Methods for assessing cognitive workload of drivers

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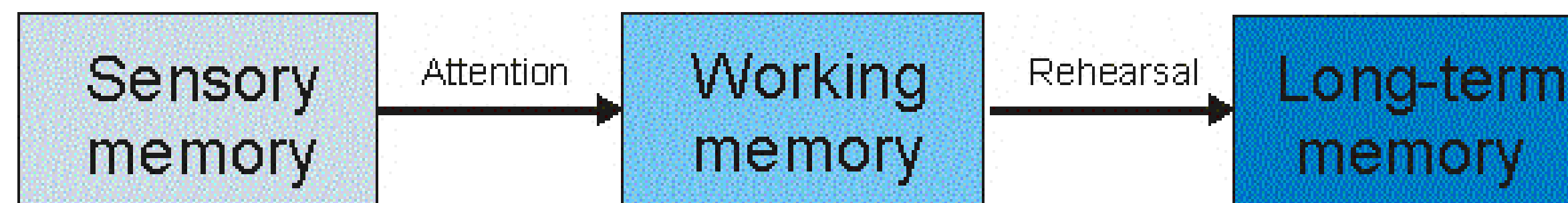Faculty of Electrical Engineering

Human sensory system

Human senses: vision, hearing, touch, taste and smell

- Physical reception of the stimulus

- Interpretation of information

Three types of memory

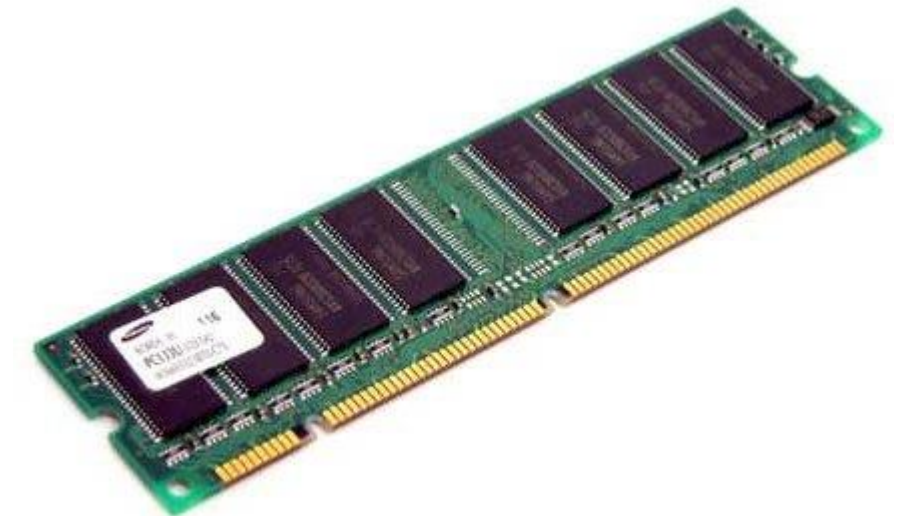- Sensory

- Short-term (working) memory

- Long-term memory

Retrieved from: livescience.com

Working memory

General properties

- Temporary recall of information

- Rapid access: ~ 70 ms

- Rapid decay (short storage time): 10-20s

  - Mental repetition -> rewrite

- Limited capacity

  - 7 ± 2 chunks of information

  - Closure: formation of chunks

Attention and distraction

Retrieved from: forsythwoman.com

Attention

- Concentration of mind on one of the competing
   stimuli or thought
- Divided and selected attention

Distraction

- Primary and secondary tasks
- Limitations and overload

Multitasking??

Retrieved from: medicaldaily.com

ICT in modern vehicles

Interaction

- Visual
- Auditory
- Tactile

Distraction

- Manual distraction
- Visual distraction
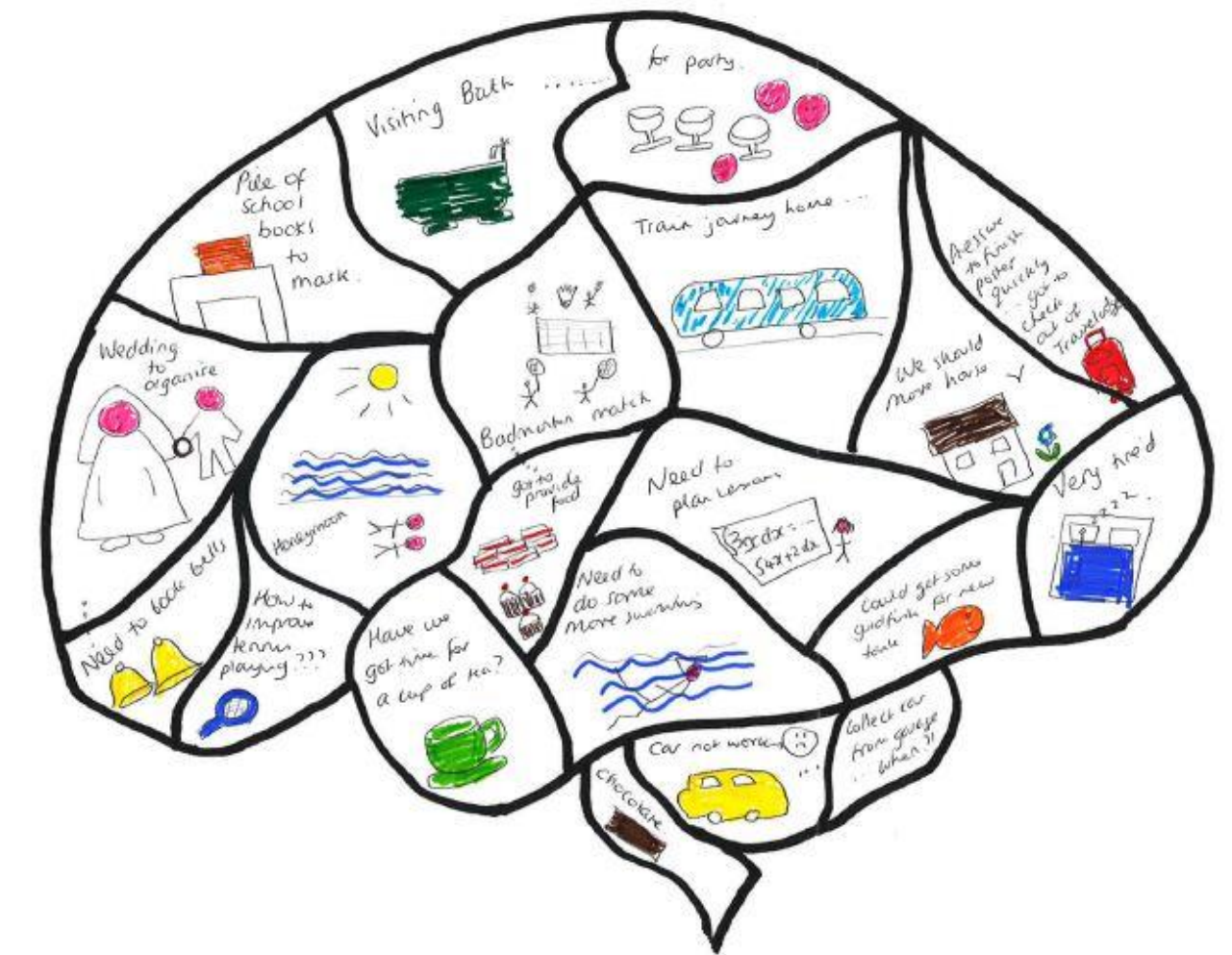- Cognitive distraction

Retrieved from: urbanmilwaukee.com

Cognitive workload

Tasks

- Speaking and listening
- Mobile phone conversations
- N-back task

	Sequence of numbers							
Current number	1	4	2	8	9	9	3	0
N-0	1	4	2	8	9	9	3	0
N-1	-	1	4	2	8	9	9	3

- Automated operation span
- …

Retrieved from: errorgirldotcom

Self-evaluation

NASA TLX

- Mental demand
- Physical demand
- Temporal demand
- Own performance
- Effort and frustration

ISA – Instantaneous self-assessment of the workload

Retrieved from: wikipedia.org

Ocular activities

- Pupil dilatation

- Gaze duration

  - Ratio between fixations and saccades

- Blink duration
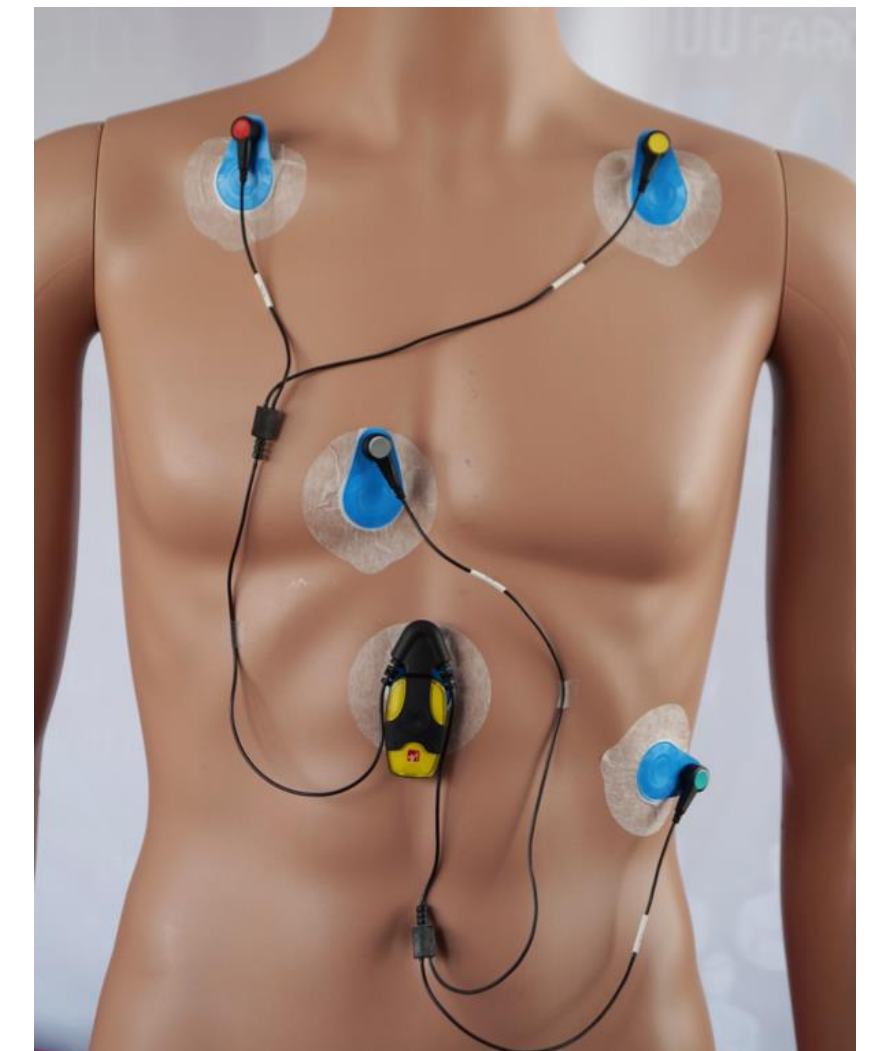
- Tunnel vision

Retrieved from: tobii.com

Do-It-Yourself Eye Tracker: http://rmantiuk.strony.wi.ps.pl/projects/diy/index.html

Physiological measurements

- Electrocardiography (ECG)

  - Heart rate (HR)

  - Heart rate variability (HRV)

- Galvanic skin response (GSR)

  - Number of peaks

- Body / skin temperature

- Respiration

Retrieved from: empatica.com

Retrieved from: defribrillator-deutschland.com

Physiological measurements

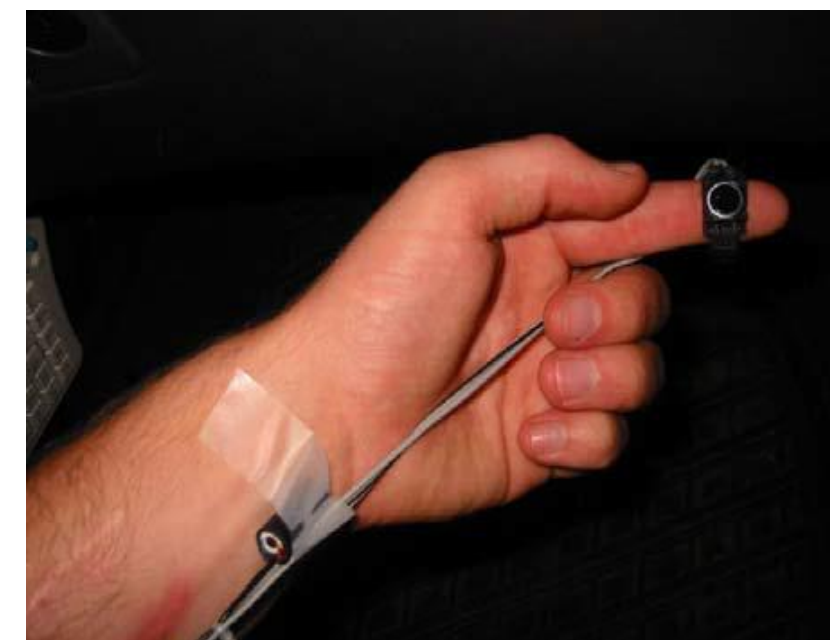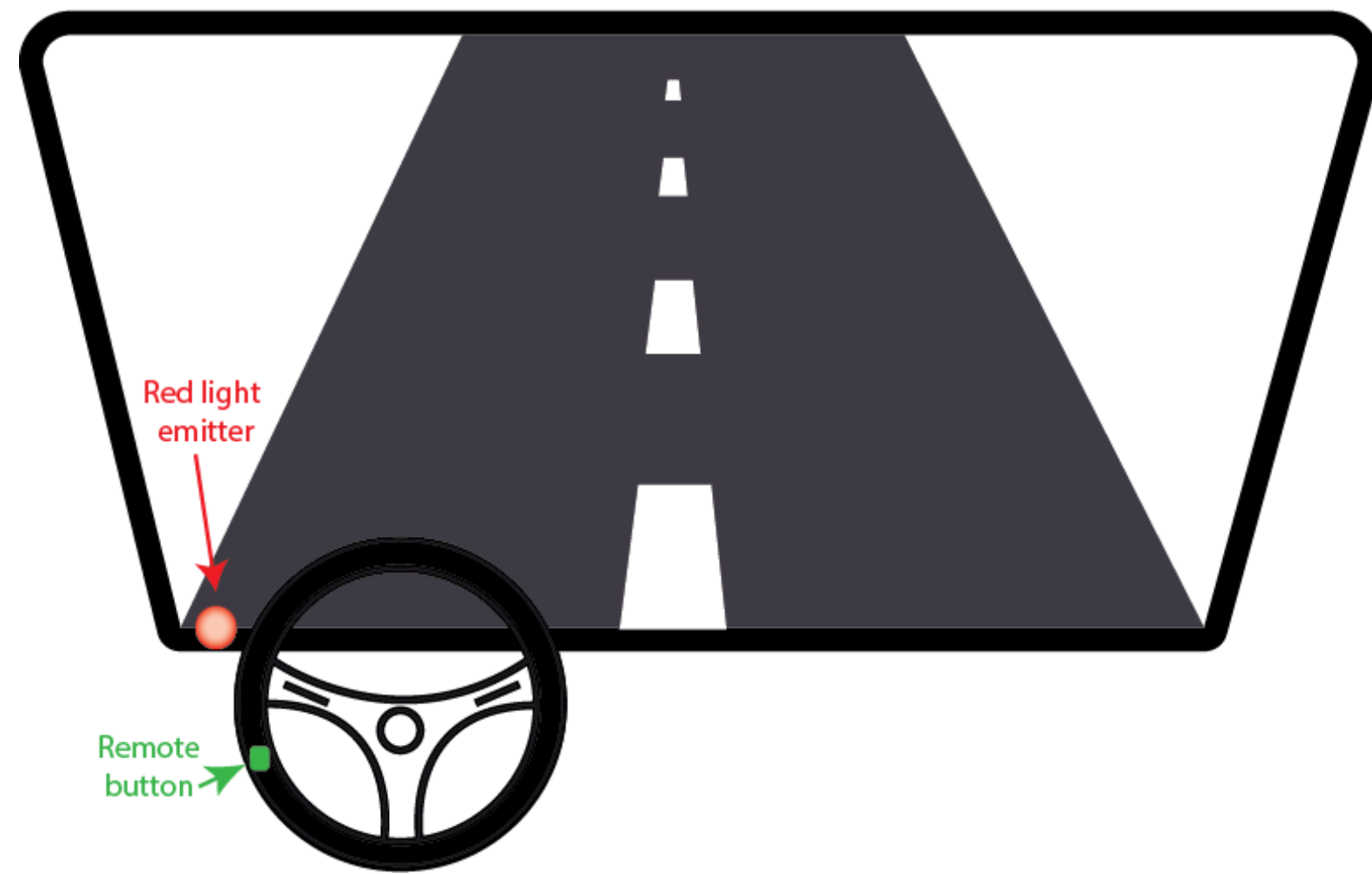- Electroencephalography (EEG)

    - Power of alpha band (8-13 Hz)

    - P300 latency (delay between stimulus

    and response)

Retrieved from: pinterest.com
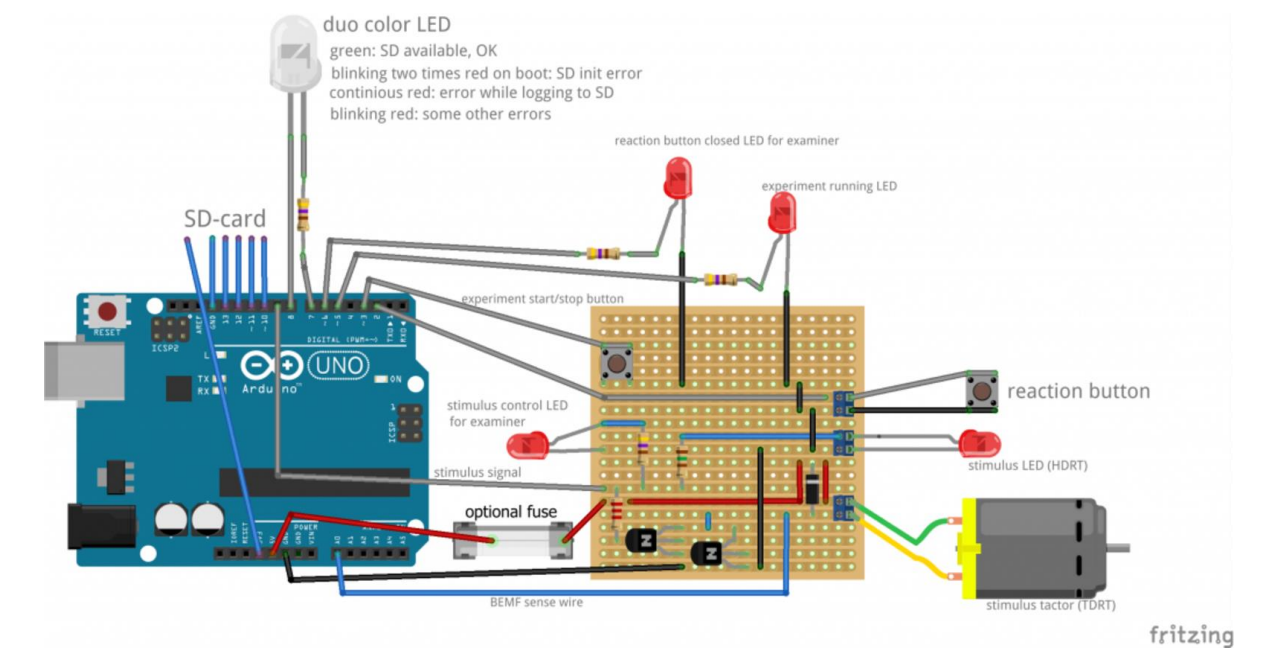
Secondary task

- Detection response task -DRT

Retrieved from: semanticscholar.org

Secondary task

- Detection response task – DRT
- Stimulus: $3000s < t < 5000s$
- Regular response: $100ms < t < 2500ms$
- Measurements

  - Response time

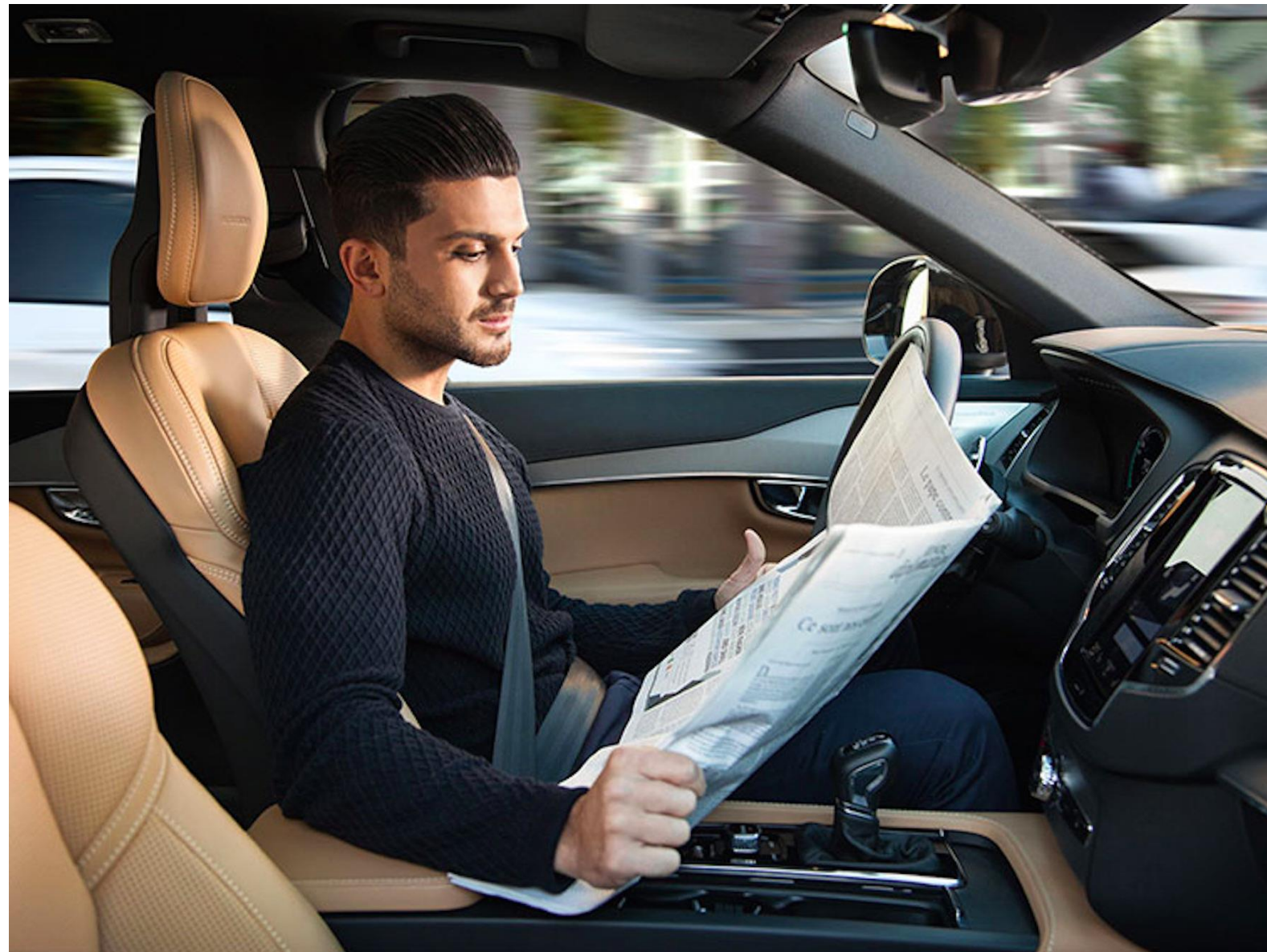 - Hit rate

- ISO Standard 17488:2016

Detection response task

- ArduinoDRT

  - Open source solution (GPL)

  - Plain-Arduino-DRT, Ethernet-Arduino-DRT, Mega-Arduino-DRT

  - Experimental protocol + SD card logger

https://github.com/InstituteOfErgonomics/ArduinoDRT

Cognitive (underload)

Retrieved from: businessinsider.com

Retrieved from: sleepmd4u.com

Retrieved from: cars.usnews.com

Thank you!