Kinetosis as a Challenge of Future Mobility Concepts and Highly Automated Vehicles

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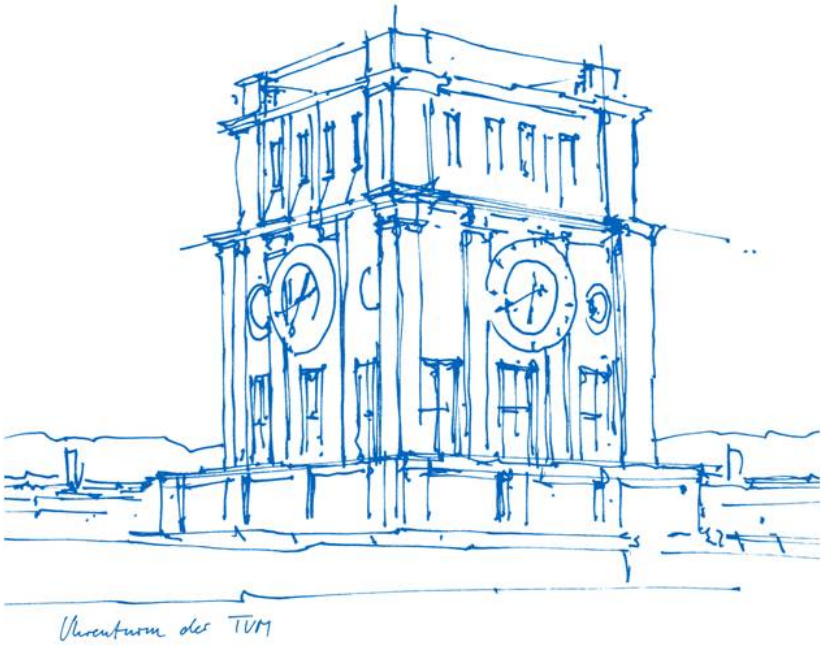


What is the presentation about?

*Kinetosis as a Challenge of **Future Mobility Concepts** and **Highly Automated Vehicles***

Reference: Internationales Verkehrswesen 2016

Aspects of future mobility concepts (2030+)

Reference: Internationales Verkehrswesen 2016

Vision Zero - Increasing Vehicle Safety

External HMI for improving situational awareness

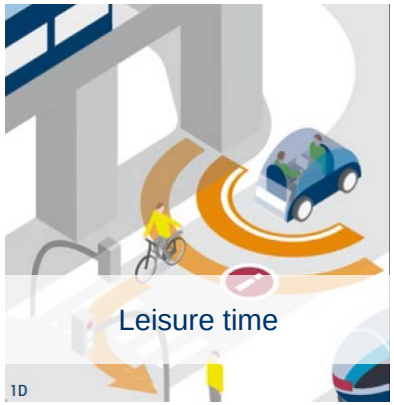
1A

Car2Car communication

1B

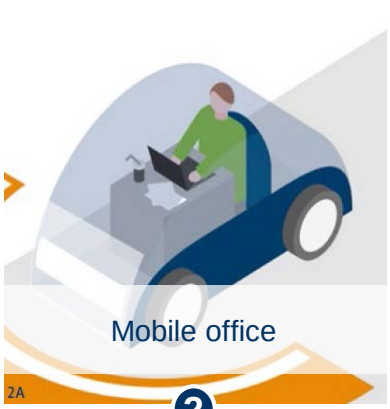
1

AV provide new Living Spaces



Leisure time

1D



Mobile office

2A

2

Multimodal public road transportation systems

Flexible route planning

3A

Information about departure times and accessibility

3C

3

New and individualized logistic concepts

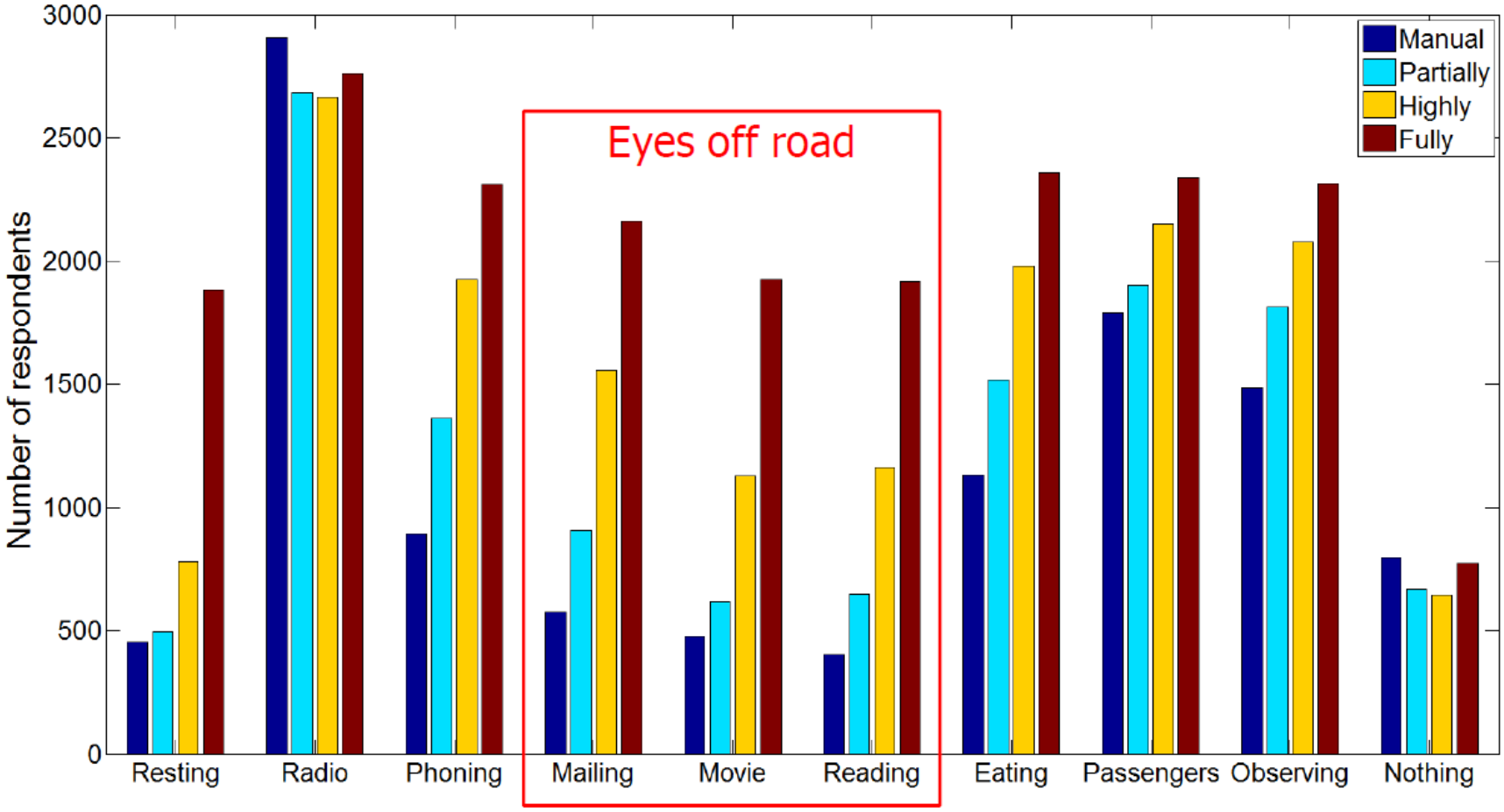
Autonomous food-delivery especially for elderly people

Improvement of sales network

4C

4

Public opinion on automated driving



Reference: Kyriakidis, Happee, de Winter. Public opinion on automated driving: Results of an international questionnaire among 5,000 respondents. TRPF-2015

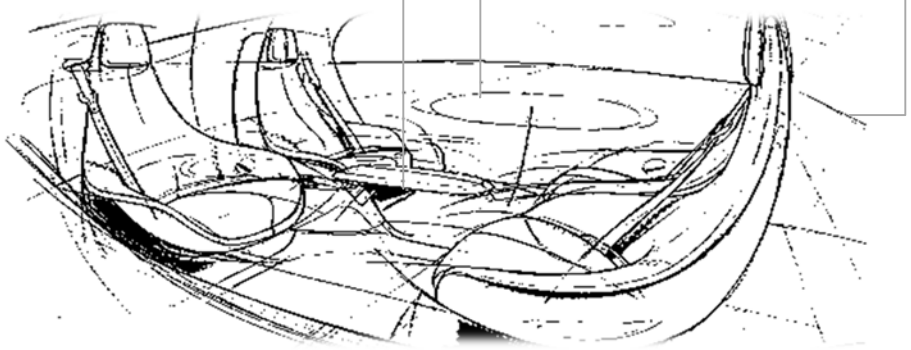
Challenges from an ergonomic perspective

The automobile becomes a private living environment.

Vis à vis positions enable passager communication.

Digital control elements allow reading, playing and working while being driven.

Internal, external, automation and motion HMI effect the usage and design of interior.



Reference: Daimler 2018

The Human Being in the center of the development

- From the customer point of view, automated vehicles are expected to increase comfort by allowing the passenger to perform alternative tasks.
- Unfortunately, the range of feasible secondary tasks will be limited by humanitarian and physiological restrictions.
- For example, working on mobile devices while driving often leads to symptoms of nausea and fatigue, which significantly affect people's behavior and their well-being.
- This phenomenon is one of the oldest protective reactions of the human organism and is called Motion Sickness (Kinetosis).
- Recent studies of M. Sivak, M. Kyriakidis or D. Criel postulate that Kinetosis will increase with automation.

Reference: Criel, Bos 2016 ; M. Kyriakidis et al. 2015 ; Sivak et al. 2015

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Forms of Kinetosis

KINETOSIS

Motion Sickness

- Carsickness, Airsickness, Seasickness, etc.
- Carousels and roller coasters
- *Debarquement*

- The cause for Kinetosis is due to movement exposure or aspects of a moving environment
- Debarquement: Characterized by sway inclination without vertigo, nausea or vomiting

Cyber Sickness

- Virtual reality (VR-glasses)
- 4-D cinema
- New multi media devices

- No movement exposure is necessary (Pseudokinetosis)
- Related to simulator sickness

Space Adaption Syndrom

- Weightlessness in space
- Parabolic flights and centrifuges

- Known as Pseudokinetosis
- Lack of gravitational force leads to unusual stimulus pattern

Simulator Sickness

- Static simulator
- Dynamic Simulator
- Hydropulser/ Stamp testing

- First examination in 1957 by Havron and Butler regarding a helicopter simulation
- Mismatch: Time delays and incongruent signals between visual and tactile irritation

Reference: Havron 1957

Basics about Motion Sickness (Kinetosis)

Reference: Irwin 1881, Mc Cauley 1992, Schmäl/Stoll 2000, Engstrom 1974, Shupak/Gordon 2006, Klosterhalfen 2005, Reason 1975, Riccio 1991, Finley 2004, Zenner 1996

WHAT is Kinetosis?

- kinein = „moving“
- Most findings based on seafaring research – Sea Sickness
- 45% of subjects report an improvement in symptoms when taking placebos
- Training effects can occur after the first exposure
- Polysymptomatic of oculomotirc, nausea and sopite symptoms

WHO experience Kinetosis?

- High inter- and intra-individual kinetosis susceptibility
- Average population susceptibility: 5-10% sensible; 75-90% medium; 5-15% resistant
- Risk groups are Children aged 2 to 12 years belong to a vulnerable group and people with a vestibular disbalance or mass discrepancy of the otoliths
- Kinetic susceptibility decreases strongly with increasing age
- Women are more likely to experience Kinetosis
- Chinese are more prone to Kinetosis stimuli than Caucasians

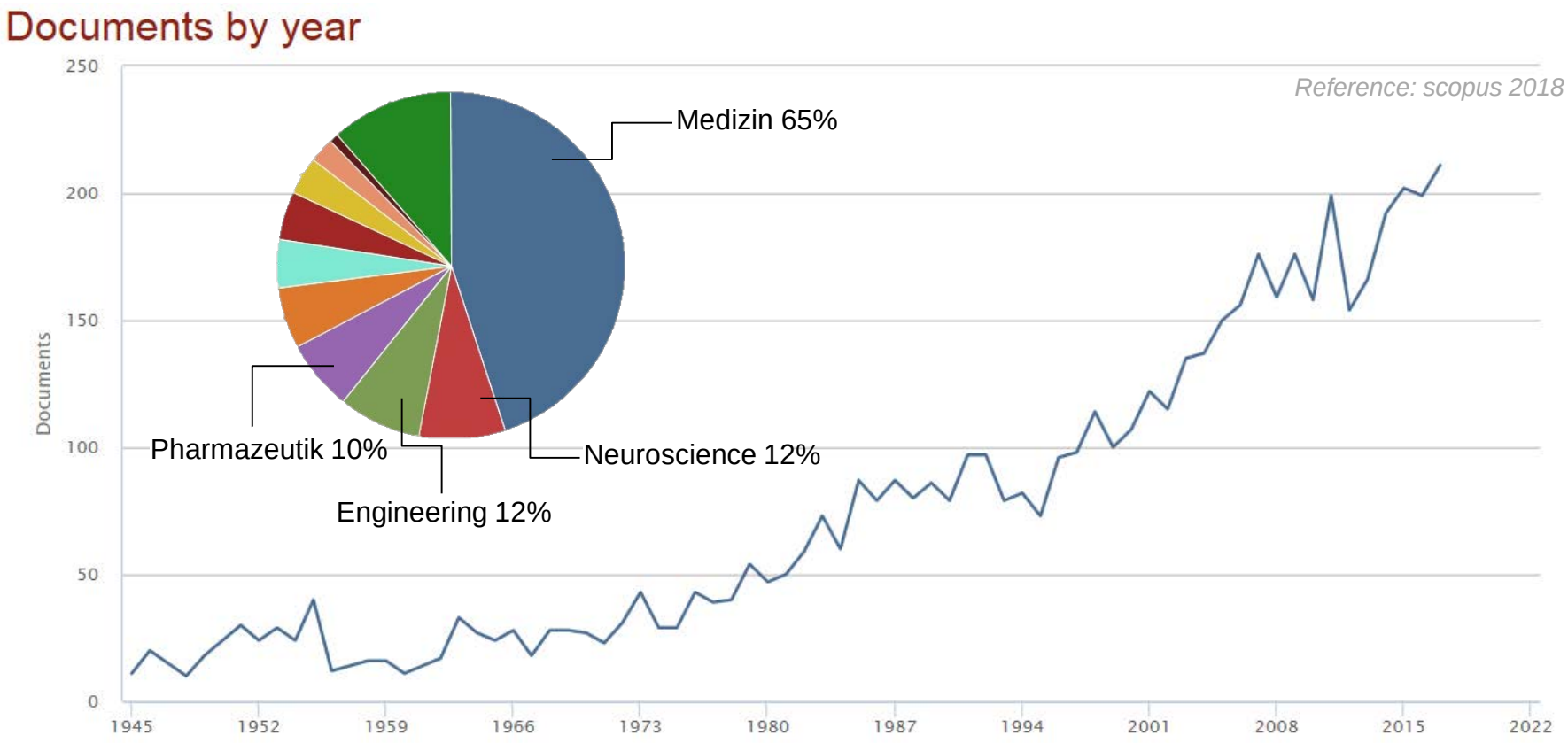
HOW can Kinetosis be avoided?

- Behavioral measures
- Pharmacological measures
- Technical measures

WHY does Kinetosis occur?

- Sensory Rearrangement Theory
- Postural Instability Theory
- Poison Theory

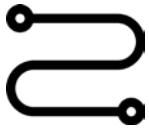
Research on Kinetosis



Research at the Chair of Ergonomics (TUM)

Mixed Design
N=25

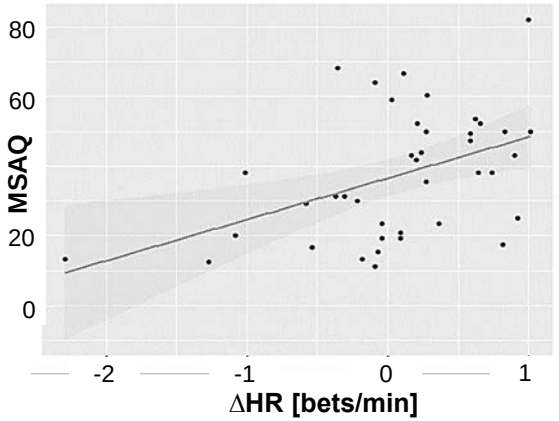
HRV, Heart Rate
Body Core Temp.
Respirationsrate

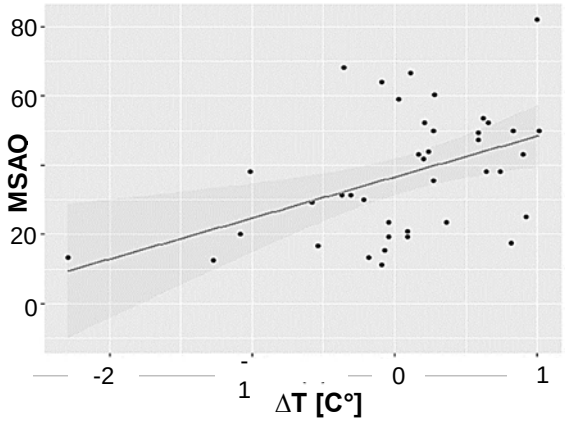


20 Min. real
test ride

V-Klasse

Objectivize | Performance | MSSQ/Time | Countermeasure





	Pre-post comparative values						
	Δ HR	Δ SDNN	Δ RMSSD	Δ LF/HF	Δ B	Δ SDBB	Δ T
MSA	r=0.29*	r=0.29	r=0.09	r=-0.20	r=-0.06	r=0.18	r=0.38**
Q	p=0.08	p=0.08	p=0.59	p=0.24	p=0.70	p=0.26	p=0.02
n	41	41	41	41	47	47	41

*p<.1; **p<.05; ***p<.01

Motion Sickness can be detected by physiological parameters. Anyhow, clustering methods of individual stress reactions presumably would increase the accuracy.

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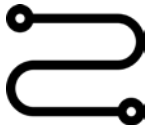

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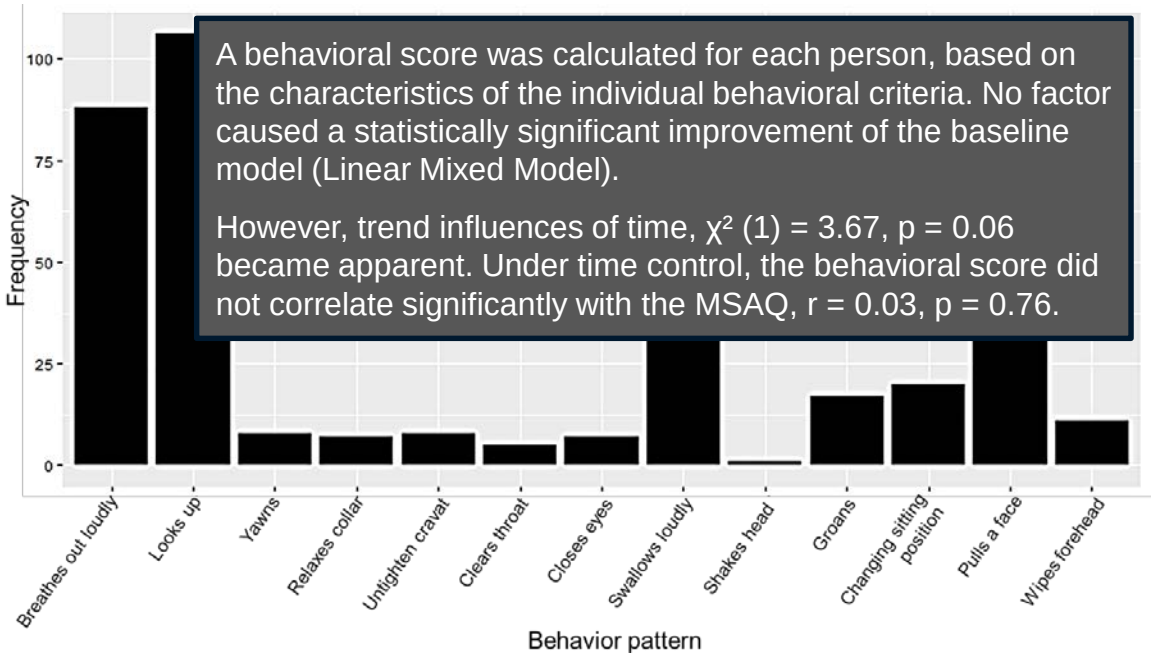

A behavioral score was calculated for each person, based on the characteristics of the individual behavioral criteria. No factor caused a statistically significant improvement of the baseline model (Linear Mixed Model).

However, trend influences of time, χ^2 (1) = 3.67, p = 0.06 became apparent. Under time control, the behavioral score did not correlate significantly with the MSAQ, r = 0.03, p = 0.76.

Motion Sickness can be detected by physiological parameters. Anyhow, clustering methods of individual stress reactions presumably would increase the accuracy.

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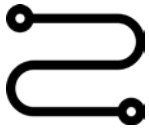

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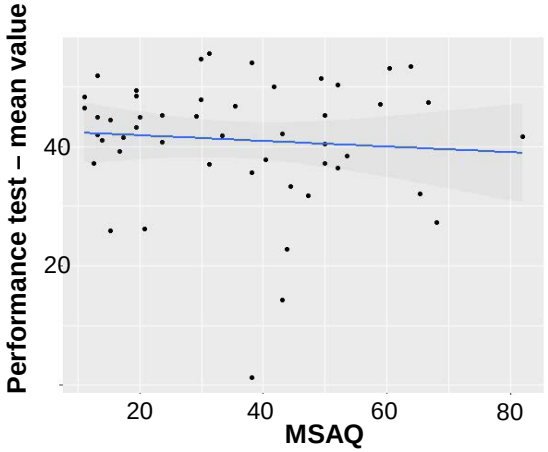

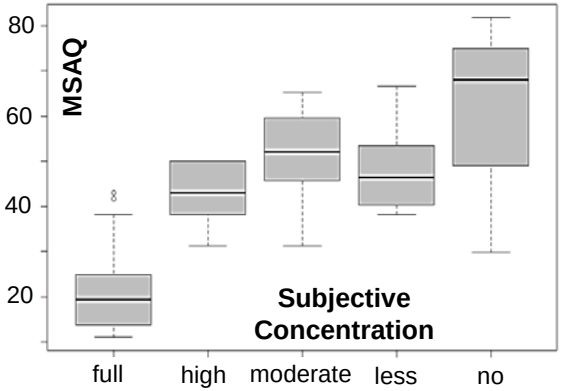

The extended multiple regression model including the MSAQ information did not improve the model fit, $\chi(1)^2 = .52$, $p = .47$.

The MSAQ proved to be a significant factor influencing subjective concentration, $\chi(1)^2 = 41.27$, $p<.0001$.

This study supports the assumption that objective (not subjective) concentration and performance are indeed unaffected by at least slight Kinetosis symptoms.

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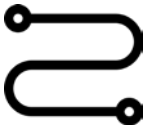

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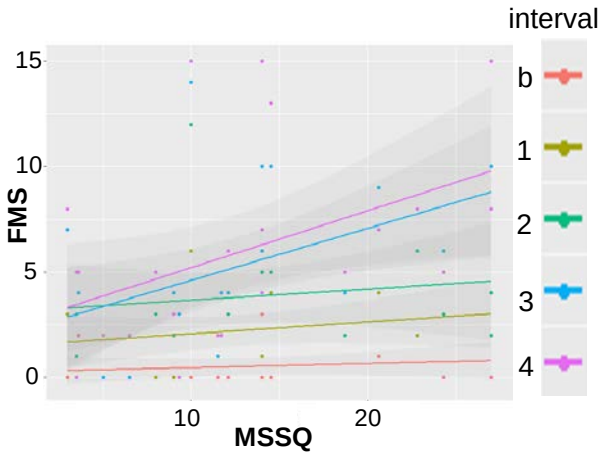

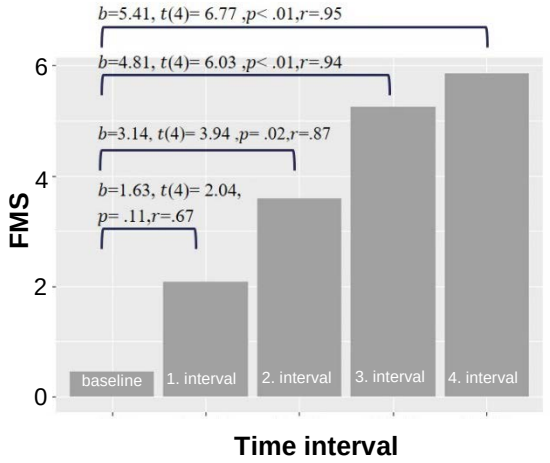

For evaluation of the MSSQ, linear mixed models were applied:

- FMS, time $t(124) = 4.60$, $p < .0001$, $r = .35$
- ø FMS: $t(23) = 2.34$, $p = .03$, $r = .44$ (identical for max. FMS)
- MSAQ: $t(23) = 2.11$, $p = .05$, $r = .40$

Kinetosis symptoms increase with time. Furthermore, the individual susceptibility has a strong impact on Kinetosis severity.

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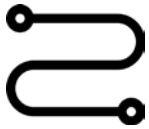

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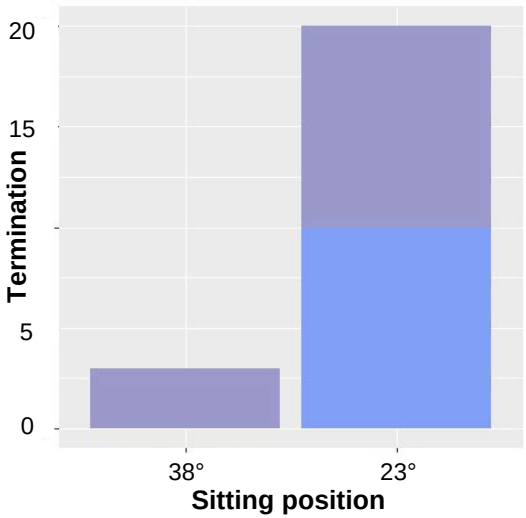
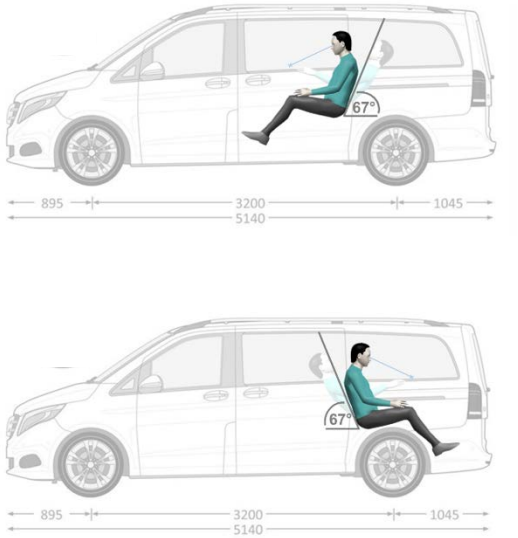


Sitting position: $\chi^2(1)=25.63$, $p<.0001$

Probability of termination:

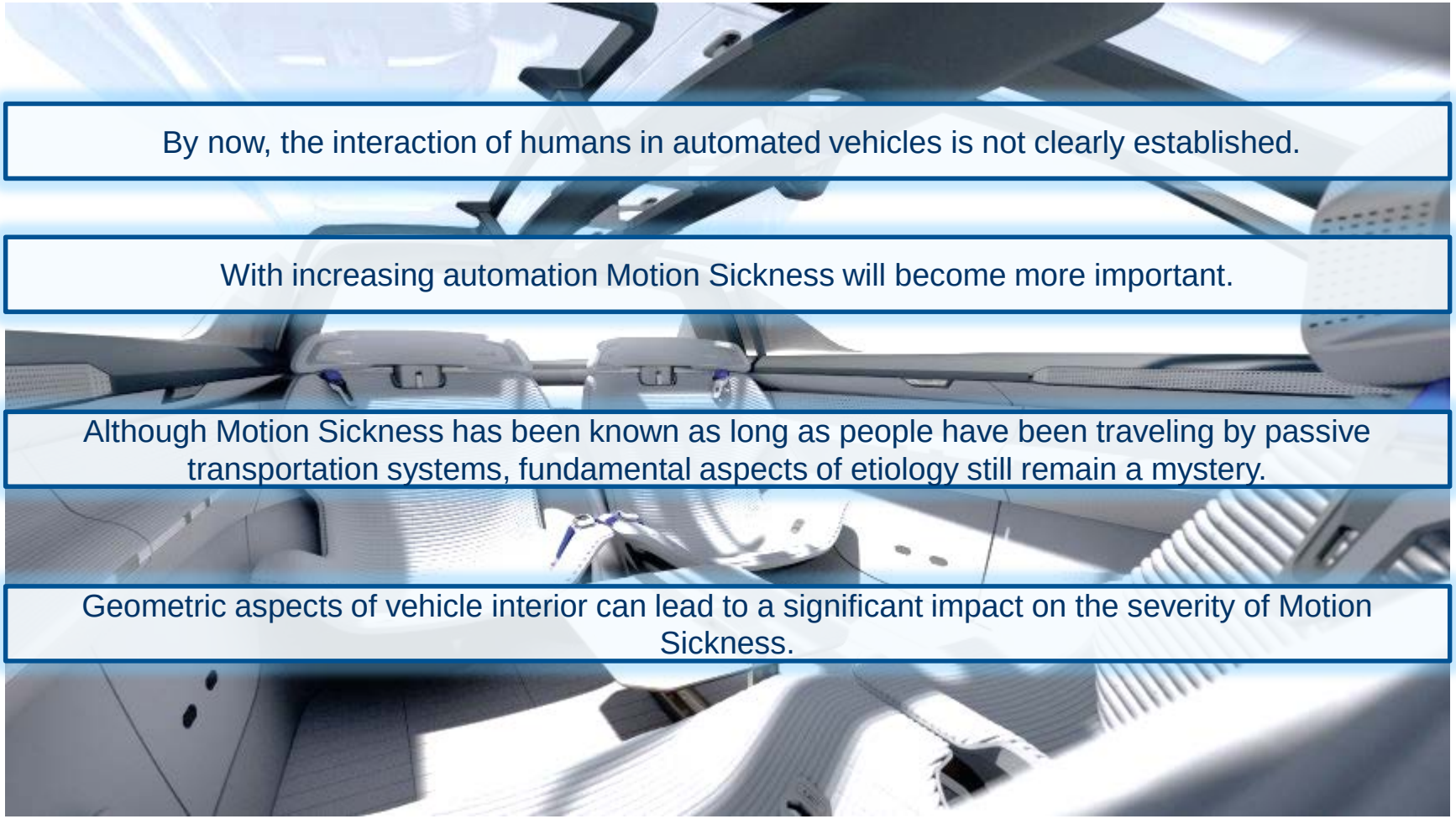
- 38° angle of the backrest: 12%
- 23° angle of the backrest: 80%



Overall, the direction of sitting position does not effect the severity of Kinetosis significantly.

The change of sitting position leads to a significant difference in the sense of comfort. Head stability has a positive effect on the well-being of the occupant while performing non-driving activities.

Summary and Outlook



By now, the interaction of humans in automated vehicles is not clearly established.

With increasing automation Motion Sickness will become more important.

Although Motion Sickness has been known as long as people have been traveling by passive transportation systems, fundamental aspects of etiology still remain a mystery.

Geometric aspects of vehicle interior can lead to a significant impact on the severity of Motion Sickness.

Reference: SpiegelOnline 2018

Thank you for your Attention!

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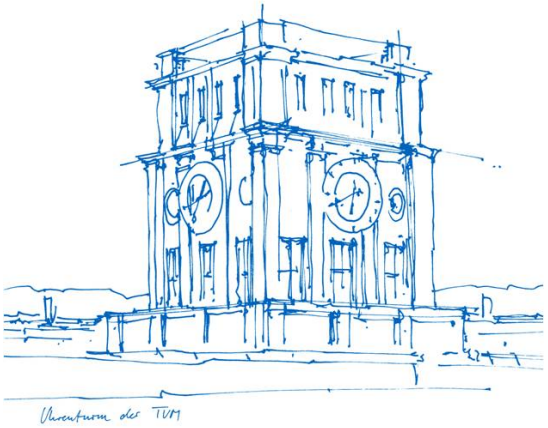

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