

Methods for assessing cognitive workload of drivers

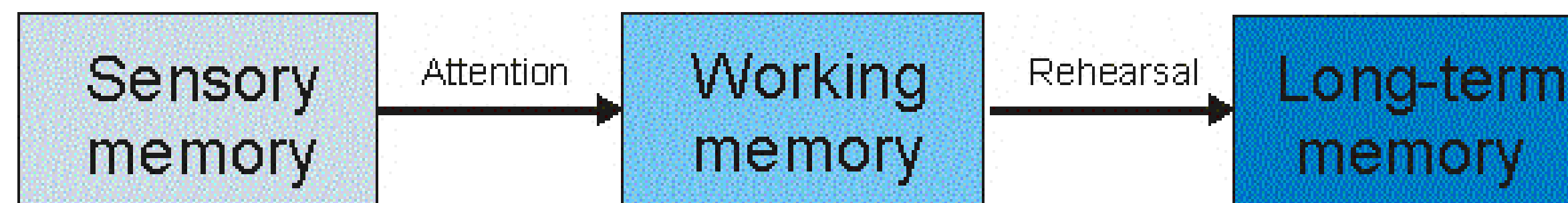
Human sensory system

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

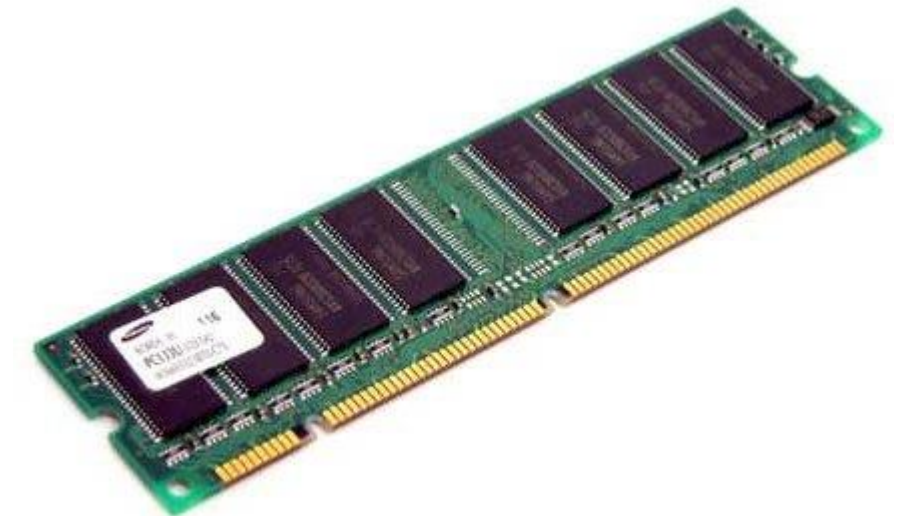


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Working memory

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

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: [forsythwoman.com](https://www.forsythwoman.com)



Retrieved from: [medicaldaily.com](https://www.medicaldaily.com)

ICT in modern vehicles

Interaction

- Visual
- Auditory
- Tactile

Distraction

- Manual distraction
- Visual distraction
- Cognitive distraction



Retrieved from: urbanmilwaukee.com

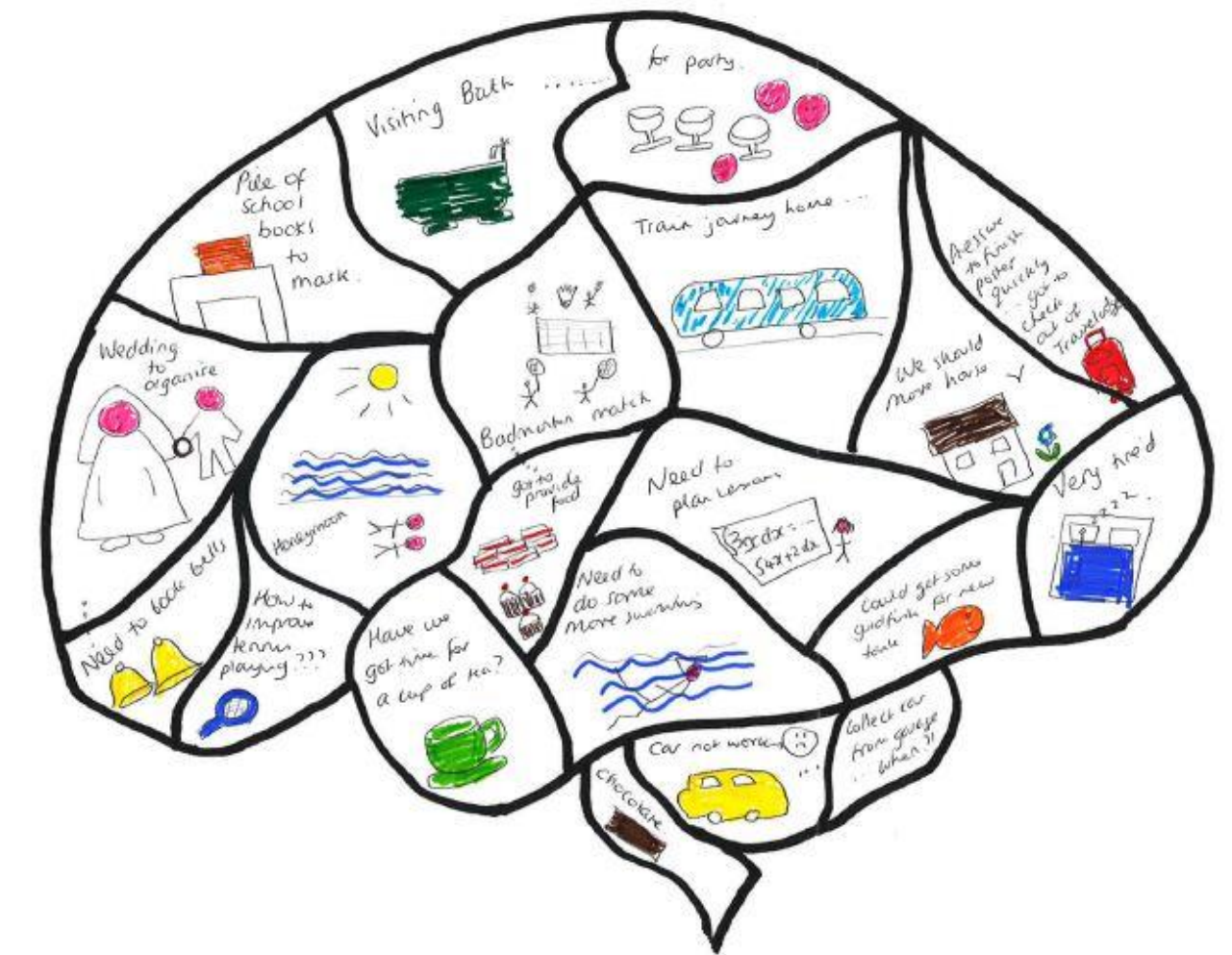
Cognitive workload

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: errorgirl.com

Self-evaluation

NASA TLX

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

ISA – Instantaneous self-assessment of the workload

NASA Task Load Index

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

Name	Task	Date

Mental Demand How mentally demanding was the task?

Very Low Very High

Physical Demand How physically demanding was the task?

Very Low Very High

Temporal Demand How hurried or rushed was the pace of the task?

Very Low Very High

Performance How successful were you in accomplishing what you were asked to do?

Perfect Failure

Effort How hard did you have to work to accomplish your level of performance?

Very Low Very High

Frustration How insecure, discouraged, irritated, stressed, and annoyed were you?

Very Low Very High

Retrieved from: wikipedia.org

Ocular activities

- Pupil dilatation
- Gaze duration
 - Ratio between fixations and saccades
- Blink duration
- Tunnel vision



Retrieved from: tobii.com

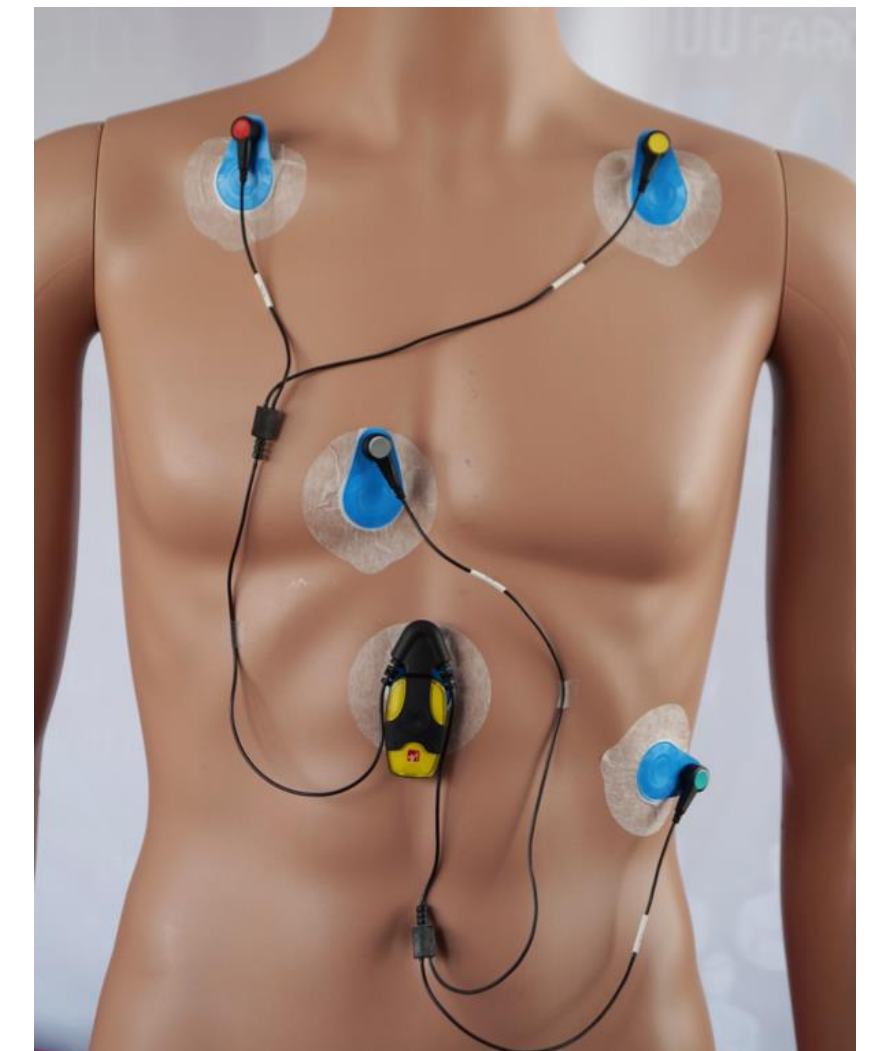
Do-It-Yourself Eye Tracker: <http://rmantiuk.strony.wi.ps.pl/projects/diy/index.html>

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: defibrillator-deutschland.com

Physiological measurements

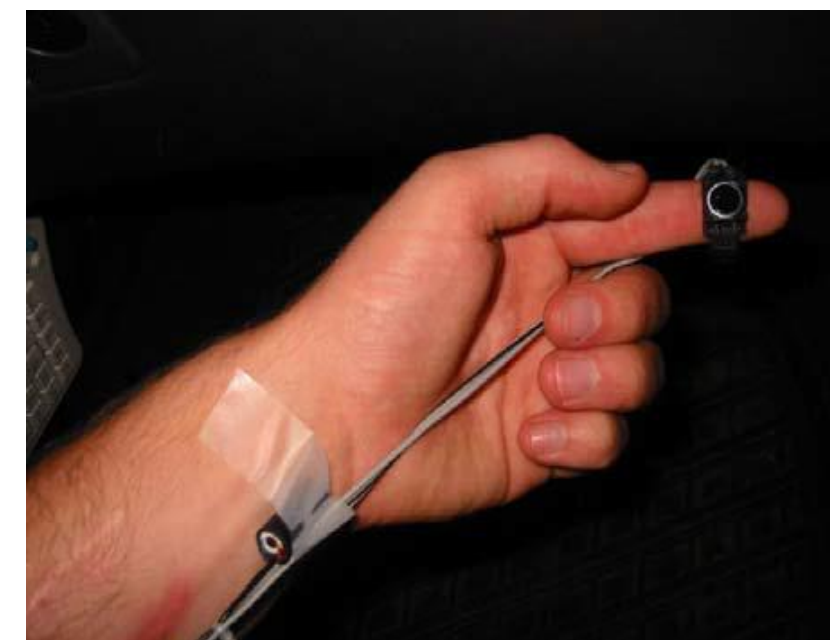
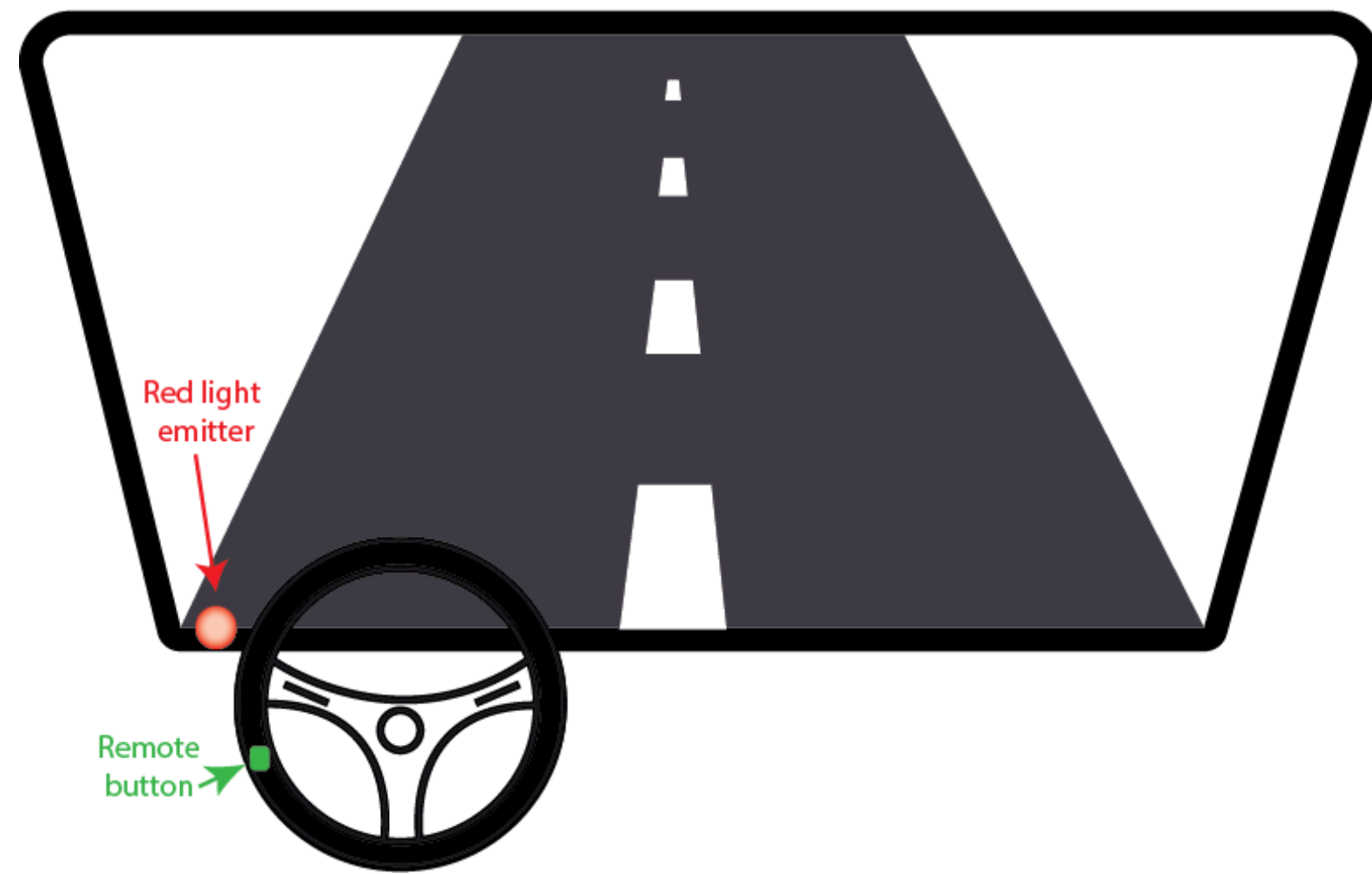
- Electroencephalography (EEG)
 - Power of alpha band (8-13 Hz)
 - P300 latency (delay between stimulus and response)



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Secondary task

- Detection response task -DRT



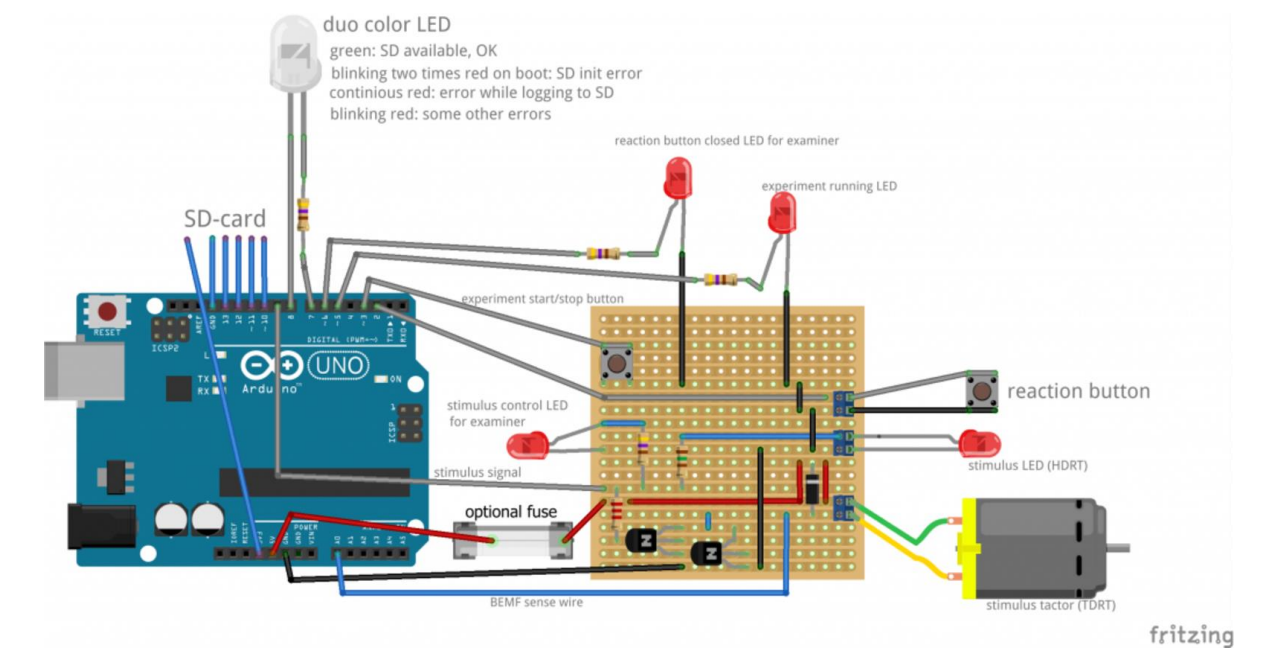
Retrieved from: [semanticscholar.org](https://www.semanticscholar.org)

Secondary task

- Detection response task – DRT
- Stimulus: $3000s < t < 5000s$
- Regular response: $100ms < t < 2500ms$
- Measurements
 - Response time
 - Hit rate
- ISO Standard 17488:2016

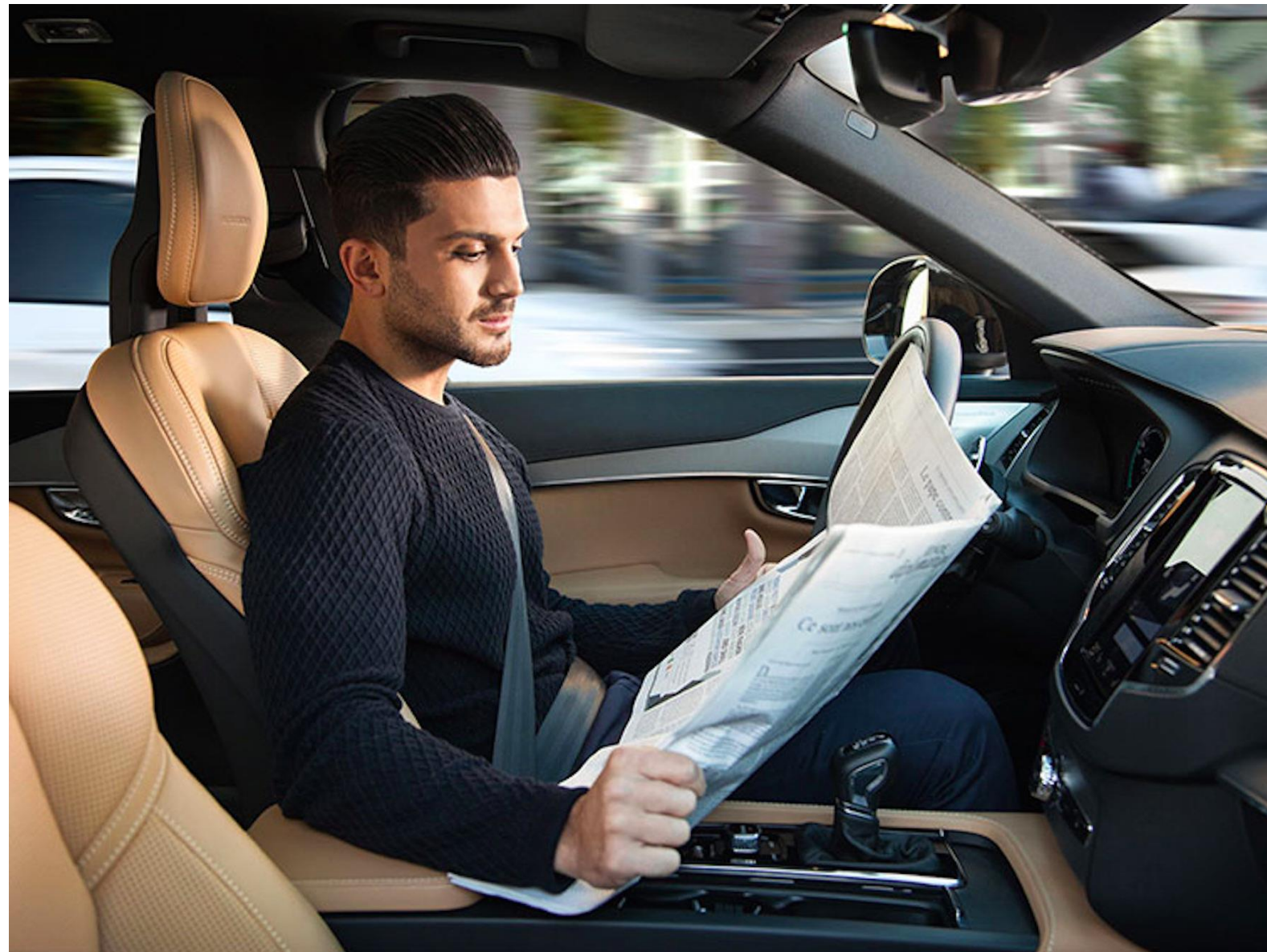
Detection response task

- 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)



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Thank you!