Lorenz Steckhan, Technical University of Munich

12 MAY 22

FINAL EVENT

IMAGinE

HMI Development for Cooperative Driver Assistance

- Default Behavior & Gamification -

AGENDA

Introduction & Overview

Default Behavior

Gamification – A concept that drives motivation?

Final HMI Concept & Evaluation

Key Messages

TUM. Technical University of Munich
Chair of Ergonomics

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Work Packages

WP 1.3

- Definition of use cases
- Analysis of Require-ments

WP 5.1

Evaluation Concept
- Definition of research objectives
- Metrics for measuring collaboration performance & driver acceptance

WP 2.4

Specific HMI questions
- Different perspectives
- Ideal conditions

Basic HMI concepts
- Driver's intention recognition
- Motivation enhancement

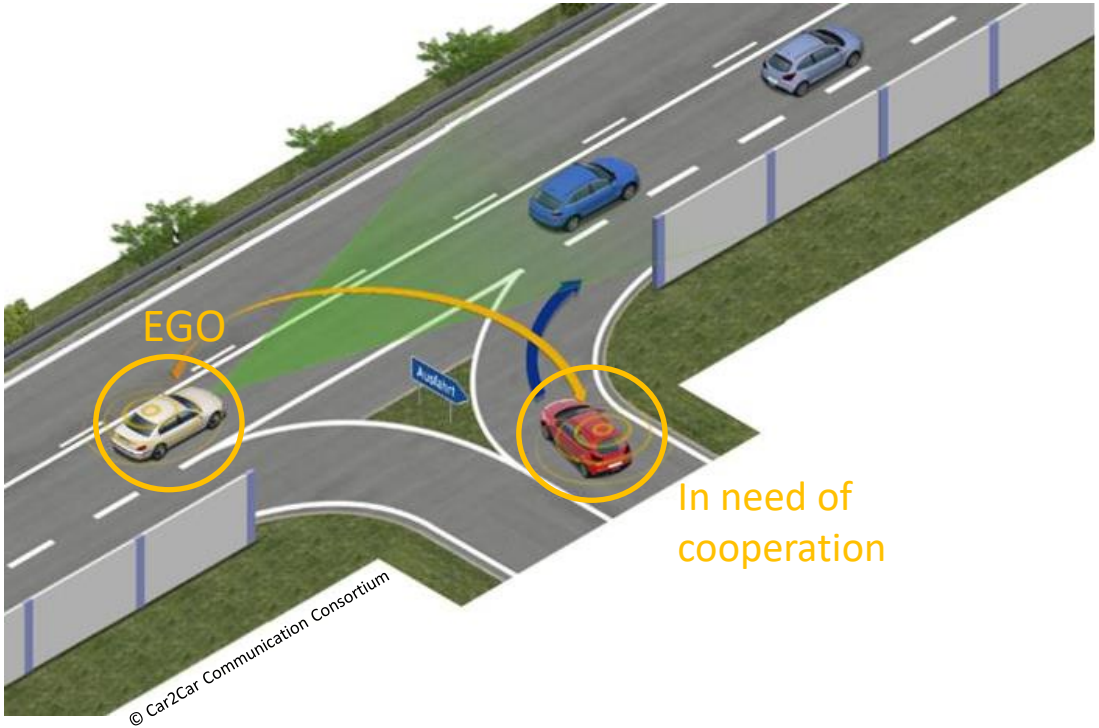
WP 3.5

- Specific scenarios for overtaking warning systems
- Beyond ideal conditions

WP 5.2

- Combination of previous results
- Development of optimized concepts
- Final evaluation

Investigations based on the scenario ”Cooperative merging on highways”



Default Behavior

What is the preferred driving maneuver of an automated assistance system for cooperative behavior?

What is the preferred default reaction of an automated assistance system when a driver does not react to a cooperation request?

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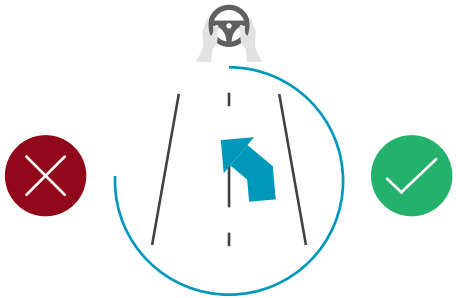
Methods

Static driving simulator (SAE 3)

N=30 (2×3 within-subject design)

Prasch et al. (2018)

Cooperation Request (HUD)



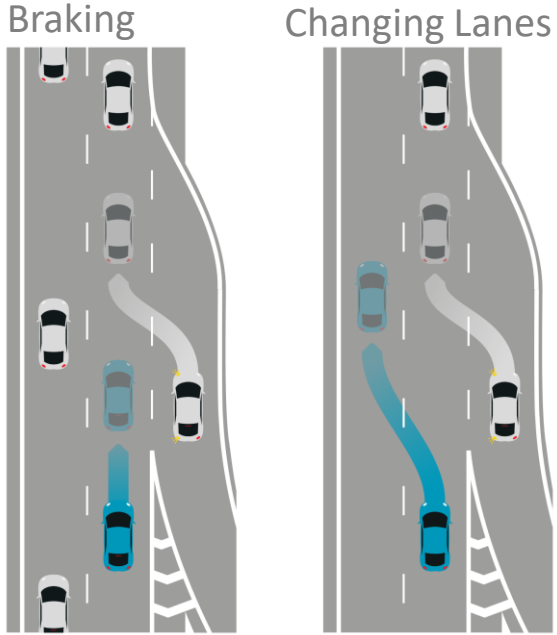
Default Reaction

Uncooperative (Decline)

Take-Over Request (TOR)

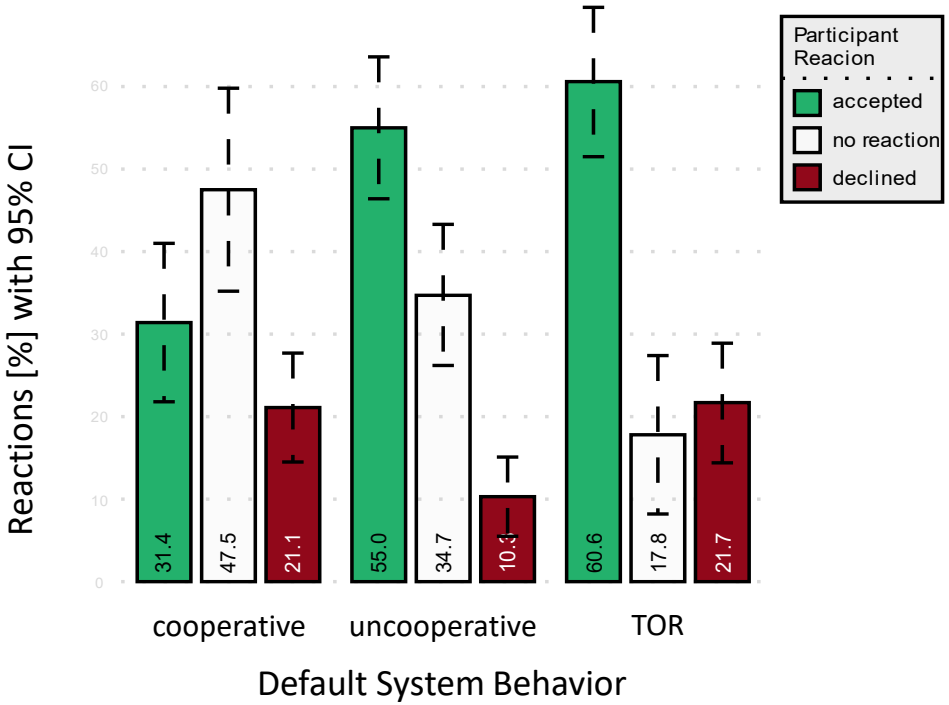
Cooperative (Accept)

Maneuver



Results

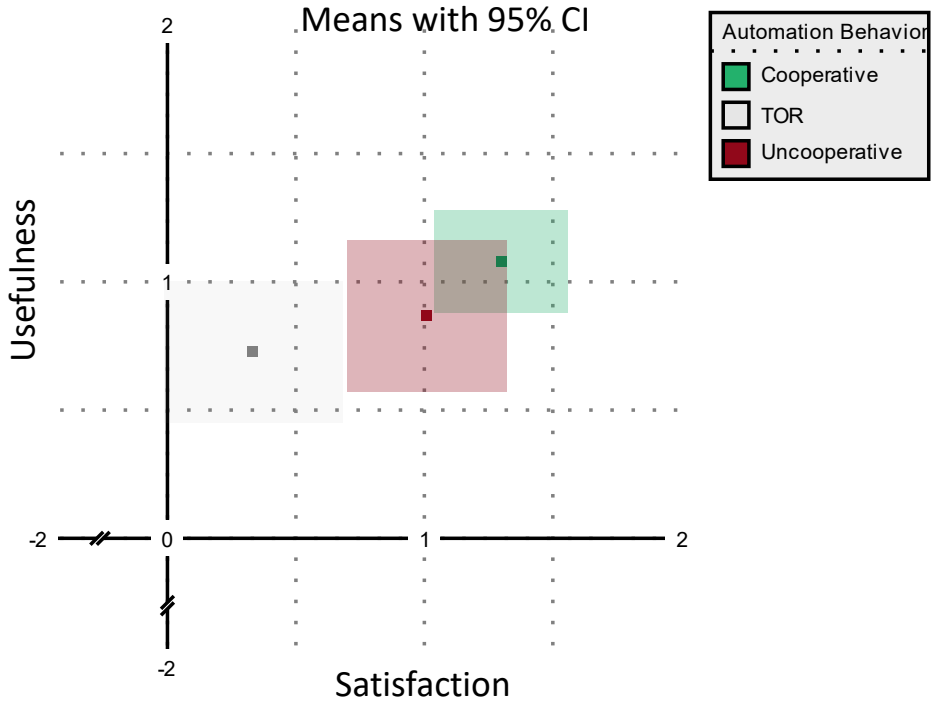
Standard Reaction



- Cooperation rate is significantly higher ($p < .001$) for the cooperative standard reaction
- Utilization of the default reaction is significantly higher ($p = .002$) for cooperative and uncooperative reactions compared to TOR
- An active choice of the default reaction is significantly more likely ($p < .001$) for cooperative behavior compared to uncooperative behavior

Results

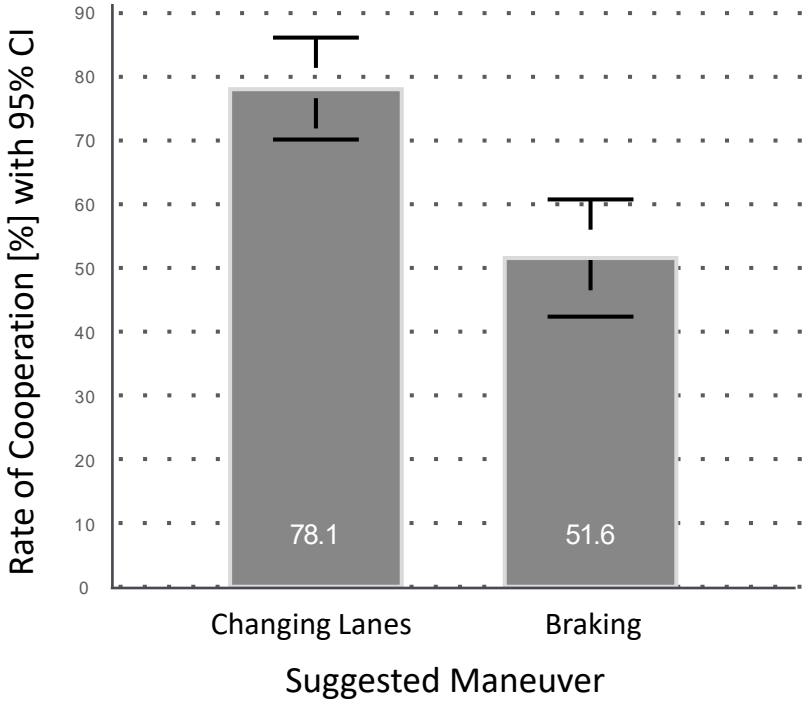
Standard Reaction



- No differences between all cases in terms of usefulness
- Significantly higher ($p < .001$) scores of satisfaction are achieved in cooperative and uncooperative conditions compared to TOR

Results

Maneuver



- Cooperation rate is significantly higher ($p < .001$) for lane change as suggested maneuver compared to braking as suggested maneuver

Gamification

A Concept That Drives Motivation?

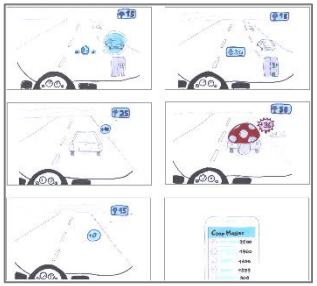
Which gamification concepts can have a motivational effect and contribute to greater cooperation rates?

Methods

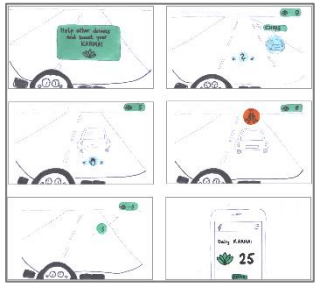
Storyboards, Interviews & Driving Simulator

Storyboards & Semi-Structured Interviews (N=20)

Cooperation Challenge



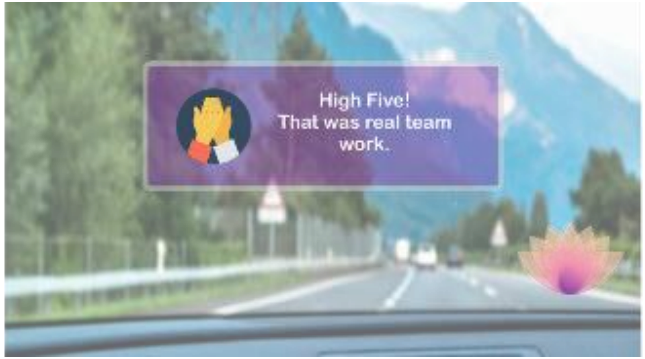
Social Driver

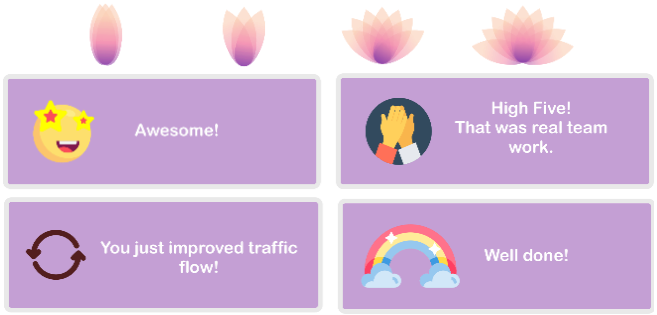


Dynamic Driving Simulator (N=30)

2×2 within-subject design

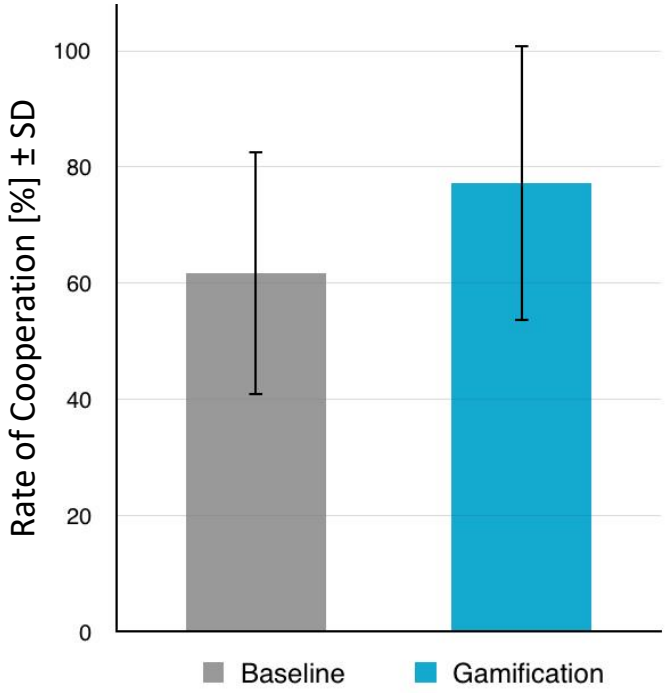
HMI Elements for Gamification





Results

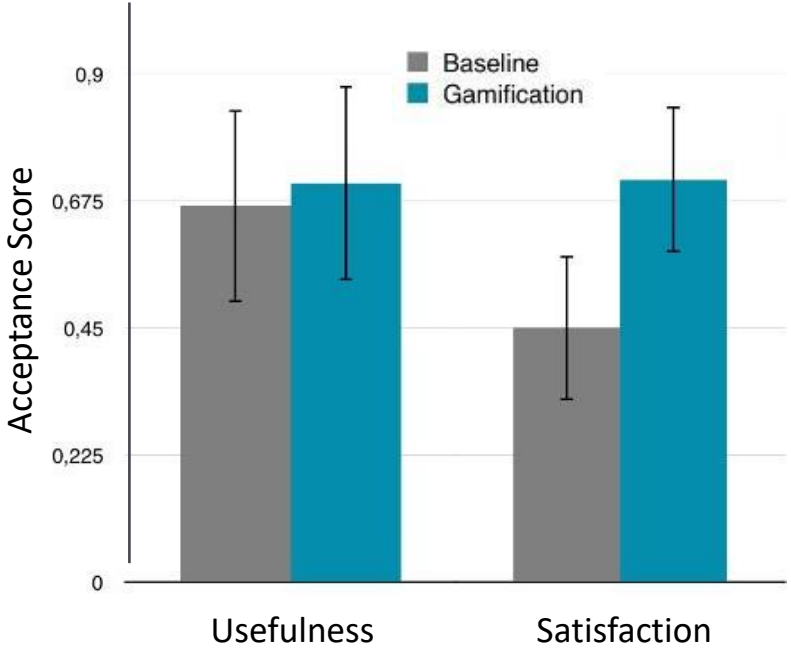
Rate of Cooperation



- Cooperation rate is significantly higher (*p = .002*) for the concept with gamification compared to a baseline concept without gamification
- In particular, this effect can be observed in scenarios with higher traffic densities

Results

Acceptance



- No differences between both conditions in terms of usefulness
- Significantly higher ($p < .001$) scores of satisfaction are achieved in conditions with gamification

Methods

Online Survey & Driving Simulator

Online Survey (N=42)

Static Driving Simulator (N=40)

HMI Elements

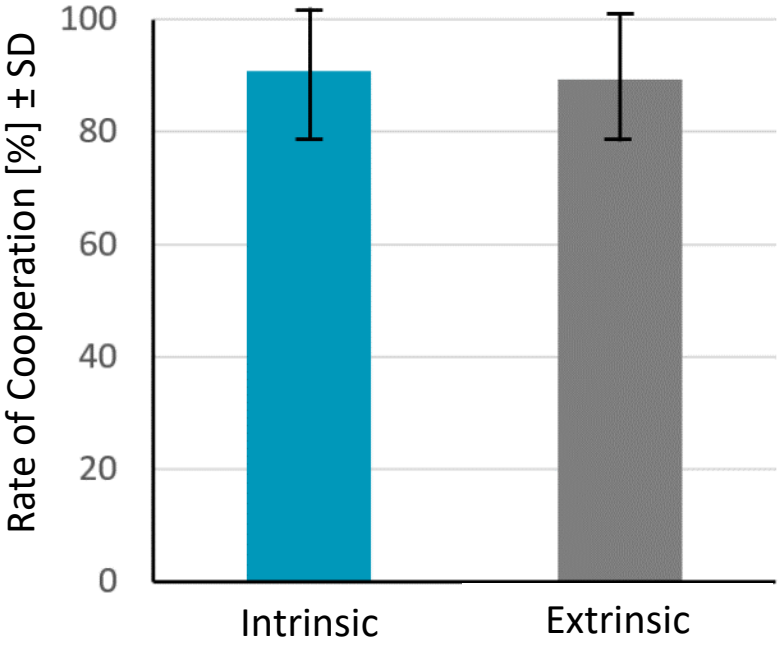
Cooperation request

A) Intrinsic motivation

B) Extrinsic motivation

Results

Rate of Cooperation



- No difference in terms of cooperation rates between both concepts
- The number of already experienced cooperation requests does not influence the rate of cooperation

Final HMI Concept

How does the level of automation and the presence of a gamified and driver-configurable cooperative assistance system affect cooperation rate and acceptance?

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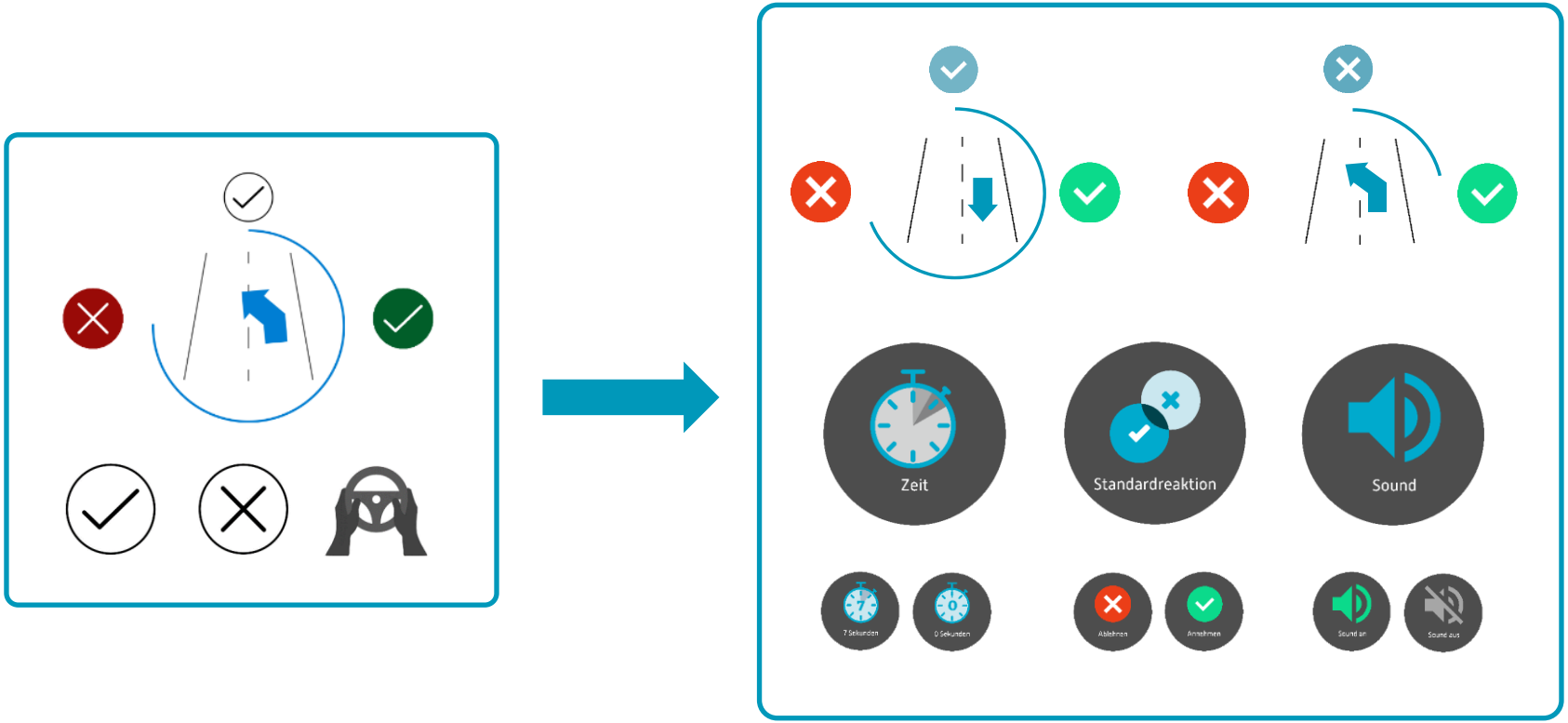
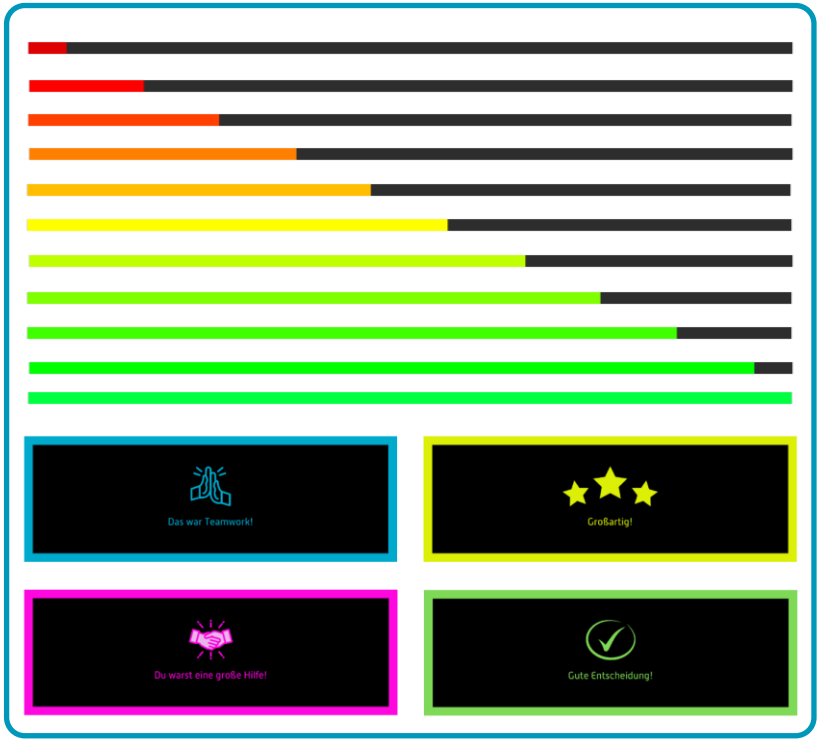
HMI Elements: Driver-Configurable



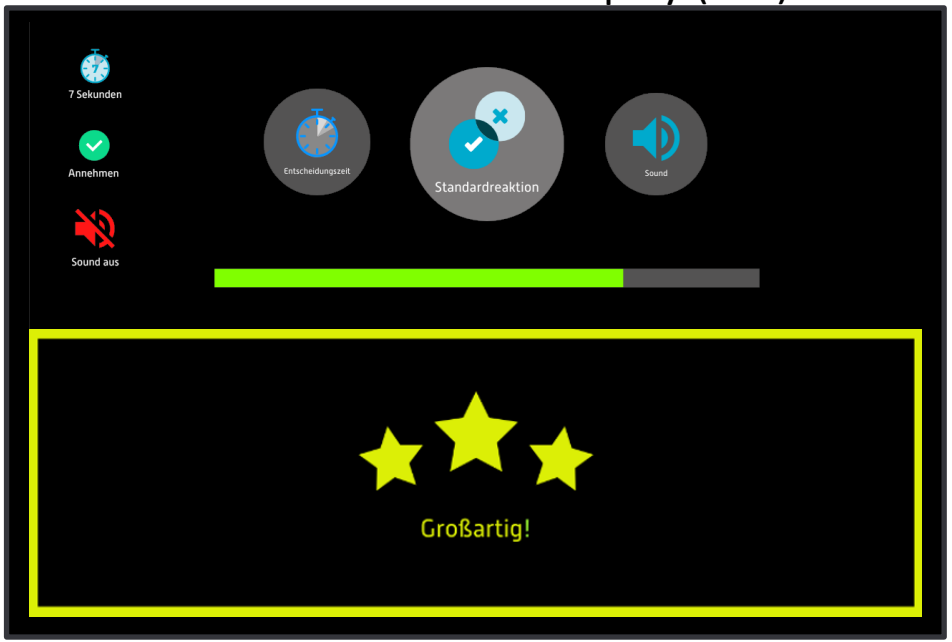
HMI Elements: Gamification



Final HMI Concept

Head-Up Display (HUD)

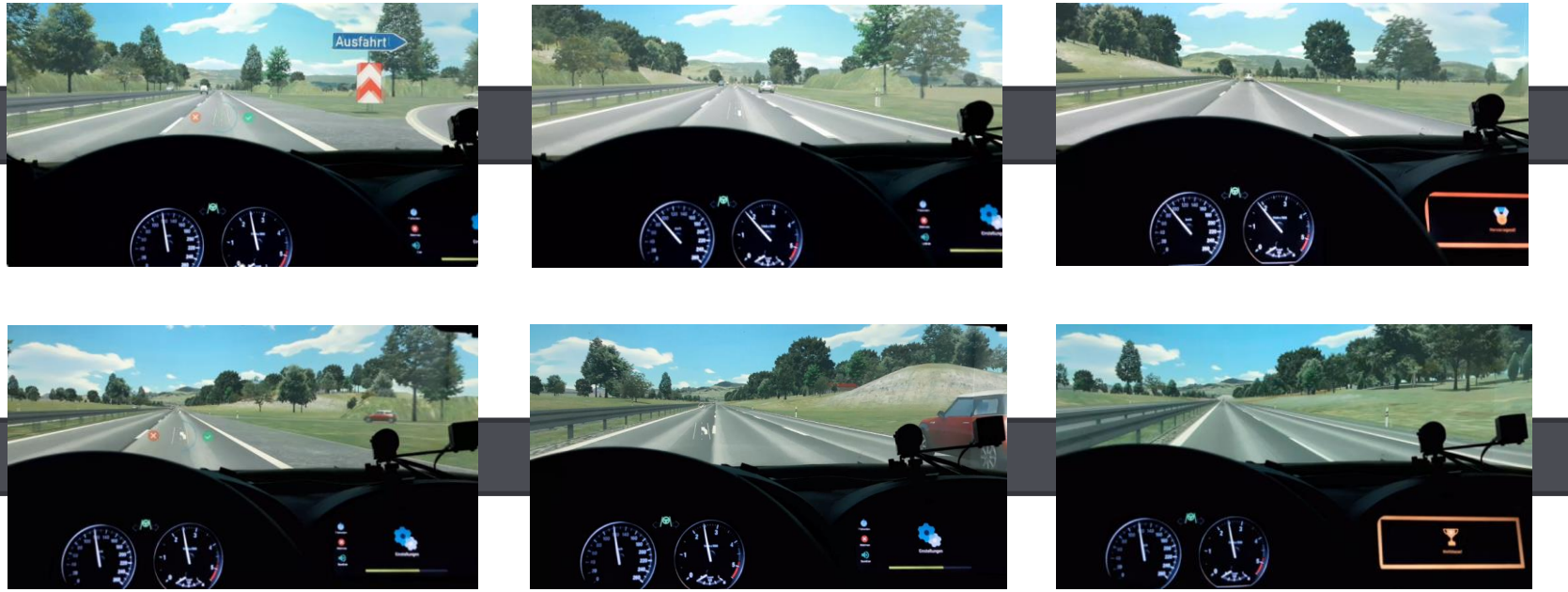
Center Information Display (CID)



Final HMI Concept

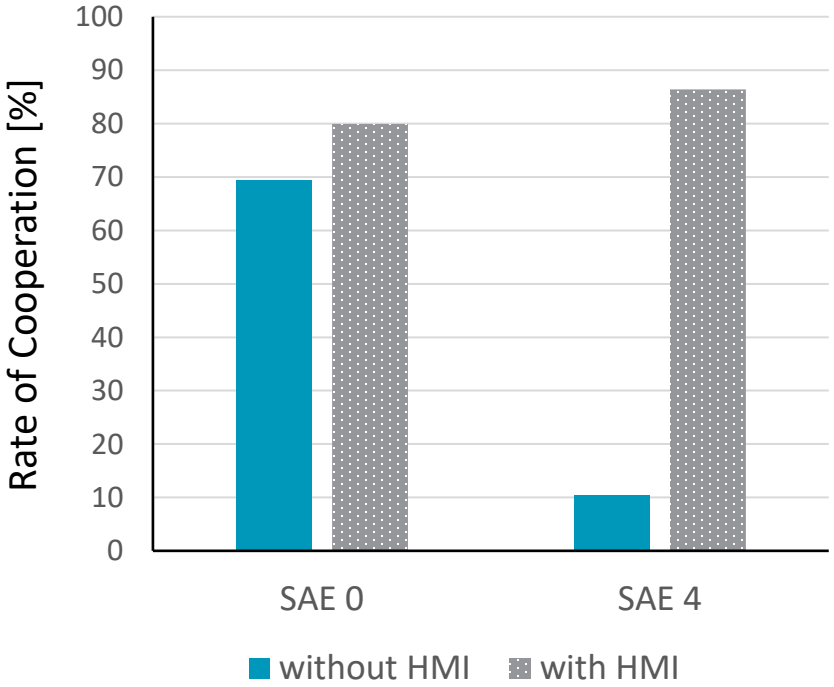
Static driving simulator

N=30 (2×2 within-subject design)



Results

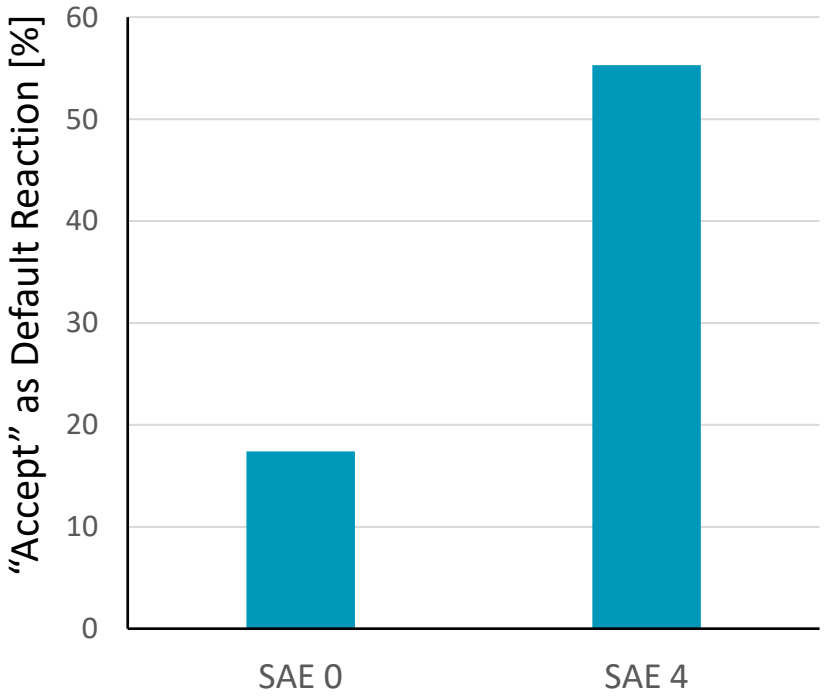
Rate of Cooperation



- A higher level of automation has a negative impact on cooperation rate without the assistance system
- Significant interaction effect exists between automation level and the presence of the assistance system in terms of cooperation rate
- The presence of the assistance system has a significantly positive ($p < .001$) influence on cooperation rate regardless of the level of automation

Results

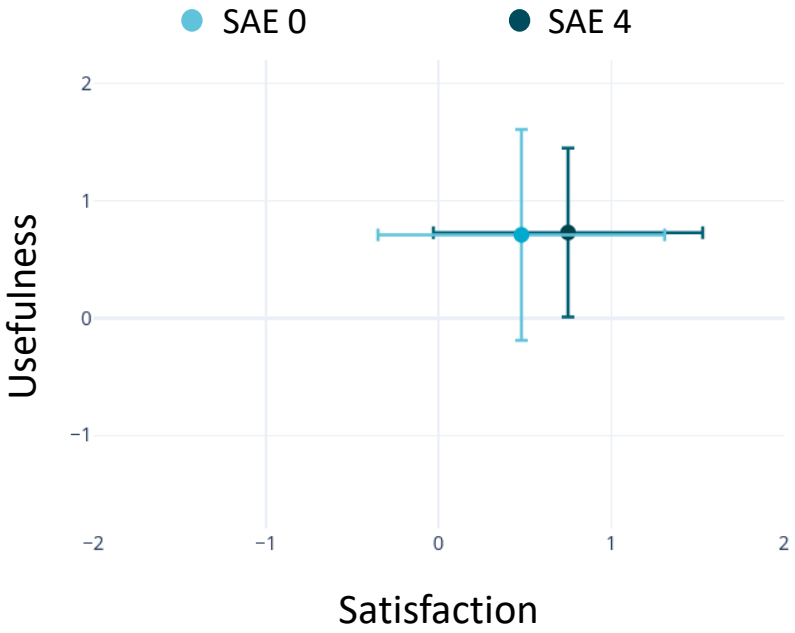
Default Reaction



- Many users choose cooperative behavior as the default response for higher levels of automation
- A higher level of automation results in a more frequent use of the default reaction of this assistance system

Results

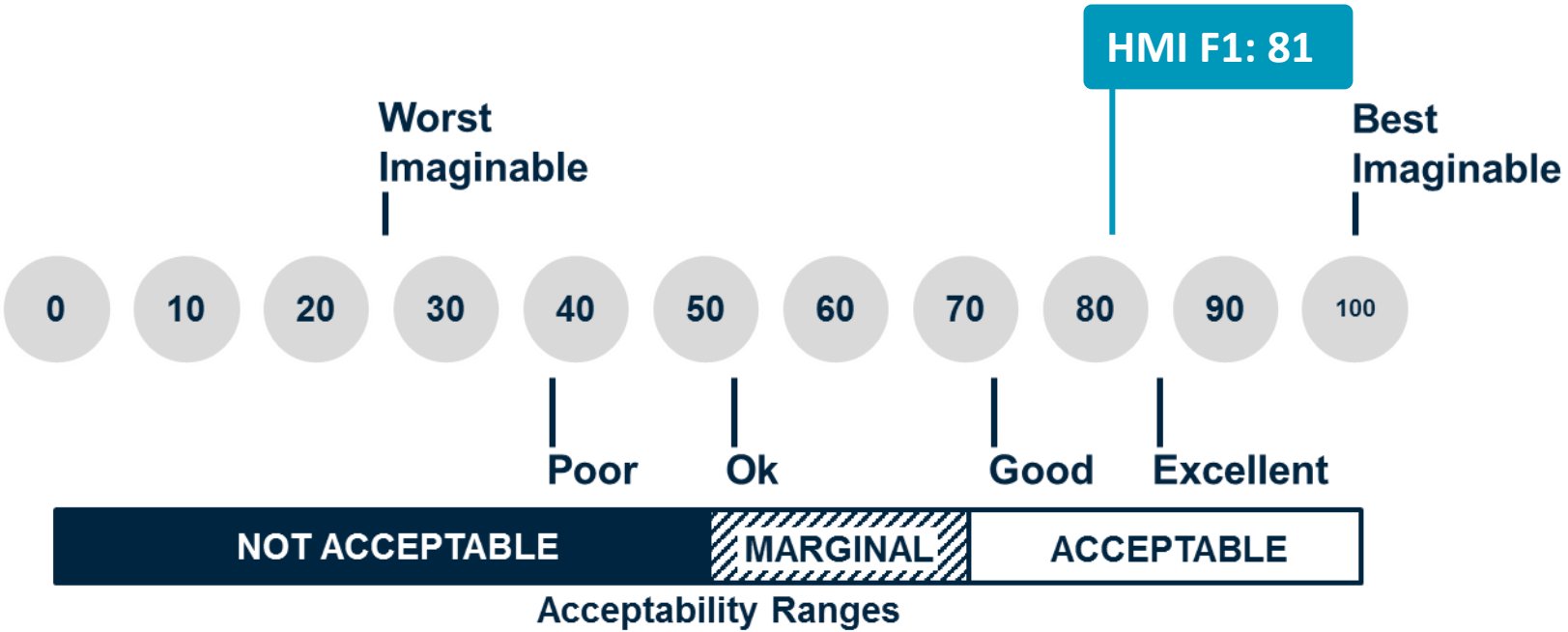
Acceptance



- No differences between both levels of automation for the final concept in terms of scores of usefulness and scores of satisfaction

Results

System Usability Scale (SUS)



Key Messages

Key Messages

- Almost no cooperation exists for higher levels of automation without cooperative assistance
- Drivers agree with automated cooperation for higher levels of automation
- The developed concept fulfills its purpose and is accepted and usable regardless of the level of automation

Key Messages

- Lane changes should be preferred as cooperative maneuvers over braking maneuvers
- Gamification is not perceived in a negative way by drivers and has a motivational effect on cooperation behavior
- Drivers should be able to influence the reaction to requests for cooperation (e.g., default reaction)

THANK YOU

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www.imagine-online.de

Images: IMAGinE, Unsplash

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References

- L. Prasch, F. Geßler, J. Reinhardt and K. Bengler, "You do the talking. Passengers are happy when the automation decides on cooperation," *2018 21st International Conference on Intelligent Transportation Systems (ITSC)*, 2018, pp. 1611-1616, doi: 10.1109/ITSC.2018.8569287