

Aging and Driving

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NC STATE UNIVERSITY

DEPARTMENT OF **PSYCHOLOGY**



**Applied
Cognitive Psychology
Laboratory**

Applied Cognitive Psychology (ACP) Lab



Feng



Laboratory for
Analytic Sciences

Reflect. Observe. Imagine.



PhD Students



Clark



Sall



Kasko



Wilkinson



Wagner

Alumni



Choi



Geden

Our Research Focus

- Human attention with applications of cognitive principles to human factors in transportation and display design



Aging and Driving



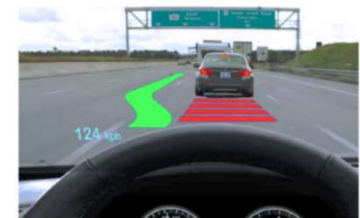
Mind Wandering



Hazard Detection

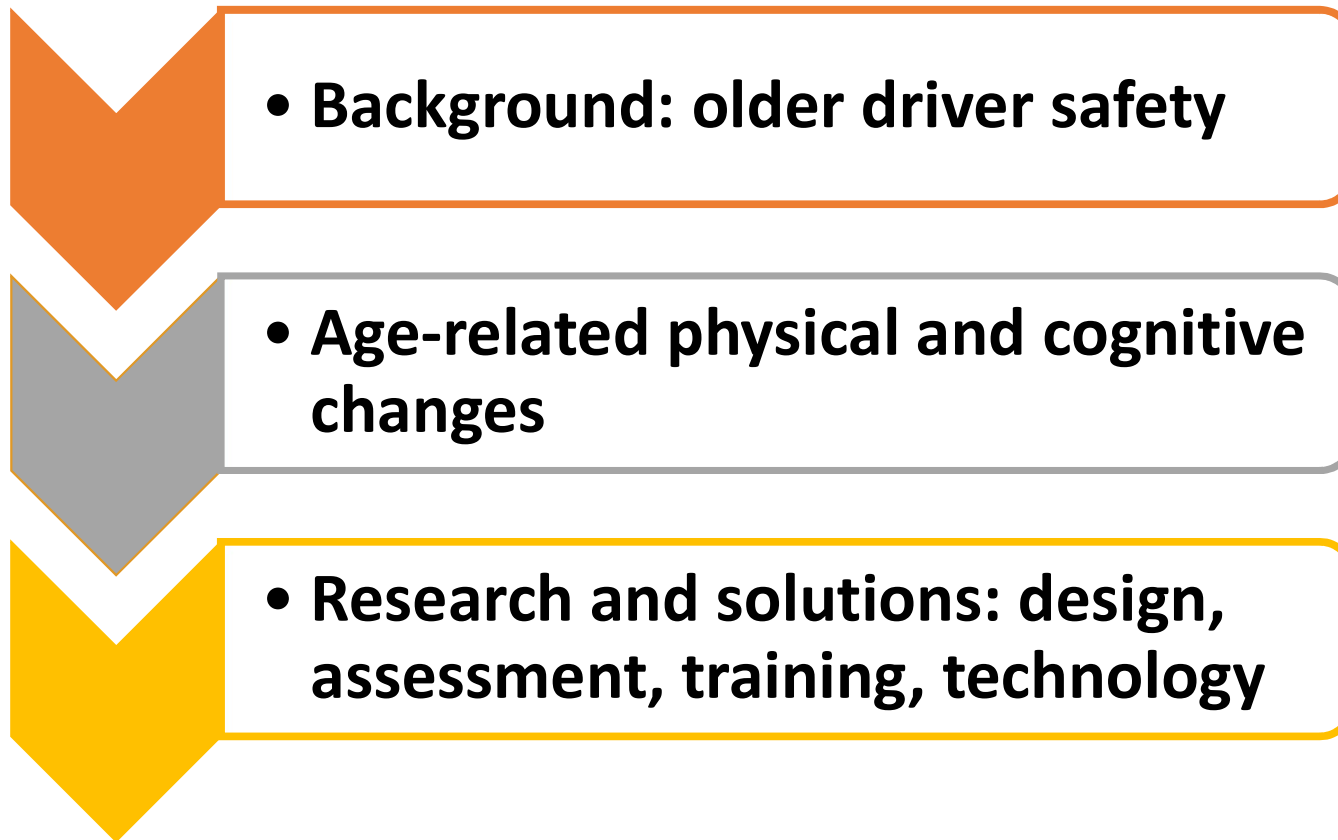


Automation

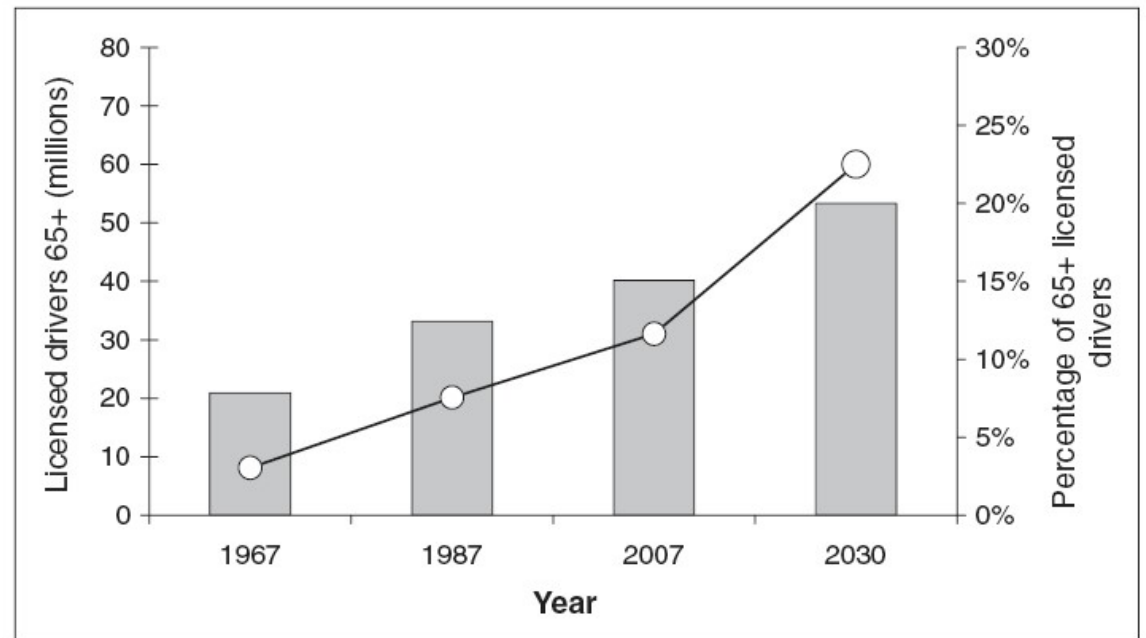


In-Vehicle Display

Aging and driving



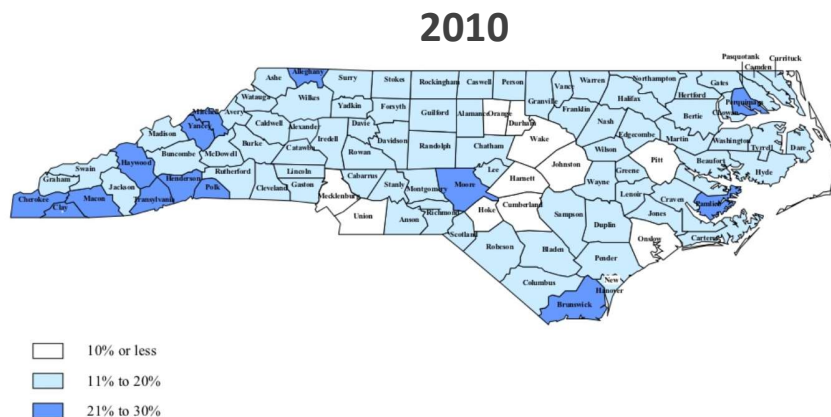
Older Drivers are the fastest growing segment



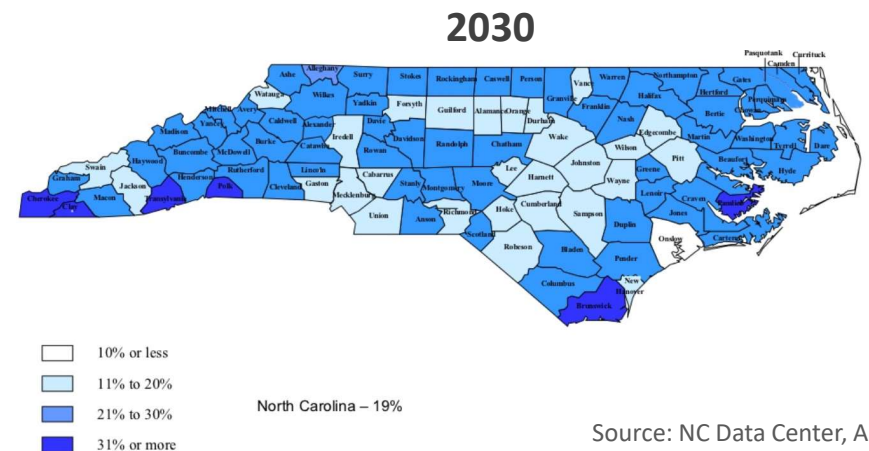
Right: United States Federal Highway Administration Statistics and Predictions

Older Drivers are the fastest growing segment

- Percent of population age 65 and over in North Carolina



Source: US Census 2010

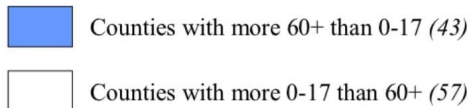


Source: NC Data Center, April 2012

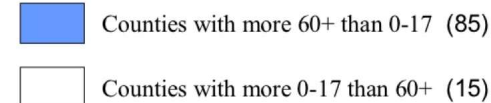
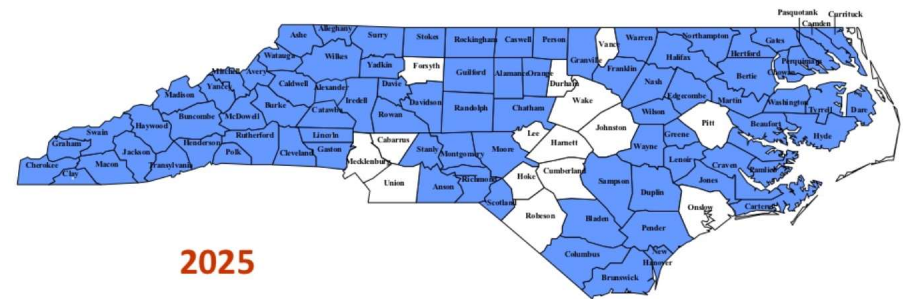
- Older drivers are not thinking about stopping driving (2017 Survey)
 - 93.8% of surveyed drivers have not thought about stopping driving (urban-96.4%, semi-rural-92.2%, rural-93%)
 - 72.2% reported that it would be a serious problem if they lose the ability to drive; only 4.8% reported that it would not be a problem

Older Drivers are the fastest growing segment

- North Carolina has the highest percentage of older drivers living in rural areas



Source: US Census 2010

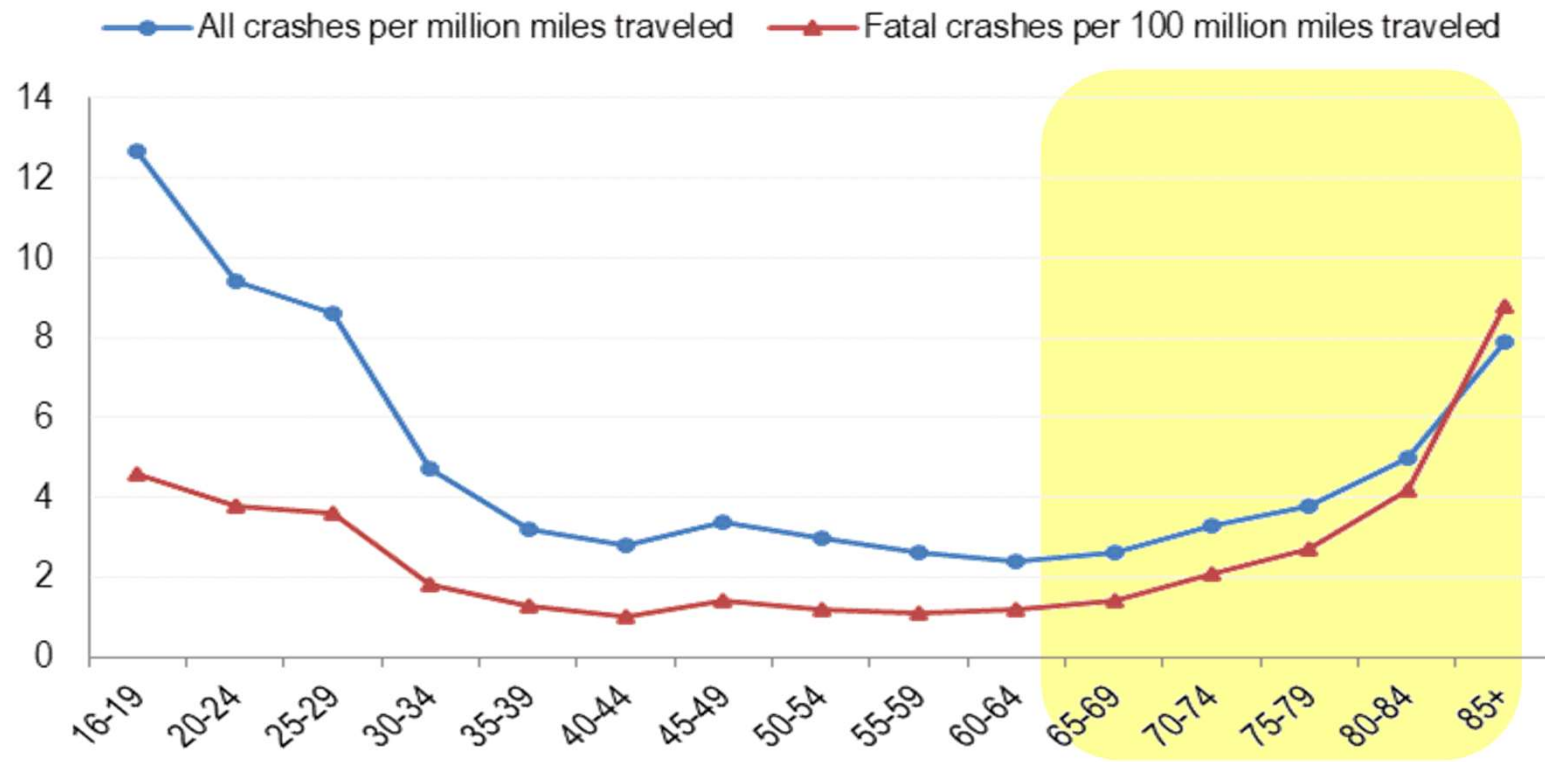


Source: NC Data Center

- Generally low utilization of alternative transportation methods (2017 survey)
 - 2.3% had taken a local bus in the past year (urban - 4.5%)
 - 8.2% had taken a taxi
 - 6.2% had used ride sharing (e.g., Uber or Lyft) (urban - 9%)

Results from the ACP Lab's Older Driver Survey in North Carolina in 2017 (n=353, age 70+)

Older Drivers are prone to vehicle crashes



Statistics from the United States National Highway Traffic Safety Administration

Capability rather than age predicts driving safety

Attentional Failures during Driving (AFD) Questionnaire

Please indicate how often the following situations have happened to you in the last six months. Using the labels at top right as a guide, please circle the appropriate number.

		Never	Hardly ever		often		Nearly all the time
27	You fail to notice an animal coming onto the road and you nearly hit the animal.	0	1	2	3	4	5
28	During a right turn, you fail to notice a cyclist or pedestrian who is entering the crosswalk from the right side, and you almost hit the person.	0	1	2	3	4	5
29	When waiting for a green light at the intersection, you fail to notice the light change when you are not directly looking at it.	0	1	2	3	4	5
30	You fail to notice road signs when they are not straight ahead.	0	1	2	3	4	5

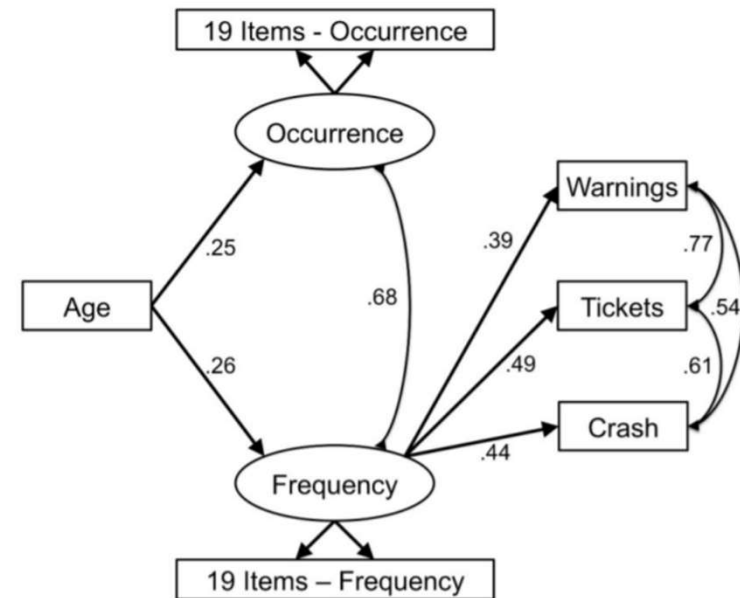


FIGURE 1 Structural model predicting driving warnings, citations and crashes from latent variables of the occurrence and frequency of attentional failures during driving.

Choi, Grünh, & Feng (2015). TRB

Age-related changes in physical capabilities

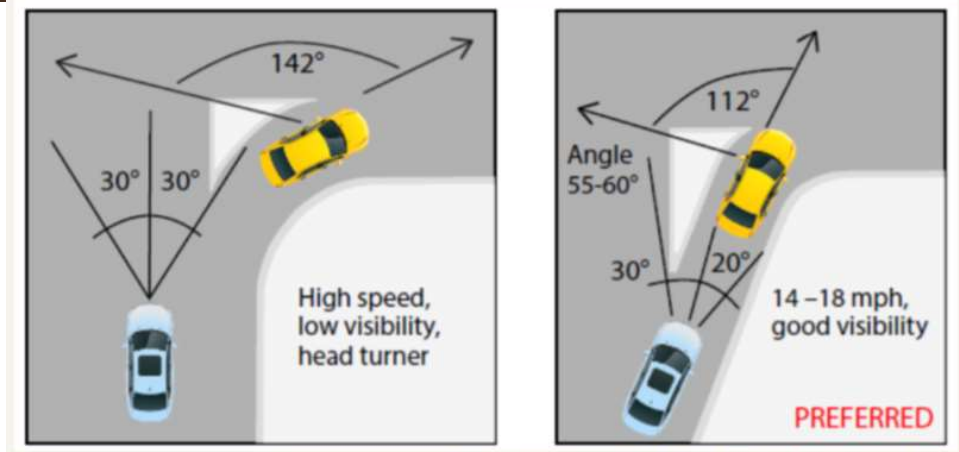
- **Posture while driving**
- Neck pain or stiffness
- Leg pain
- Diminished arm strength



Image from seniordriving.aaa.org

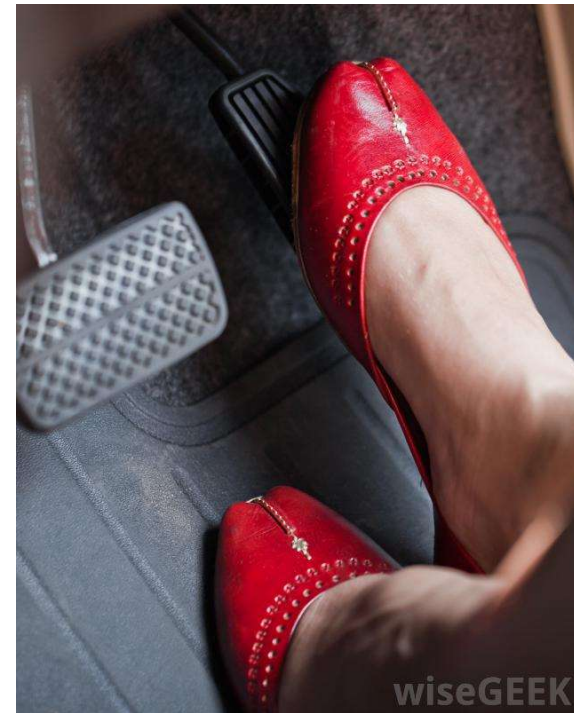
Age-related changes in physical capabilities

- Posture while driving
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Age-related changes in physical capabilities

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Age-related changes in physical capabilities

- Posture while driving
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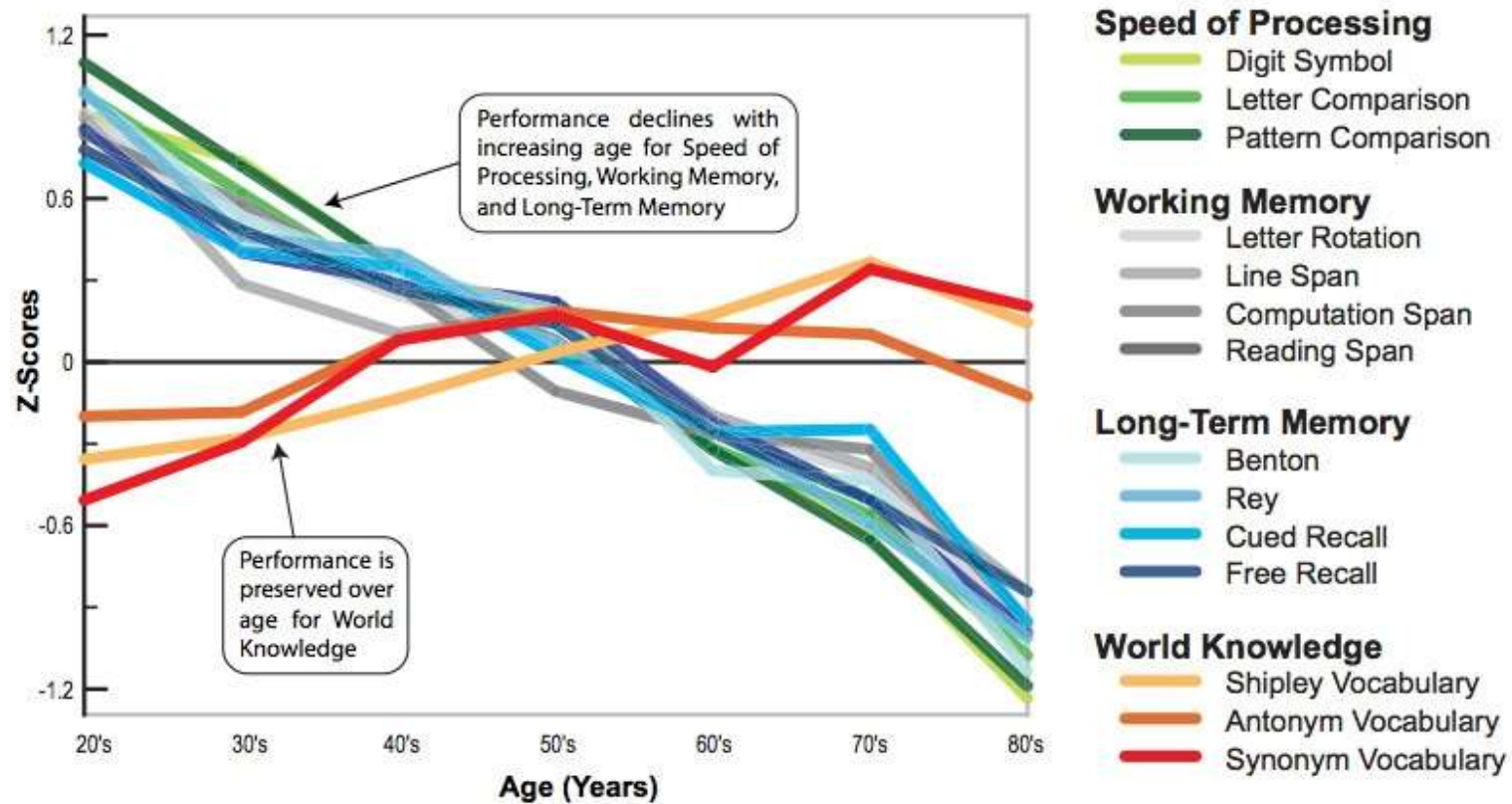
Age-related changes in physical capabilities

- Posture while driving
- Neck pain or stiffness
- Leg pain
- Diminished arm strength



- **Influence from medication on physical and cognitive capabilities**

Age-related cognitive declines



Age-related changes in sensory processing

- **Vision**

- Reduced visual acuity



- Reduced contrast sensitivity



2	8	5	7	4
7	9	4	6	3
1	6	2	8	9
7	5	4	3	2
4	8	1	7	6
9	6	4	3	2
8	6	3	1	5
1	2	5	6	3



Age-related changes in sensory processing

- **More vision problems**

- Macular Degeneration



This is how a street scene looks with normal vision.

Example of a Macular Degeneration

- Glaucoma



This is how a street scene looks with normal vision.

Example of Glaucoma.

- Cataract



This is how a street scene looks with normal vision.

This is how the same scene looks with

- Design for visibility and legibility



Age-related changes in sensory processing

- Hearing

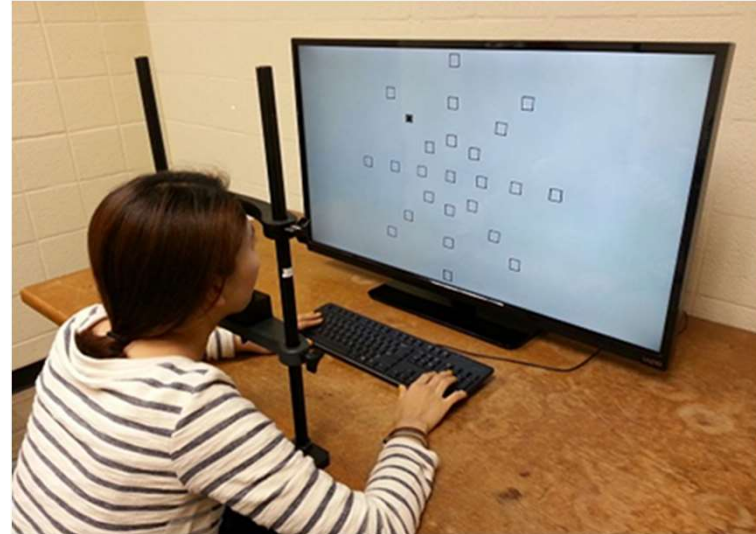
- Audible ranges decrease throughout lifetime
 - A young person can hear sounds as low as 20 Hz and as high as 20 kHz
 - By age 30, most people are unable to hear frequencies above 15 kHz
 - By age 50, the upper limit is 12 kHz
 - By 70 it's 6 kHz
- Auditory cues provides spatial information
- Rely more on visual information



[Hyundai's interface](#); Audio-visual conversion, audio-tactile conversion

Age-related changes in attention

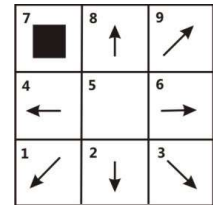
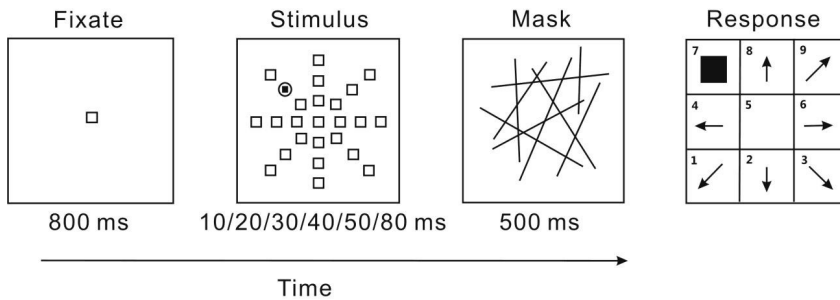
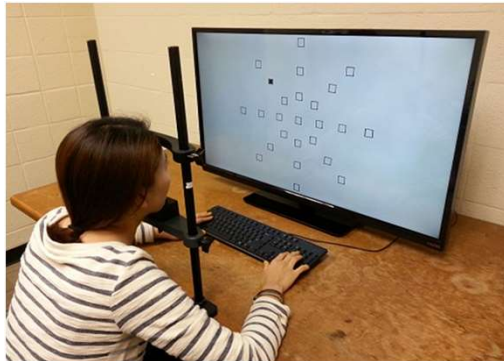
- Attention problems are **much more difficult to be aware of**



- How can a driver get informed? Individual characteristics in performance?

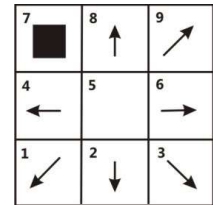
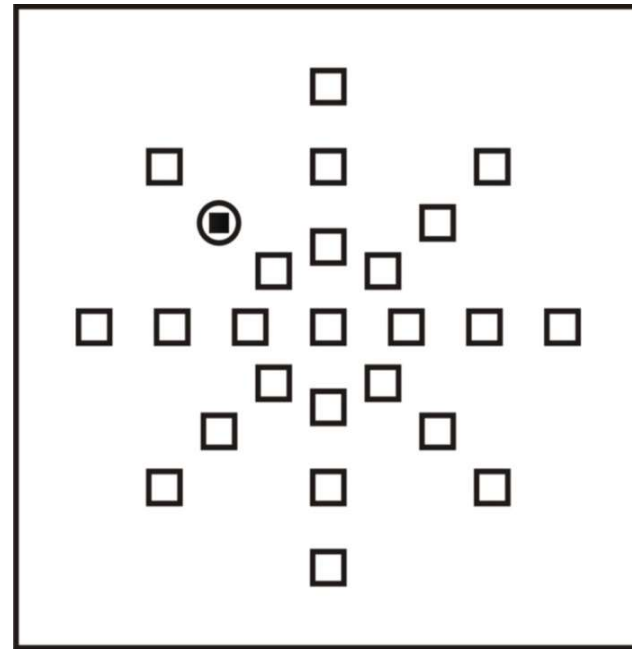
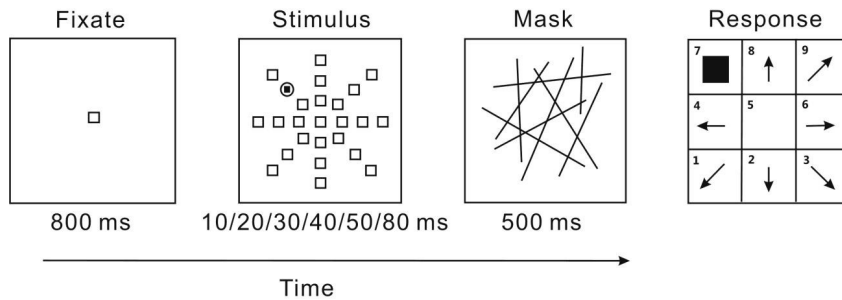
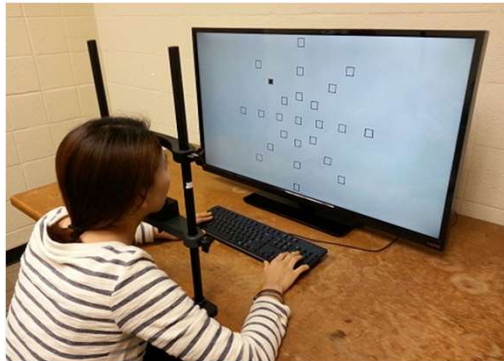
Age-related changes in attention

- Attentional Visual Field Task



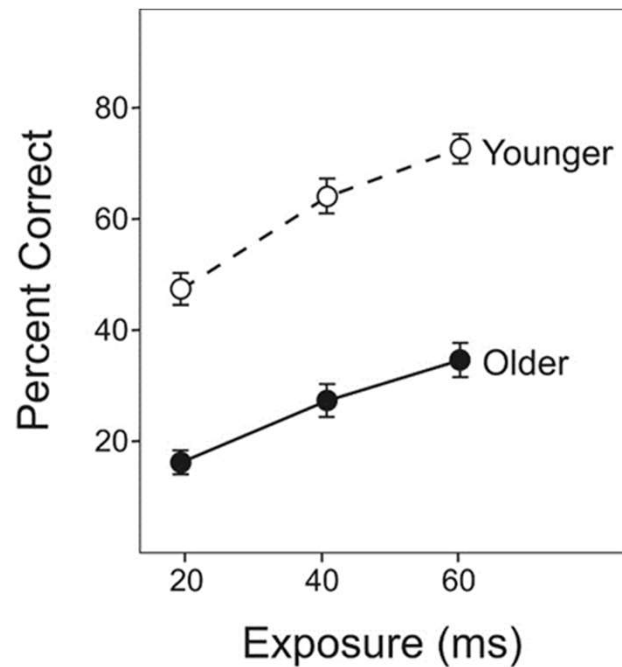
Age-related changes in attention

- Attentional Visual Field Task

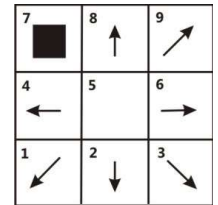
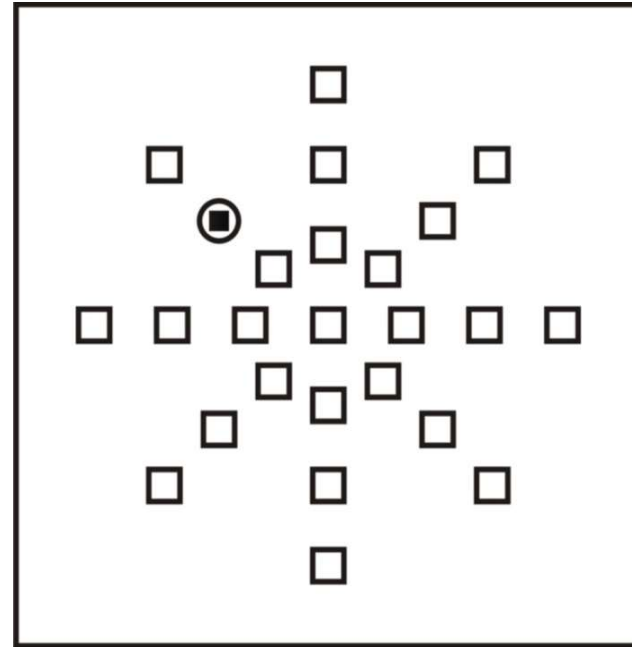


Age-related changes in attention

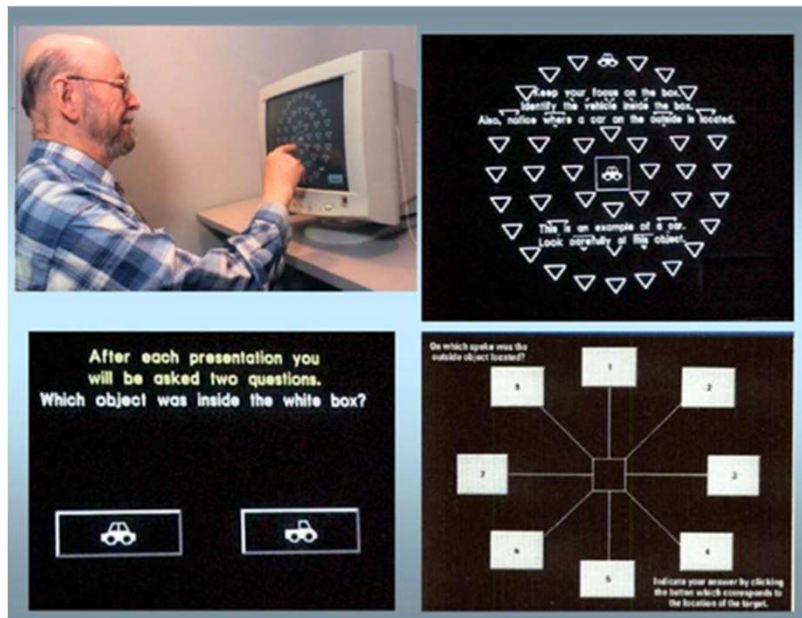
- Attentional Visual Field Task



Feng et al (2016). EJOA



Measuring attention in the context of driving



Measuring attention in the context of driving

- The Drive Aware Task



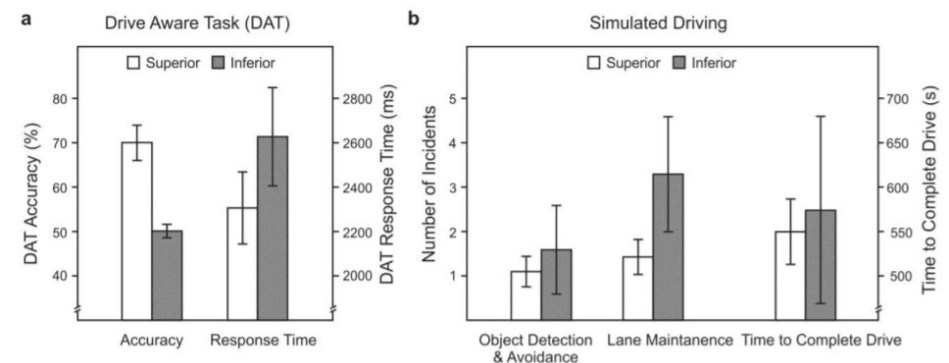
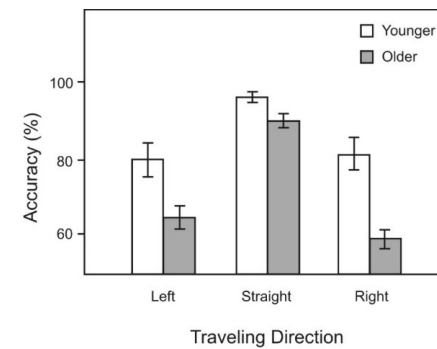
Measuring attention in the context of driving

- The Drive Aware Task



Measuring attention in the context of driving

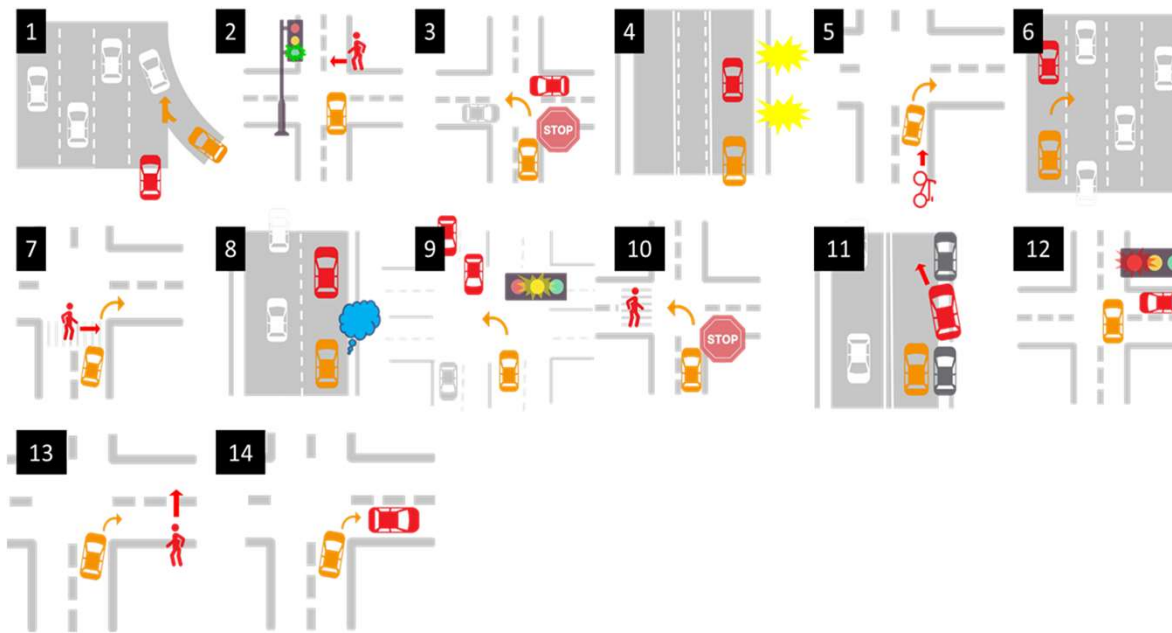
- The Drive Aware Task



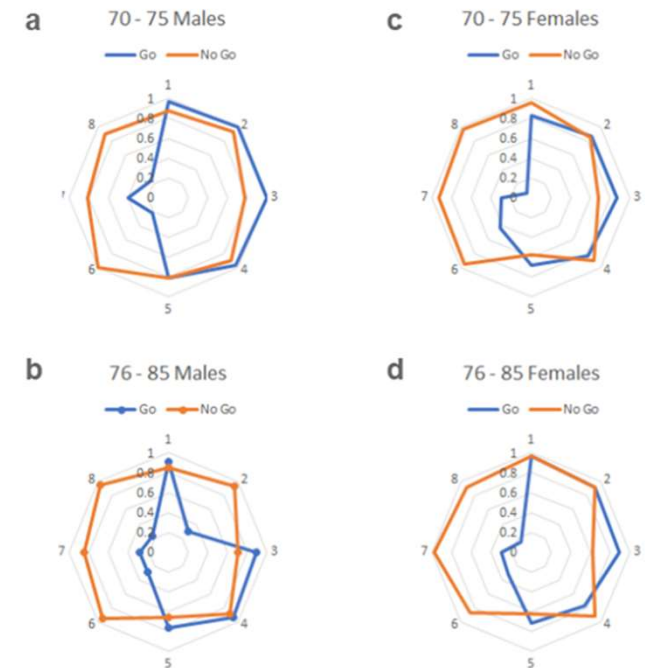
Feng et al. (2015). TRB

Attention in various driving scenarios

- Finding attentional mechanisms, **individual characteristics, training**



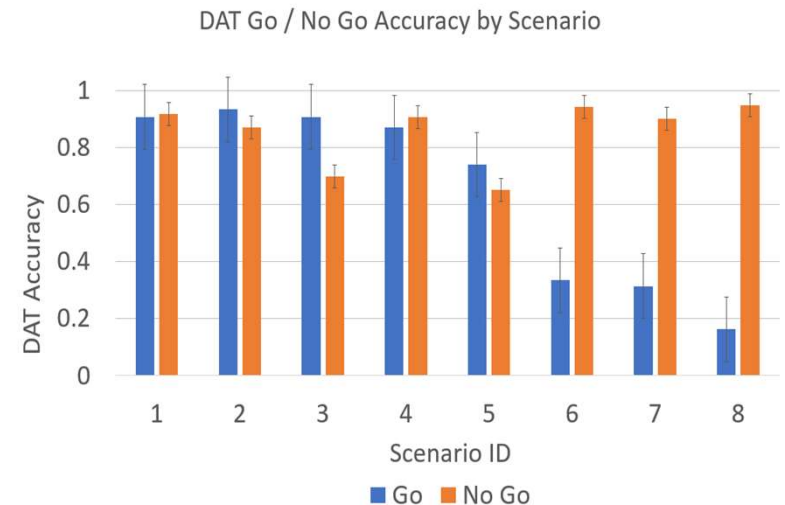
Choi, Kasko, & Feng (2019). Gerontologist



Kasko, Choi, & Feng (submitted). HFES

Awareness and self-regulation on driving

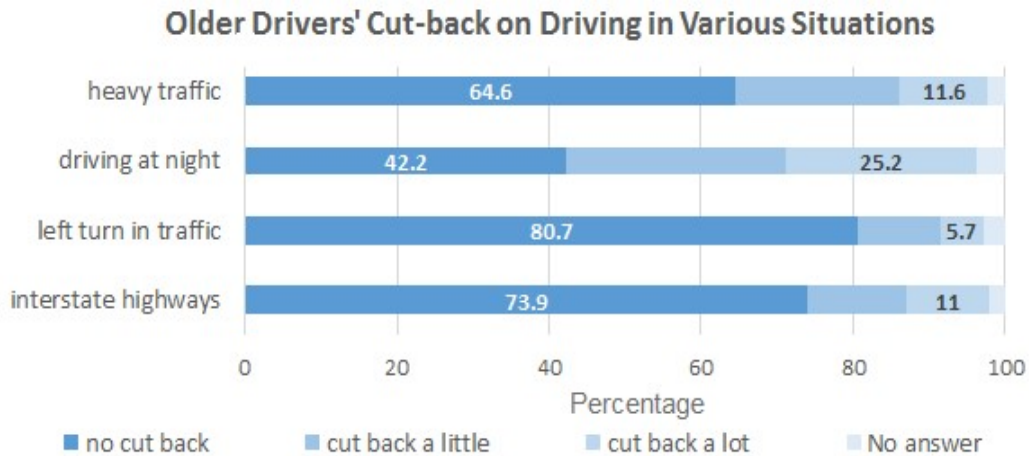
- **Older drivers bias decision making** based on traffic context
 - Driving scenes with low or high traffic load
 - Compare to younger drivers, older drivers much more likely to choose no-go with higher traffic load (Feng et al., 2018)



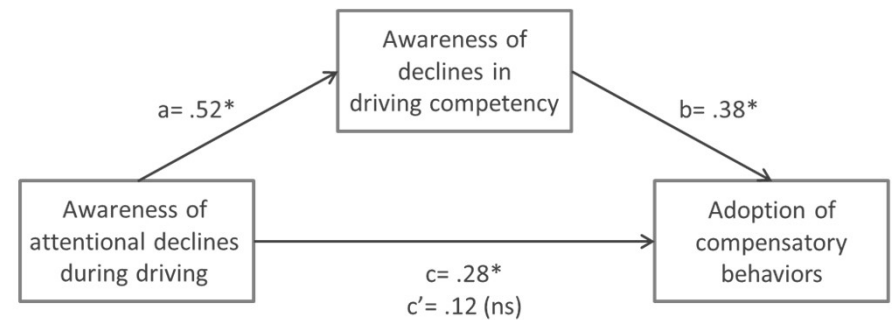
Kasko, Choi, & Feng (submitted). HFES

Awareness and self-regulation on driving

- Older drivers regulate driving behavior



Results from the ACP Lab's 2017 survey of older drivers in North Carolina.



Choi (2016). Dissertation

- Promote awareness and self-regulation**

Other considerations

- **Conversations in the family:** only 8.5% of older drivers noted concerns from family members; responses showed opportunities as well as challenges (from 2017 Survey)
 - “Wife afraid of riding in dark, bad weather, heavy traffic and on expressway”
 - “My daughter does not feel that I should drive long distances ... 300 miles or more.”
 - “My husband has cut back on his driving a lot, and does not like to be a passenger”
 - “They don’t want me driving because my sight and judgement have gotten worse in the last 20 years but I won’t stop”
 - “My grandson said he wanted to take my keys away from me. I punched him in the nose.”
- Partial licensing?

How about technology?

- Lane departure warning
- Forward collision warning
- Adaptive cruise control
- Blind spot warning
- Smart headlights
- ...

Car Technology That Helps Older Drivers

Active Safety and Convenience Features for Staying Mobile

by Doug Newcomb • October 30th, 2015 • | Share: [f](#) [t](#) [e](#) [in](#)



Will new technology fix all these issues?

- Tech adoption
- Training
- Technical support
- Design that considers older drivers' needs



Safety Features

• • • •

All About Today's Car Safety Features

High-tech eyes and ears that can keep you safe on the road.

[Learn More](#)



- “Silver” rating, designing and marketing a “senior” car?

[Eby, D., & Molnar, L. J. \(2012\). Has the time come for an older driver vehicle? Report No. UMTRI-2012-5.](#)

Will vehicle automation fix all these problems?

Self-driving cars could change the way you get around in retirement

PUBLISHED THU, OCT 11 2018 • 8:34 AM EDT | UPDATED THU, OCT 11 2018 • 9:49 AM EDT

Trafficandcommuting

Driverless cars promise far greater mobility for the elderly and people with disabilities

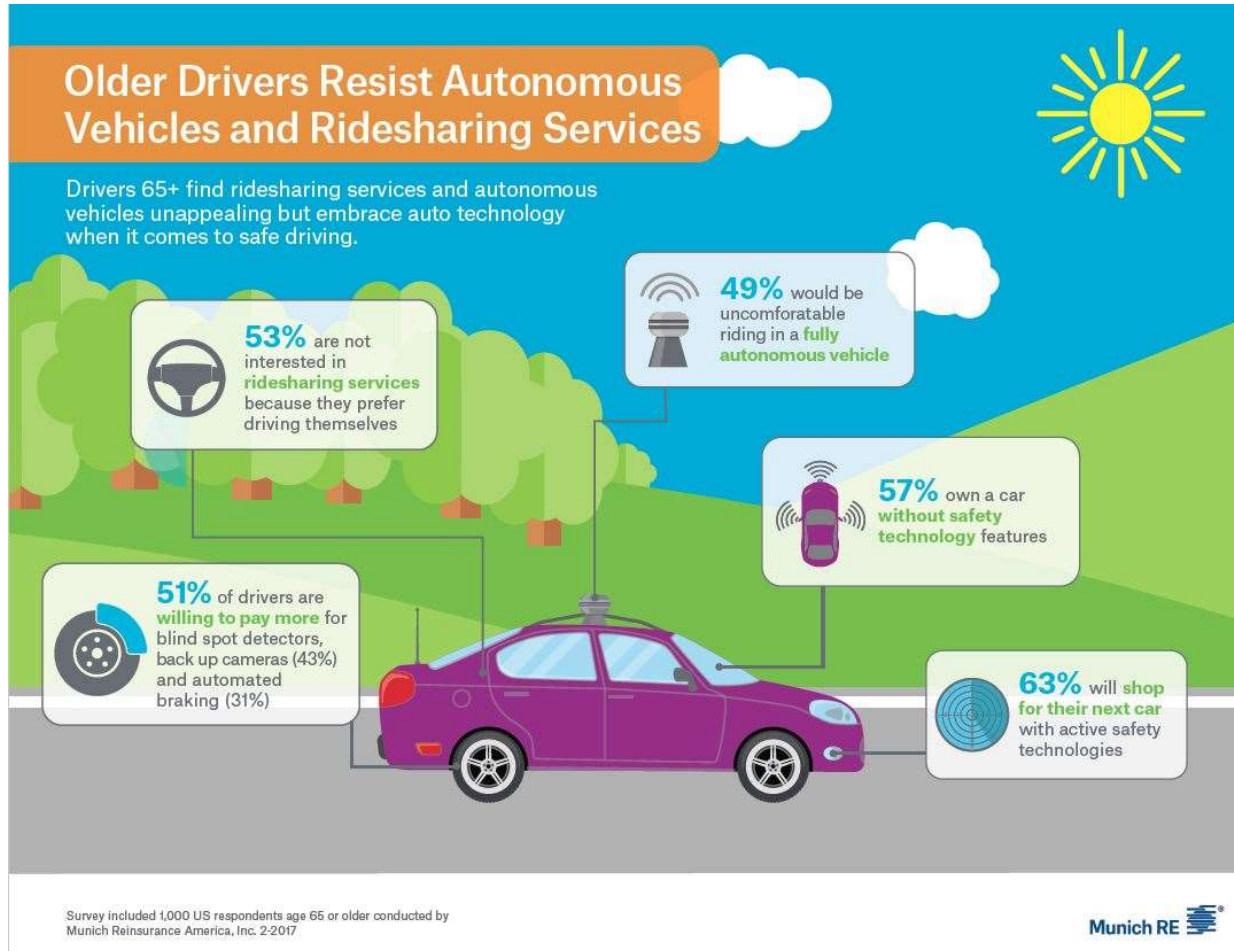
Newsletters

Autonomous Vehicles Can Benefit Seniors All Over the World

18 SEPTEMBER 2017

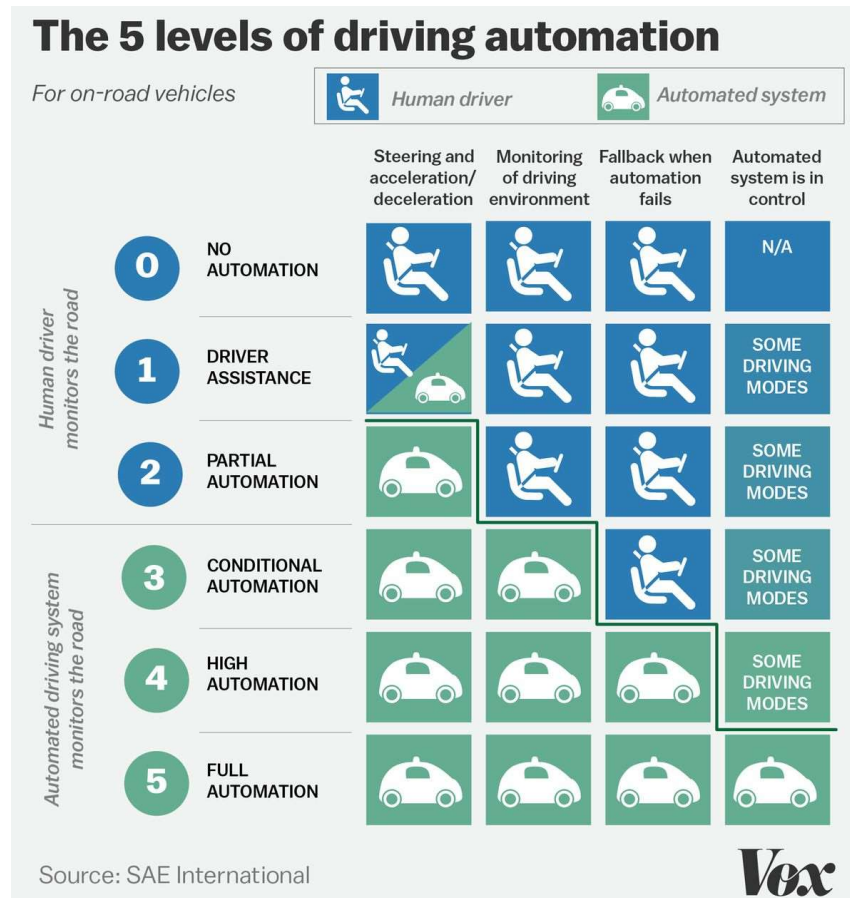


Will vehicle automation fix all these problems?



Driver interaction with high level automation

- How will older drivers interact with high level vehicle automation?



Driver interaction with high level automation

- **Take over**: the transfer of control to the driver after automated driving



Clark & Feng (2017). AAP

Driver interaction with high level automation



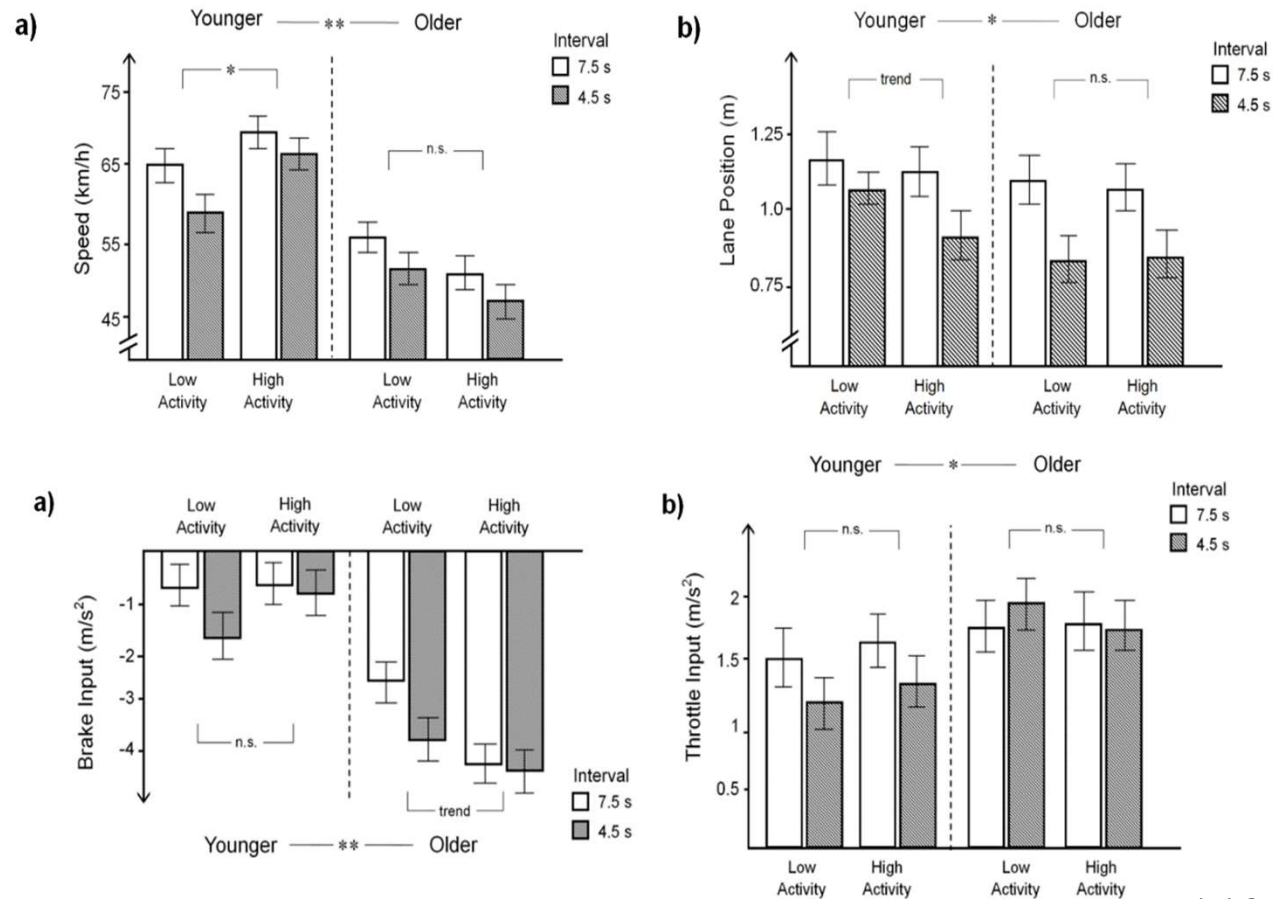
Clark & Feng (2017). AAP

Driver interaction with high level automation

Engagement in non-driving-related activities during autonomous driving					
		Younger		Older	
		Low Activity	High Activity	Low Activity	High Activity
Demographics					
	Mean age	18.8	20.9	69.9	70.9
	% of men	75%	56%	67%	56%
Mean # of Occurrences (counts)					
	Reaching	0.0	0.7	0.1	0.6
	Grooming	5.5	6.8	2.1	6.7
	Electronic Device^{a, g, a×g}	2.3	10.0	0.0	0.7
	Talking to others^{a, g, a×g}	0.5	0.8	2.2	7.4
	Talking to self	0.5	2.7	0.7	0.4
	Music	0.0	0.0	0.1	0.0
	Eyes off road	17.9	30.1	13.7	14.2
Mean Duration Per Occurrence (seconds)					
	Reaching	0.0	0.1	0.9	2.0
	Grooming	6.1	5.5	1.5	8.6
	Electronic Device^{a, g, a×g}	12.7	47.6	0.0	10.9
	Talking to others^{a, g, a×g}	1.0	0.4	6.6	24.5
	Talking to self	2.7	7.1	0.3	7.2
	Music	0.0	0.0	5.1	0.0
	Eyes off road	6.8	5.4	8.0	5.9
Total Duration of all activities (seconds)^g		99.5	554.2	27.4	336.0

Clark & Feng (2017). AAP

Driver interaction with high level automation



Will vehicle automation fix all these problems?

- **Maybe** some of the problems; also new problems are created
- Partial licensing according to driver capability and vehicle capability?
- Again, technology adoption, training, technical support
- Urban vs. rural areas

Summary

- Older drivers experience higher fatal crash risks
- Our physical and cognitive capabilities decline as we age
- Guidelines on road design for the aging population
- Assessment, cognitive training, rehabilitation, self-regulation, family, and policy
- Technology offers promises, but efforts are needed to support technology adoption and proper use
- A personalized rather than one-size-fits-all approach should be taken

