Applications of eye tracking technology in driving status detection

Ganzin Research

2023/07/02

Categories of driving distraction

- National Highway Traffic Safety Administration (NHTSA)

  1. Cognitive distraction
      (mind of the driving duty)

  2. Visual distraction
      (eyes off the road)

  $\longrightarrow$ Eye-tracking related

  3. Physical distraction
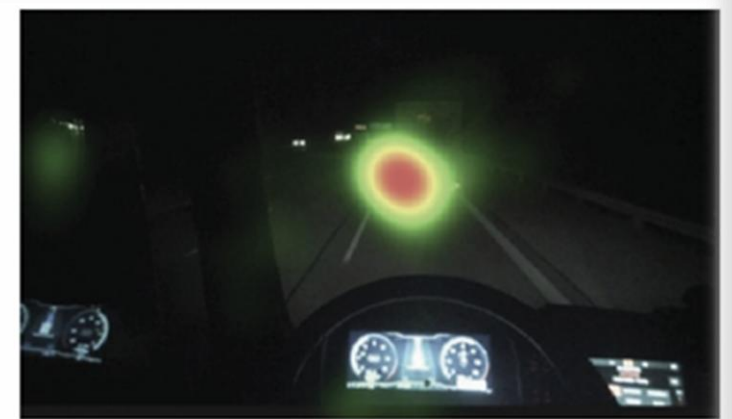   (hands off the wheel)

  4. Auditory distraction
      (ears off the auditory signals)

Source: Getty images

Visual distraction

- Situational awareness (SA): the conscious awareness of actions.

- SA in driving: whether the driver is looking at the import areas related to the driving behaviors.

(Castritius et al., 2021)

Eye movement indexes of cognitive distraction

Fatigue (drowsiness)

- PERCLOS (percentage of eye closure, Wierwille et al, 1994)
- Blink frequency (Schleicher et al., 2008)
- Blink duration
- Delay of lid reopening
- Saccade duration
- Fixation duration
- Microsleep (Thorslund., 2004)

Mental workload

- Pupil size (Laeng & Alnaes, 2019)

Fatigue: PERCLOS

- Percentage of time during a one-minute period for which the eyes remain.

$$PERCLOS = \frac{duration\ of\ eye\ closed}{total\ duration} \times 100\%$$

- Percentage of time during a one-minute period for which the eyes remain.
- PERCLOS80, PERCLOS70, and EYEMEAS (EM) (70, 80% , and half closed)

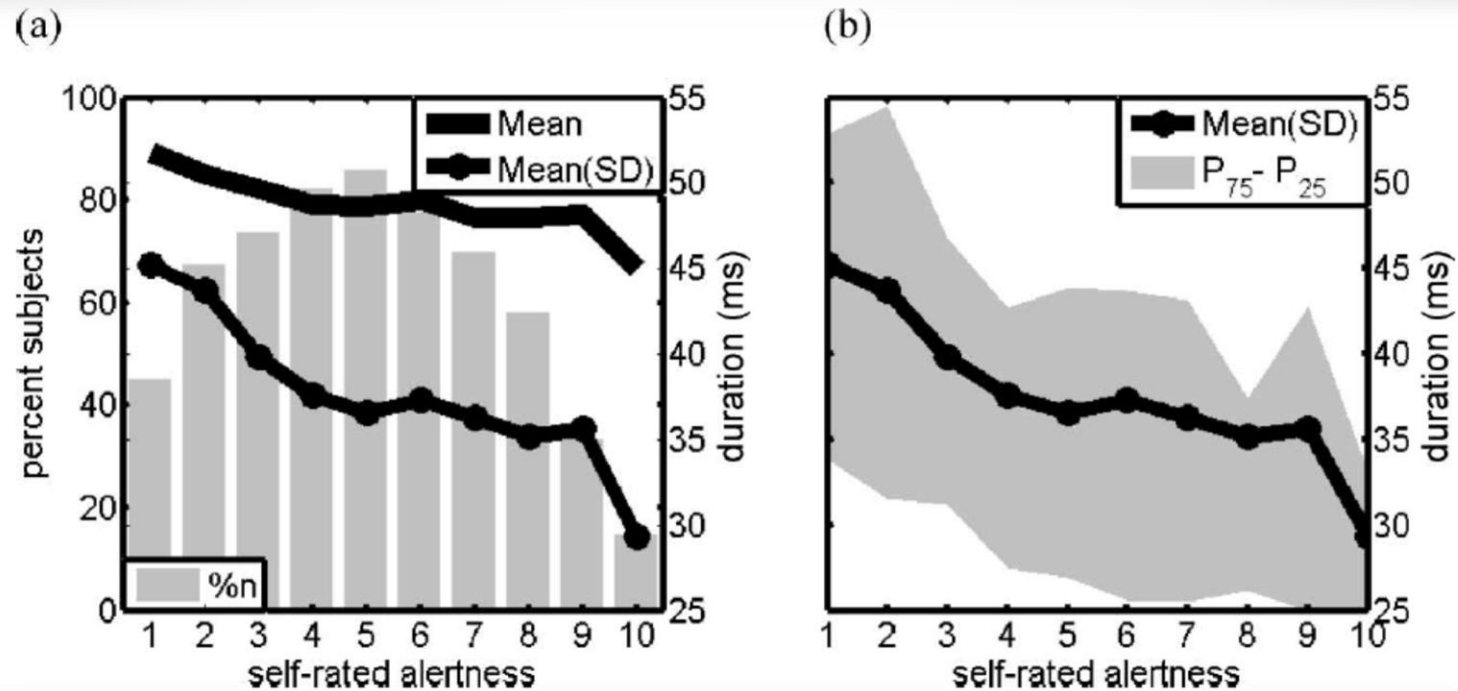$$\frac{Duration\ of\ eyes\ closed\ over\ 80\%, 70\%, or\ 50\%}{Total\ time} \geq Threshold$$

Fatigue: Blink-related indexes
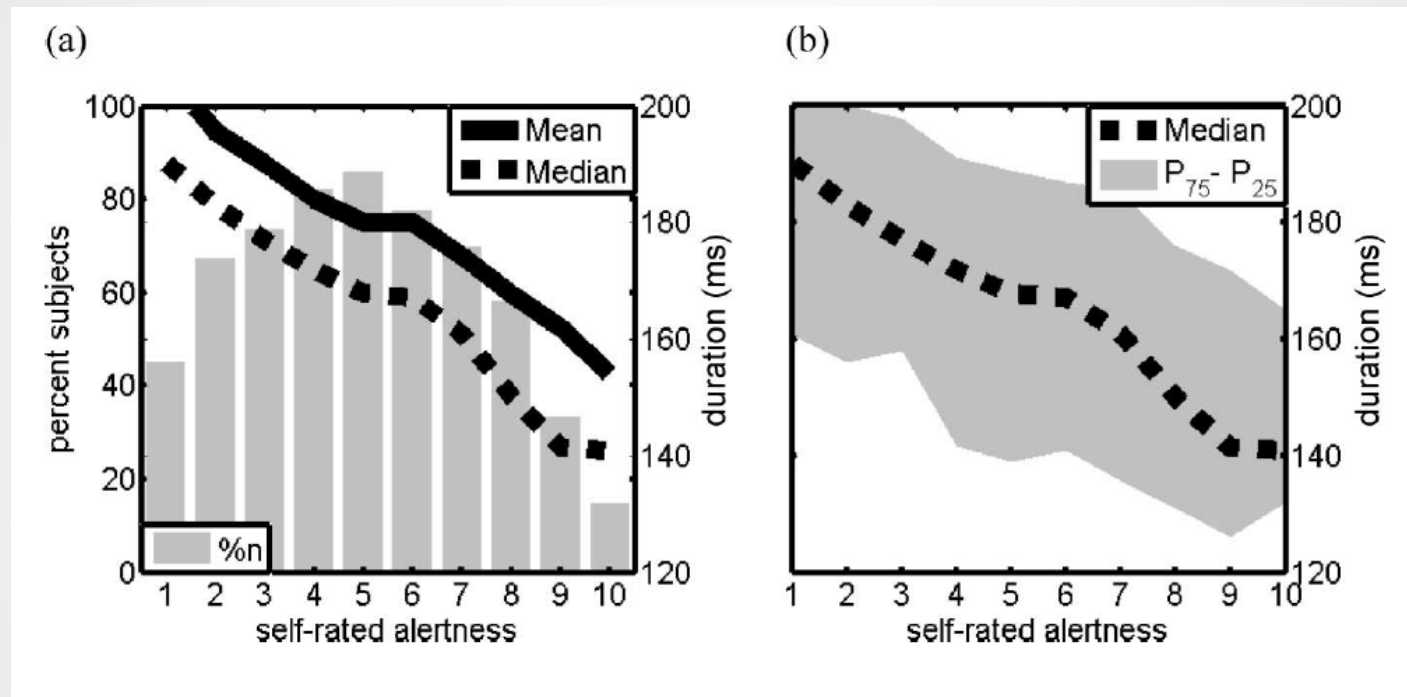
(Schleicher et al., 2008)

- Fatigue ⬆: blink duration ⬆、blink frequency ⬆
- Delay of reopening and standardized lid closure speed are similar indexes.
- Microsleep: the upper lid of the eye remains in contact with the lower lid between 0.5 and 10 seconds.
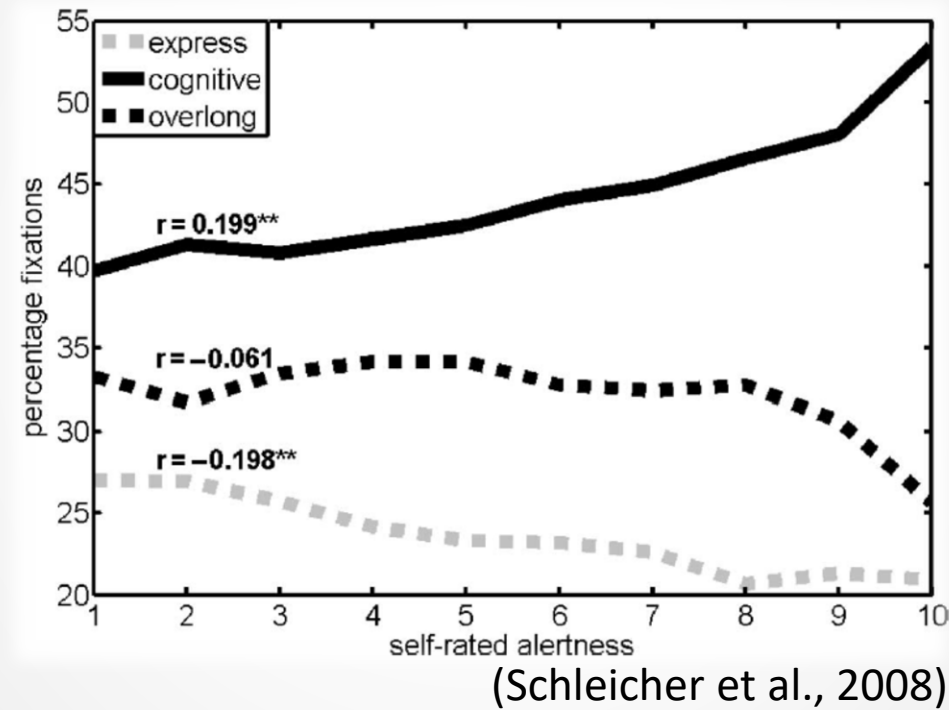
Fatigue: Saccade duration

(Schleicher et al., 2008)

- Fatigue ⬆: stand deviation of saccade duration ⬆

Fatigue: Fixation duration

(Schleicher et al., 2008)

- Fatigue ⬆: the percentage of cognitive fixation (150 – 900 ms) ⬆

Mental workload: pupil dilation

- Mental workload ⬆: pupil dilation ⬆

References

- Castritius, S. M., Schubert, P., Dietz, C., Hecht, H., Huestegge, L., Liebherr, M., & Haas, C. T. (2021). Driver Situation Awareness and Perceived Sleepiness during Truck Platoon Driving–Insights from Eye-tracking Data. *International Journal of Human–Computer Interaction, 37*(15), 1467-1477.

- Laeng, B., & Alnaes, D. (2019). Pupillometry. *Eye movement research: An introduction to its scientific foundations and applications*, 449-502.

- Schleicher, R., Galley, N., Briest, S., & Galley, L. (2008). Blinks and saccades as indicators of fatigue in sleepiness warnings: looking tired?. *Ergonomics, 51*(7), 982-1010.

- Thorslund, B. (2004). *Electrooculogram analysis and development of a system for defining stages of drowsiness*. Statens väg-och transportforskningsinstitut.

- Wierwille, W. W., Wreggit, S. S., Kirn, C. L., Ellsworth, L. A., & Fairbanks, R. J. (1994). Research on vehicle-based driver status/performance monitoring; development, validation, and refinement of algorithms for detection of driver drowsiness. *final report* (No. HS-808 247).