Truck drivers' turning information concept – a psychological approach

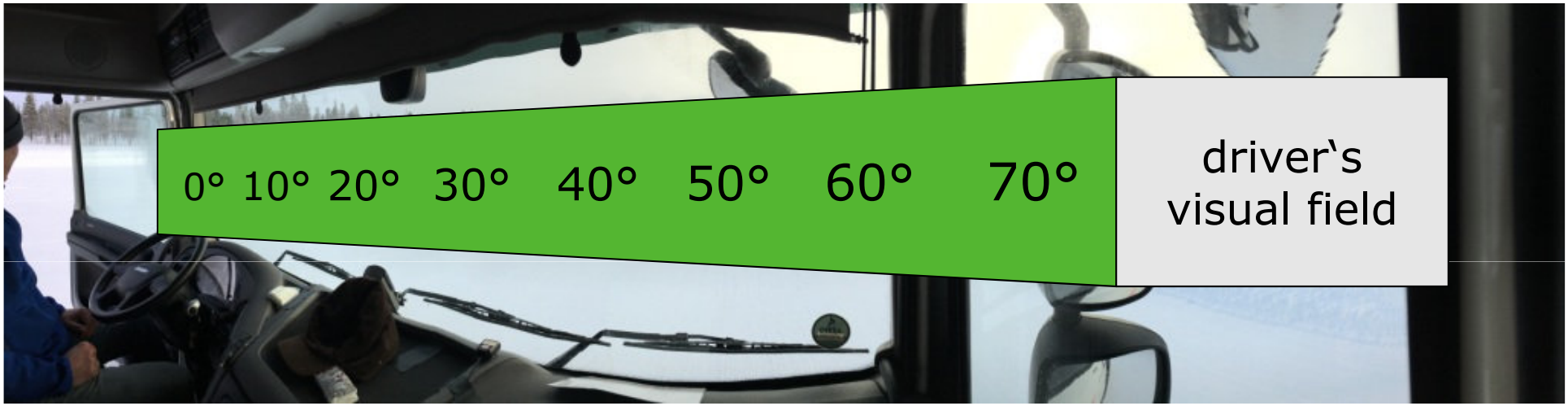
M.Sc. Alexander T. Frey

Federal Highway Research Institute

Agenda

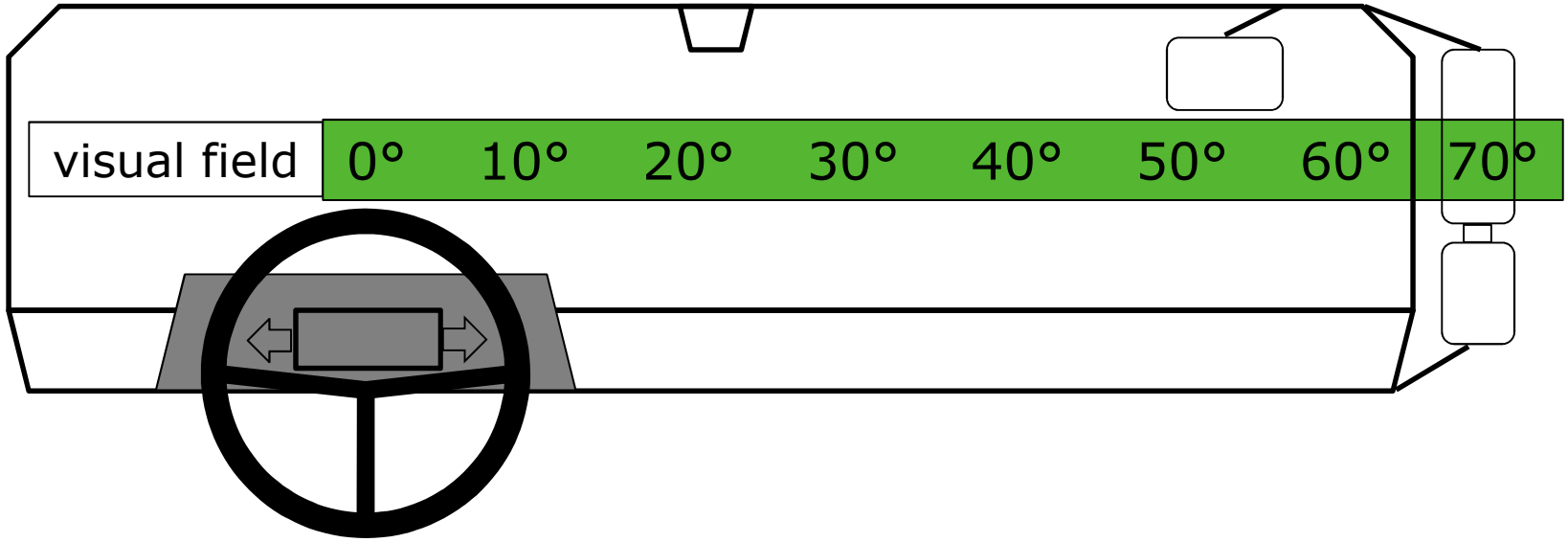
- Truck driving – the visual field
- Turning information concept
- Human factors‘ approach
- Where to place visual information?
- What about colors?
- How to avoid disturbance?
- Conclusions

Truck driving – the visual field



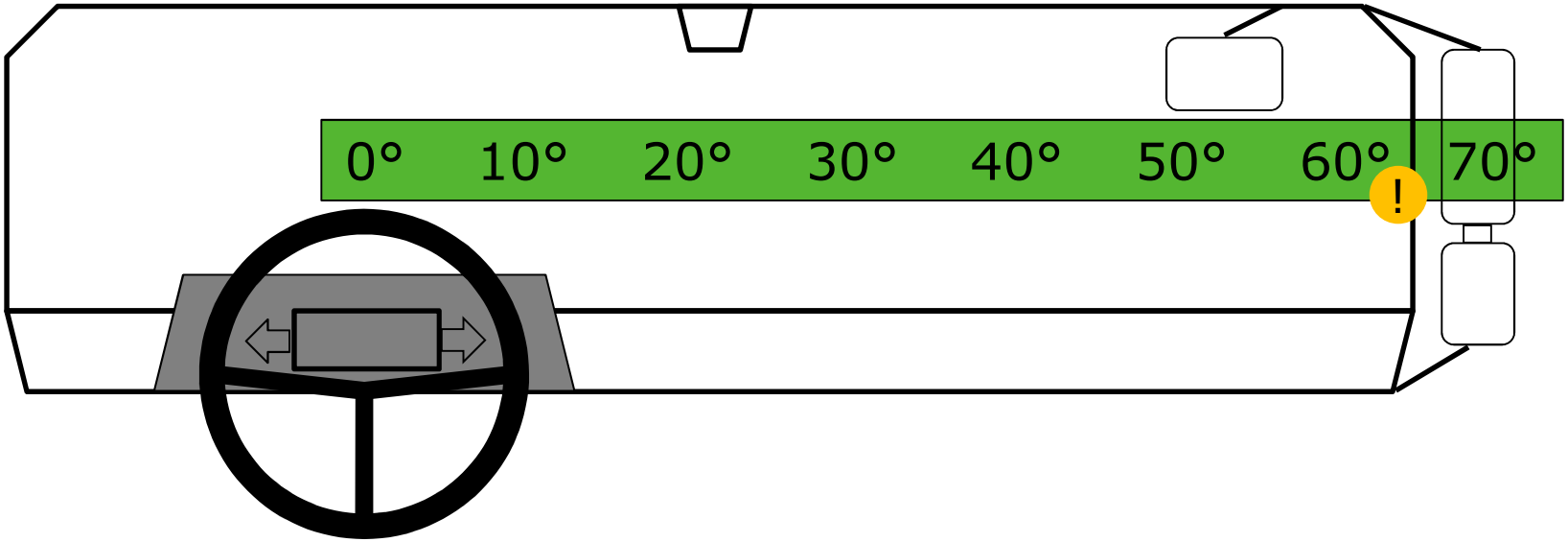
Driver‘s head and gaze turns in the direction of driving!

Turning information concept



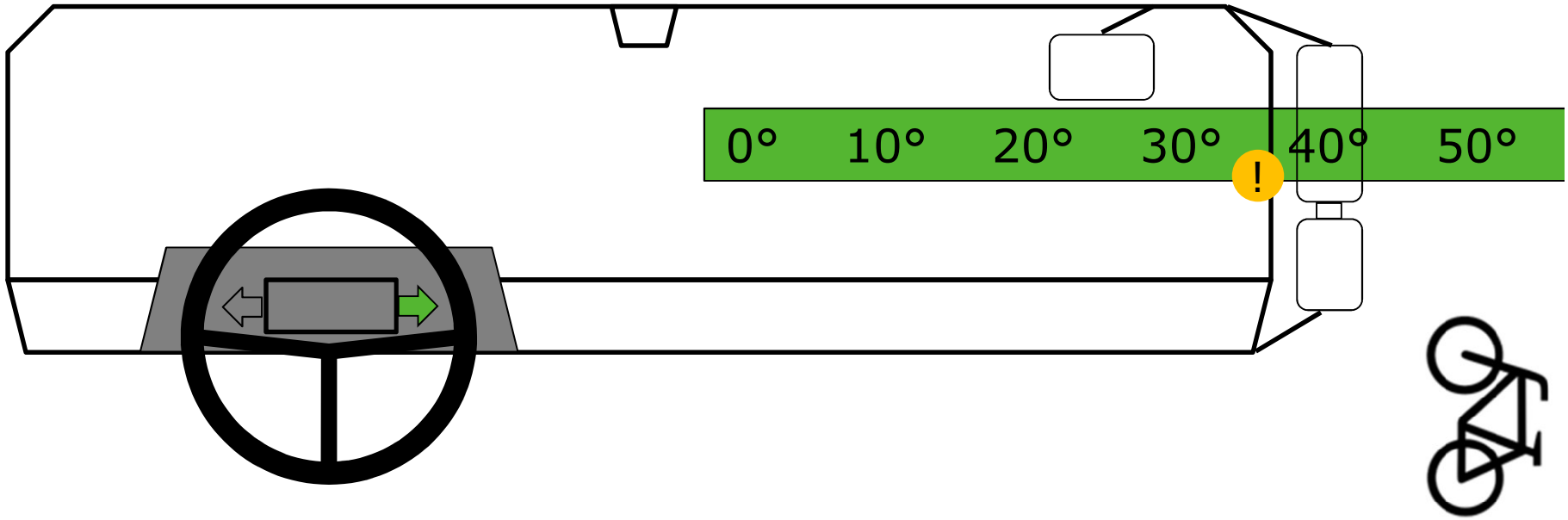
→ No accident prone situation

Turning information concept



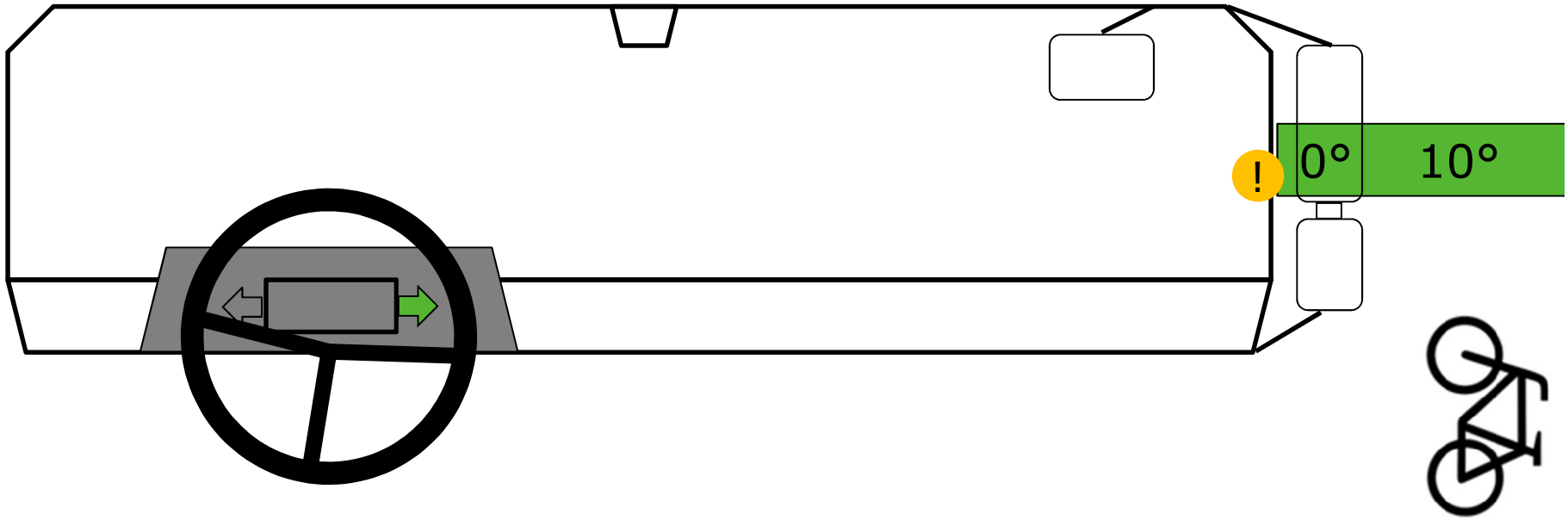
→ Driving straight ahead, blind spot detection

Turning information concept



→ Driving straight ahead, preparing turning,
(direction indicator <u>maybe</u> activated)

Turning information concept



→ Begin turning, direction indicator maybe activated,
→ gaze perhaps into mirror's direction

Human factors‘ approach

- Drivers‘ task
  - steer and control with available information
  - primarily visual (ANDERSEN, 2011)
  - many decisions in short time span
- Humans make decisions very fast under uncertainty (TVERSKY & KAHNEMAN, 1974)
  - by available information
  - by representative information (memory involvement)

Human factors‘ approach

1. Support drivers with information!
2. Make perception possible!
3. Create attentional fixation! (WOGALTER, CONZOLA & SMITH-JACKSON, 2002)
4. Notice recommendations of design! (e.g. EN ISO 9241 [110])
5. Take situational aspects into account! (POWELLEIT ET AL., 2015)
   (e.g. accident prone situations)

What do we need?

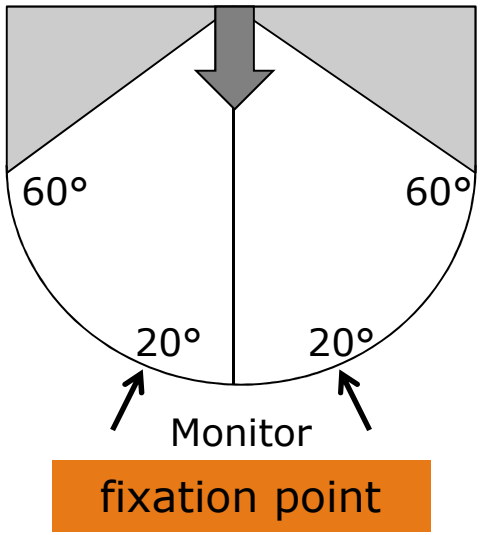
We need a recognizable and interference-free information concept!

Where to place visual information?

- Spatial resolution depends on the optical angle! (GOLDSTEIN, 1997)

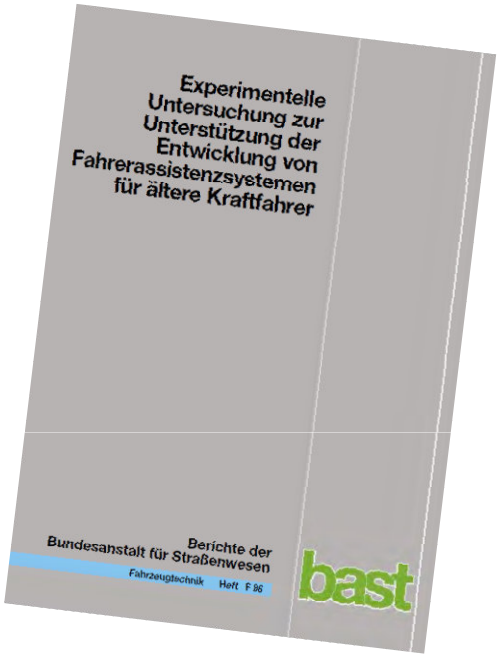
https://www.psychologie.uni-heidelberg.de/ae/allg/lehre/wct/w/w3_visuelles_system/w321_staebchen_und_zaepfchen.htm

Where to place visual information?



- Experimental study with participants *N*=30

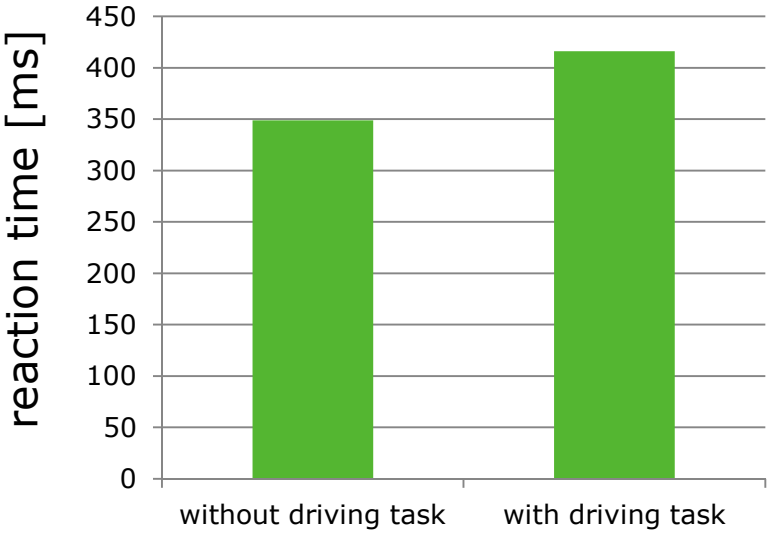
  (age between 20 and 45 years, *M*=30,53; *SD*=7,57):
- Reaction to peripheral visual stimuli (LED)
- Duration 50 ms, different time intervals
- With/without driving task



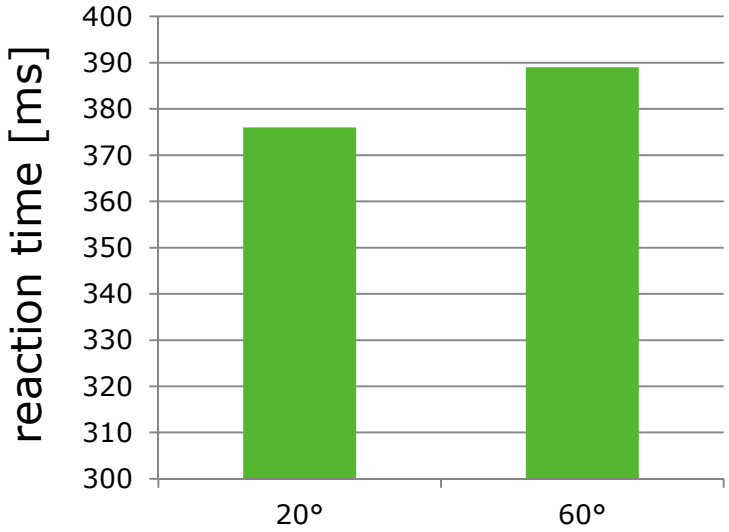
HOFFMANN et al. (2013)

Where to place visual information?

HOFFMANN et al. (2013)



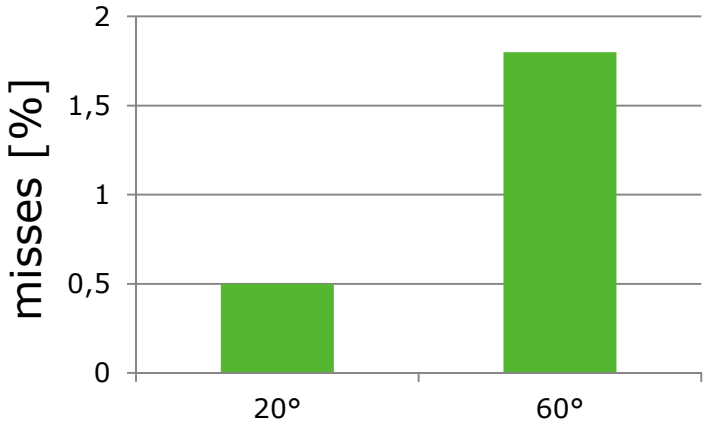
- The driving task is important for reaction times
- ($F(1,29) = 92.16$, $p<.001$)



- Reactions to visual stimuli in 20° are significant faster than reactions to stimuli of 60°
- ($F(1,29) = 92.16$, $p<.001$)

Where to place visual information?

HOFFMANN et al. (2013)



- With driving task:
  Significantly more misses
  of stimuli from 60° than from 20°
- z=-5.21, p<.001

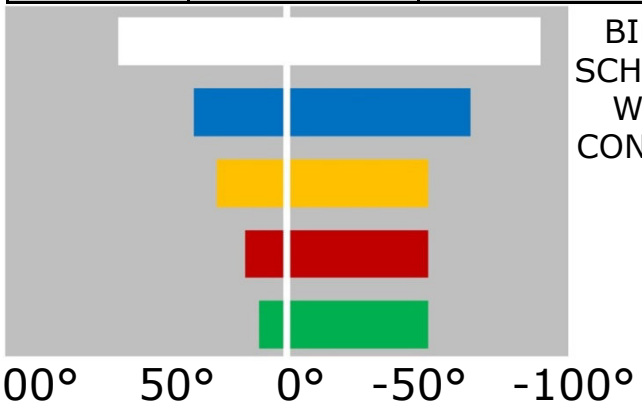
Explanation:

- More easily to recognize stimuli at 20° in comparison to 60°
- Marginal effect sizes!
- Drivers are able to notice visual stimuli even at 60°
  without moving their gaze
- Restrictions: Laboratory condition; participants know that stimuli will occur at defined positions

What about colors?

- Color-effect only for small stimuli (1° visual angle) (WERNEKE & VOLLRATH, 2011)
- Recognition of colors in periphery: lower spatial resolution (GEGENFURTHNER & HANSEN, 2006)
- Enhancement of size and intensity of stimuli → enhance the possibility of perception

color	Visual angle nasal	Visual angle temporal	Visual angle total
white	60°	90°	150°
blue	33°	65°	98°
yellow	25°	50°	75°
red	15°	50°	65°
green	10°	50°	60°



BIRBAUMER & SCHMIDT (1999); WOODSON & CONOVER (1964)

How to avoid disturbance?

- No use of warnings!
  - A warning creates maximum attentional focus (e.g. visual + acoustic + tactile) (WICKENS, 2002)
  - This can lead to distraction!

- Use of information!
  - Giving a hint to a danger without disturbance is possible
  - Avoidance of startle responses

How to avoid disturbance?

- Well-balanced flashing
  - Enhancement: higher urgency
  - more disturbance possible (BALDWIN & LEWIS, 2013)
- Survey (*N*=36) (FÄRBER, 2003)
  - Camera-Monitor-Systems (monitor in approx. 30°)
  - approx. 50% of participants prefer an bicycle icon inside the monitor when a bicycle appears in the blind spot
  - approx. 14% dislike it
- 30° (around fixation) is most important for vehicle control!

(LACHENMAYR, 2006)

Turning information concept

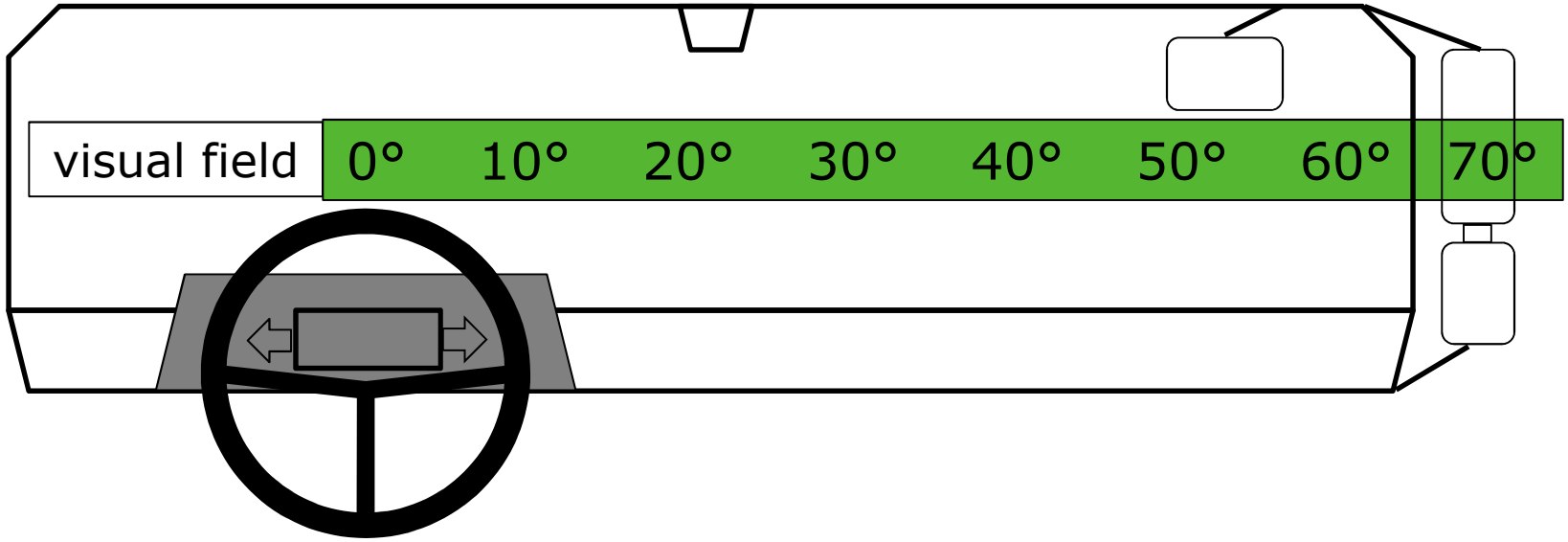
The balance between recognizable and interference-free is the key!

- You can achieve it!
  - …using the periphery
  - …using human's gaze movement
- Display blind spot information!

Turning information concept

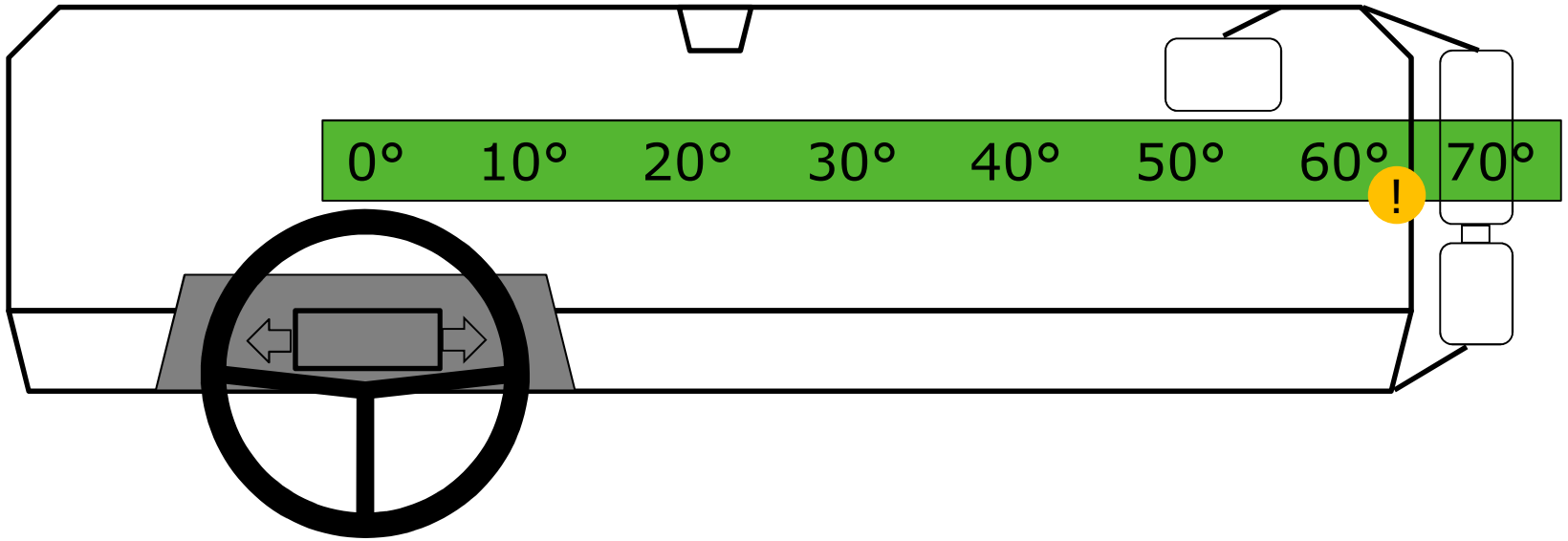
- Display blind-spot information!
  - Stamp out the blind spot!
  - Familiar for drivers (car experience)
  - Drivers expect backward information next to mirrors
  - **Benefit of 23%** regarding injury crashes (CICCHINO, 2017)

Turning information concept



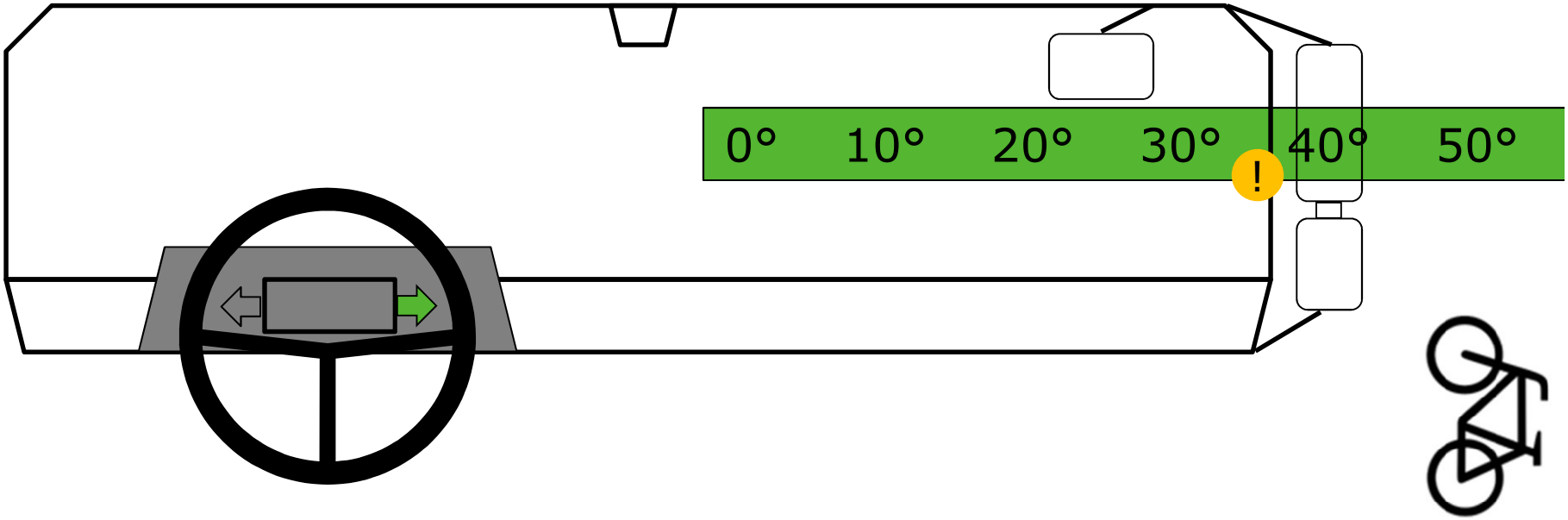
→ No accident prone situation

Turning information concept



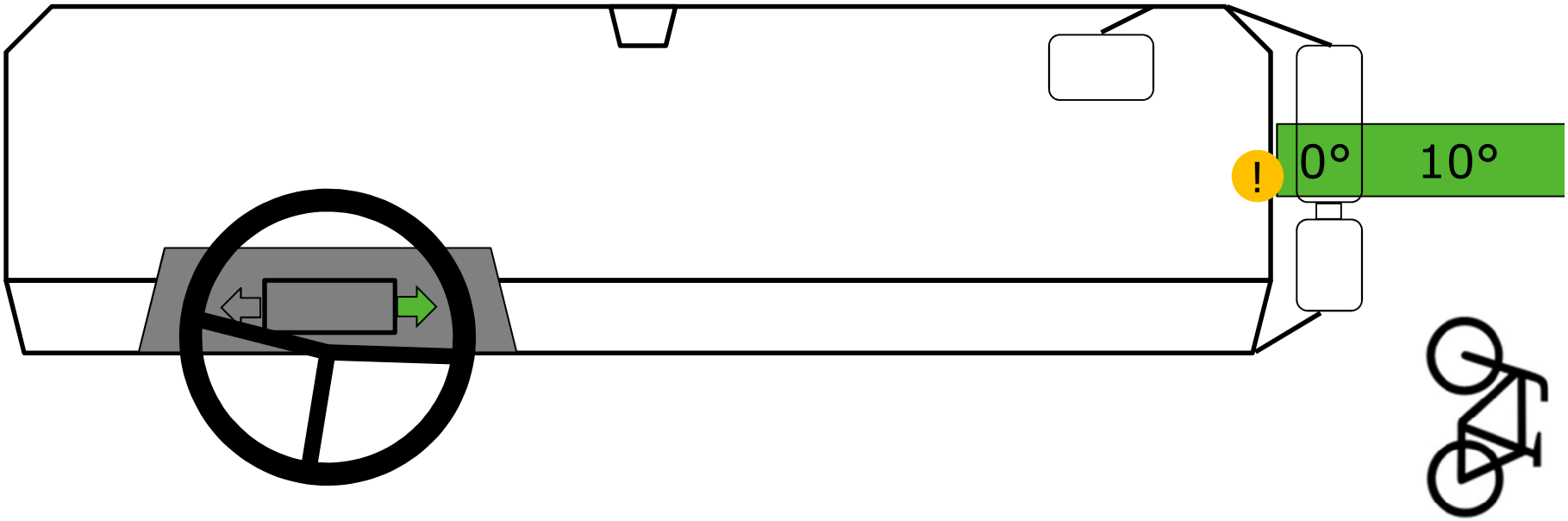
→ Driving straight ahead, blind spot detection

Turning information concept



→ Driving straight ahead, preparing turning,
(direction indicator <u>maybe</u> activated)

Turning information concept



→ Begin turning, direction indicator maybe activated,
→ gaze perhaps into mirror's direction

Conclusions

- Not disturbing (robustness in case of false positives)!
- Well informing (in use case)!
  - Perception increases when gaze turned!
- Information location (e.g. at A-pillar) equivalent with hazard location!
  - Information is at the right place at the right time!
- Use of mirrors is encouraged!
- Overall: Good support in complex situations!

Thank you for your attention!

Federal Highway Research Institute

References

- ANDERSEN, G. J. (2011): Sensory and perceptual factors in the design of driving simulation displays. In: D. L. FISHER; M. RIZZO; J. K. CAIRD; J. D. LEE (Eds.): Handbook of Driving Simulation for Engineering, Medicine, and Psychology (pp. 8-1-8-11). Boca Raton, FL: CRC Press
- BALDWIN, C. L., & LEWIS, B. A. (2013). Perceived urgency mapping across modalities within a driving context. *Applied Ergonomics.*
- BIRBAUMER, N., & SCHMIDT, R. F. (1999). *Biologische Psychologie (4th ed.). Springer-Lehrbuch. Berlin, Heidelberg, New York: Springer.*
- CICCHINO, J. B. (2017). Effects of Blind Spot Monitoring Systems on Police-reported Lane-change Crashes.
- EN ISO 9241 [110]
- FÄRBER, B. (2003). Auswirkungen neuer Informationstechnologien auf das Fahrerverhalten. *BERICHTE DER BUNDESANSTALT FUER STRASSENWESEN. UNTERREIHE MENSCH UND SICHERHEIT*, (149).
- GEGENFURTHNER, K. R., & HANSEN, T. (2006). Farbwahrnehmung. In Funke, Joachim, Frensch, & Peter A. (Eds.), *Handbuch der Psychologie: Bd. 5. Handbuch der Allgemeinen Psychologie - Kognition (pp. 157–164). Göttingen: Hogrefe.*
- GOLDSTEIN, E. B. (1997). *Wahrnehmungspsychologie: Eine Einführung. Spektrum-Lehrbuch. Heidelberg [u.a.]: Spektrum, Akad. Verl.*

References

- HOFFMANN, H., WIPKING, C., BLANKE, L., & FALKENSTEIN, M. (2013). Experimentelle Untersuchung zur Unterstützung der Entwicklung von Fahrerassistenzsystemen für ältere Kraftfahrer. *BERICHTE DER BUNDESANSTALT FUER STRASSENWESEN. UNTERREIHE FAHRZEUGTECHNIK*, (86).
- LACHENMAYR, B. (2006): Gesichtsfeld und Verkehr. Wie funktioniert das periphere Sehen? Ophthalmologe, 103, 373-381
- POWELLEIT, M., MUHRER, E., VOLLRATH, M., HENZE, R., LIESNER, L., & PAWELLEK, T. (2015). *Verhaltensbezogene Kennwerte zeitkritischer Fahrmanöver (BASt-Bericht F 100).*
- TVERSKY, A., & KAHNEMAN, D. (1974). Judgment under uncertainty: Heuristics and biases. *science*, *185*(4157), 1124-1131.
- WERNEKE, J., & VOLLRATH, M. (2011). Signal evaluation environment: a new method for the design of peripheral in-vehicle warning signals. *Behavior Research Methods, 43(2), 537–547.*
- WICKENS, C. D. (2002). Multiple resources and performance prediction. *Theoretical Issues in Ergonomics Science, 3(2), 159–177.*
- WOGALTER, M. S., CONZOLA, V. C., & SMITH-JACKSON, T. L. (2002). Research-based guidelines for warning design and evaluation. *Applied Ergonomics, 33(3), 219–230. doi:10.1016/S0003-6870(02)00009-1*
- WOODSON, W. A., & CONOVER, D. W. (1964). *Human engineering guide for equipment designers (2nd ed.). Berkleley: University of California Press.*