German Research Center for Artificial Intelligence GmbH

DFKI

simTD

Task-Driven System Exploration Enhances Subsequent Instruction Effects: Testing the Applied sim^{TD} Vehicle-to-X Human Machine Interface

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1. Introduction

The sim^{TD} project is shaping tomorrow's safe and intelligent mobility through testing vehicle-to-x communication and its applications. Before applying this new system in a large-scale field operational test, we measured the influence of drivers' interaction with the human machine interface on their driving performance in a safe driving simulation setup.
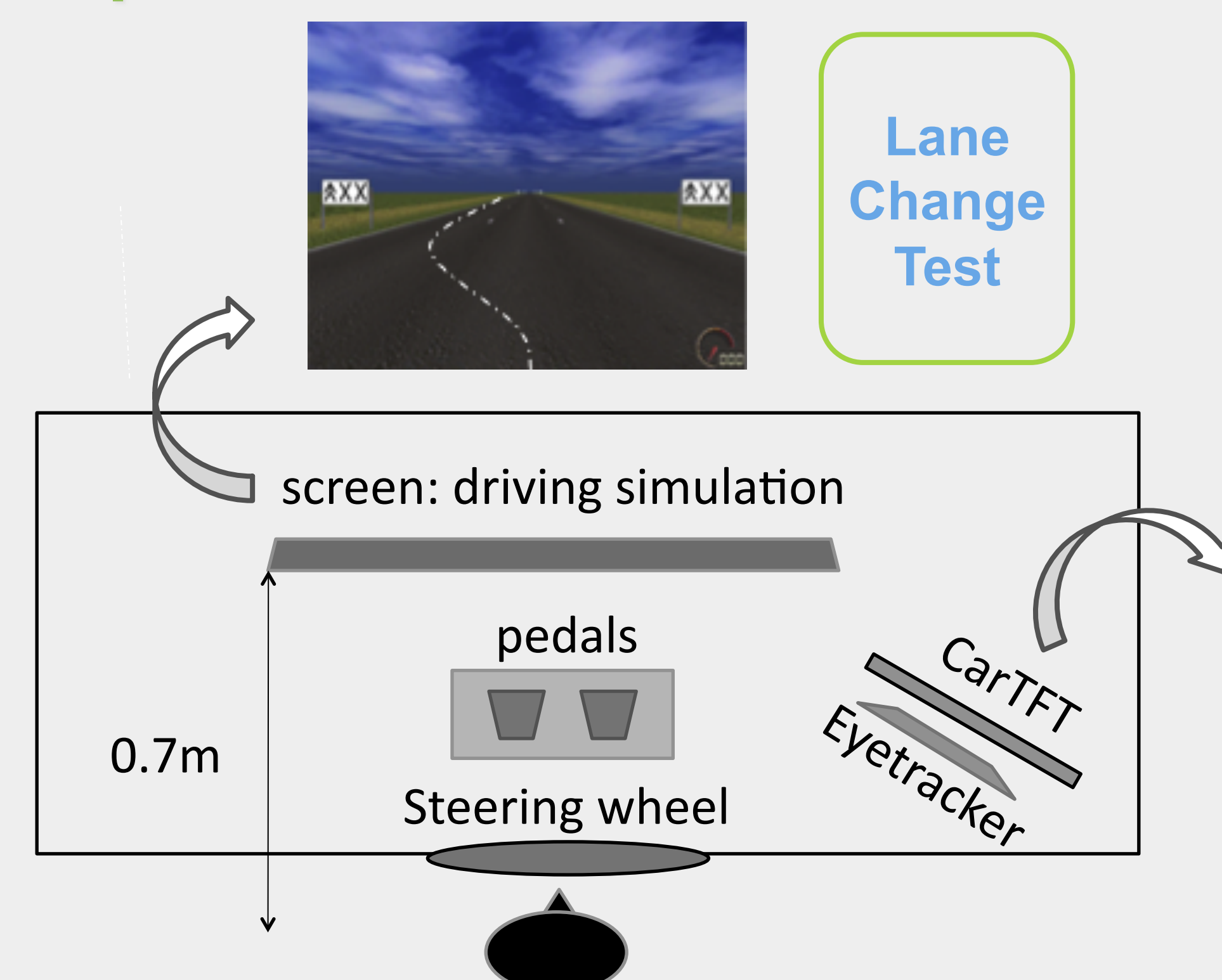
2. Research Questions – highly practical relevance:

➢ Does the sim^{TD} HMI fulfill two visual distraction criteria of the Alliance of Automobile Manufacturer's „Statement of Principles, Criteria and Verification Procedures on Driven Interactions with Advanced In-Vehicle Information and Communication Systems" [1] ?

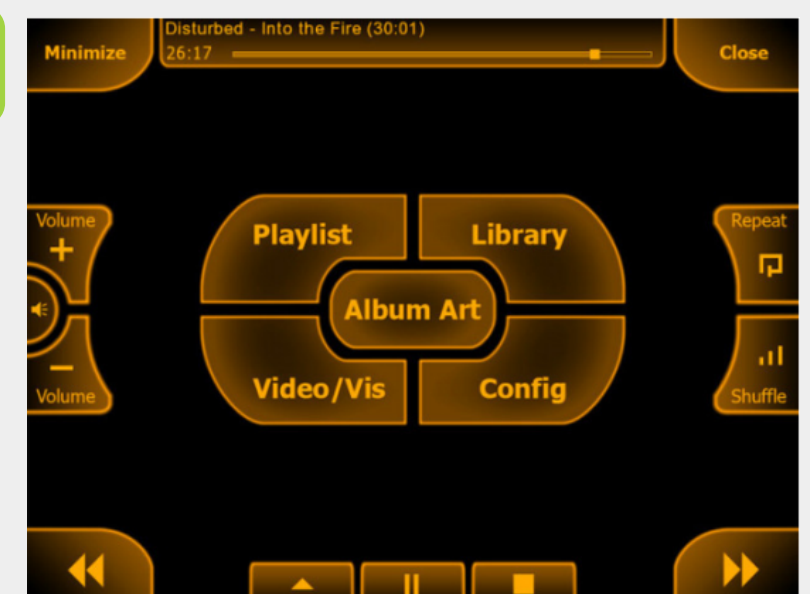➢ Do initial HMI instructions improve task or driving performance?

3. Experiment

Lane Change Test

screen: driving simulation

pedals

0.7m

Steering wheel

CarTFT

Eyetracker

25 Subjects (14 female, 11 male; age: 21 – 45 years; paid 10 €)

Tertiary Tasks

radio screen

13 typical radio tasks e.g. volume adjustment, to mute or to skip a song.

12 different tasks in each of two drives with (offline) sim^{TD} HMI [2] e.g.

- What temperature is expected in Saarbrücken this evening? 20°C
- On your route there is lost cargo. In which distance do you have to expect this obstacle? 1,5 km
- How expensive is the soccer game in Stuttgart next Saturday? 10 €
- You have spotted a deer close to the street: Send a system message about animals on the street

sim^{TD} HMI screenshots

Achtung! verlorene Ladung

1,5 km

Melden — Hindernisse, Zentrale, Befragung
Einstellungen — System, Navigation, Debug-Log

	practice	baseline 1	instruction	cond. 1	instruction	cond. 2	(+ control)	baseline 2
Group A	no tertiary task	no tertiary task	✔	sim^{TD} 1	-	sim^{TD} 2	radio	no tertiary task
Group B	no tertiary task	no tertiary task	-	sim^{TD} 1	✔	sim^{TD} 2	radio	no tertiary task

4. Results

Eye Gaze Behavior

Duration of glances onto sim^{TD} screen for task completion:

mean = 0,6s sd = 0,53s

mean = 0,63s sd = 0,57s

mean = 0,61s sd = 0,58s
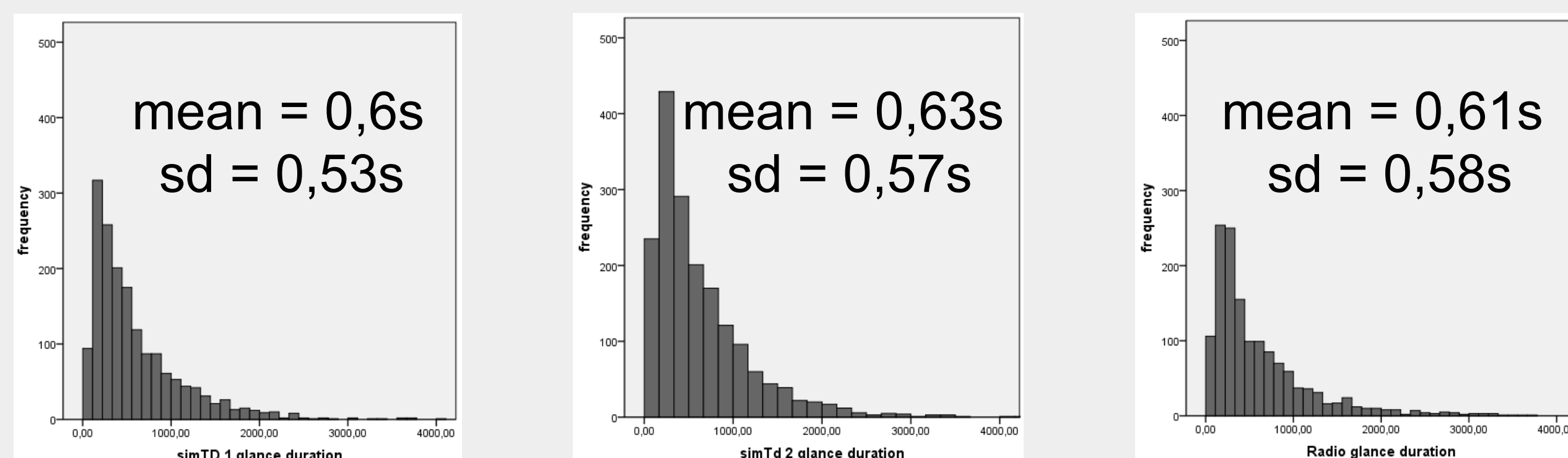
Even without prior system instructions, the 85th percentile of glance duration is below 2 seconds (sim^{TD}1 & sim^{TD}2 → 1.1 sec.).

The 85th percentile of total glance time on the display to perform a task was shorter than 20 seconds in the second drive after instructions and participants' exploration (12.0 sec.; sim^{TD}1 → 25.2 sec.)

Mean accumulated gaze duration per task:

simTD 1, simTD 2, Radio
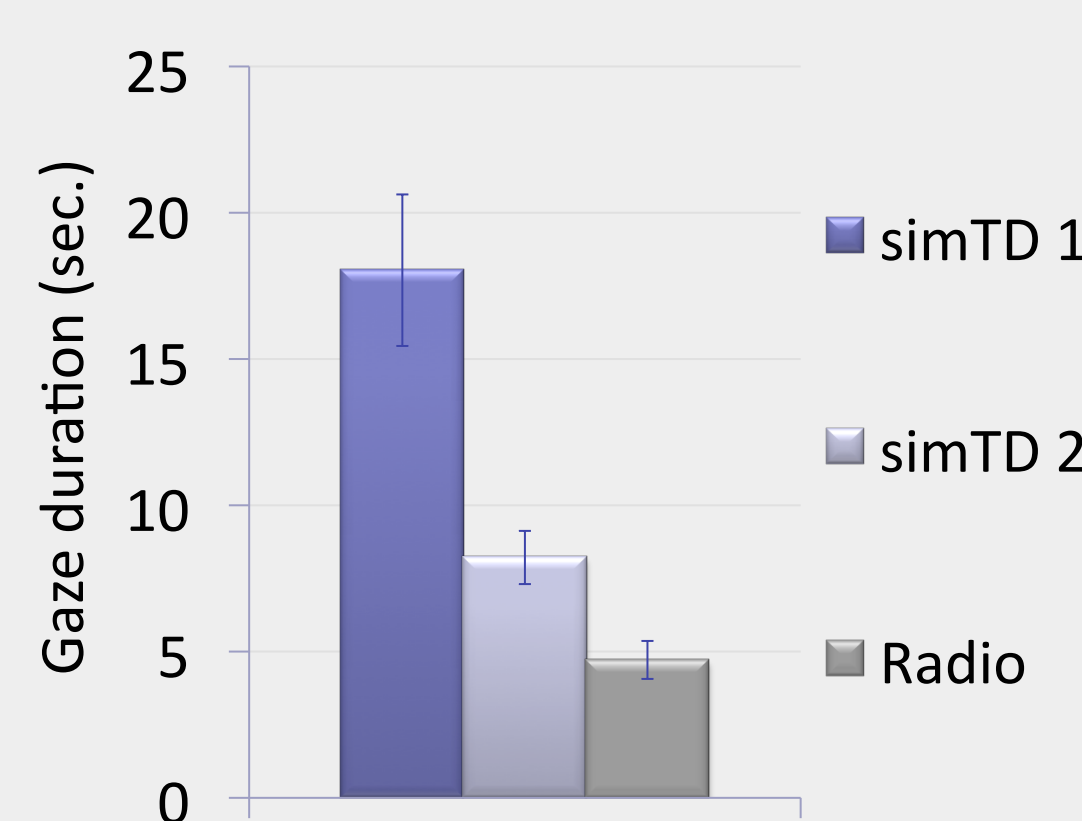
Task Performance

Number of correctly fulfilled tasks with sim^{TD} HMI:

instruction before usage / instruction after first usage

simTD 1 / simTD 2
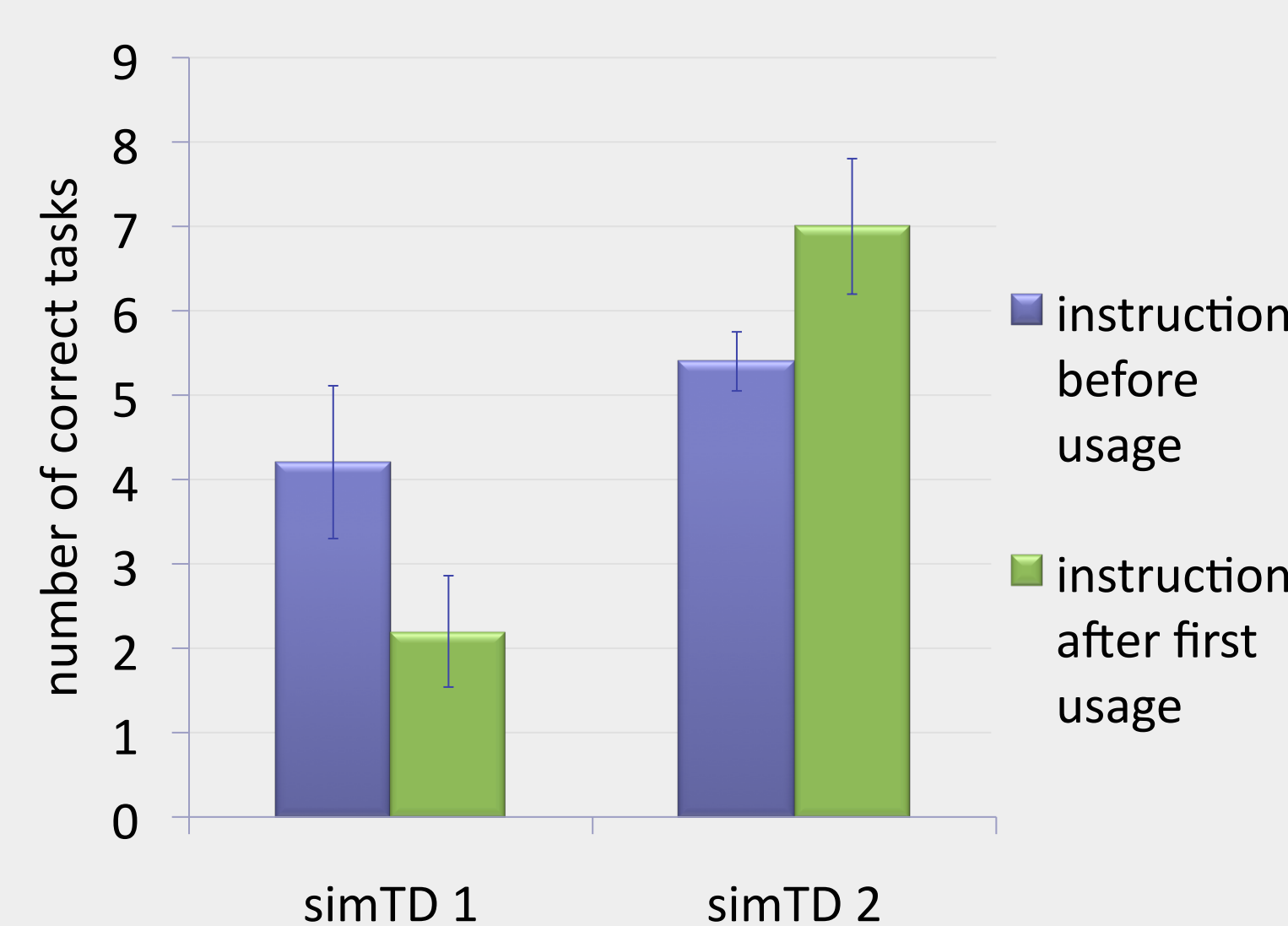
Significantly more tasks completed in second drive ($F(1,23) = 22.58$, $p < .001$, $\eta^2_p = .50$).

Significant interaction between drive and time of instruction ($F(1,23) = 8.13$, $p < .01$, $\eta^2_p = .26$)

Ratings of system

All ratings about the system (e.g. graphical quality, system navigation, understandability, self-descriptiveness, [3]) were rated significantly above average on a 5-point scale ($t > 2.6$, $p < .05$).

Driving Performance

Driving performance was significantly worse in the first sim^{TD} drive compared with both the radio task ($p < .01$) and the second sim^{TD} drive ($p < .05$). No other comparisons were significant.

5. Conclusion

- After instructions and practice, the sim^{TD} HMI meets two major AAM criteria for information presentation.
- Instructions are even more effective after participants explored the system themselves.

6. References

[1] Alliance of Automobile Manufacturers. Statement of Principles, Criteria and Verification Procedures on Driver Interactions with Advanced In-Vehicle Information and Communication Systems, Washington, D.C.: Alliance of Automobile Manufacturers, 2006.

[2] ISO/TR 16352: Road vehicles – Ergonomic aspects of in-vehicle presentation for transport information and control systems – warning systems, 2005.

[3] ISO 9241: Ergonomie der Mensch-System-Interaktion – Teil 110: Grundsätze der Dialoggestaltung, 2006.

IC TTP 2012

Traffic and Transport behaviour: interaction between theory and practice

Groningen, Netherlands, August 29th –31st 2012