Driving fitness in the elderly – validation of visual and driving-aptitude tests

Grundler, W.[1,2], Bao, Y.[1,3,4], Pöppel, E.[1,3], Strasburger, H.[1,3]

[1] Generation Research Program, Ludwig-Maximilians University Munich, Prof.-Max-Lange-Platz 11, Bad Tölz, Germany
[2] Volkswagen AG, Group Research K-EFFB/E, Wolfsburg, Germany
[3] Inst. of Med. Psychology, Goethestr. 31, München, Germany
[4] Department of Psychology and Key Laboratory of Machine Perception, Peking University, Beijing, China

Introduction

- By 2050, the number of people in the EU aged 65 and above will have increased by 70%, and over 80 by 170%.[1]
- Mobility is key in facing challenges of demographic change, for independent living, and for promoting health and quality of life.
- Safe driving requires visual and cognitive abilities. The present study aims at a validation of apparatus and methods of testing vision and cognitive aptitude, with driving competence as the criterion of validity.

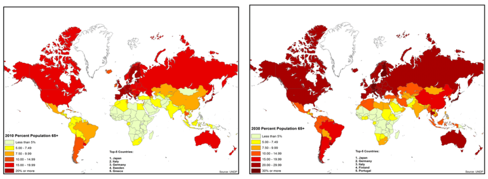

Figure 1. Old age dependency ratios, 2010 (left) und 2030 (right)[2]

Methods

From May 2004 to February 2005, cognitive, visual and road driving tests were conducted in elderly drivers in Bad Tölz (Germany). Driving-specific abilities were tested by a standardized test battery ("Standard Plus") in the "Expert System Traffic" (Schuhfried, Austria). Visual diagnostics included visual acuity, visual field, and contrast sensitivity. Results of psychological and visual tests were used as statistical predictors of variance in subjects' driving performance.

Psychological Testing

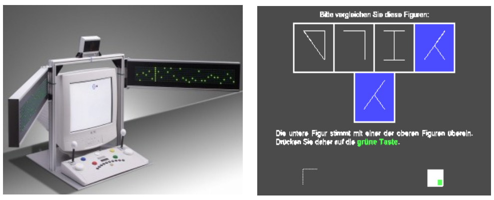

Figure 2. Psychological testing on the Vienna Test System (VTS, Schuhfried, Austria):
"Peripheral Perception (PP)": dynamic visual field and selective divided attention (left), and selective focused attention (right).

Visual Diagnostics

Figure 3. Manual kinetic perimetry on an Octopus 101 (left), recognition contrast sensitivity on an standard PC (R_Contrast, right).

Figure 4. Visual acuity measured on an Oculus Binoptometer.

On-Road Driving Test

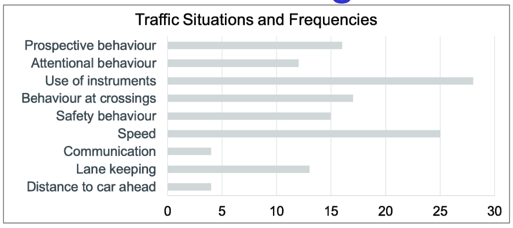

Figure 5. The road driving test lasted ~45 minutes and comprised 134 defined situations that were rated by both an expert and a trained rater. Inter-rater reliability ρ=0.59–0.79 (Spearman). Global driving performance rated on a six-point scale, with "1" denoting the best score.

Subject Sample

- Sample of 92 drivers (60 m, 32 f). Mean age 68.5 y (range 60–91 y; median 67 y; SD 6.6 y).
- Participants were volunteers with valid driving license; normal visual fields only.

Results

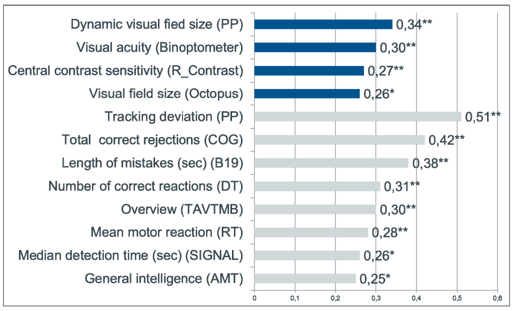

Figure 6. Visual and cognitive performance indicators correlated significantly with driving competence (Pearson, **p=0.01, *p=0.05).

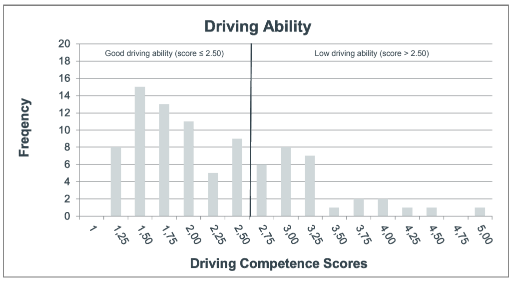

Figure 7. Driving ability was derived from driving competence by a sample split at score 2.5. Ranges below 2.5 were interpreted as good driving ability. 25 drivers failed the hypothetical license test.

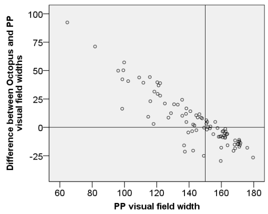

Figure 8. The two measures of visual-field width compared. Horizontal and vertical lines indicate equality. Field widths measured on the Octopus 101 and the on the VTS differ widely, the Octopus measures being higher. Correlations between measures are low (r=0.285, p=0.007, n=87).

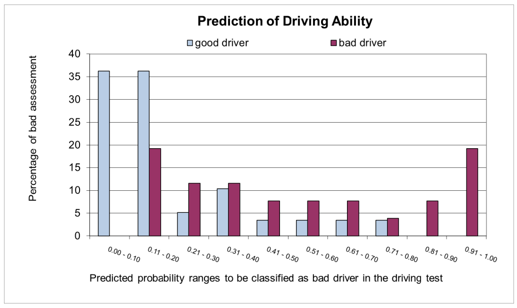

Figure 9. Prediction of driving ability.
- The set of significant predictors was reduced by stepwise regression with backward elimination.
- Binary logistic regressions were used for further analysis.
- Logistic regression allows deriving probabilities for driving ability. The model resulted in a classification rate of 77%.

		Predicted Driving Ability		
		Good dr. (score ≤ 2.5)	Bad dr. (score > 2.5)	percentage of correct classifications
Driving ability	Good drivers (score ≤ 2.5)	53	6	89.8
	Bad drivers (score > 2.5)	13	12	48.0
Total percentage				77.4

Figure 10. Classification rates for driving ability.
- While specificity (identifying persons with good driving ability) is good (90%), sensitivity (identifying low driving ability) is low (48%).
- 13 out of 25 persons with low driving ability were classified incorrectly.

	regression coefficients	Wald	df	Sig.
Focused attention (COG)	–.177	4.553	1	.033
Divided attention (PP)	.278	7.618	1	.006
Recognition time (SIGNAL)	.755	.269	1	.604
Dynamic visual field (PP)	.007	.254	1	.614
Visual acuity (Visus)	–.317	1.591	1	.207
Central recognition contrast sensitivity (R_Contrast)	.360	.726	1	.394

Figure 11. Performance indicators for selective and divided attention were the only significant parameters of the test battery.

Conclusion

- Visual performance indicators have only limited predictive power for driving aptitude (20% explained variance, EV); 80% are person-specific.
- Psychometric tests are more important (35% EV).
- Best singular predictors were lane tracking (26% EV), Schuhfried's dynamical peripheral vision PP (12% EV).
- The label "visual field" for PP on the VTS is mis-leading.
- Acuity (9%) and perimetry (7%) are of little importance.

References — [1]www.move-age.eu; [2]Old age dependency ratio is the ratio of the number of people older than 64 to the working-age population (ages 15–64). Graphs from www.newgeography.com.