There is more to driving than 20/20

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Objectives

• To appreciate how driving affects the lives of your patients and others.
• To appreciate that driving is an important public health issue.
• To appreciate that communication is as important as testing.
• To appreciate the environmental and visual components that can affect driving.
• To understand the relationship of “routine” visual tests, results, and how they can relate to driving.
• To help appreciate that legal driving is not always safe driving and that those who are safe drivers may not always be legal.
• To appreciate that this is about risk assessment in a dynamic environment.

Driving is the primary mode of transportation for most people and a symbol of independence and life style.

Driving limitation impacts:
- access to health care, housing location, and employment opportunity
- psychological well-being (increased depression and feeling of isolation)
- family and friends

General risk factors for driving controllable vs. non controllable

Age is primary and is complicated by:

• Physical well-being
• Medication
• Environment
• Distraction
• Emotional state - general stress and road rage
• Visual sensory/motor function
• Visual information processing and cognition

Aging

The first group of baby boomers turned 65 in (2011), each day 126,000 people will turn 65 worldwide, in 2031 it will be 216,000

(Fishman TC, A Shock of Gray)

Last baby boomer will turn 50 in December 2015 (AARP 2015)

Last baby boomer will turn 65 in 2030

By 2030, almost 20% of the US population will be 65+. (AARP Bulletin, 10/06)

The number of Americans 85 years and older is growing at three times the rate of the general population (U.S. Census Bureau 2000)

By midcentury 90+ year olds will be 6.7 million

(Number of 90-plus year olds aged 90 and older, 2010-2050, Bureau of the Census 2010)

As many as 50,000 Americans are 100 years or older. (US Census 2000)

TBI

1.5 million people experience TBI yearly, of which 75% are felt to be mild.¹

5.3 million Americans live with a long-term disability as a result of TBI.²

Males are more likely than females to sustain a TBI at any age.

Children aged 0 to 4 years, older adolescents aged 15 to 19 years, and adults aged 65 years and older are most likely to sustain a TBI.

Falls are the leading cause of TBI. Rates are highest for children aged 0 to 4 years and for adults aged 75 years and older.²

A number of small studies and anecdotal reports have suggested that sports involving repeated head trauma may have long-term risks of neurodegenerative disease.³

1. Suter PS, Harvey LH. Vision Rehabilitation. CRC Press.
Risk assessment in a dynamic environment

- Between 30 and 60 percent of people with severe brain injury return to driving after they are injured.
- People with brain injury may place limitations on their driving habits; they may drive less frequently than they did before the injury or drive only at certain times (such as during daylight), on familiar routes, or when traffic is light.
- By 2020, 40 million drivers will be over 65, and by 2049 one out of four drivers will be over 65 years old.
- Older drivers often times limit their driving to time of day, complexity of route, weather, etc.

I believe that we do not have good information on mild TBI and Baby Boomers: ... just "shake it off."

Licence for driving from the patient’s and doctor’s perspective:

- Visual assessment for 
  
  As long as the individual’s VA and/or VF was good enough to allow them to get a license, they can continue to drive until that license expires (4-12 years), regardless of how poor their acuity or visual field becomes.
  
- Visual assessment for driving.
  
  Those individuals whose VA or VF drops below their state’s licensure standards are no longer legal to drive from that time forward, not just after they come up for renewal.

Things to think about

- To what extent should ODs be involved in a patient’s driving privileges?
- Is there a right way and a wrong way to inform drivers whose driving privileges need to be restricted or revoked?
- What devices/eyewear or other solutions exist to help drivers keep their licenses and, by extension, their independence? Who are ideal patients for these prescriptions?
- What (visual) factors should be considered when evaluating a patient for driving?
- What are an OD’s ethical obligations regarding “vision” and driving?

And the quandary…

- “Physicians’ warnings to patients who are potentially unfit to drive may contribute to a decrease in subsequent trauma from road crashes, yet...”
- “…formal warnings may reduce the patient’s quality of life, jeopardize doctor–patient relationships, burden family members, and generate bureaucratic hassles.”

Seniors and post TBI

- A group of older drivers with ocular pathologies, who were judged as being unsafe in driving during in-traffic conditions, reported that they drove regularly and didn’t consider themselves unsafe.
- “…significant other or caregiver is more likely than the individual with traumatic brain injury to determine whether or how much driving will be done post-injury.”

Wood, JM, Maton, K. Comparison of driving performance of young and old drivers (with and without visual impairment) measured during in-traffic conditions, Ophth, 2001 May;78(5):343-9


Driving discussion

• Be empathetic
• Discuss risk assessment, not character
• Discuss law
• Discuss family dynamic
• Be understandable

Bioptics

• Used to pass visual acuity requirement
• Not used to pass visual acuity requirement, but can use to drive
• Can not use at all
• Monocular vs. binocular system
• Specific power, visual acuity through the bioptic, and field of view through the bioptic
• Used at specific times of day
• Used with or without formal driver training

Instruction for telescopic activities

• Know the functional field of view of the telescope
• Locate a stationary target
• Pick up the telescope to position it in front of your eye or lower your head, then focus the telescope
• When (patient is) stationary: spot stationary objects, then spot, scan, track moving targets
• When (patient is) moving: spot stationary objects, then spot, scan/track moving objects
• Appreciate spatial relations between objects in the telescope
• Develop visual memory with what and where objects were seen with the telescope, including tachistoscope activities for speed and accuracy
• Visual closure for speed of identification of landmark

Positioning the exit pupil

1. Practice without optics.
2. Introduce optics: Hold the telescope away from the eye, and look at the disk of light (exit pupil) at the back of the telescope.
3. Slowly bring the telescope closer to the eye, until the disk of light becomes the view seen through the telescope.
4. When the telescope is closest to the eye, the field of view will be at its maximum.

VISUAL STANDARDS

Why is this such a difficult problem?

1) “Accidents most often have multiple causes rather than being attributable to one specific human impairment.
2) In detailed accident analysis, the most frequently cited human causes of accidents are either attentional or higher-order perceptual failings.”

(Tract et al, 1977)

Ethical dilemma

Do you use the data you gather only for the benefit of the patient or for the benefit of society?

Are the visual acuities and visual fields which are necessary for a license... the same as the visual requirements necessary for driving?
The sport of driving

Driving is a non contact sport with the goal to go from one place to another without contact or incurring penalties (i.e., fines, injuries, or damage).

“Driving requires rapid response and the ability to carry out several activities at once, such as monitoring for hazards while steering and controlling the speed of the vehicle.”

Lana TM, Toxopeus R, Wilson D, The effects of visibility conditions, traffic density, and navigational challenge on speed compensation and driving performance in older adults. Accident Analysis and Prevention, 2010

The need for a coach

A Certified Driver Rehabilitation Specialist (CDRS) obtains certification from the Association for Driver Rehabilitation Specialists (ADED) by fulfilling education and experience qualifications and passing a certification exam.

Amy Lane OTR/L, CDRS

Offensive and defensive thinking

• Not all drivers know or obey all the rules of the sport.
• Not all drivers have the same capability due to differences in physical ability, experience, familiarity with the environment, and reaction time.
• Young have speed but not experience, old have experience but not speed, and some have neither, but they can all suit up for the game.

Certified Driver Rehabilitation Specialist (CDRS)

The term Driver Rehabilitation Specialist (DRS) signifies one who “plans, develops, coordinates and implements driver rehabilitation services for individuals with disabilities.”

The purpose of the certification process is to protect the public by:
• providing measurement of a standard of current knowledge desirable for individuals practicing driver rehabilitation;
• encouraging individual growth and study, thereby promoting professionalism among driver rehabilitation specialists;
• formally recognizing driver rehabilitation specialists who fulfill the requirement for certification.

Amy Lane OTR/L, CDRS

Speed of play changes: 15-80 mph

Reaction depends on
• Sensation: the time it takes to detect the sensory input from an object.
• Perception/recognition: the time needed to recognize the meaning of the sensation.
• Situational awareness: the time needed to recognize and interpret the scene, extract its meaning and possibly extrapolate into the future.
• Response selection and programming: the time necessary to decide which, if any, response to make and to mentally program the movement.
• React

Marc Green: http://www.visualexpert.com/Resources/reactiontime.html
The aging process

“Aging has clear effects on fluid cognitive abilities, from processing speed and executive function to working memory and episodic retrieval, most of which decline systematically throughout the life span.” This will be be modified by concurrent activity.

“Driving is perhaps one of the most cognitively complex everyday activities, involving the ability to successfully negotiate one’s environment on the road by making quick decisions and attending and reacting to various stimuli.”

Macular degeneration

There is “a weak association between cognitive function and early ARM in middle aged persons.”

“However, data suggest a possible association of advanced AMD and visual acuity with cognitive impairment in older persons.”

MPOD and cognition

• Lutein and zeaxanthin may have a neuroprotective effect in the brain.
• Research suggests that those with lower MPOD performed less well on “global cognitive function, executive function, memory, and processing speed.”

Diabetes

“Long diabetes duration and young age of diabetes onset were the strongest predictors of cognitive impairment, with effects on
– psychomotor speed
– memory processing speed
– attention
– working memory
– verbal ability
– general intelligence
– executive functions…”

Diabetes

• “There is a link between type 2 diabetes and mental decline…

• After 5 years, participants with diabetes at the start of the study experienced nearly three times the decline in functions like memory and the ability to think quickly compared with those without diabetes. (The decline was greater in people over age 60.)”

Diabetes Care, online 02/2010

Impairments and deficits post TBI

• Poor motor coordination
• Balance problems
• Visual deficits
• Audiovestibular dysfunction
• Communication deficits
• Post traumatic epilepsy
• Apathy
• Lack of ability to initiate purposeful behavior
• Behavioral excess (impulsivity or disinhibition)
• Limited stamina and endurance, fatigue
• Distractibility
• Limited attention and concentration span
• Poor memory
• Inadequate planning, organizing, decision-making, and problem solving skills
• Limited safety awareness and judgement
• Poor topographical orientation
• Impaired time awareness
• Slow information processing

Knepp S, Rubin A, Community re-entry issues and long term care, Brain Injury Medicine, Demos, 2007

And the solution

“Changes in the presentation of information—to enable strategies that reduce processing or memory demands—may in turn ameliorate age-related declines in adaptive decision making.”

Hemminger CE, Medline DJ, Hartell SA, Processing Speed and Memory: Medium-Age-Related Differences in Decision Making, Psychology and Aging, 2010

What do we know about drivers in general?

“Patients often overestimate their driving skills, believe that statistical data do not apply to them, and fail to take protective actions to reduce trauma from road crashes.”


What do we know about older drivers?

Older drivers with or without a visual impairment are rated as being less safe than younger and middle aged drivers with normal vision.

Wood, JM, Mahon, K, Comparison of driving performance of young and old drivers (with and without visual impairment) measured during in-traffic scenarios, OVS: 2001 May;78(5):343-9

PREVALENCE OF GERIATRIC HIGHWAY ACCIDENTS

Older drivers are reported to have a higher number of crashes per distance traveled than either young or middle-aged drivers

Wood JM, Age and Visual Impairment Decrease Driving Performance as Measured on a Closed Road Circuit, Human Factors, 2002 Jul-Aug;44(4):624-34

Older individuals are more likely to be disabled or die in an accident.

Drivers older than 65 are almost twice as likely to die in car crashes as those ages 55-64

American Automobile Association
Selective attention

“Driving is particularly challenging as evidenced by the relatively high crash rates of older drivers who are more likely than young drivers to be involved in multi-vehicle crashes in complex conditions and at intersections.”


OLDER DRIVERS are overly represented in certain types of accidents

• Yielding the right of way
• Improper turning (especially when crossing traffic)
• Failure to obey traffic directions
• Older drivers have accidents mostly at intersections. 50% of all fatal accidents for drivers>80 years old are intersection collisions, while drivers up to the age of 50 years old account for 23% of intersection collision


General risk factors for driving

Physical well-being/medication

• Trauma
• Dementia
• Delirium
• Psychiatric illness
• Learning disability
• Toxic effects of medication
• Drugs and alcohol

Long term follow up of TBI

• Functional outcome 10 years following mild to severe TBI with injury severity...
• Participants showing poorer outcome on the Glasgow Outcome Scale performed more poorly on cognitive measures of information processing speed, attention, memory, and executive function.


General risk factors for driving

• Age
• Physical well-being
• Medication
• Emotional state
  - Anxiety
  - Depression
  - Road rage
  - General stress
• Attitude

Influence driver’s attention which influences sensory processing and perception

Selective attention

“Majority of motor vehicle collisions may be the result of inattention caused by increased distractibility, and evidence shows that older adults are particularly vulnerable to the effects of distraction.”


If it takes 1 ½ sec to decide…

- 15 mph = 22 ft/sec
- 20 mph = 29 ft/sec
- 30 mph = 44 ft/sec
- 40 mph = 59 ft/sec
- 50 mph = 73 ft/sec
- 60 mph = 88 ft/sec
- 65 mph = 95 ft/sec
- 70 mph = 103 ft/sec
- 80 mph = 117 ft/sec
- 90 mph = 132 ft/sec
- 100 mph = 147 ft/sec

Stopping Sight Distance S=dr+db

- S=stopping sight distance
- dr=driver reaction distance (decision distance)
- db=braking distance (action distance)
- v=velocity
- dr=v.tr
- db=\frac{v^2}{2g(f+G)}
- f=coefficient of friction between tires and pavement (varies with speed – for wet, glazed asphalt it varies from about 0.45 at a speed of 10km/h to 0.2 at a speed of about 70km/h)
- G=average grade

The above distances depend on whether a vehicle goes into a skid or not: distances increase drastically when vehicles go into a skid.

Arrive Alive South Africa Stopping Sight and Driver Reaction Time

General risk factors for driving

- Distraction
  - NHTSA reports 30% of 3 million accidents are attributed to distractions while driving
  - Hair
  - Make-up
  - Brushing teeth
  - Tuning the radio
  - Reading
  - Reaching for something
  - Reaching for that dropped lit cigarette
  - Rear seat
  - Eating
  - GPS
  - Cell phones

Cell phone

- “Cell phone conversations tend to artificially constrict the peripheral awareness as measured by a visual field. This suggests that cell phone use while driving can decrease the perceptual visual field, making the driver less aware of the surroundings and more susceptible to accident.”

Maples WC, DeRosier W, Hoenes R, The effects of cell phone use on peripheral vision. OptometryJAOA, 1/2008

Day dreaming

- “You are five times more likely to be involved in a fatal crash because you were “lost in thought” than if you were distracted by the use of some electronic device, according to new research by the Erie Insurance Group.”

- “The study focused on the 65,000 fatal accidents that occurred in the U.S. over the last two years, identifying 10 percent as the result of some form of distracted driving…”

Dog day afternoons

- “Among the potential driving-related distractions that have recently been receiving attention is driving with pets in the vehicle. This is partly based upon recent reports of MVCs caused by drivers who were distracted by pets in the vehicle.

It has been reported that roughly 70% of households own companion animals and that 56% of pet owners report riding with a pet in the vehicle at least once a month; 30% of those driving with pets in the vehicle admit to being distracted.

Additionally, while 83% of those surveyed agreed that an unrestrained dog was likely dangerous in a moving vehicle, only 16% have ever used any type of restraint on their own pet.”

And the one receiving lots of press: Texting

Sending a text causes a typical driver to look away from the road for 4.6 seconds in a 6 sec interval...at 55 mph, a car will travel nearly 125 yards in that time...more than the length of a football field.

Driver distraction in commercial vehicle operations, US Dept of Transportation, Sept 2009

Caveat

Fan interfering with play

In 2011, pedestrian deaths accounted for 14% of all traffic fatalities. Over two-thirds (70%) of pedestrian fatalities occurred at non-intersections versus at intersections. AARP

Selective attention

“Vehicles are now commonly instrumented with sophisticated navigation and entertainment systems which, like mobile phones, may add to the driver’s attentional burden, distracting them from the primary task of driving.”

Wood JM, Chaparro A, Philippe L, Hickson L. Useful field of view predicts driving in the presence of distracters. OVS 2012;89:373-81

General variables that can impact driving are
- Changes in the field of play:
  - Light vs. heavy traffic
  - “In Washington county heavy truck accidents account or 7.7% of all accidents in 2013, compared to 5.9% in 2004.”
  - “Associated Press did an analysis of traffic deaths and US census in 6 drilling states and found fatalities have quadrupled.”
  - “Traffic fatalities in PA drilling counties rose 4% from 2009-2013 while the rest of the state fell 19%.”


Playing in variable elements

- Dawn and dusk
- Night
- Rain/snow
- Glare
- Fog
- Geography
- Intersections
- Interstate highways
- Rush-hour/heavy traffic
- Driving alone
- Parallel parking
- Cue prompts
- Clutter

Night driving

- Fatality rates are 3-4 X higher than daytime (NHTSA, 2001)
- Drivers 65 and older have greater fatalities at night than others, except younger than 25 (Mortimer, RD Fall, JC, 1989)
- Difficulty based on poor spatial and temporal processing
- Different luminance cause adaptation difficulties
- Increase in contrast, depth awareness, and visual reaction time...overdriving the headlights
- Pedestrian concerns
Glare
Distracting glare-Discomforting glare-Disabling glare-Veilng glare

AM vs PM (driving direction, especially when the sun is low) or artificial lights

Glares recovery times increase systematically with age and have been related to driving safety. Older adults who have retinal disease (BRD, AMD) have even longer recovery times.

Prolonged exposure to veiling glare can result in muscular fatigue and "attitudinal tensionness that degrades driving skills."

Sports vision hierarchy
• Monocular sensory processing: visual acuity (resolving ability, contrast sensitivity)
• Binocular sensory processing (stereo vision: eye alignment, suppression, etc.)
• Neural processing (visual decision making)
• Visual integration in a dynamic not static environment
• Goal


Visual requirements for driving?
• Central eye sight
• Peripheral sight
• Glare recovery
• Fixation, scanning, and eye coordination
• Eye head coordination
• Single simultaneous binocular vision
• Color vision
• Depth perception/stereo vision
• Contrast detection
• Figure ground
• Visual memory
• Eye head coordination and reaction time
• Eye foot coordination and reaction time
• Awareness of the surrounds

Visual acuity
• Black stationary target on a very white background. No time limit to respond.
• Says nothing about cognition
• States VA from 20/40 to better than 20/200 to play

Impact of central vision on driving
Important to maximize visual acuity at distance and near with updated Rx, but be wary of traumatic refractive changes.

Visual acuity does not reflect the visual complexity of driving (there is a weak correlation)...however in a recent study between "normal" eyes and various levels of AMD, it was found that older drivers with intermediate AMD had a reduced risk of accidents compared to others including "normals."

Compensate, avoid, caution, and self-regulate


Dry eye and driving
• 20 subjects, 6 with mild severity dry eye disease (DED), and 14 with moderate severity DED based on Delphi approach.
• Response time was higher in those with dry eye disease in a driving simulator.
• A hypothesis from this study was that in high speed or complex situations, if a person’s eyes are open longer than “normal,” the quality of an image being viewed can be degraded.
• Conclusion: “driving visual performance is correlated with ocular optical aberrations and patient-felt quality of life in this disease.”

Caveat...

• Central field loss, which reduces visual acuity and possibly contrast sensitivity, can cause a decrease in response time for road hazard detection, most importantly pedestrians (bikers).
• In approximately 65%, scotomas are lateral to the PRL, so scanning is critical to locate environmental obstacles.
• Still want best corrected visual acuity but need to differentiate between detection and identification!

Impact of central vision on driving

Acuity tests do not reflect the visual complexity of driving (there is a weak correlation).
Other (visual) skills may be more important, i.e., familiarity of environment.
Drivers can have good central vision but still be high risk.
Drivers with poor central vision may have voluntarily stopped driving.
Central vision loss creates legal difficulty.

DYNAMIC VISUAL ACUITY (DVA)

• The ability to perceive an object when there is relative motion between the observer and the object and, people with identical static visual acuity may have markedly different DVA.
• DVA is more closely related to accidents than static acuity.
• DVA drops off at an earlier age and more rapidly after 50; probably reflecting fine oculomotor control.

Saccades and pursuits

• There is no age-related loss of ability to maintain accurate fixation when viewing a small, stationary stimulus. However, there are age-related inaccuracies for more eccentric locations. Fixation accuracy for pursuit eye movements for older observers breaks down when target velocity > 10 degrees/second. This is exacerbated when competing/distracting stimuli are present.
Saccades have reduced peak velocity and increased onset latencies with age.
(Spencer et al, 1986)

Fixation, pursuits, and saccades

• Operator fixates on a target (stationary vs dynamic)
• Influences to modify fixation might be object or activity in peripheral visual field (novel or unpredictable stimuli) which can create random pursuits or saccades
• Goal: learn anticipatory (voluntary) rather than reflex eye movements
• Can be impacted medically...

Near/far activities

Road to dashboard

• Tonic vergence
• Fusional vergence
• Voluntary vergence
• Accommodative vergence
• Proximal vergence
• Tonic accommodation
• Reflex accommodation
• Voluntary accommodation
• Convergence accommodation
• Proximal accommodation
Peripheral vision

- Awareness of environmental obstacles such as pedestrians, vehicles, signs, etc
- Basis for egocentric vs allocentric framework of driving
- Spatial relationships and simultaneous processing
- Movement judgement estimations
- Loss vs neglect

Visual rehabilitation

- Rehabilitating someone with a visual field loss is analogous to teaching someone to safely walk backwards.
- The prime consideration is safety, with the identification and discrimination of targets in the environment not always critical to the primary goal of safely going from point A to point B.

Walking backwards

- Walking backwards requires one initially to have an awareness of one’s own body space, and the physical ability to periodically peer around and look in the direction to which one is intent on going.
- It is interesting to point out that the area behind one (i.e., the non seeing area) is not perceived as black or dark, but rather is simply a space that is not seen all the time.

Peripheral visual field requirements

Peripheral VF requirements for licensing are specified in 36 states, ranging from a horizontal monocular/binocular VF of 20°–150° some specific to nasal, temporal and/or vertical dimension
Some states only for commercial drivers

Peripheral vision

Crash rates were twice as high among those with binocular field loss than without.


A question that arises is the impact of sudden field restriction (stroke) vs. change over time (POAG).

Cultural vs. survival vision

Glaucoma

Those with glaucoma report more difficulty with driving than those free of the disease.

Glaucoma impacts contrast sensitivity as well. Motorists with glaucoma were 3.6 times more likely to be involved in crashes than those with normal vision.

(Owsley, et al., 1998)
Hemianopia

- “The number of disabled stroke survivors in the U.S. is estimated to be more than 3 million annually.
- As many as one third of stroke survivors in rehabilitation have either homonymous hemianopia or hemi neglect.
- Can be complicated with midline shift.

Peli E, Field Expansion for Homonymous Hemianopia by Optically Induced Peripheral Exotropia, Optometry and Vision Science, Vol. 77, No. 9, September 2000

Impact of a hemianopic visual field loss on driving

- A driver could have difficulty reacting to bikes, other vehicles, pedestrians, steering in a straight line, and incorrect lane positioning.
- Add post TBI symptoms to visual field loss: difficulty maintaining a constant position in a lane.


Training with optics for sector prism

1. Sit and view into the prism every 8-10 seconds.
2. Reach for a close target to get an appreciation for the displacement.
3. Stand and view into the prism every 8-10 seconds.
4. Walk in a controlled environment, and view into the prism every 8-10 seconds.
5. Walk in an uncontrolled environment, and view into the prism every 8-10 seconds.

Always tell someone what is being seen.


Training with EP prism

- “Stand approximately 20-30 inches in front of the patient. Bring your hand in from the blind side (approximately 15 inches from the patient) either above or below the pupil, wiggle the fingers, until the hand is seen.
- Have the patient turn the eyes or head to look at the fingers through the center of the lens, not looking through the prism.
- Same as above, but have the patient reach out and touch your fingers as soon as they are detected (while looking forward). This will help to understand the displacement of the image.
- Same as above but now walk; it is important not to look through the lower prism when walking (like a bifocal).
- Ultimately, the patient should be able detect objects while simultaneously looking straight ahead.”

Chadwick Optical

Mars Letter Contrast Sensitivity Test

- Set of 3 near charts
- Each letter fades by 0.04 log units
- Norms for different levels of loss
  - Profound (<0.48)
  - Severe (0.52-1.00)
  - Moderate (1.04-1.48)
  - Normal > age 60 (1.52-1.76)
  - Normal < age 60 (1.72-1.92)

1. Contrast sensitivity is more visually representative of the real world than standard visual acuity measurement.
2. However, contrast sensitivity test may not be comparable to real life due to masking of the target by background elements! Contrast sensitivity issues based on person’s ability and environment.

Cataracts and glare

“The Impact of Cataracts on Mobility project demonstrated drivers with cataracts are 2.5 times more likely to be involved in motor vehicle accidents than age-matched drivers without cataracts.”

“one of the most common complaints from patients with cataracts is that glare impairs their night driving.”

Cataracts and driving

- Those with cataracts experience a reduction in driving and an increase in accidents compared to those without cataracts (due to contrast impairment).
- Those who underwent cataract surgery and IOL implant had half the crash rate of those who did not, in the follow up period. (4-6 years)

(Owsley et al, JAMA, 2002)

Driving Simulation

- Combines memory, attention (with and without distracters) and perception
- Dynamic (integration of time/space)
- Links impairments in cognitive function to behavioral output (performance)
- Can be used as both a test and a treatment
- However if not driving simulation, then simulate some of the components of driving

Visual processing skills when driving

1) Detect the information
2) Localize the information
3) Decide what to do with the information
4) Make a motor response

Simultaneous visual processing when driving

- Relevant vs irrelevant information
- Selective attention
- Visual scanning
- Information processing


Reaction time

"Automatic processes occur without awareness of intent and they can be carried out concurrently with other processes without compromising performance," as with experienced (middle aged) drivers.

"Controlled processes occur with awareness, and are deliberate and goal oriented. These processes are effortful and slow and it is difficult to carry out several controlled processes at once," as with the novice and the elderly drivers.

Lowe TD, Tornatore R, Newell G. The effects of visibility conditions, traffic density, and navigational challenge on speed compensation and driving performance in older adults. Accident Analysis and Prevention, 2011

Modifiers

- As we age it takes more time to visually process between 2 or more visual events under increasingly more complex task demands
- Must react to and integrate visual information (scene sampling, peripheral vision, cluttered scenes, environmental challenges, etc.)
Useful field of view
sight/processing/cognition
UFOV-an area from which one can extract visual information in a single glance without eye or head movement, measured binocularly, and involves detection, localization, and identification of targets against complex background
Speed of processing under increasingly complex visual scenes
Higher order processing skills such as rapid visual processing, selective, and divided attention

www.visualawareness.com drroenker@visualawareness.com,
Roenker DL, Cissell GM, Ball DT, Wadley VG, Edwards JD. Speed of processing and driving simulator training result in improved driving performance. Human Factors 2003

Decreased UFOV
Older drivers have a narrower UFOV, therefore their attention to elements in driving is more restricted:
“Over the past 9 years, relative involvement of older drivers in pedestrian hits was higher than their relative involvement in crashes in general.”

Conclusion: older drivers experience difficulty in identifying pedestrians outside their UFOV which can lead to crashes

Navigating while driving
Following a route (egocentric) vs way finding (allocentric)
Allocentric
– Can “compromise driving performance”
– Taxes memory and divides attention
– Hampers abilities to:
  • remember directions
  • respond to given direction (i.e., turn right)
  • locate landmarks (i.e., the blue house, 3rd stop sign)

Lana TM, Toxopeus R, Wilson D. The effects of visibility conditions, traffic density, and navigational challenge on speed compensation and driving performance in older adults, Accident Analysis and Prevention,42,2010

Figure ground
“Clutter increases demands on selective attention: the ability to select relevant items from irrelevant ones in the visual scene.”¹
“selective attention may be differentially more effective in predicting driving difficulties in situations of divided attention which are commonly associated with crashes.”²

1. Lana TM, Toxopeus R, Wilson D. The effects of visibility conditions, traffic density, and navigational challenge on speed compensation and driving performance in older adults, Accident Analysis and Prevention,42,2010
2. Wood JM, Chaparro A, Lacherez P, Hickson L. Useful field of view predicts driving in the presence of distracters, OVS; 89,(4), 2012: 373–381

Recommendations
Comprehensive eye examination
• Functional assessment of contrast sensitivity function
• Functional assessment of glare recovery time
• Assessment of information processing
• Assessment of out of instrument reaction time with eye hand, eye foot, scanning, etc.
• Assessment of spatial/temporal awareness, i.e., where targets are, how long will it take to time a target’s proximity
  Address with vision therapy and “brain games”
  Behind the wheel driving instruction

“Cognitive training can be effective in improving various aspects of objective cognitive functioning: memory performance, executive functioning, processing speed, attention, fluid intelligence, and subjective cognitive performance.”

Correlate vision and cognitive deficits with the following

- Driving exposure: how often does someone drive?
- Previous crashes, including:
  - Where were the accidents, i.e., city, country, intersections, etc.?
  - Traffic conditions: i.e., heavy, light
  - What time of day were the accidents, AM, PM, at dawn or dusk, etc.?
  - What were weather conditions like, i.e., rainy, snowy, foggy, etc.?
  - Type of roadway, i.e., paved, stone, etc.?
  - Visual acuities or visual fields?
  - Were drugs or alcohol involved in these accidents?
  - Were other medical conditions factors, i.e., diabetes, seizures, etc.?
  - Age groups, i.e., 65-70, 70-80, 80+?
  - How far from the person's home were these accidents?
- Other??

And the future... the driverless car

- Who will program the car?
- Who will be responsible for accidents: computer programmer, auto manufacturer, over ride based on human decision?
- Complacency of passenger, i.e., like cruise control
- Who gets the license (like telemedicine or drone control)?