

Driver fatigue

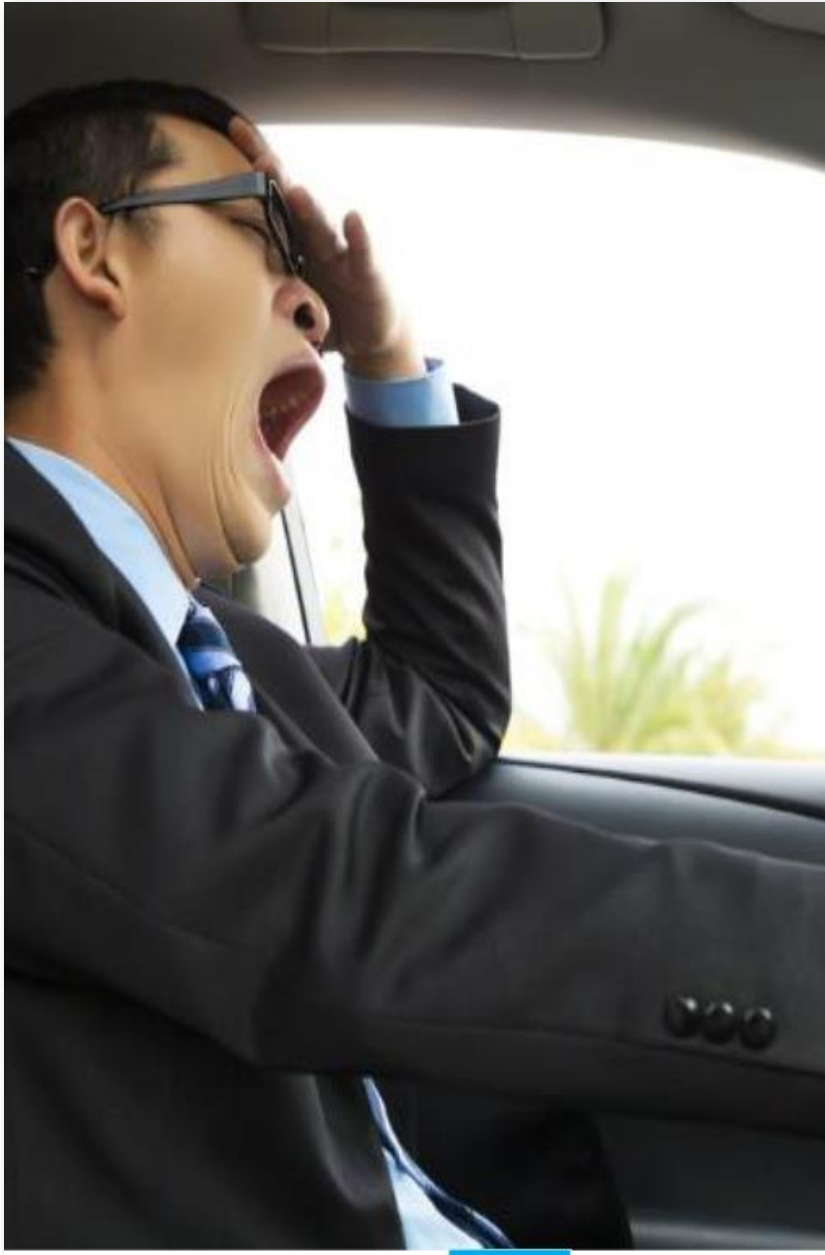
Contribution to the RSA Academic Lecture 2020

Charles Goldenbeld

(with support of Ingrid van Schagen)

The Hague, 5 October 2020





Contents

- What is driver fatigue?
 - definition
 - causes & distinctions
- The problem
 - prevalence
 - crashes and crash risk
 - risk groups
- Countermeasures
 - Regulation/enforcement
 - Education and information
 - Road infrastructure
 - Vehicle technology



Definition

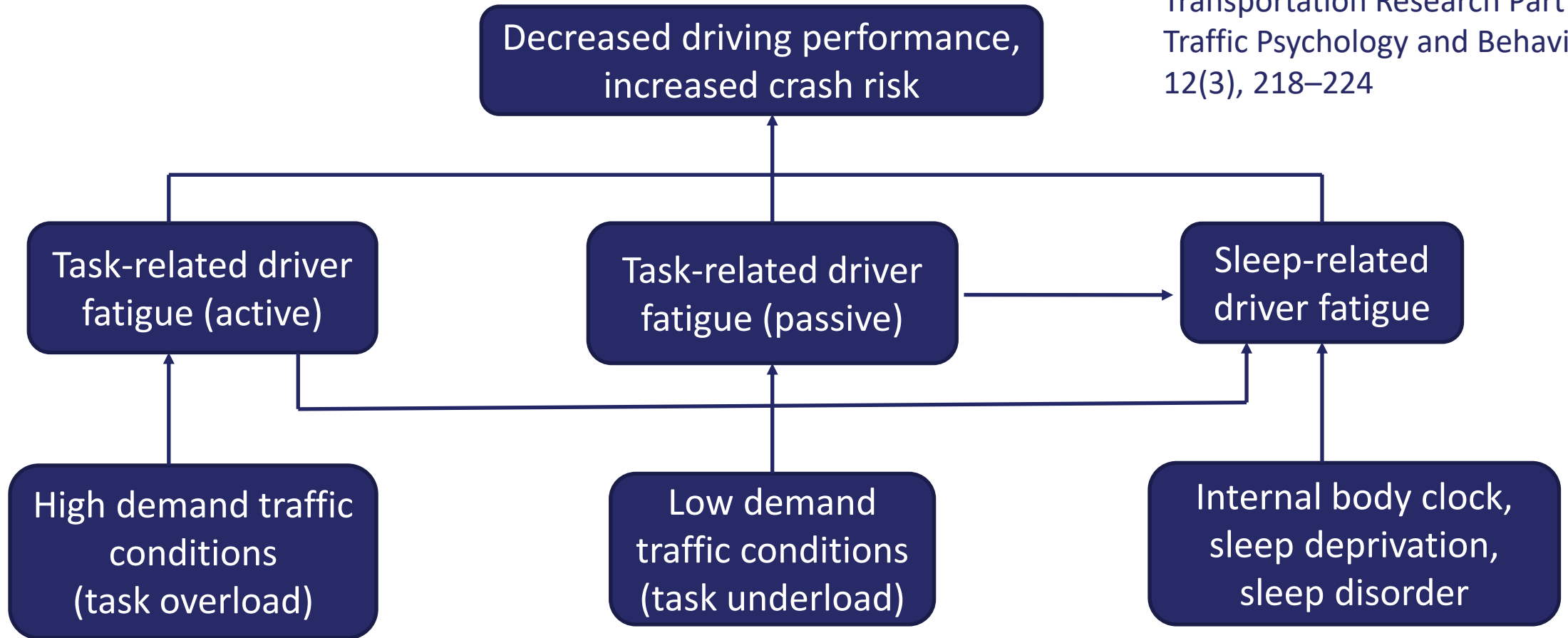
- No single accepted general definition
- Fatigue, sleepiness and drowsiness related concepts
- Umbrella term
- “... a general psychophysiological state which diminishes the ability of the individual to perform the driving task by altering alertness and vigilance” (Thiffault & Bergeron, 2003)

Thiffault & Bergeron (2003). Monotony of road environment and driver fatigue: a simulator study. *Accident Analysis & Prevention*, 35, 381-391.



Causes & types driver fatigue

May, J.F. & Baldwin, C.L. (2009).
Driver fatigue: The importance of
identifying causal factors of fatigue
when considering detection and
countermeasure technologies.
Transportation Research Part F:
Traffic Psychology and Behaviour,
12(3), 218–224



Fatigue & automated driving

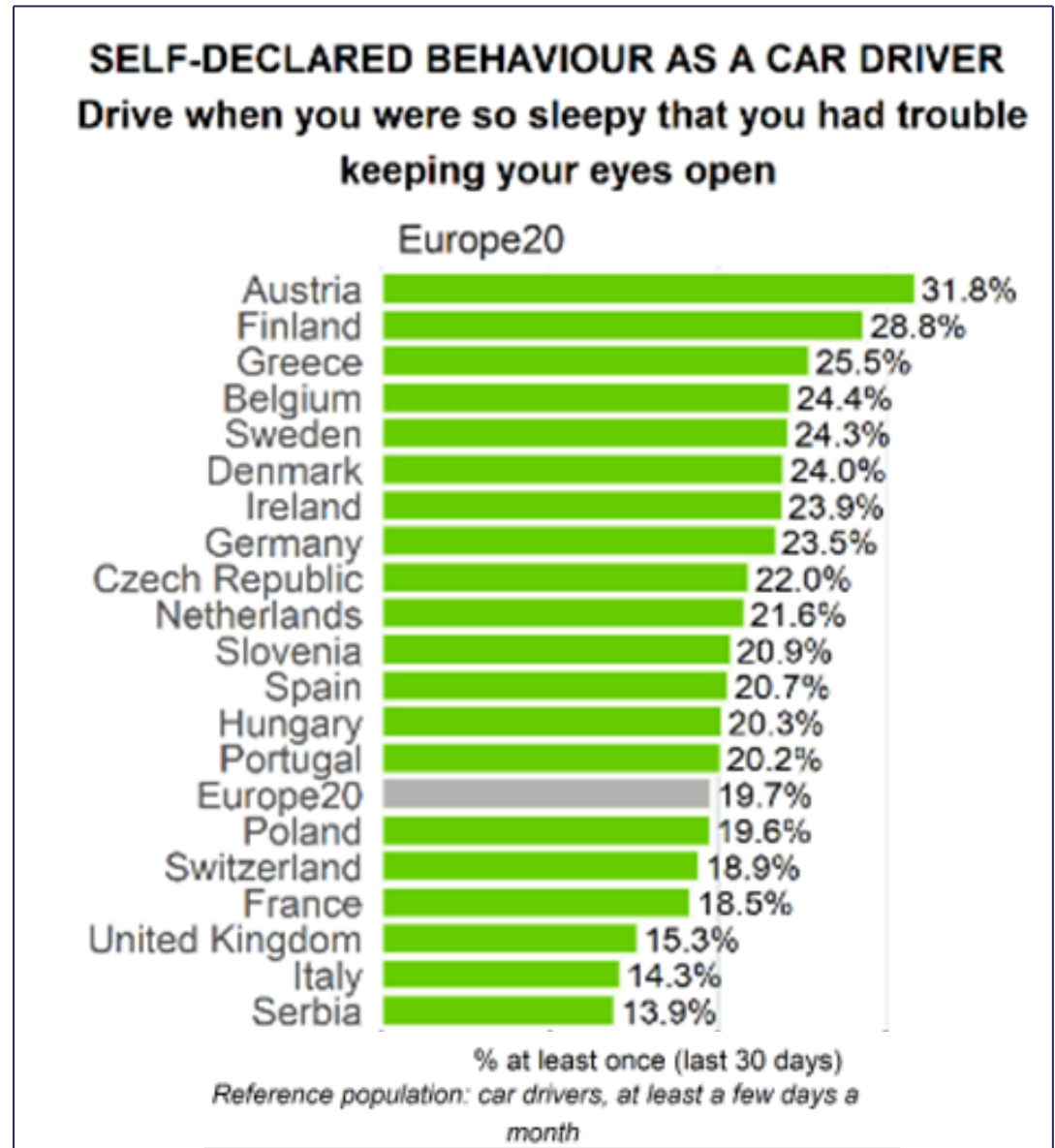
- In a simulator study Vogelpohl et al. (2019) found that drivers under automated driving conditions...:
 - *frequently became fatigued (even if they did not previously suffer from a lack of sleep)*
 - *sometimes too slow to react to take-over requests (slower reaction time)*
 - *sometimes too quick to deactivate the automation (before being sufficiently aware of their surroundings – lesser reaction quality)*

Vogelpohl, T., Kühn, M., Hummel, T., & Vollrath, M. (2019). Asleep at the automated wheel—Sleepiness and fatigue during highly automated driving. *Accident Analysis & Prevention*, 126, 70–84.

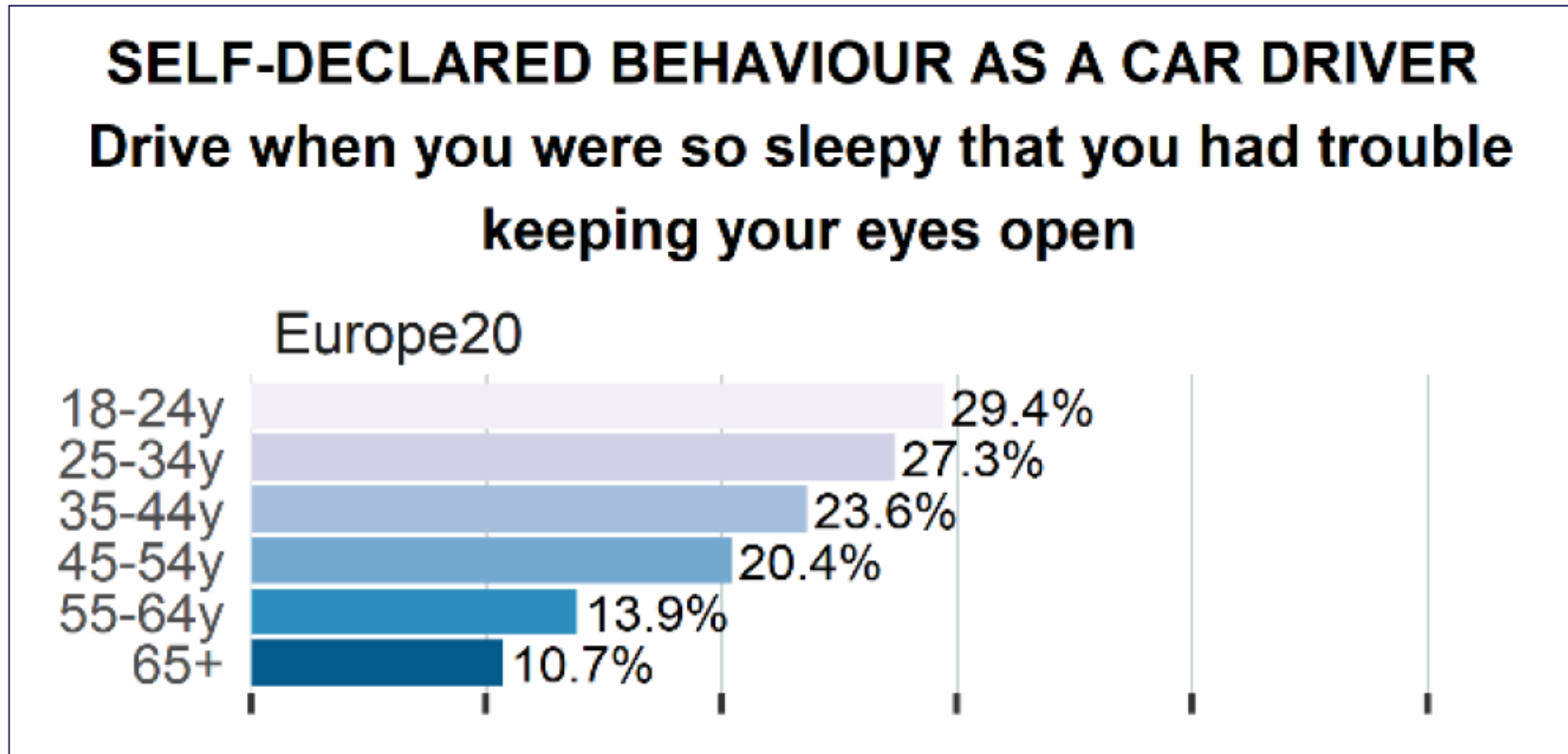


Prevalence self-reported driver fatigue Europe: ESRA-2 survey 2018

Goldenbeld, C., & Nikolaou, D. (2019). Driver fatigue. ESRA2 Thematic report Nr. 4. ESRA project (E-Survey of Road users' Attitudes). Institute for Road Safety Research SWOV, the Hague.



Age differences in self-reported driver fatigue: ESRA-2 results

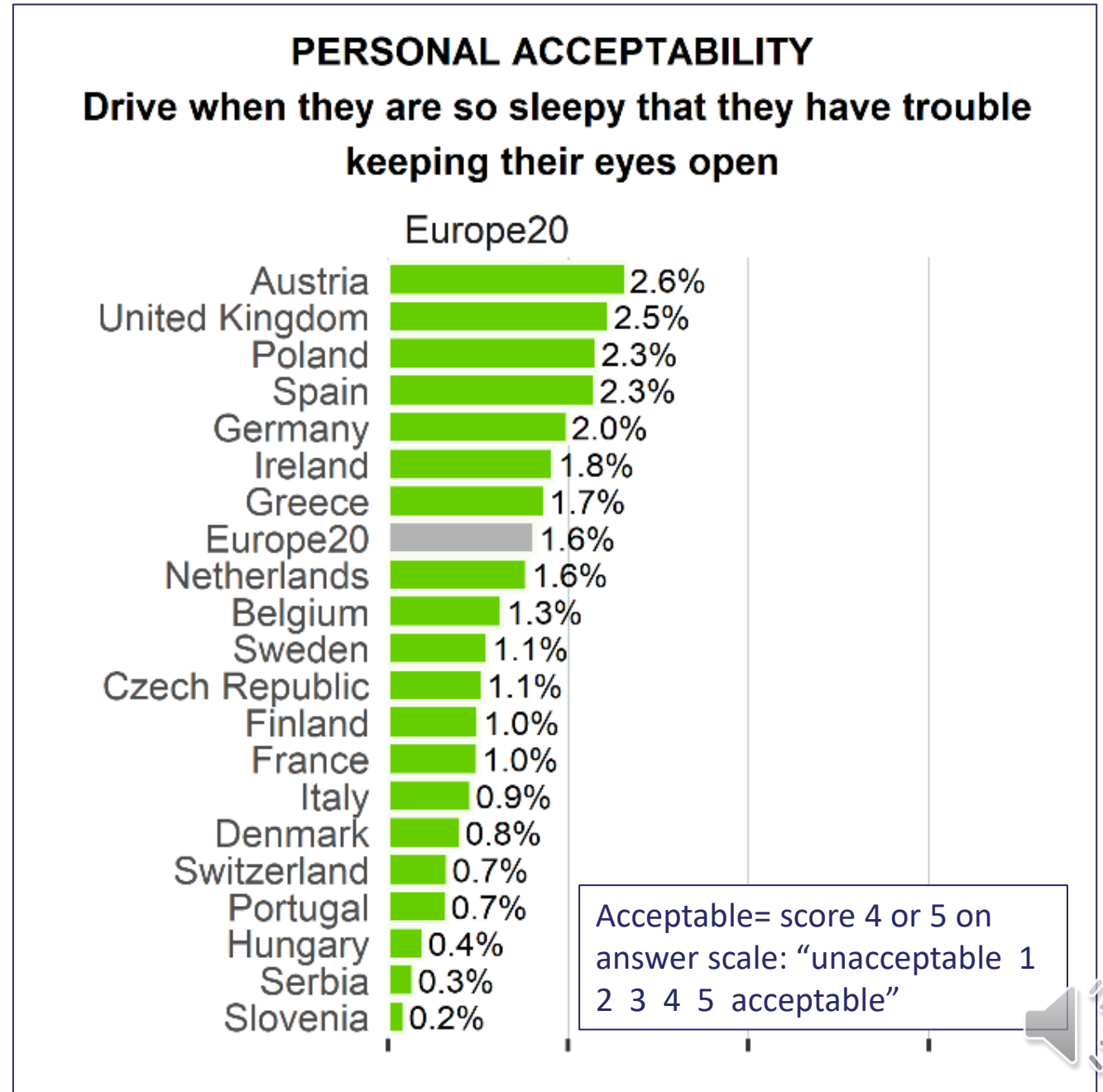


Personal acceptability fatigued driving

Question: “How acceptable do you, personally, feel it is for a CAR DRIVER to drive when they’re so sleepy that they have trouble keeping their eyes open?”

Source: ESRA-2

Goldenbeld, C., & Nikolaou, D. (2019) Driver fatigue. ESRA2 Thematic report Nr. 4. ESRA project (E-Survey of Road users’ Attitudes). Institute for Road Safety Research SWOV, the Hague, the Netherlands



Drivers' actions against fatigued driving

Sources:

Vanlaar, W., Simpson, H., Mayhew, D., & Robertson, R. (2008). Fatigued and drowsy driving: A survey of attitudes, opinions and behaviors. *Journal of Safety Research*, 39, 303–309.

Anund, A., Kecklund, G., Peters, B., & Akerstedt, T. (2008). Driver sleepiness and individual differences in preferences for countermeasures. *Journal of Sleep Research*, 17, 16–22.

Individual countermeasure against driver fatigue	Survey Canada, drivers Ontario, 2006 N = 750 car drivers (Vanlaar et al., 2008)	Survey Sweden, 2002-2003, N = 1880 car drivers (Anund et al., 2008)
Open window	44%	47%
Talk to passenger	34%	35%
Turn radio on	30%	52%
Stop and exercise	31%	54% (stop and short walk) 28% (stop and exercise)
Stop and nap	15%	18%
Move around (while driving)	26%	27%
Caffeine/coffee	29%	45%
Eat/drink	28%	32% (candy) 26% (fruit) 6% (energy drink)
Sing	29%	31%
Talk on cell phone	12%	Not included
Use nicotine	Not included	14%
Drive slower	Not included	13%



Effect on crash involvement

- Driver fatigue contributing factor 15 - 20% crashes
- Highest shares found for fatal crashes, crashes on motorways & truck crashes
- Large variation estimates studies: 5 - 50%
- Depends largely on assessment method:
 - police registrations
 - in-depth accident investigations
 - questionnaires (self-reported)

European Commission (2020) Road safety synopsis – Fatigue. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.



Effect on crash risk

- A meta-analysis of 14 studies: crash risk when driving fatigued 1.29 times higher (95% Conf. Intervals 1.24 – 1.34; Moradi et al., 2018)
- A naturalistic driving study of over 3,500 USA drivers: crash risk of driving fatigued 3.4 times (95% Conf. Intervals 2.3 - 5.1; Dingus et al., 2016)

Sources:

Dingus, T.A., Guo, F., Lee, S., Antin, J.F., Perez, M., Buchanan-King, M. & Hankey, J. (2016). Driver crash risk factors and prevalence evaluation using naturalistic driving data. In: National Academy of Sciences of the United States of America PNAS. vol. 113, 2636-2641.

Moradi, A., Nazari, S.S.H. & Rahmani, K. (2018). Sleepiness and the risk of road traffic accidents: A systematic review and meta-analysis of previous studies. Transportation Research Part F: Traffic Psychology and Behaviour.



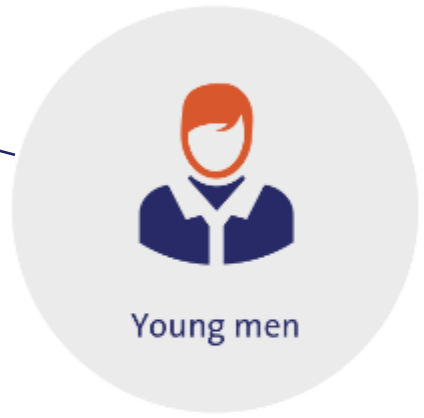
Risk groups:



Risk groups

USA: driver fatigue associated with 13% of truck crashes resulting in fatality/injury (Starnes, M., 2006. Large-Truck Crash Causation Study: An Initial Overview (DOT HS 810 646). NHTSA, Washington).

Young drivers (18-24 yrs). over-represented in sleep-related crashes (Shekari Soleimanloo et al., 2017. The effects of sleep loss on young drivers' performance: A systematic review. PLoS ONE 12(8): e0184002)



High rates of fatigued driving among taxi drivers in different locations world-wide (Menéndez et al. 2019. Individual, business-related, and work environment factors associated with driving tired among taxi drivers in two metropolitan U.S. cities, Journal of Safety Research, 70, 71–77).

US study: 37.5% drivers participating in a simulator test drive after working the night shift were involved in a near-crash event compared with zero near-crashes of shift workers after sleep (Lee et al., 2015. High risk of near-crash driving events following night-shift work. PNAS, 113, 176-181).



“.. persons with sleep apnea have a 2 to 3 times increased risk of crash, compared with the general population (Ellen et al., 2006, Systematic review of motor vehicle crash risk in persons with sleep apnea). Journal of clinical sleep medicine)



Fatigue countermeasures



Regulation/enforcement



Education and information



Road infrastructure



Vehicle technology



Education & information

- Effects measured in: knowledge, beliefs, risk perception, intentions
- Stand-alone campaigns: only small effect on actual behaviour to be expected
- Campaigns should show recommended behaviours and highlight their usefulness and effectiveness
- For professional drivers: education part of fatigue management programs

Adamos, G., Nathanail, E., & Kapetanopoulou, P. (2013). Do road safety campaigns work? How to assess the impact of a national fatigue campaign on driving behaviour. *Transportation Research Record: Journal of Transportation Research Board*, no. 2364 (pp. 62–70). Transportation Research Board of the National Academies, Washington, D.C.



Road infrastructure

Preventing fatigued driving:

- Provision of rest areas for truck & car drivers (e.g. Bunn et al., 2019)

Preventing consequences of fatigued driving (European Commission, 2020):

- Rumble strips
- Safety barriers and obstacle-free zones

Bunn, T.L., Slavova, S., & Rock, P.J (2019). Association between commercial vehicle driver at-fault crashes involving sleepiness/fatigue and proximity to rest areas and truck stops. *Accident Analysis and Prevention*, 126, 3–9.

European Commission (2020) Road safety synopsis – Fatigue. European Road Safety Observatory. Brussels, European Commission, Directorate General for Transport.



Vehicle technology

- Advanced driver assistance systems ADAS may reduce fatigue-related crashes
- 2 mechanisms: warning the driver or intervening
- New 2019 EU regulation on motor vehicle type approval makes mandatory starting 2022:
 - *intervening Lane Keeping System for passenger cars & light commercial vehicles vans*
 - *a warning Lane Departure Warning system for buses & trucks*
 - *driver drowsiness and attention warning system for all vehicle categories*
 - *a range of advanced vehicle safety features for all vehicles*

European Union (2019). Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users [....]. Official Journal of the European Union, L 325/1.



Driver fatigue: happy end?

- Stubborn problem
- A number of solutions - to some extent - effective
- Vehicle technology/automation: new solutions (& challenges)



SWOV

**Thank
you!**

[swov.nl](https://www.swov.nl)

