BMW GROUP

TECHNISCHE UNIVERSITÄT CHEMNITZ

THE ROLE OF MENTAL MODELS IN THE EFFECTIVENESS OF DRIVER MONITORING SYSTEMS

INA MARIE KONIAKOWSKY | BMW GROUP[1] & UNIVERSITY OF TECHNOLOGY CHEMNITZ[2]

Yannick Forster[1], Josef F. Krems[2], Andreas Keinath[1]

DDI 2024 | MICHIGAN

01

BACKGROUND.

DRIVER MONITORING SYSTEMS.

Driver monitoring systems (DMS) are becoming a standard safety feature in vehicles.

HANDS OFF THE WHEEL. EYES ON THE ROAD.

Available Cadillac Super Cruise offers the ease and convenience of hands-free driving on compatible roads.

seeingmachines

Seeing Machines
@seeingmachines · Follow

As @DrMikeLenne explains, #drivermonitoringsystem technology is as important a #safety technology as the three point seatbelt and random breath testing. Learn more - hubs.ly/Q01R77gK0
#roadsafety #seeingmachines

EURO NCAP
www.euroncap.com

EUROPEAN NEW CAR ASSESSMENT PROGRAMME
(Euro NCAP)

ASSESSMENT PROTOCOL – SAFETY ASSIST
SAFE DRIVING

Implementation 2023

Version 10.1

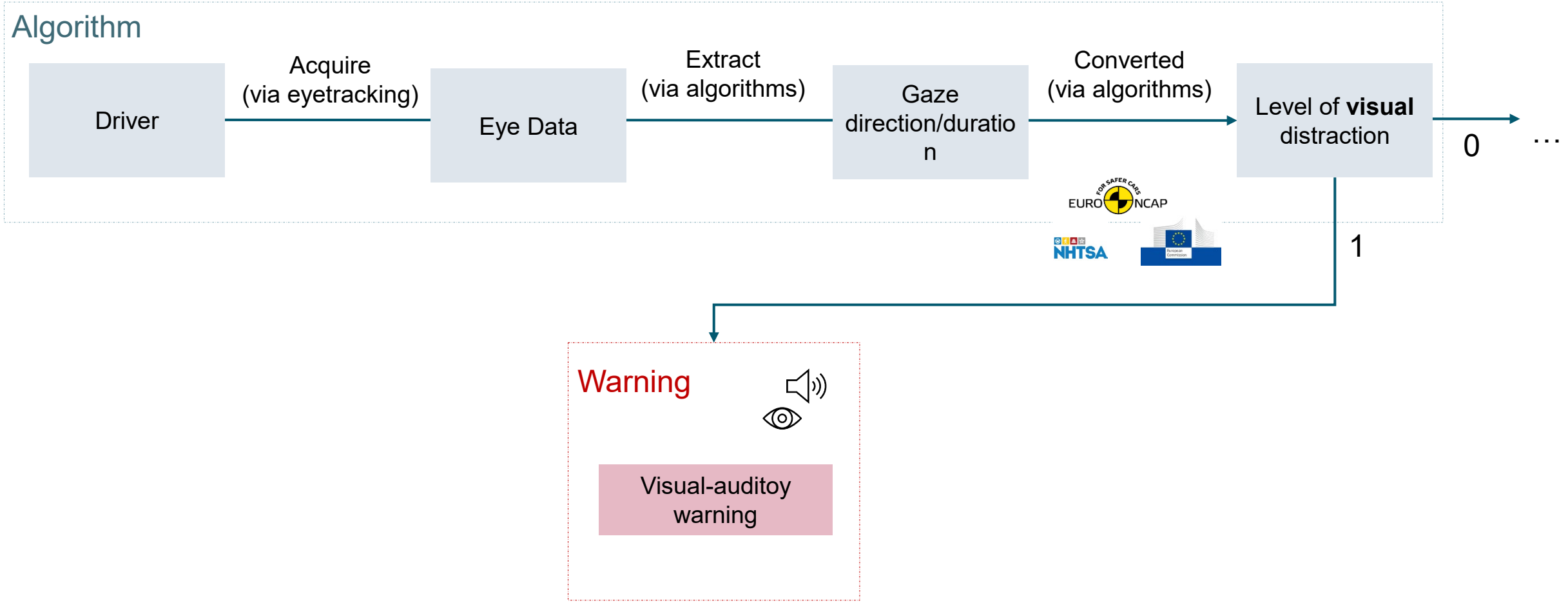
CES

Polestar 3 To Show Off Driver-Monitoring Technology At CES

The Polestar 3 has an advanced driver-monitoring system from fellow Swedish firm Smart Eye

by Brad Anderson December 16, 2022 at 07:29 1

DISTRACTION DETECTION ALGORITHM.



DRIVER DISTRACTION.

TECHNISCHE UNIVERSITÄT CHEMNITZ

> Driver distraction can be understood as a diversion of attention from the primary driving task to a competing secondary or tertiary task (Regan, Lee & Young, 2008).

RESEARCH QUESTION.

How **effective** are warnings, triggered by driver monitoring systems in reducing visual distraction?

DMS reduce the probability of long glances (> 2s)
(Atwood, 2019)

No significant effect on gaze behavior
(Ahlström, 2013)

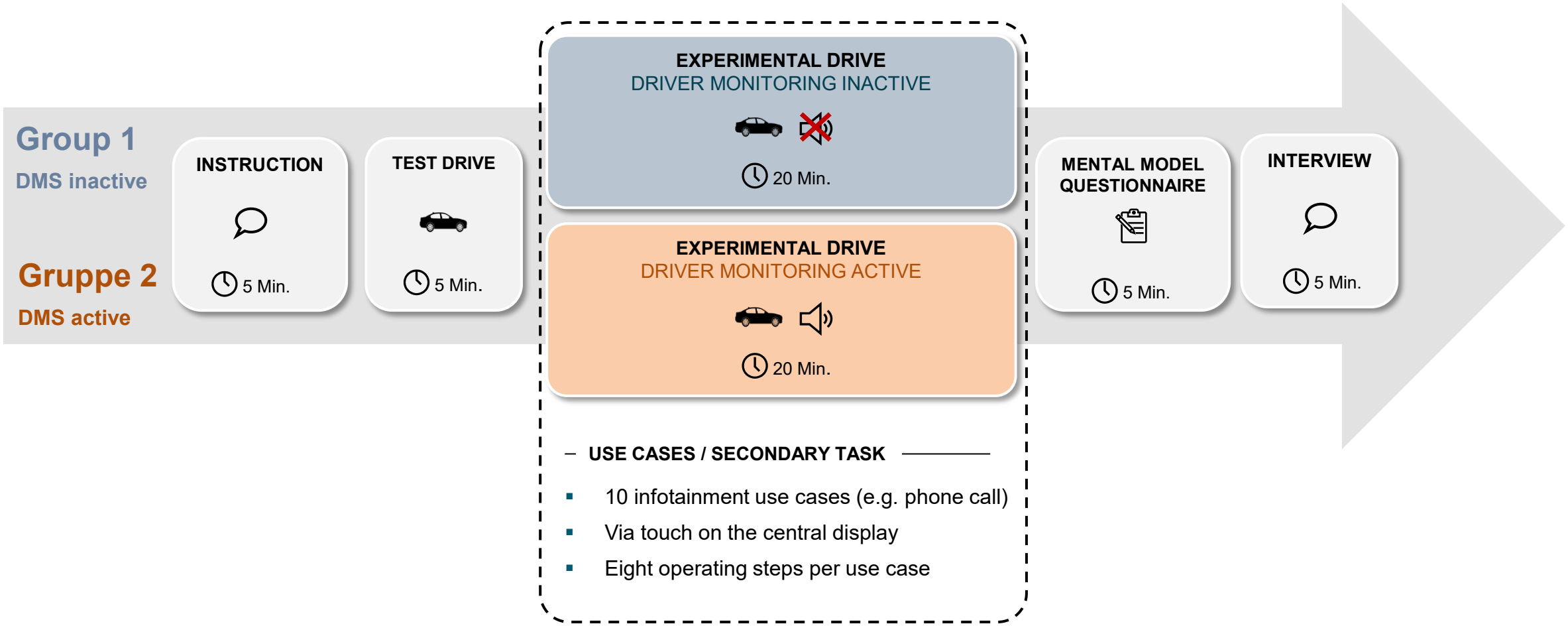
… the effectiveness of a warning system depends on the user‘s understanding
(Wogalter, 2018)

… what role does the drivers‘ mental model of the DMS play?

02

STUDY DESIGN.

EXPERIMENTAL PROCEDURE.



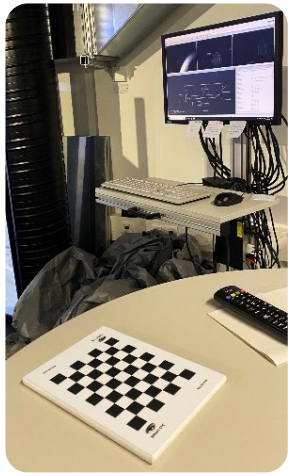
STUDY DESIGN.

ATTENTION WARNINGS

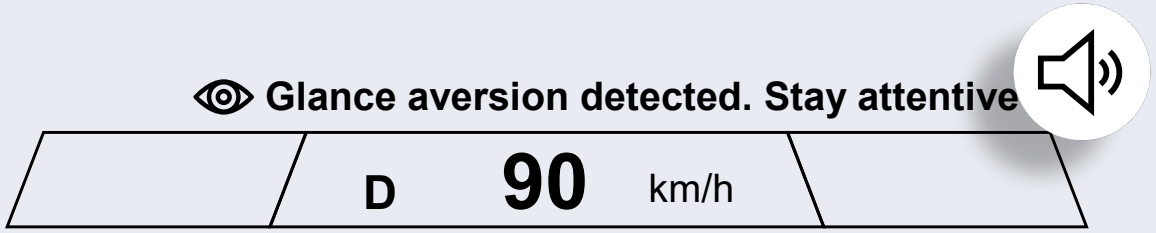
Visual-auditory warnings following the Euro NCAP algorithm specifications for distraction:

Long Distraction	Visual attention time sharing
Single gaze aversion away from the forward roadway.	**Repeated** short gaze aversion away from the forward roadway.
Driver looks away for **> 3 s**	Driver looks away for a cumulative **10 s** within the last 30 s window.

DRIVING SIMULATOR + EYE TRACKER

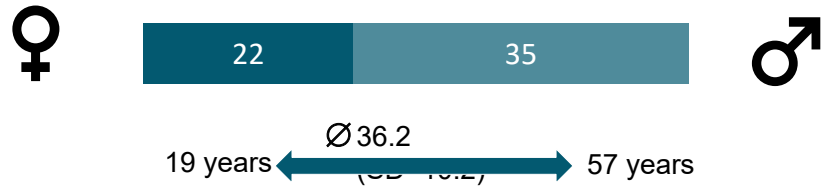


HMI



DEMOGRAPHY

N=57 participants



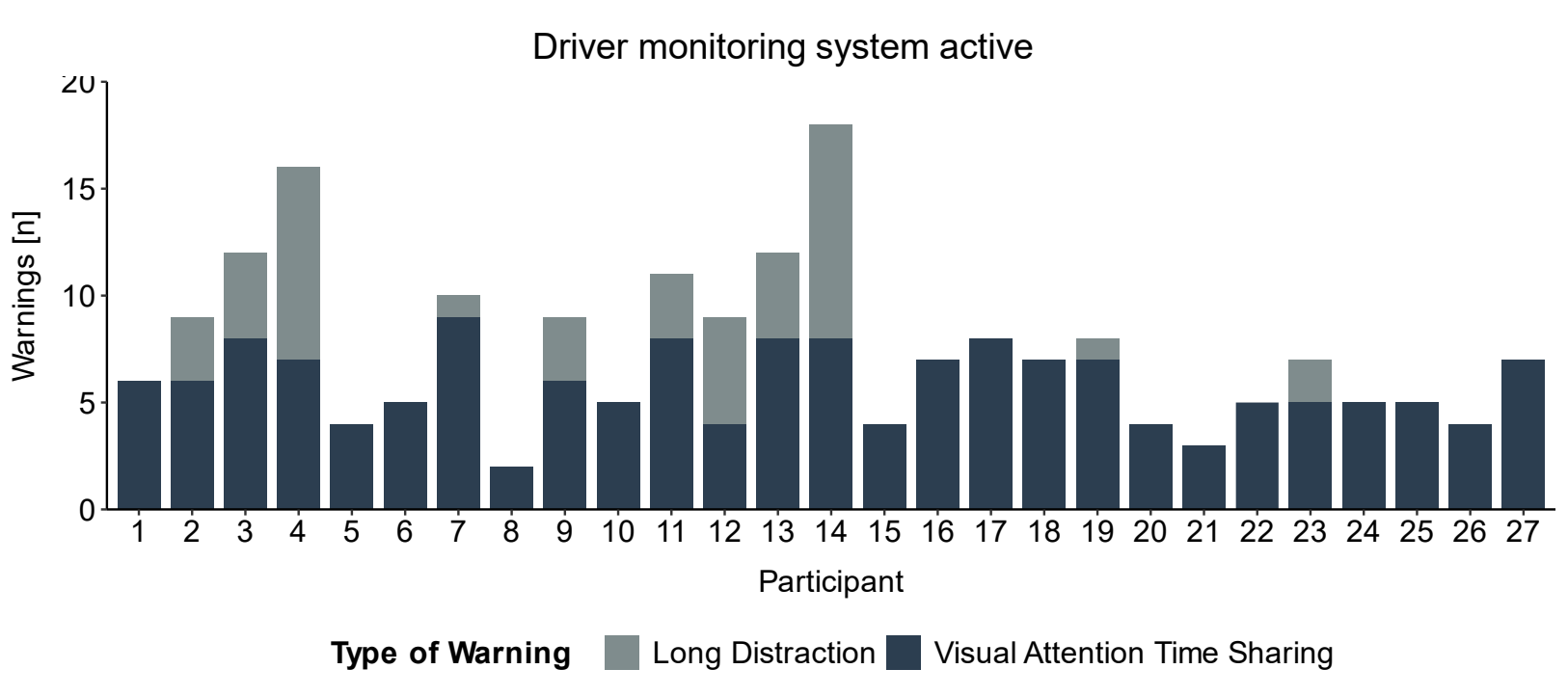
03

RESULTS.

RESULTS.

Number of long distraction and visual attention time sharing.

How many warnings were triggered by the DMS, when it was active? N=57



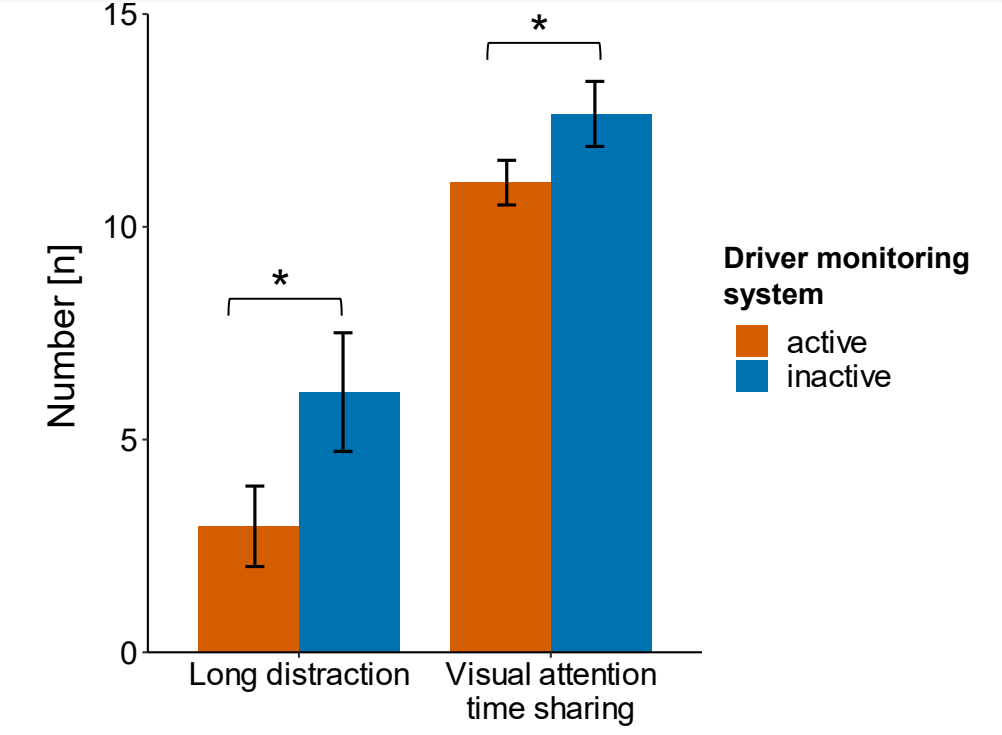
CONCLUSION

Higher number and more evenly distributed instances of visual attention time sharing than long distraction.

RESULTS.

Effectiveness of DMS.

How often did the DMS detect distraction? **N=57**



Long distraction

$t(50) = -1.87$, $p = .033$, $d = 0.52$

→ Reduction by **52%**

Visual attention time sharing

$t(50) = -1.74$, $p = .044$, $d = 0.48$

→ Reduction by **13%**

CONCLUSION

When the DMS was **active** (triggered warnings), distraction was detected significantly less often. The effect was greater with LD than with VATS.

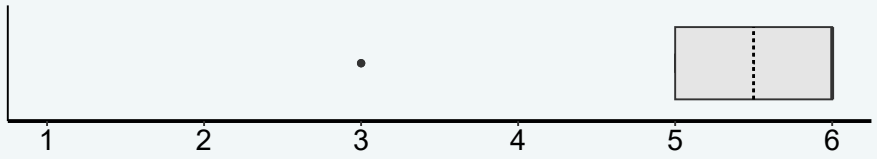
RESULTS.

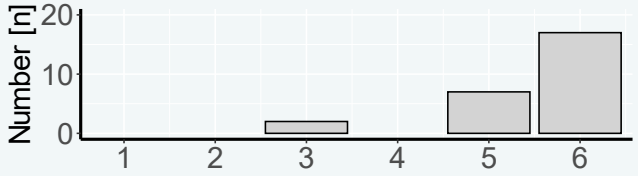
Mental model of the DMS.

Did drivers build a correct mental model of the DMS? **N=57**

Long distraction

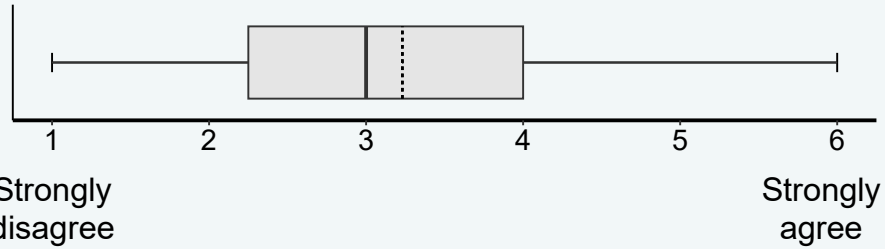
The system issues warnings for long off-road glances

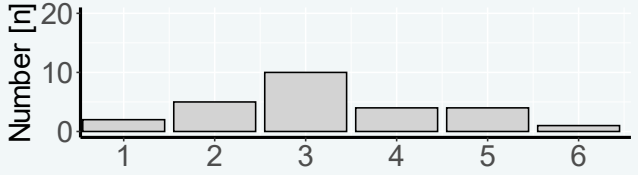




Visual attention time sharing

The system issues warnings for multiple short off-road glances.





CONCLUSION

Drivers correctly stated that **long glances** would trigger warnings. However they were **unsure**, whether **multiple** short glances would trigger a warning.

04

CONCLUSION

TAKE AWAY MESSAGES.

TECHNISCHE UNIVERSITÄT CHEMNITZ

Key findings

- The DMS significantly reduced visual distraction
- The effect for long distraction was larger than for visual attention time sharing
- Drivers had diffulties building a correct mental model of the VATS warnings

↳ Keep the complexity of DMS algorithms as low as possible so that drivers can build a correct mental model.

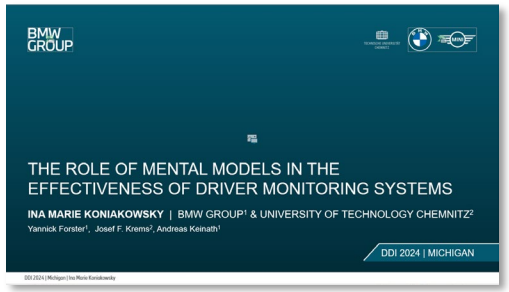
? Is it reasonable to issue so many VATS-warnings given that the effect is small, the mental model is complex, and there is a lack of theoretical evidence?

THANK YOU!

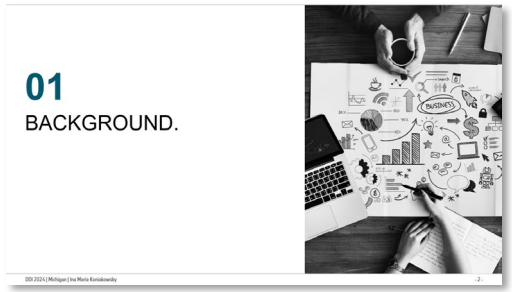
Ina Marie Koniakowsky

ina.koniakowsky@bmw.de

TECHNISCHE UNIVERSITÄT CHEMNITZ

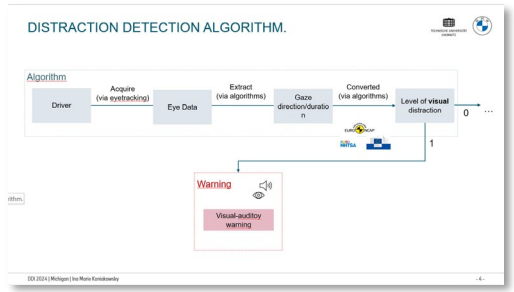


1

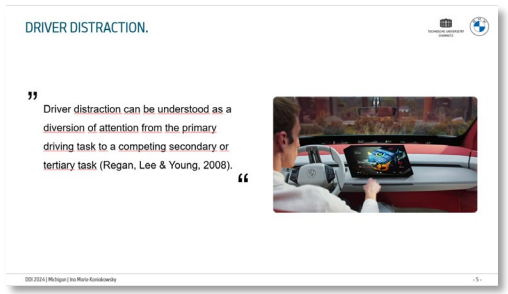


2

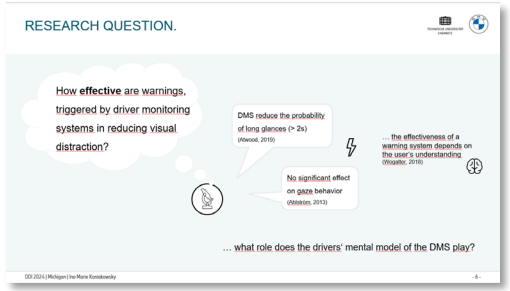
3



4

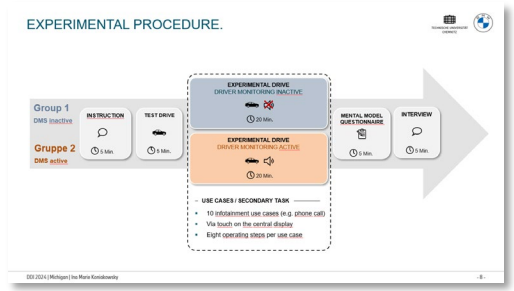


5

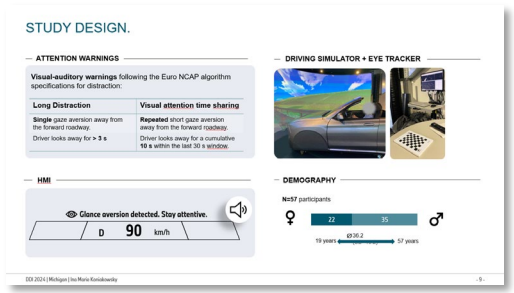


6

7

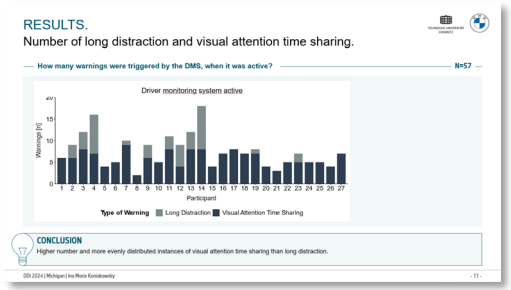


8

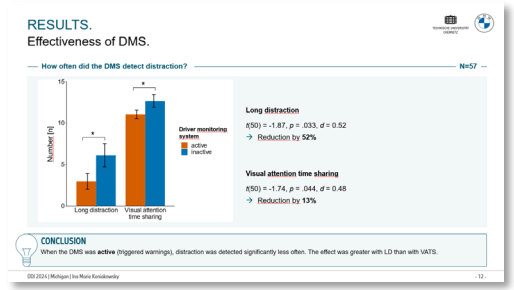


9

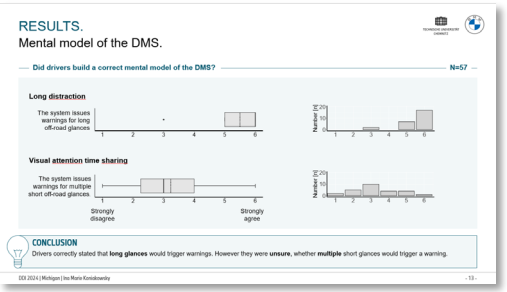
10



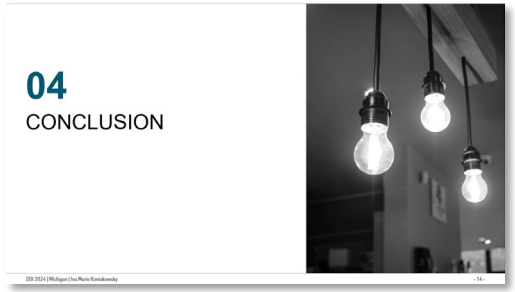
11



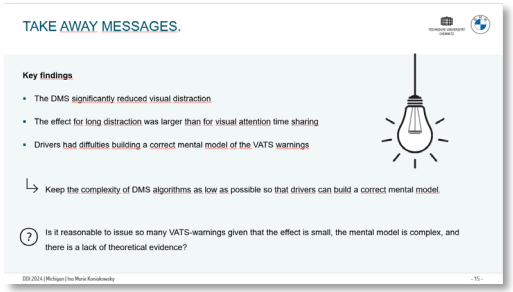
12



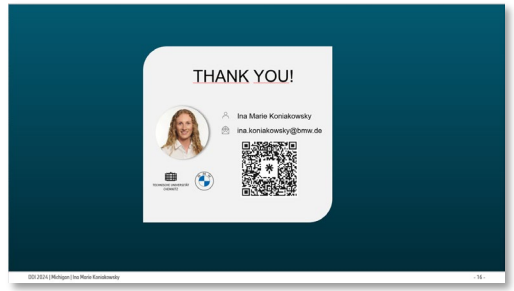
13



14



15



16

REFERENCES

Ahlström, C., Kircher, K., & Kircher, A. (2013). A Gaze-Based Driver Distraction Warning System and Its Effect on Visual Behavior. IEEE Transactions on Intelligent Transportation Systems, 14(2), 965–973. https://doi.org/10.1109/TITS.2013.2247759

Atwood, J. R., Guo, F., & Blanco, M. (2019). Evaluate driver response to active warning system in level-2 automated vehicles. Accident Analysis & Prevention, 128, 132–138. https://doi.org/10.1016/j.aap.2019.03.010

Regan, M. A., Lee, J. D., & Young, K. (2008). Driver distraction: Theory, effects, and mitigation. CRC press.

Wogalter, M. S. (2018). Communication-human information processing (C-HIP) model. In Forensic human factors and ergonomics (pp. 33-49). CRC Press.