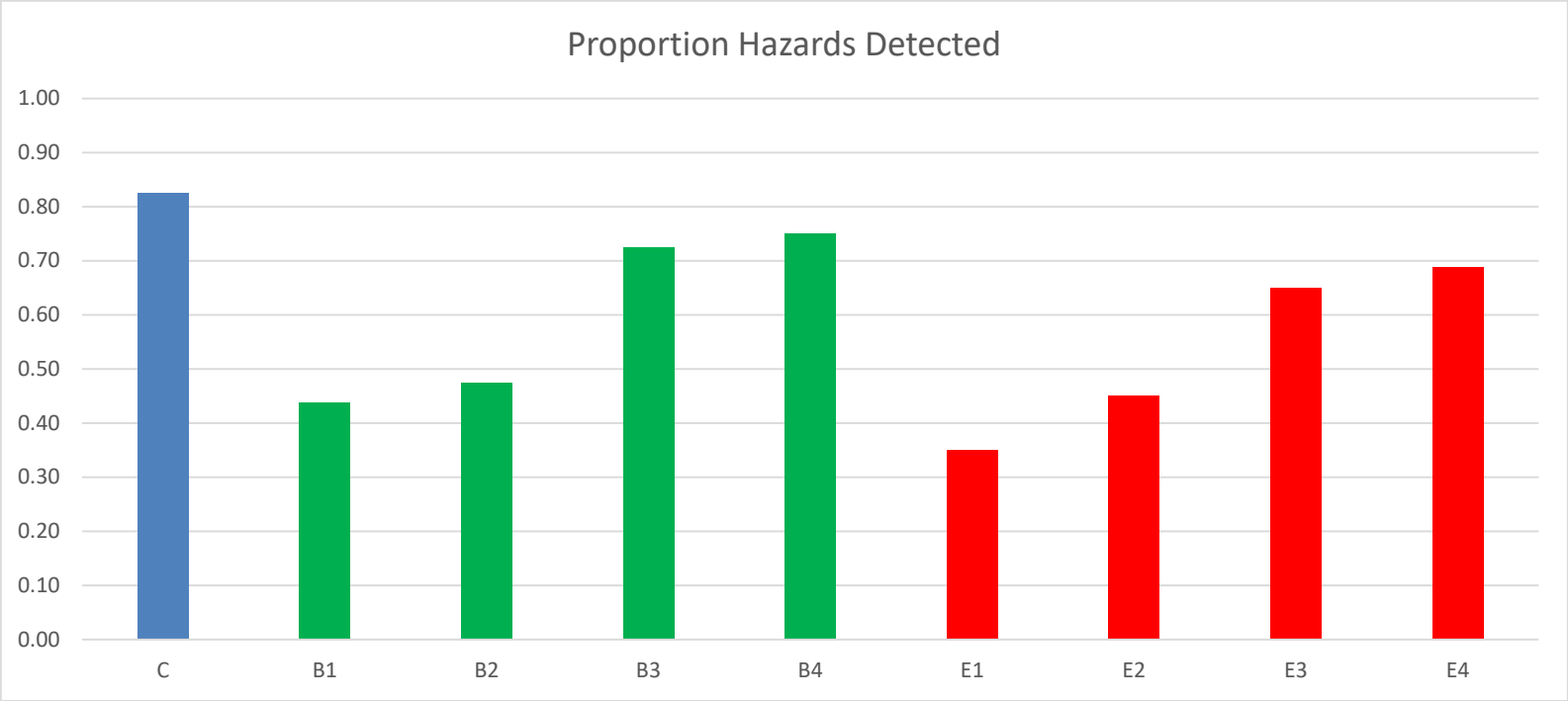
Nine groups in experiment

- **Continuous**: One group continuous (5 participants)
- **Alternating Unloaded**: Four groups in alternating baseline condition (5 participants each)
  - **B1**: 2 s down, 1 s up, ….
  - **B2**: 2 s down, 2 s up, ….
  - **B3**: 2 s down, 3 s up, ….
  - **B4**: 2 s down, 4 s up,….
- **Alternating Loaded**: Four groups in alternating loaded condition (5 participants each)
  - **E1**: 2 s down, 1 s up, ….
  - **E2**: 2 s down, 2 s up, ….
  - **E3**: 2 s down, 3 s up, ….
  - **E4**: 2s down, 4 s up,….

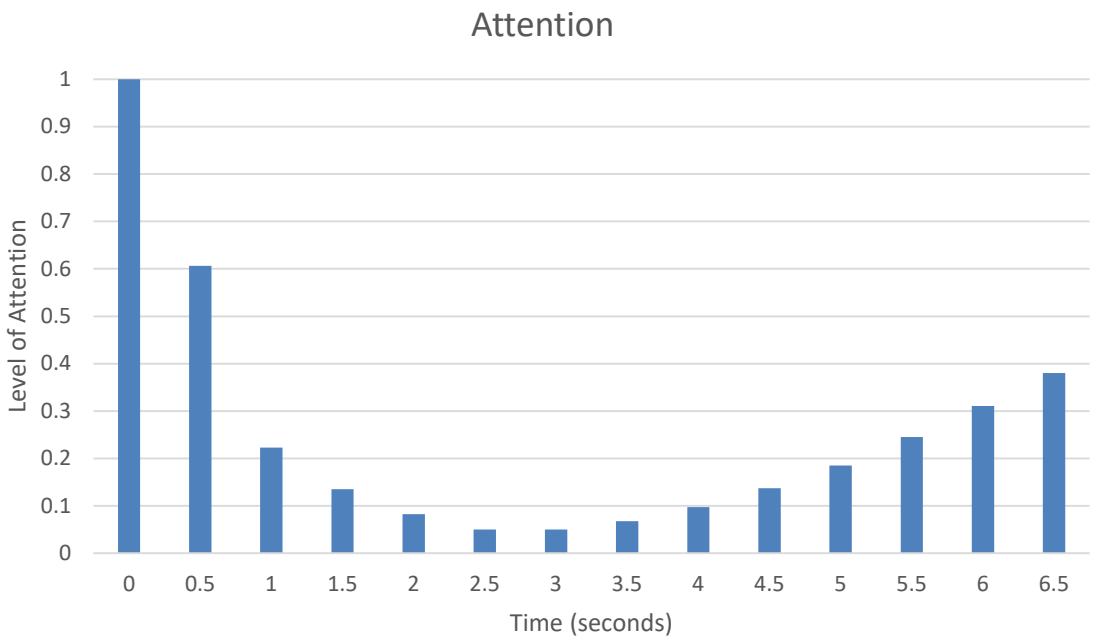
Scenarios and dependent variables



Results:


Proportion Hazards Detected
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
C
B1
B2
B3
B4
E1
E2
E3
E4

What about microsleeps?



Glances Inside

Glances Outside

Part V

Conclusion

Levels of Automation: Black swans and lumberjacks redux

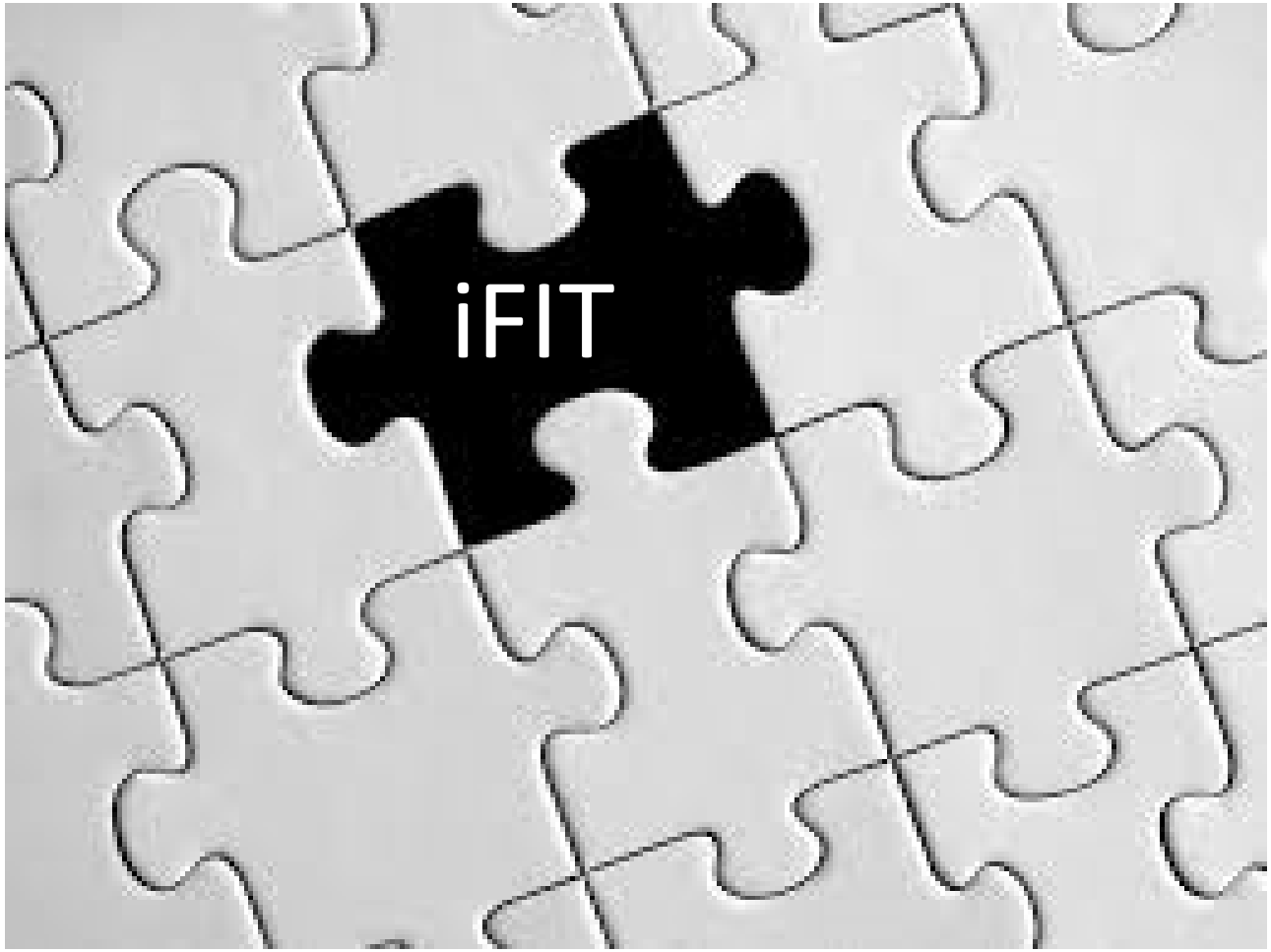
Wickens, 2014

Credit: Google images, noncommercial reuse

Functional Impairments

Credit: Google images, noncommercial reuse

Institute for Functional Impairment in Transportation



Credit: Google images, noncommercial reuse

Fatigue and Automation in Transportation: Black Swans and Lumberjacks Redux

Sleep and Fatigue
September 26, 2018

Donald L. Fisher, Ph.D. and Stephen Popkin, Ph.D.
Volpe National Transportation Systems Center

The National Transportation Systems Center

Advancing transportation innovation for the public good

U.S. Department of Transportation
Office of the Secretary of Transportation
John A. Volpe National Transportation Systems Center

www.cdc.gov/niosh/topics/workschedules/webinars.html

email: twh@cdc.gov for the unedited transcript

References

- AAA FTS. (2017, November 19). *Adaptive Cruise control*. Retrieved from AAA Foundation for Traffic Safety: https://www.aaafoundation.org/adaptive-cruise-control
- Cadillac. (2018). *2018-cad-ct6-owners-manual.* Retrieved September 22, 2018, from https://www.cadillac.com/content/dam/cadillac/na/us/english/index/ownership/technology/supercruise/pdfs/2018-cad-ct6-owners-manual.pdf
- Costa, G. (2010). Shift Work and Health: Current Problems and Preventive Actions. *Safety and Health at Work, 1*, 112-123. doi:10.5491/SHAW.2010.1.2.112
- Costa, G., Akerstedt, T., Nachreiner, F., Baltieri, F., Carvalhais, J., Folkard, S., . . . Silvério, J. (2004). Flexible working hours, health, and well-being in Europe: some considerations from a SALTSA project. *Chronobiology International, 21*, 831-844.
- Fisher, D., Young, Y., Zhang, L., Knodler, M., & Samuel, S. (2017). *Accelerating teen driver learning: Anywhere, anytime training.* Washington, D.C.: AAA Foundation for Traffic Safety.
- Gaspar, J., Brown, T., & Schwarz, C. (2017). Examining the effectiveness of forward collision warnings for drowsy drivers. *Proceedings of the Ninth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design .* Iowa City: School of Public Health, University of Iowa.
- Hamid, A. (2013). *Effect of total awake time on drivers' performance and evaluation of training interventions to mitigate effects of total awake time on drivers' performance.* Amherst, MA: University of Massachusetts.
- He, J., Becic, E., Lee, Y.-C., & McCarley, J. (2011). Mind Wandering Behind the Wheel: Performance and Oculomotor Correlates. *Human Factors, 53*, 13-21.
- Klauer, S., Dingus, T., Neale, V., Sudweeks, J., & Ramsey, D. (2006). *The impact of driver inattention on near-crash/crash risk: an analysis using the 100-Car naturalistic driving study data.* Washington, D.C.: National Highway Traffic Safety Administration.

References

- Lee, J., McGehee, D., Brown, T., & Reyes, M. (2002). Collision Warning Timing, Driver Distraction, and Driver Response to Imminent Rear-End Collisions in a High-Fidelity Driving Simulator. *Human Factors, 44*, 314-334.
- Lerner, N., Baldwin, C., Higgins, S., Lee, J., & Schooler, J. (2015). Mind wandering while driving: What does it mean and what do we do about it? *Proceedings of the Human Factors and Ergonomics Scoeity 59th Annual Meeting.* Santa Monica: CA: Human Factors and Ergonomics Society.
- Lin, C.-T., Chuang, C.-H., Kerick, S., Mullen, T., Jung, T., Ko, L.-W., . . . McDowell, K. (2015). Mind-Wandering Tends to Occur under Low Perceptual Demands during Driving. *Scientific Reports, 6*. doi:10.1038/srep21353
- Litman, T. (2018). *Autonomous Vehicle Implementation Predictions: Implications for Transport Planning.* Victoria, Bristish Columbia: Victoria Transport Policy Institute.
- Mehler, B., Reimer, B., Lavallière, M., Dobres, J., & Coughlin, J. (2014). *Evaluating Technologies Relevant to the Enhancement of Driver Safety.* Washington, DC: AAA FTS.
- National Highway Traffic Safety Administration. (2018). *United States Department of Transportation. NHTSA.* Retrieved from Drowsy Driving: https://www.nhtsa.gov/risky-driving/drowsy-driving
- Paterson, J., & Dawson, D. (2016). Fatigue and road safety for young and novice drivers. In D. Fisher, J. Caird, W. Horrey, & L. Trick (Eds.), Handbook of Teen and Novice Drivers: Research, Practice, Policy and Directions. Boca Raton: FL: CRC Press.
- Paulozzi, L. (2005). United States pedestrian fatality rates by vehicle mile. Inujury Prevention, 11(4).
- Popkin, S. (Ed.). (2015). Worker fatigue and transportation safety (Vol. 10). Santa Monica, California: Human Factors and Ergonomics Society.
- Rodd, H., & Trick, L. (2017). Predictors of mind-wandering while driving. Proceedings of the Ninth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Desig. Manchester, VT: University of Iowa.

References

- Rodd, H., & Trick, L. (2017). Predictors of mind-wandering while driving. *Proceedings of the Ninth International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Desig.* Manchester, VT: University of Iowa.
- Sallinen, M., & Hubin, C. (2015). Fatigue-inducing facotrs in transportation operators. In S. Popkin (Ed.), *Reviews of Human Factors and Ergonomics. Worker Faitgue and Transportation Safety (Volume 10)* (pp. 138-173). Santa Monica: Human Factors and Ergonomics Society.
- Samuel, S., & Fisher, D. (2018). *Loss of situation awareness with Level 2 automated vehicles: A driving simulator study.* Amherst, MA: Arbella Insurance Human Performance Laboratory, Department of Mechanical and Industrial Engineering, University of Massachusetts.
- Samuel, S., Hamid, M., Borowsky, A., Zafian, T., & Fisher, D. (2014). Evaluation of effect of total awake time on driving performance skills: Hazard anticipation and hazard mitigation - A simulator study. *Annual Meetings of the Transportation Research Board* (pp. TRB Paper 14-3297). Washington, D.C.: National Academies of Science.
- Seppelt, B., Seaman, S., Lee, J., Angell, L., Mehler, B., & Reimer, B. (2017). Glass half-full: On-road glance metrics differentiate crashes from near-crashes in the 100-Car data. *Accident Analysis and Prevention, 107*, 48-62.
- Tefft, B. (2012). Prevalence of motor vehicle crashes involving drowsy drivers, United States, 1999-2008. *Accident Analysis and Prevention, 45*, 180-186.
- Thomas, F., Rilea, S., Blomberg, R., Peck, R., & Korbelak, K. (2016). *Evaluation of the safety benefits of the Risk Awareness and Perception Training program for novice drivers (DOT HS 812 235).* Washington, DC: National Highway Traffic Safety Administration.
- Wickens, C. (2014). Black Swans and Lumberjacks: the role of complacency, automation bias and cognitive tunneling in interaction with highly reliable automation. Keynote Address. . *Resilience Week 2014. Transforming the resiliance of cognitive, cyber-physical systems*. Kansas City: Alion Science and Technology. Retrieved January 19, 2016, from http://resilienceweek2014.inl.gov/cognitivesystems/Pres/Wickens_Keynote2014.pdf