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Age is Just a Number?
Modern Cognitive Function Tests
Individual Assessment of Driver Fitness and Behavioural Change

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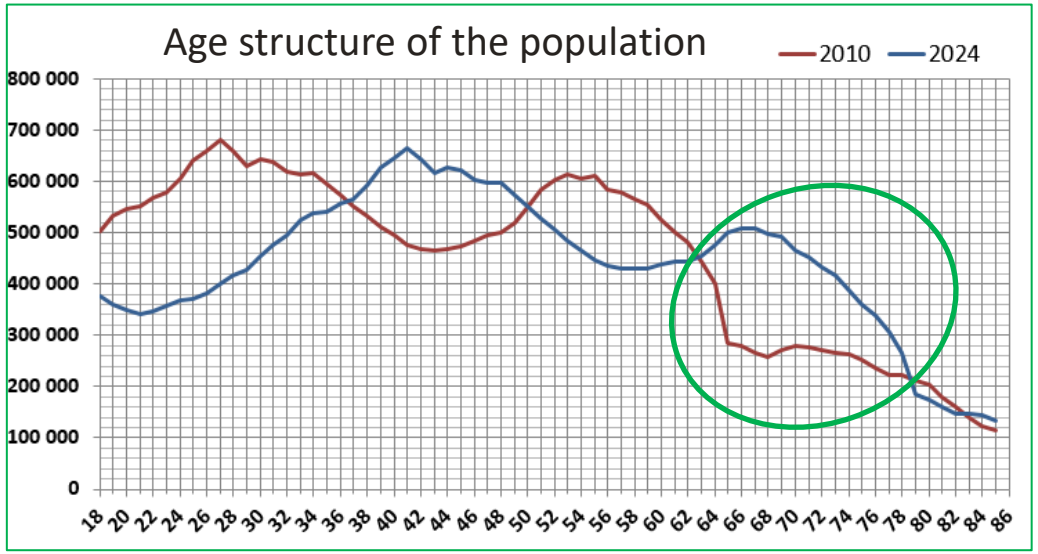
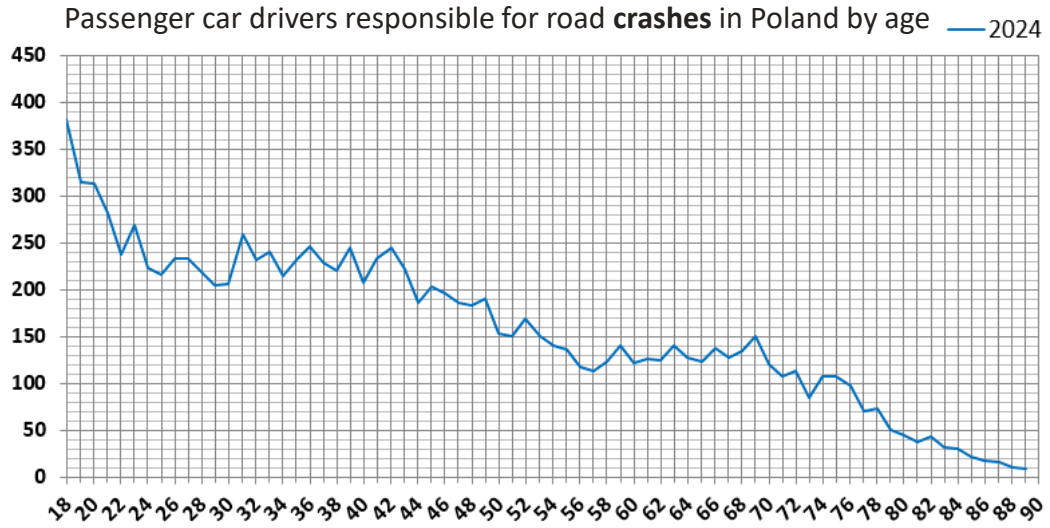
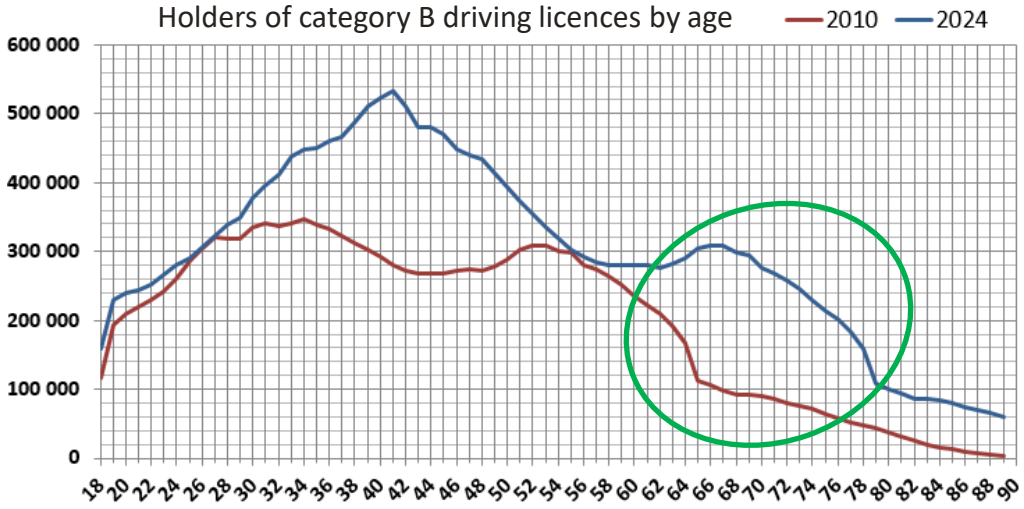
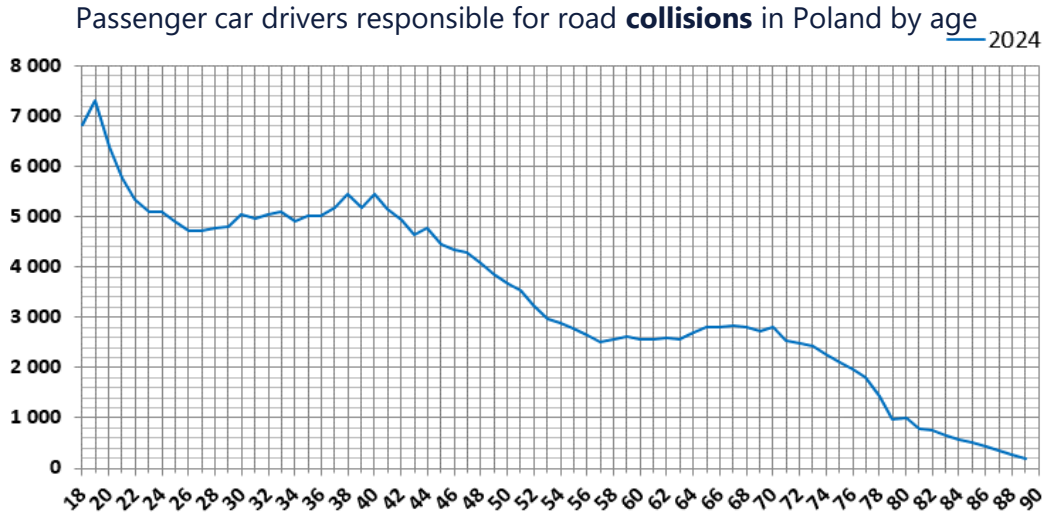
Age and crash-risk indicators

Statistical data – Poland









Age and Crash Risk

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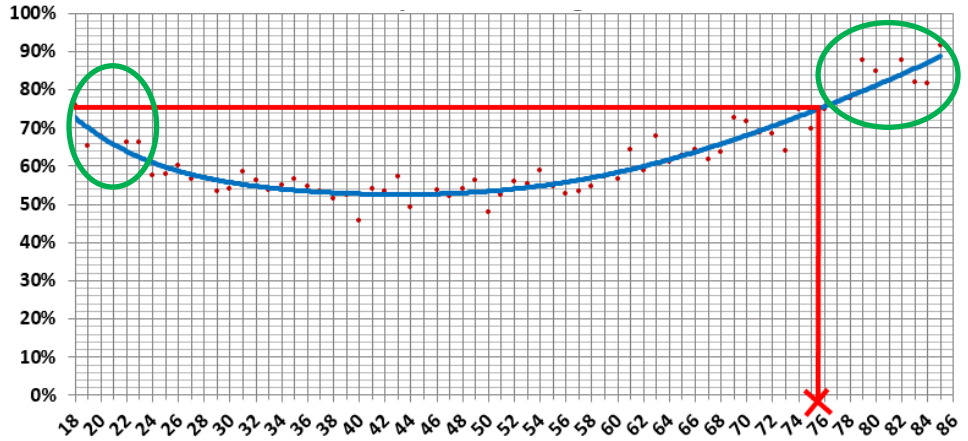
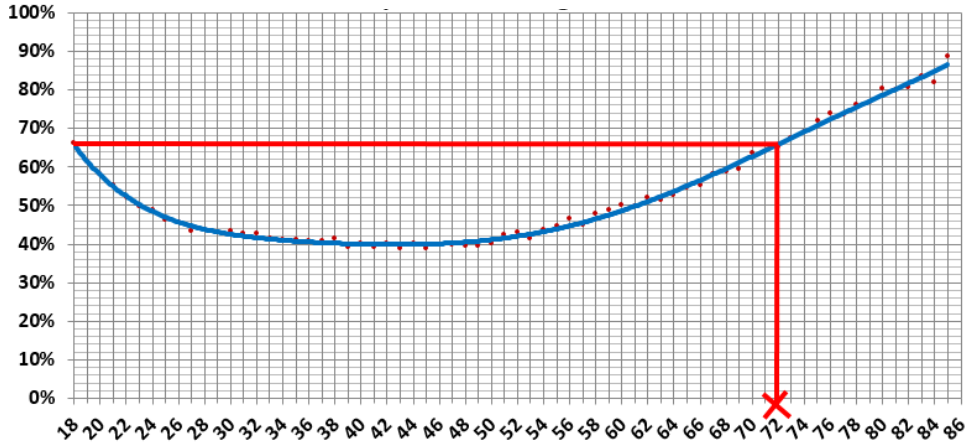
Crash risk index for passenger car drivers by age · 2024

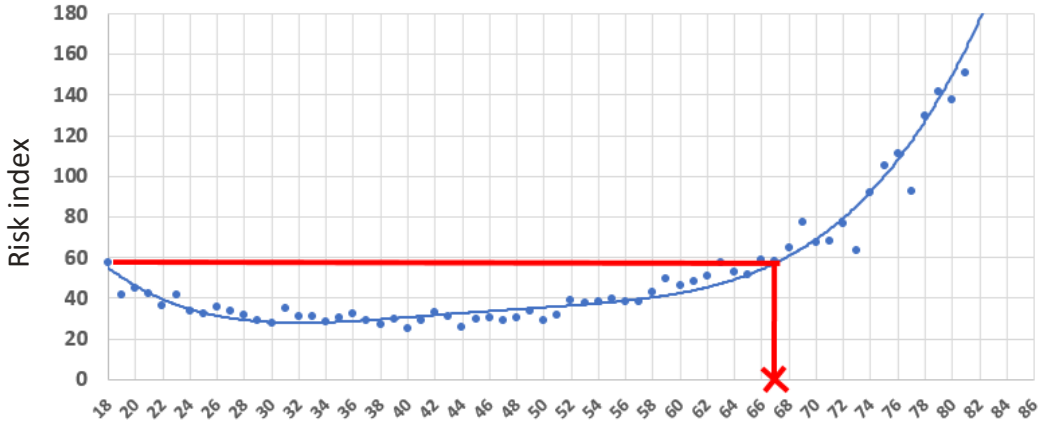


Collision risk index for passenger car drivers by age · 2024



$$\text{crash/collision risk index} = \frac{\text{Number of passenger-car drivers responsible for road accidents or collisions (by age)}}{\text{Number of passonger-car drivers involved in road accidents or collisions (by age)}} \times 100\%$$

Age-specific crash risk per billion kilometres



$$\textbf{Risk index} = \frac{\text{Drivers responsible for road crashes (by age)}}{\text{Annual kllometres driven (in Billion km)}}$$

Passenger car drivers exceed the crash risk of the youngest drivers only after:

- 76 years — based on crash involvement
- 72 years — based on collision involvement
- 67–74 years — based on kilometres driven

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Psychological fitness

Individual Assessment of Driver Fitness and Behavioural Change

Lifelong changes in psychological fitness

Psychometric perspective

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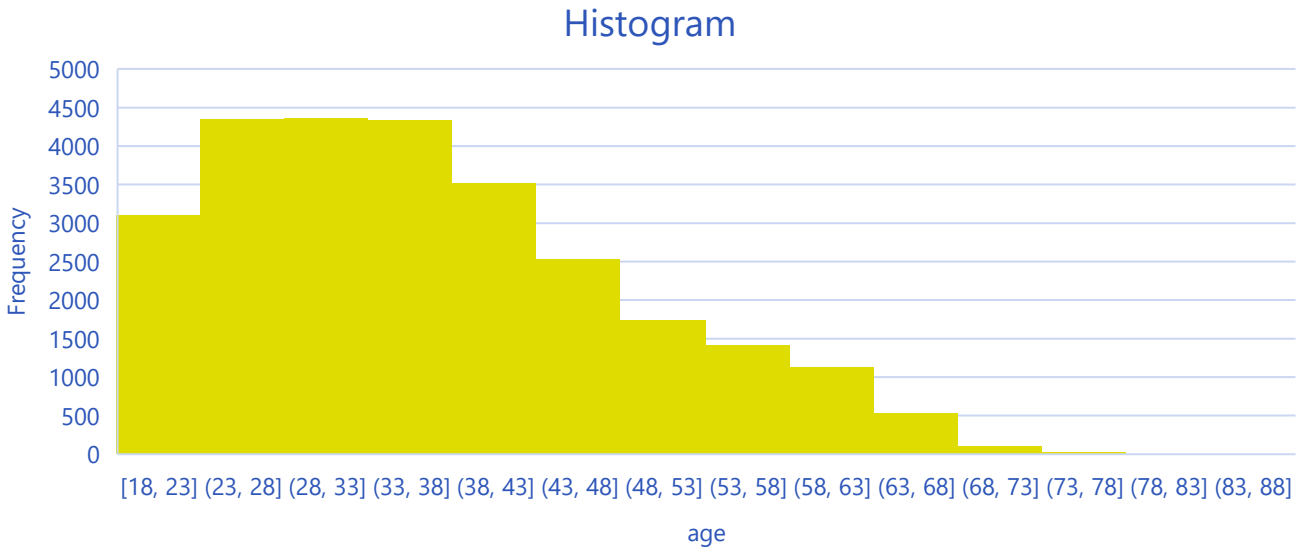
Method

- Test2Drive is a battery of psychometric tests, used in obligatory professional drivers testing in Poland.
- System is implemented in 250 psychological laboratories.
- Test2Drive includes 10 tests
  - Psychomotor performance: Simple and Choice Reaction Time, Coordination, 2D coordination
  - Cognitive performance: Visual attention, Traffic Reasoning, Anticipation
  - Personality: Emotional lability, Personality Maladjustment, Stress Coping

The database

- A data from 26 855 professional and fleet drivers were included in study.
- The data were collected for diagnostic, not scientific purposes- some records were incomplete and excluded pairwise.
- 94% men, 6% women.



Age

		Frequency	% valid
Valid	20-29	8042	29,9
	30-39	8574	31,9
	40-49	5664	21,1
	50-59	3026	11,3
	60-69	1455	5,4
	70-79	94	,4
	Total valid	26855	100,0
Missing	<20	271	
	80+	4	
	System missing	25	
	Total missing	300	
Total		27155	

Lifelong changes in psychomotor performance

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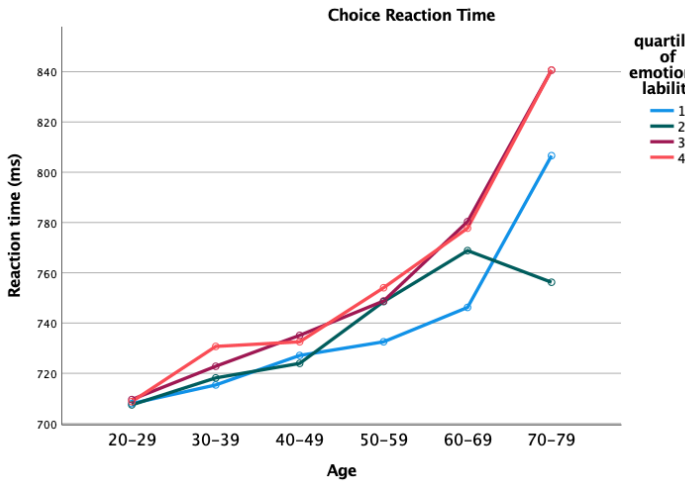
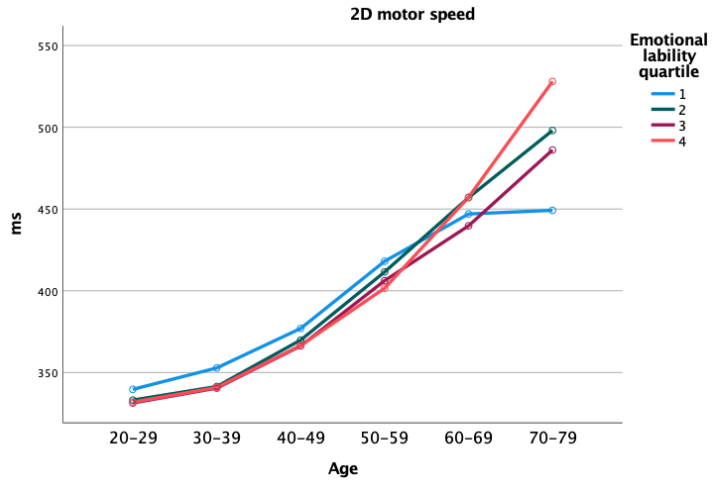
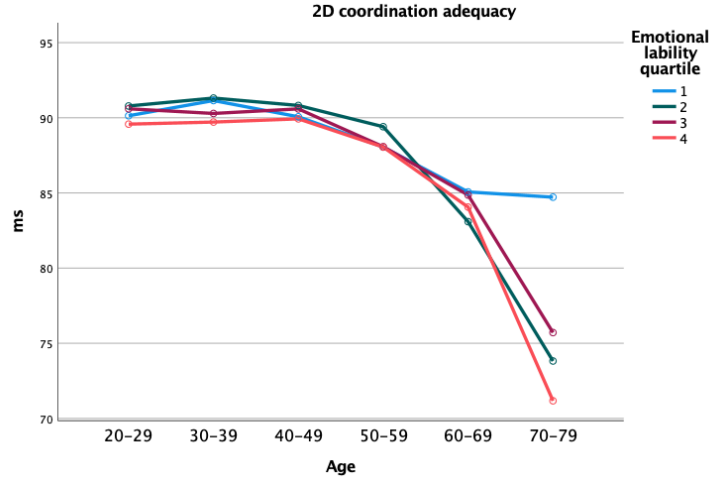






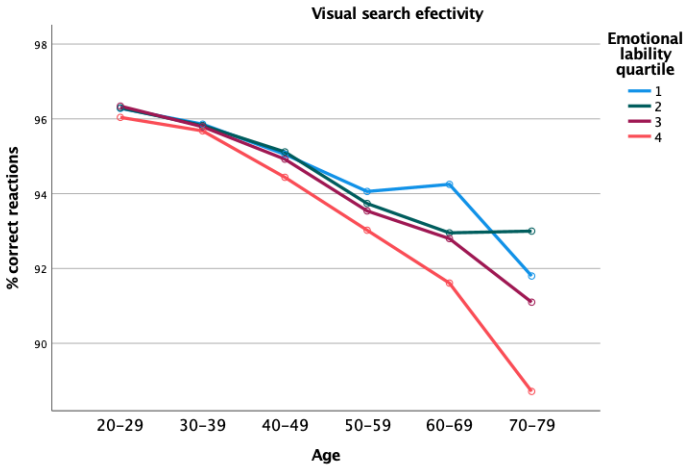
		Age		Interaction	
Variable	N	Eta-square	significance	Eta-square	significance
Choice reaction time	18305	.035	<.001	.003	<.001
2D Motor speed	19779	.084	<.001	.001	ns
2D Coordination Adequacy	19773	.013	<.001	.001	ns

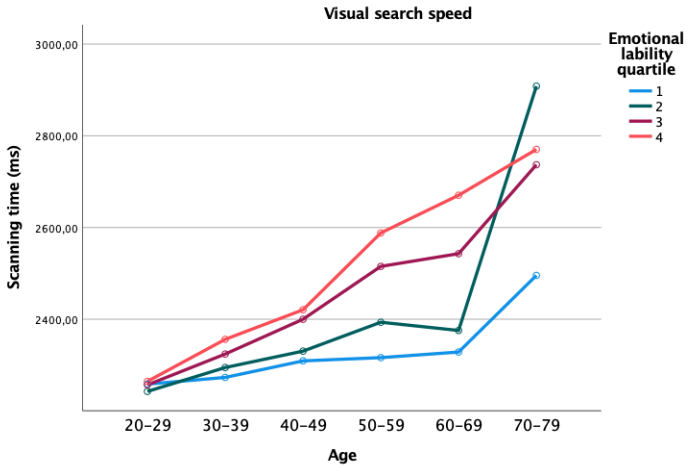
Emotional stability is an important moderator of age effect on psychomotor and cognitive performance.

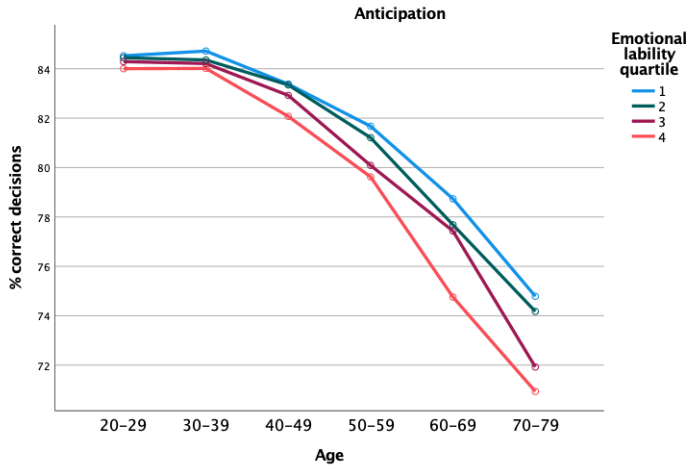
In **Choice reaction time** age effect is much **stronger in emotional-stable group**.

Age effect on coordination is independent from emotional stability.

Lifelong changes in cognitive performance



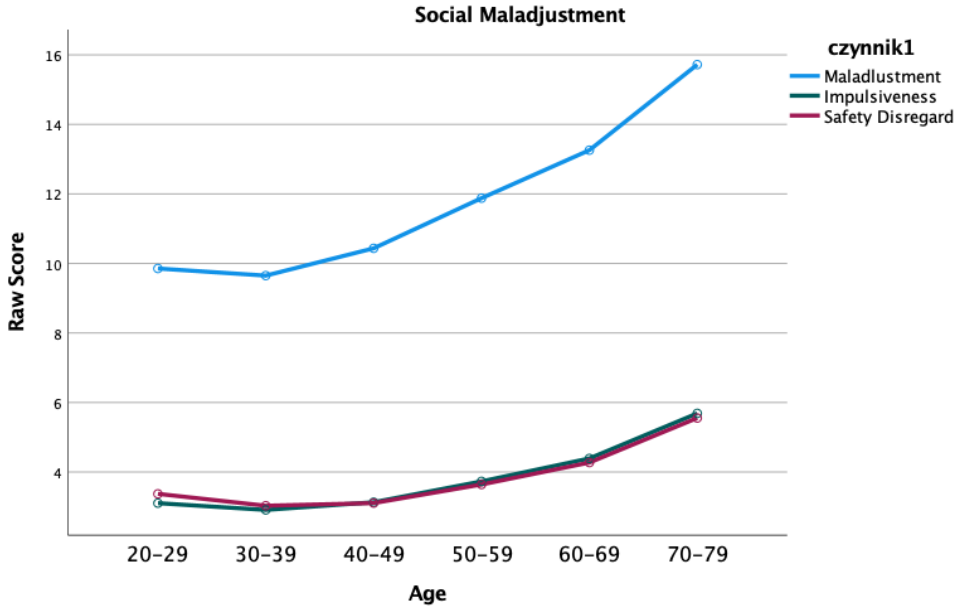


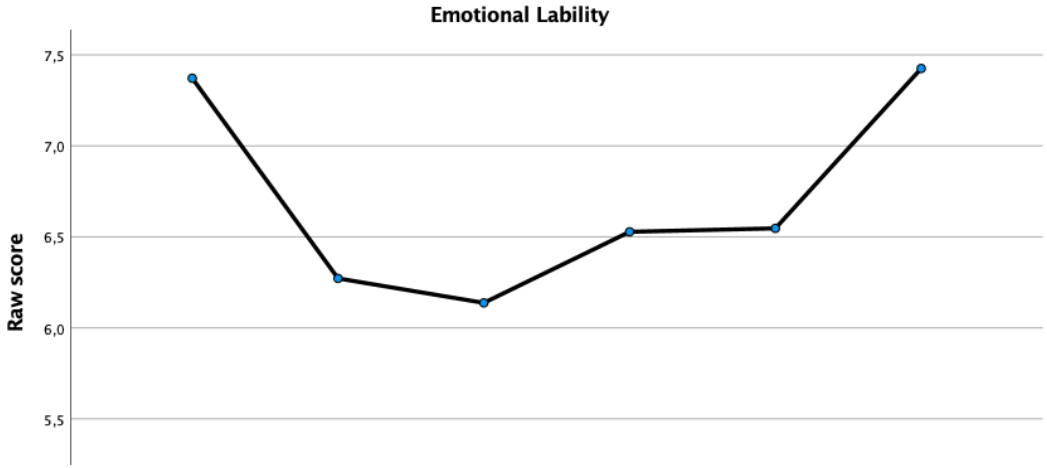


Visual search is worsening with age; effect is stronger in emotionally unstable subjects.
Anticipation performance depends on age, but not on emotional stability.

		Age		Interaction	
Variable	N	Eta-square	significance	Eta-square	significance
Visual search effectivity	25447	.035	<.001	.002	<.001
Visual search speed	25438	.016	<.001	.004	<.001
Anticipation	18293	.037	<.001	.001	ns

Lifelong changes in personality



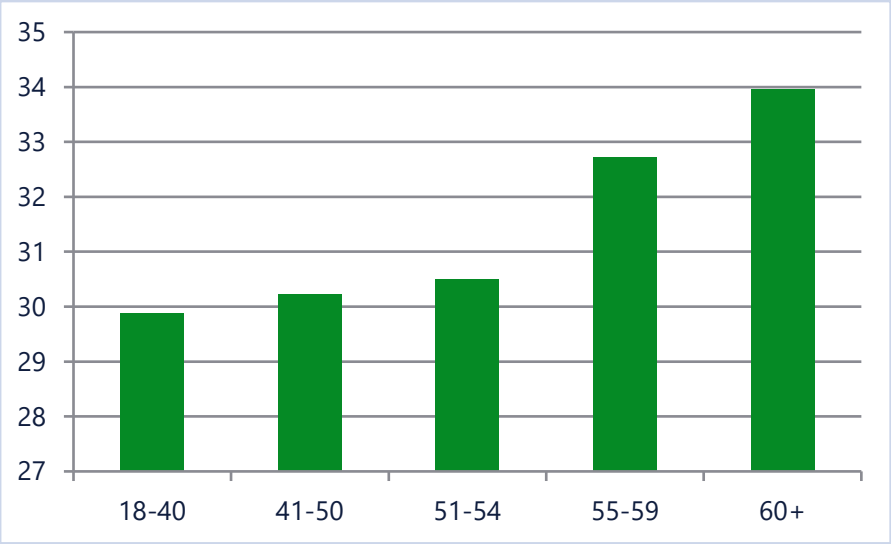


Age effects

Effect of ageing is significant for all variables, but dependencies are not linear.

	Eta-square	Istotność
Maladjustment	.051	<.001
Impulsiveness	.031	<.001
Safety rules disregard	.031	<.001
Emotional Lability	.009	<.001

COGNITIVE FUNCTIONS and AGE

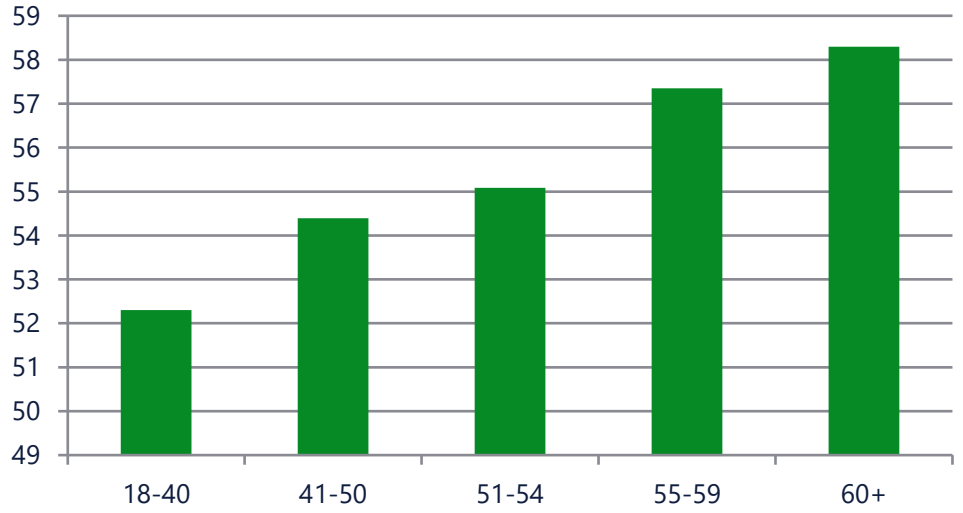


REACTION TIME

The increase in reaction time is greater in women group and in **complex situations**.

DECISION TIME

The **efficiency of braking processes** deteriorates with age, and this leads to **problems with action control**. Coxon, Van Impe, Wenderoth & Swinnen (2012) explain this by the **loss of dopamine rece**ptors.



Immature Cognitive Skills

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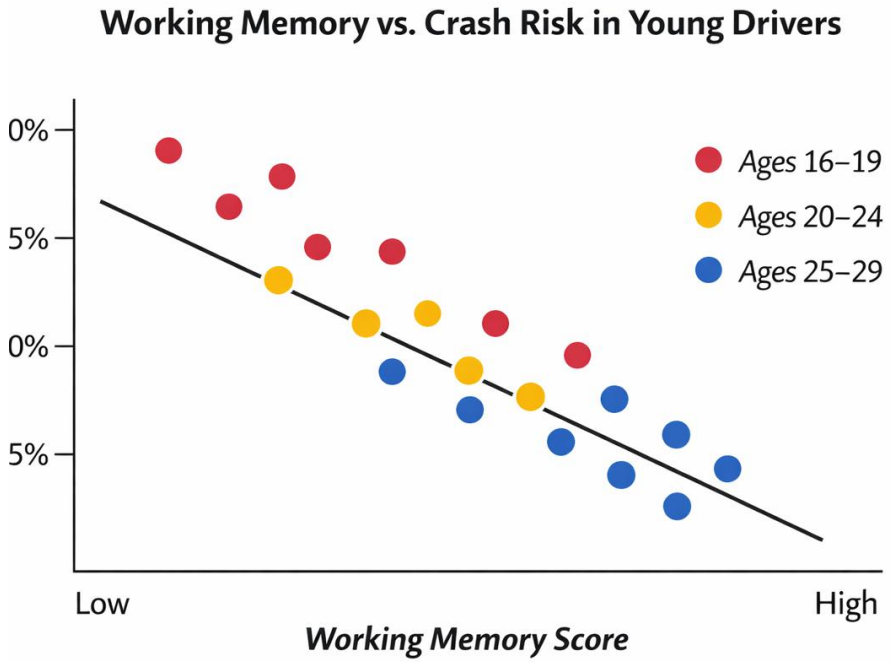
Underdeveloped cognitive functions increase crash risk and unsafe driving behaviours.

- Simulator studies link **weaker executive functions, attention, visuospatial skills, and psychomotor speed** to more speeding, lane deviations, and collisions.
- Reviews identify **immature visual scanning, hazard anticipation, and distraction** handling as major contributors to excess crashes among novice drivers.
- **Visual attention deficits**:
  - Incomplete maturation of visual–spatial attention, working memory, and processing speed → slower hazard recognition (Romer et al., 2014).
  - Novice drivers detect hazards less efficiently and underestimate risk (Deery 1999).
- **Attention failures and distraction**:
  - Real-world data show visual inattention (cell phone use, reaching for objects) raises crash odds × 2.7–6.9 (Gershon et al., 2019).
  - Teens less likely to glance at hidden hazards or disengage from secondary tasks (Chan et al., 2010).

Working Memory and Young Drivers



Working memory is a core cognitive safety factor.

Young drivers with weaker or slower-developing WM are significantly more vulnerable to crashes.

- Lower WM and more **texting** while driving **independently** predict higher odds of ≥1 crash in young novice drivers (Walshe et al., 2017; 2017a).
- Higher WM capacity is linked to **better lane keeping, faster reaction times, and fewer tickets** and **accidents** (Zhang et al., 2023).
- In 18–20-year-olds, WM was the **strongest predictor** of crash involvement, even after controlling for age, sex, IQ, and driving experience (Walshe et al., 2017a).
- Slower **developmental growth** of WM during adolescence predicts **higher crash odds** years later, independent of impulsivity or sensation seeking (Walshe et al., 2019).
- Reviews show WM is the most consistently **crash-relevant executive function**: more crashes, citations, inattentive driving, poorer lane keeping, worse hazard detection (Walshe et al., 2017b).

Factors influencing novice driver behaviour

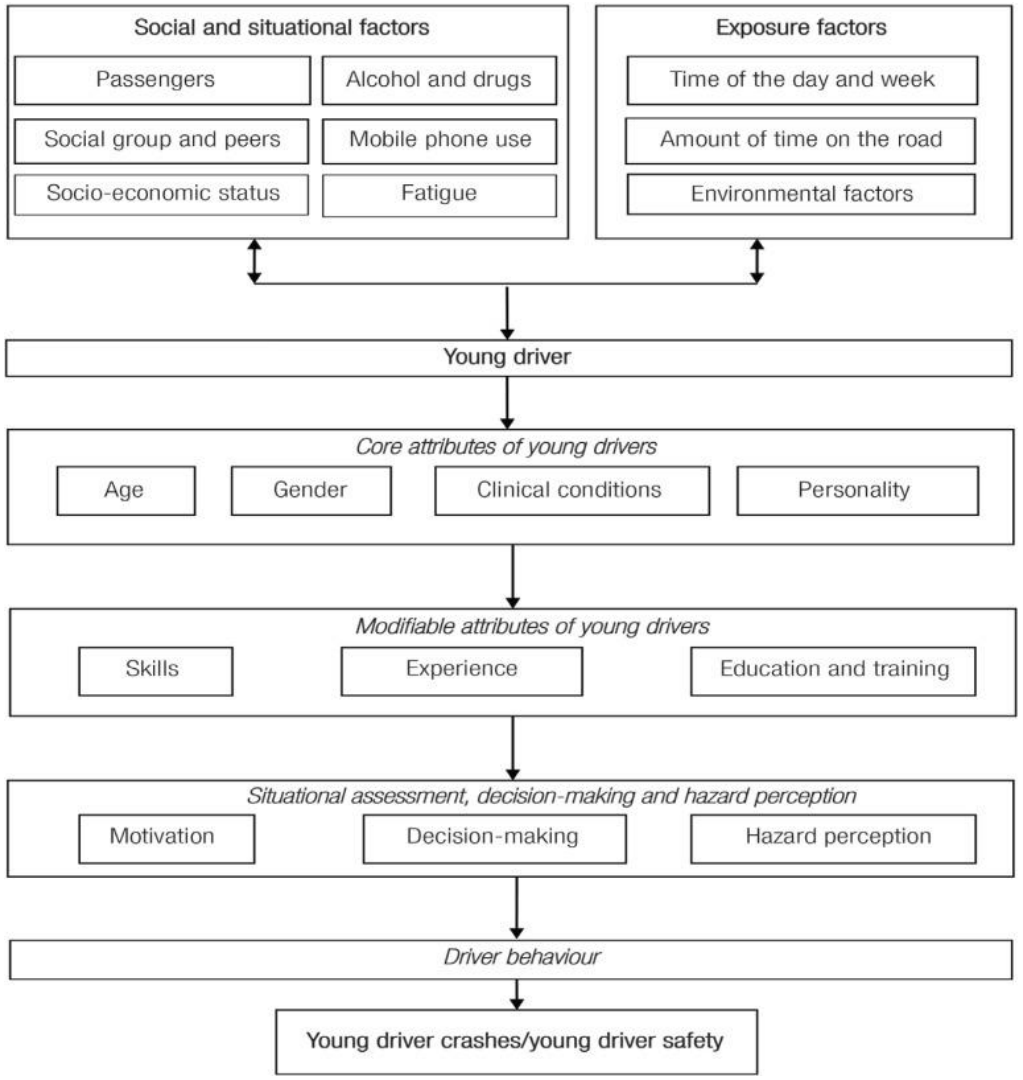


Figure 1: Factors relating to young driver safety, (*Williamson*, 1999)

Cognitive testing for novice drivers is justified by:

- Deficits in hazard perception (attention, prediction, and visual search)
- Limited attentional capacity and processing speed
- Maturing executive control ((inhibitory control, risk assessment)
- Inefficient visual search strategies

Not justified by:

- Personality traits (sensation seeking, aggression, egocentrism)
- Social or behavioural norms
- Learned violation patterns

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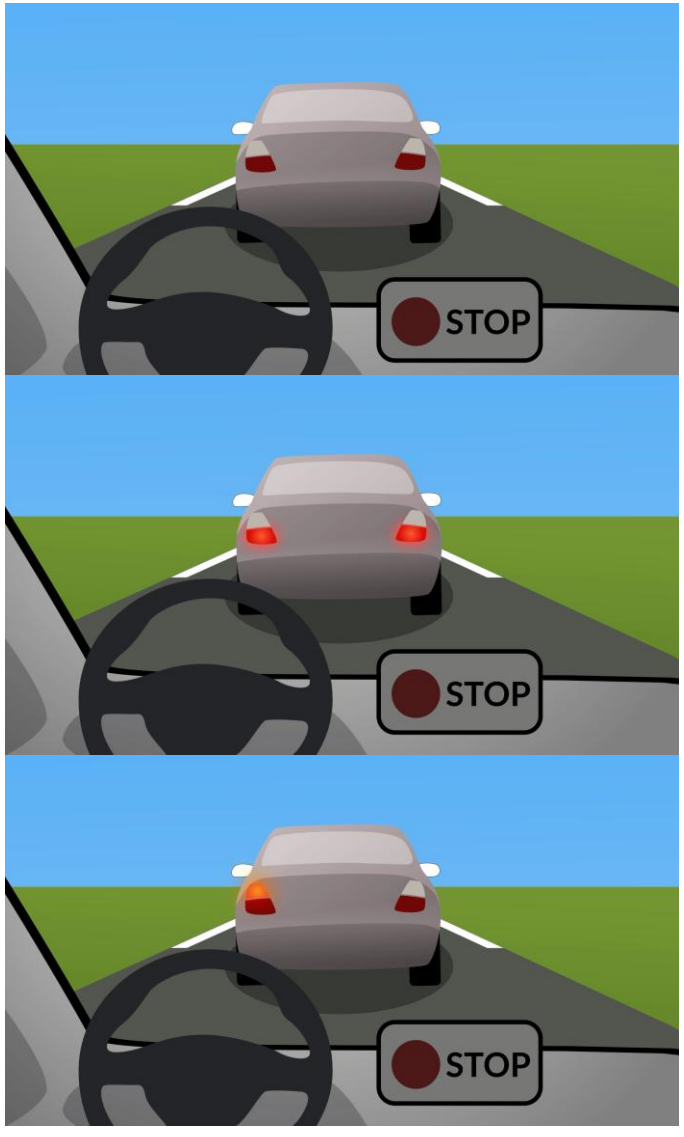
SelfTest

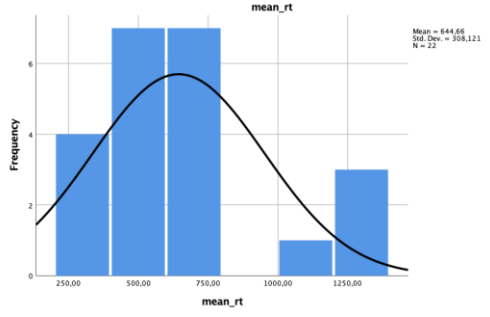
Modern Cognitive Function Tests
- fast and friendly reliable psychological testing

Reaction time

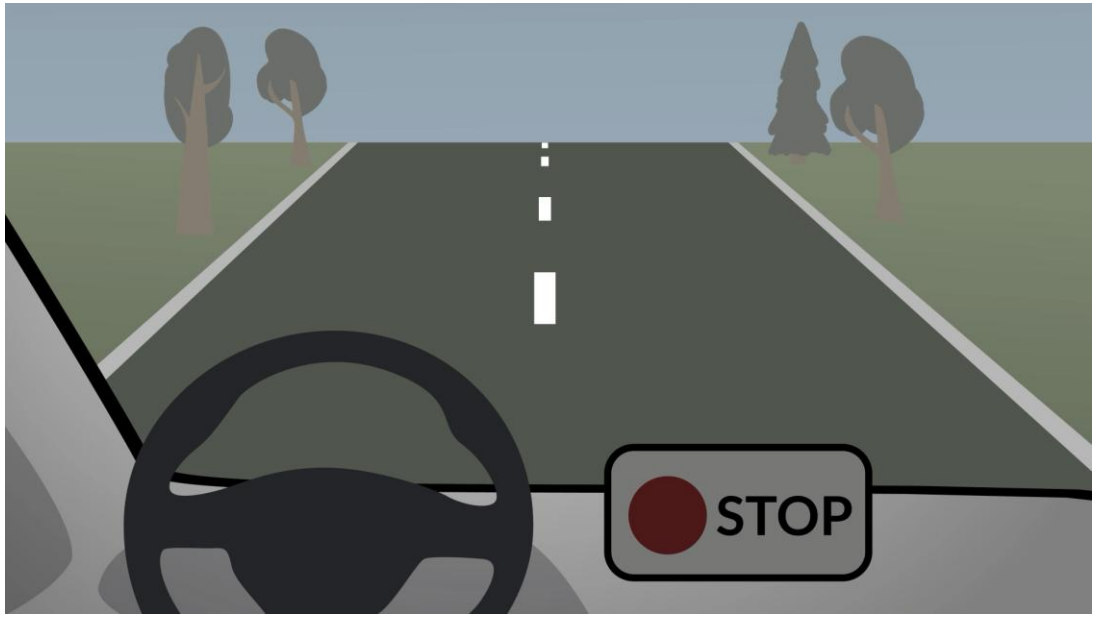


In both reaction time tests, a person is asked to press spacebar when stop lights appear on the car in front.
In simple reaction task stimuli are identical.
Test outcomes are mean reaction time (as an indicator of processing speed) and standard deviation – as a measure of sustained attention.
Cronbach alpha=.968

In choice reaction task a person is asked to differentiate yellow turn signal (shall be ignored) from red stop signal (spacebar shall be pressed).
Test outcomes are decision time and number of errors (inhibition effectiveness).
Cronbach alpha=.942



Perception

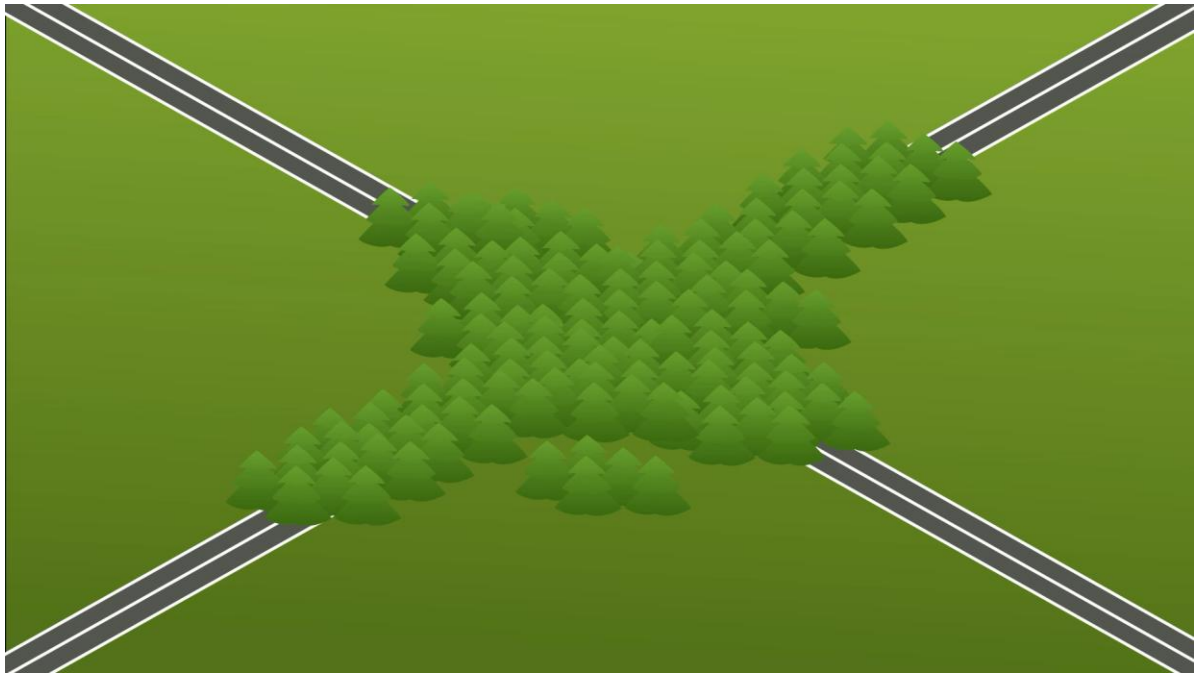


In perception test, a person is asked to recognize human shapes between trees. Contrast is deliberately low to simulate poor visual conditions.

Test variables are reaction time and number of correct reactions.

Crobach alpha= .908

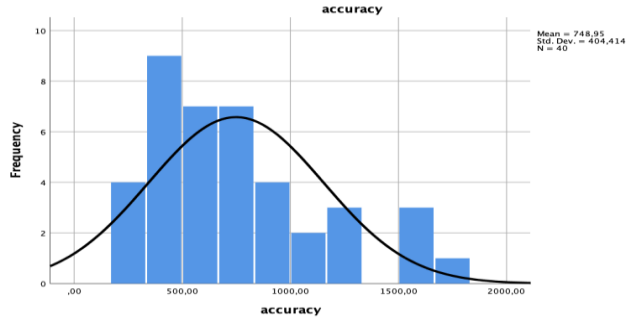
Anticipation



Adequate situational awareness requires anticipation. Anticipatory control is much more effective than reactive behaviour.

In **anticipation test**, subject is asked to estimate the moment of crossing the vehicles behind trees.
Precision of estimation is the main variable in this test.

Cronbach's alpha= .804



SelfTest
COMFORT & SAFETY

Memory test

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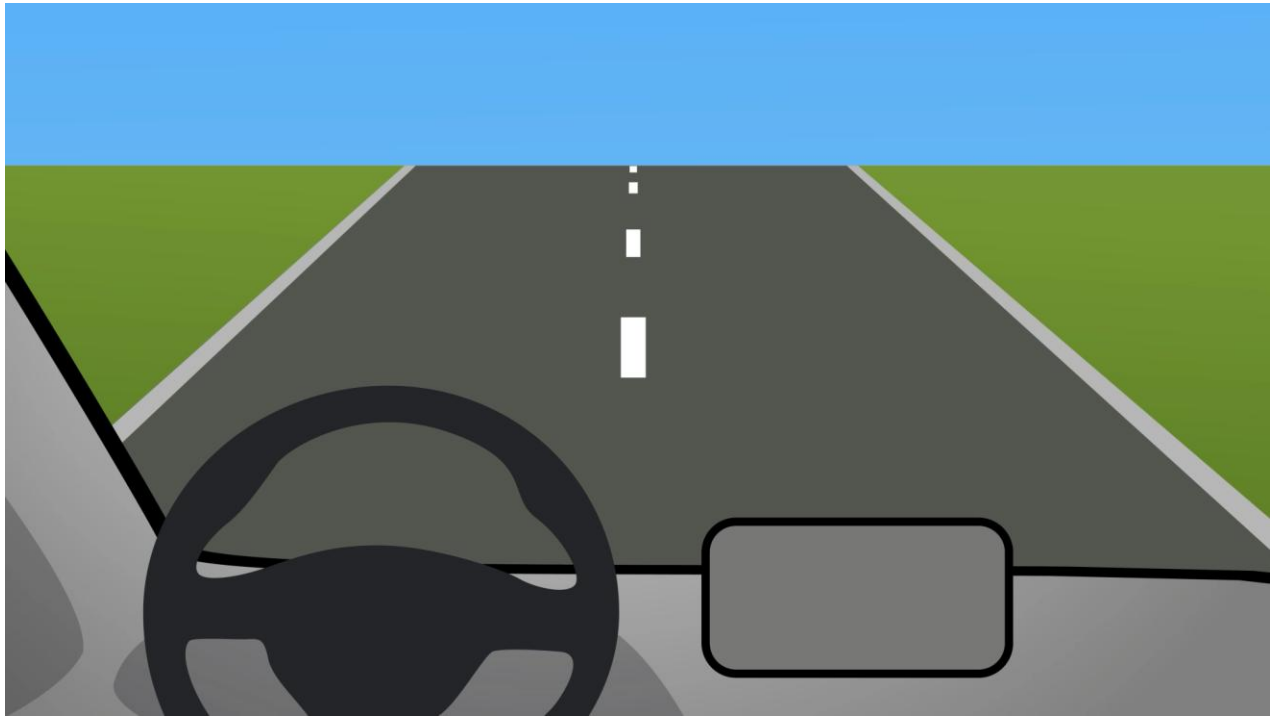
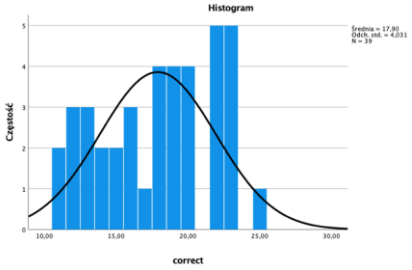


Short time memory is necessary to integrate information about environment and traffic participants.

Memory test is based on n-back procedure. It requires reaction, when observed speed limit sign is identical to previous one (or the one before the previous one).
The test outcome is the number of correct reactions.
Cronbach alpha= .761



TEST EVALUATION

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Advantages

SelfTest COMFORT & SAFETY

- Ensured anonymity
- Home-based accessibility
- Personalized approach
- Self-evaluation of core cognitive functions relevant to driving
- Increased awareness
- Access to custom solutions

  - *(Older drivers' version currently available in 4 languages; youth-adapted version in development)*

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Conclusions & Recommendations

Self-Assessment in Training and Examination

Conclusions

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If we require cognitive assessment for drivers 60+, then the same rationale applies to youth:

- Both groups show similarly **limited cognitive control**
- Both demonstrate **elevated crash risk**
- **Complex conditions** and **new situations** pose a challenge for young and older drivers
- **Personal fitness** + **Neuropsychological** Explanation aligned with natural biological processes
- Early-adult drivers combine immature executive functions with high exposure

→ **Cognitive screening is equally justified at licence entry.**

- Mental and physical fitness, training, level of stress and **momentary emotional state** are key factors.
- **Self-awareness** and planning helps all of us to stay safe on the road.
- Improving **working-memory** capacity **through training**, **attention management**, and **distraction reduction** can significantly enhance road safety for novice (and senior) drivers.

→ **Age alone doesn't disqualify a driver — it signals the need for tailored remedial actions.**

COGNITIVE FUNCTIONS and AGE

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Young Drivers (16–24)

- Developing Working Memory
- High Distractibility
- Attention Failures
- Poor Hazard Anticipation

Older Drivers (65+)

- Slower Processing Speed
- Reduced Working Memory
- Slower Reaction Times
- Declining Vision & Spatial Skills

Cognitive functions shape driving safety at all ages.

COGNITIVE FUNCTIONS and AGE

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Cognitive Self-Testing

- Check alertness & fatigue
- Adjust tasks to learner's condition
- Attention Failures
- Peor-Hazard Anticipation

Personalized Training

- Tailor lessons to cognitive profile
- Monitor progress & adjust hours

Post-Exam Feedback

- Review exam & self-test results
- Discuss stress & focus issues

Combine training, self-awareness, and reflective feedback to *improve driving readiness.*

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Thank You for Your Attention

SelfTest

COMFORT & SAFETY

Barbara Krol
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