AUTONOMOUS VEHICLE INTERFACE DESIGN FOR MILD VISUAL IMPAIRMENT

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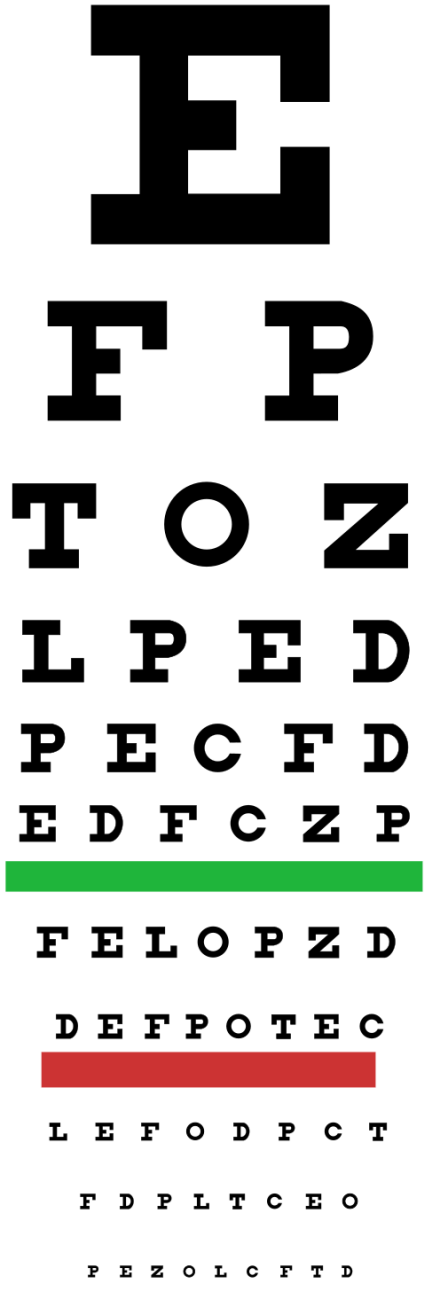
DISCLOSURES

The authors have no financial conflicts of interest to disclose

OVERVIEW

- Visual acuity and requirements for driving
- Promise of autonomous driving in the setting of visual impairment
- Current status of user interfaces in autonomous vehicles
- Recommendations



1	20/200
2	20/100
3	20/70
4	20/50
5	20/40
6	20/30
7	20/25
8	20/20
9	
10	
11	

What most people see at 70 feet, you need to stand 20 feet away to see

What most people see at 20 feet, you can see at 20 feet

WHO categories of visual acuity

WHO category	Presenting distance visual acuity worse than	equal to or better than
0 Mild or no visual impairment		6/18 3/10 (0.3) 20/70
1 Moderate visual impairment	6/18 3/10 (0.3) 20/70	6/60 1/10 (0.1) 20/200
2 Severe visual impairment	6/60 1/10 (0.1) 20/200	3/60 1/20 (0.05) 20/400
3 Blindness	3/60 1/20 (0.05) 20/400 1/60*	1/60* 1/50 (0.02) 5/300 (20/1200)
4 Blindness	1/50 (0.02) 5/300 (20/1200) No light perception Undetermined or unspecified	light perception

* or counts fingers (CF) at 1 metre

VISUAL ACUITY REQUIREMENTS IN THE STATE OF MARYLAND

Unrestricted driver's license:

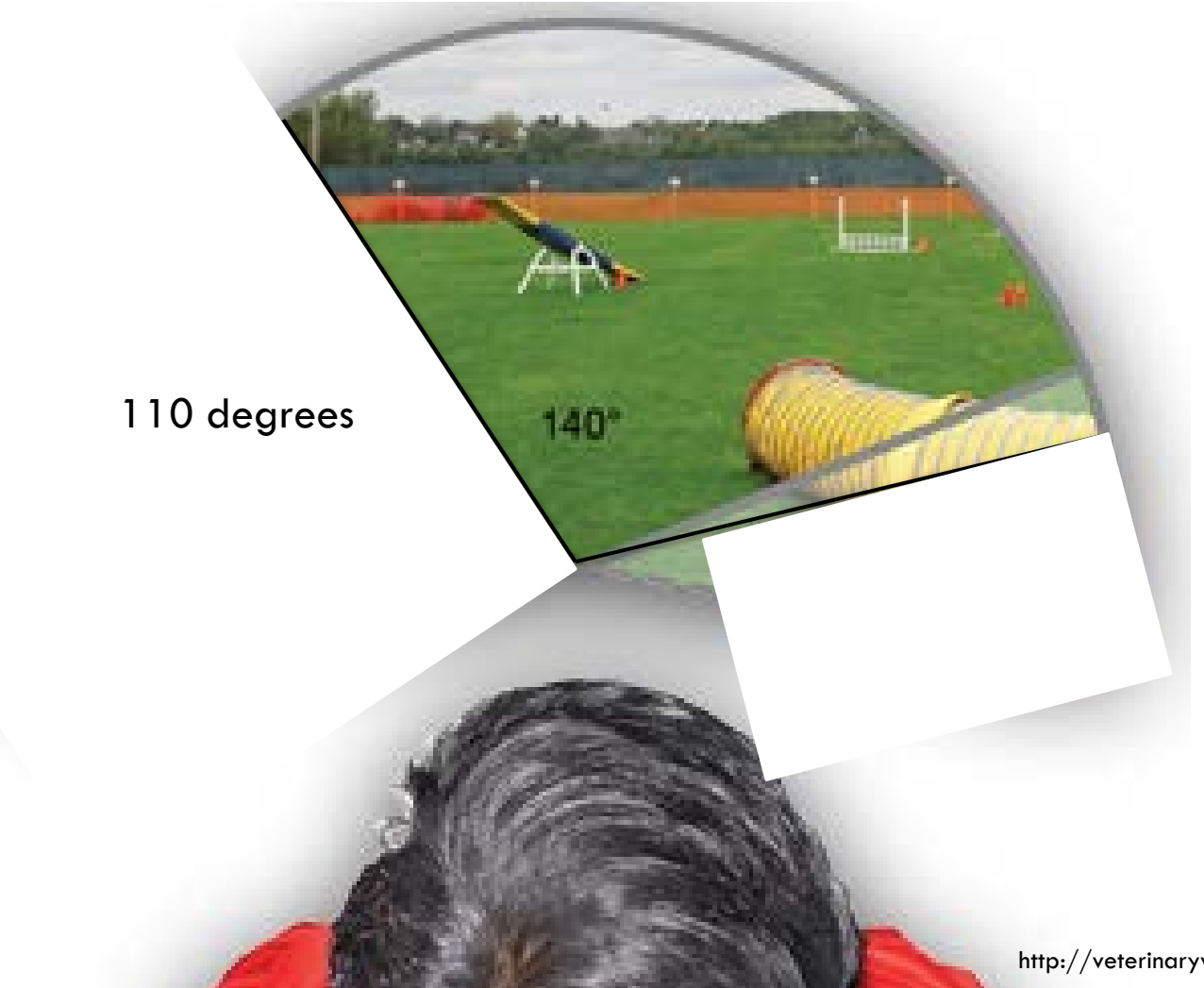
- Binocular vision
- Visual acuity (Snellen) of at least 20/40 in each eye
- A continuous field of vision of at least 140 degrees

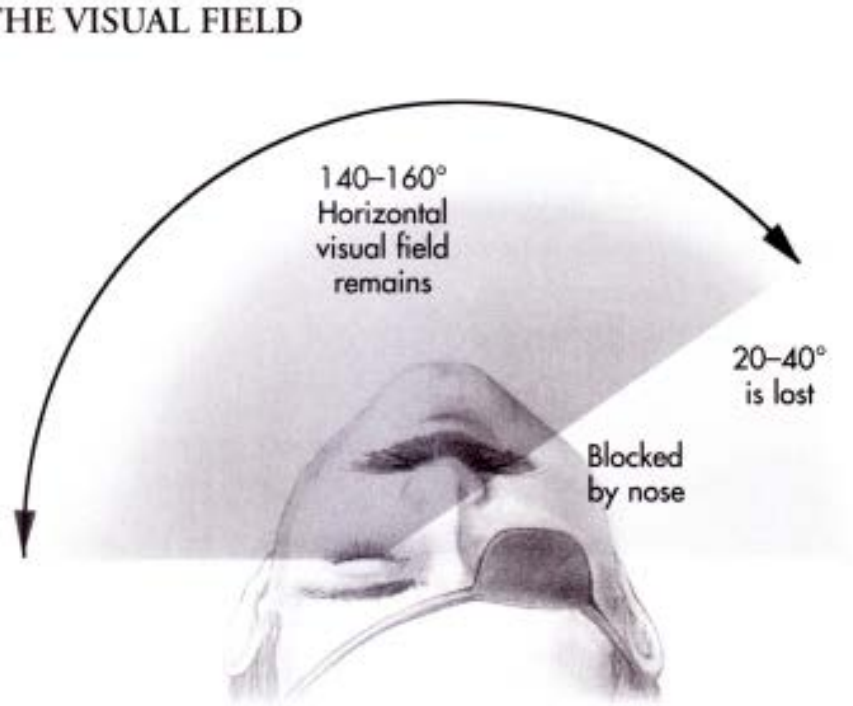
Restricted license:

- Visual acuity of at least 20/70 in one or both eyes
- A continuous field of vision of at least 110 degrees, with at least 35 degrees lateral to the midline of each side
- (Requirements must be simultaneous.)

VISUAL FIELDS

110 degrees





http://veterinaryvision.com/wp-content/uploads/2012/06/vision1.jpg

https://eyeternus.wordpress.com/tag/visual-field/


2016/04/05 11:59:06

110 degrees

A Prospective, Population-Based Study of the Role of Visual Impairment in Motor Vehicle Crashes among Older Drivers: The SEE Study

Gary S. Rubin,[1] Edmond S. W. Ng,[2] Karen Bandeen-Roche,[3] Penelope M. Keyl,[4] Ellen E. Freeman,[5] Sheila K. West,[5] and the SEE Project Team[6]

1801 drivers age 65 to 84

120 (6.7%) involved in crash during 2-4 year observation interval

Glare sensitivity and visual field loss were significant predictors of crash involvement

Investigative Ophthalmology & Visual Science, April 2007, Vol. 48, No. 4


MAX
18
18
mph
150
Orleans St
E Monument St
Bond St
N Carolin
McElderry St
0.1 mi
42 mi
46°F
ROSENBAUM POCKET VISION SCREENER
TESTING DISTANCE
95
874
2843


0
Zwieback St
N Broadway
N Washington St
N Wolfe St
400 ft
44 mi
40° F
ROSENBAUM POCKET VISION SCREENER


$0
ae7p
140
120
100
80
60
40
20
320
160
80
40
20
kW
15
30
60
0
mph
32,927
mi
12
3
6
9
R N D


ae7p
140
120
100
80
60
40
20
320
0
mph
mi
191 mi
54° F
12
ROSENBAUM POCKET VISION SCREENER
distance equivalent
Jaeger
Point

IMAGE ANALYSIS

Each image was graded by 3 separate graders

Size of characters measured by pixels using GIMP 2.0 software

Measurements averaged across graders and extrapolated to nearest levels of visual acuity


WELLS FARGO

Minimum Visual Acuity Required (Snellen) to visualize indicator: 2013 Model S

Dash Object	@ 14 in	@28 in	@36 in	@42 in
Current Speed (mph/kph)	20/400	20/200	20/175	20/150
“MPH/KPH”	20/60	20/40	20/25	20/20
Power (kW - the number)	20/70	20/40	20/30	20/25
Odometer:	20/80	20/50	20/40	20/40
Drive mode (P, R, N, D)	20/80	20/50	20/40	20/40
Time (2:38pm)	20/80	20/50	20/40	20/40
Temperature	20/80	20/50	20/40	20/40
Range	20/80	20/50	20/40	20/40
Battery length	20/400	20/200	20/175	20/150
Battery width	20/80	20/50	20/40	20/40

Minimum Visual Acuity Required (Snellen) to visualize indicator: 2017 Model X

Dash Object	@ 14 in	@28 in	@36 in	@42 in
Current Speed (mph/kph)	20/400	20/200	20/175	20/150
“MPH/KPH”	20/70	20/40	20/30	20/25
Max speed	20/100	20/50	20/40	20/40
“Max”	20/40	20/20	20/15	20/15
Steering wheel icon	20/400	20/200	20/150	20/150
Temperature	20/70	20/40	20/30	20/25
Range	20/70	20/40	20/30	20/25
Next street on gps	20/70	20/40	20/30	20/25
Distance to next street on GPS	20/63	20/30	20/25	20/20
Street names on GPS	20/63	20/30	20/25	20/20
Lane line width	20/30	20/15	20/13	20/10

Usability of Car Dashboard Displays for Elder Drivers

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ABSTRACT

The elder population is rising worldwide; in the US, no longer being able to drive is a significant marker of loss of independence. One of the approaches to helping elders drive more safely is to investigate the use of automotive user interface technology, and specifically, to explore the instrument panel (IP) display design to help attract and manage attention and make information easier to interpret.

In this paper, we explore the premise that dashboard displays can be better designed to support elder drivers, their information needs, and their cognitive capabilities. We conducted a study to understand which display design

activities increase with age [4, 3, 10, 27]. At this point, elders relinquish all independence, and must rely on public transportation, formalized care, or a family member to leave one's primary home [22]. To fight against the inevitable loss of independence, elders often keep driving long after it is safe for them to do so. Impairments such as decay in vision, hearing, and general mobility issues which restrict range of motion and fine motor skills work to collectively reduce the performance of elderly drivers [32, 14, 25]. In particular, elders face a decline in the ability to perform secondary tasks while driving, which require attention switching between the primary task of driving and the

Figure 1: Six dashboard designs used for the study.

DESIGN ELEMENTS FOR ELDERLY DRIVERS

Elderly had better driving performance in high contrast of size and no color

Color reduced legibility

Addition of color and low contrast of size resulted in significantly longer gaze dwell-on time (2.65 seconds longer in a driving task)

With autonomous driving, is gaze dwelling less of an issue?


MAX
18
18
mph
150
Orleans St
E Monument St
Bond St
N Carolin
McElderry St
0.1 mi
42 mi
46°F
ROSENBAUM POCKET VISION SCREENER
TESTING DISTANCE
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874
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CONCLUSIONS

For individuals with mild visual impairment who are able to legally drive, autonomous vehicles offer the potential for increased safety

User interfaces must be optimized to allow this segment of drivers to maximally benefit from the opportunities afforded by autonomous driving

Recommendation: “Accessibility mode”?

- How interfaces are utilized by elderly in autonomous vehicles may vary, but can be edited with updates

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