CHEMNITZ UNIVERSITY OF TECHNOLOGY

To trust or not to trust – Comparing two trust in automation scales when assessing an external HMI in automated vehicles

A.-C. Hensch, I. Kreißig, M. Beggiato, and J. F. Krems

Introduction

The **human-machine interaction** becomes increasingly relevant due to the rising number of automated system functions in various domains [1, 2]. The users' **trust in automation** represents an **essential determinate** to ensure the **acceptance** as well as efficient and **safe interactions** with automated systems. Trust in automation can be defined as "*the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability*" [3]. The concept of trust in automation can be **efficiently assessed by questionnaires**. However, there is a variety of inventories to collect users' trust [e.g., 4, 5]. Therefore, the current study **compared two trust in automation scales** that were repeatedly applied to evaluate users' trust when interacting with a valid and an invalid external HMI (eHMI) as means of communication in automated vehicles (AVs) as an automated system: The unidimensional **Trust in Automation Scale by Jian et al. (2000)** [4] vs. the multi-faceted **Trust in Automation Scale by Körber et al. (2019)** [5]. The data revealed **comparable trends of results** for participants' trust ratings. The findings indicated that applied inventories should be selected depending on the **research design and issue,** such as repeated measures.

Aim of the study: Comparison of two Trust in Automation Scales (unidimensional Trust in Automation Scale by Jian et al. (2000) vs. multi-faceted Trust in Automation Scale by Körber et al. (2019))

Method

Sample and procedure

Participants

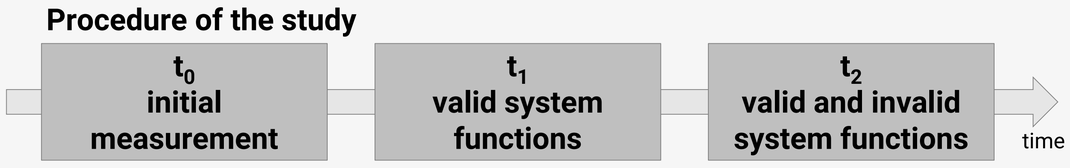
- *N* = 36 (19 women, 17 men)
- *M* = 58 years (*SD* = 20.95)

Measurement

- Repeated assessment of trust in an eHMI as means of communication in AVs with two different trust scales (within-subject factor; t_0 - t_2)

Figure 1. Investigated eHMI in the windscreen of the vehicle.

Procedure of the study



For further information of the study and additional results see [6].

Applied questionnaires

Jian Trust in Automation Scale [4]

- Assessment of trust in automation as a state
- Unidimensional; 12 items
- 7-point Likert scale: [1] *"not at all"* to [7] *"absolutely"*
- Averaged to overall trust score (Cronbach's $\alpha_{t0\text{-}t2}$: .86 - .96)

Körber Trust in Automation Scale [5]

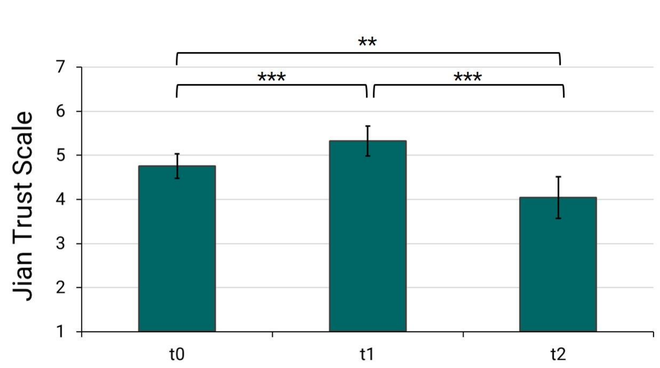
- Assessment of trust in automation as state and trait
- Multi-faceted; subscales individually applicable
- State: Reliability/ Competence (6 items), Understandability/ Predictability (4 items), Intention of Developers (2 items)#, Familiarity (2 items)#, Trust in Automation (2 items)#
- Trait: Propensity to trust (3 items)
- 5-point Likert scale: [1] *"strongly disagree"* to [5] *"strongly agree"*
- Averaged to respective subscale scores (Cronbach's $\alpha_{t0\text{-}t2}$: .51 - .86)

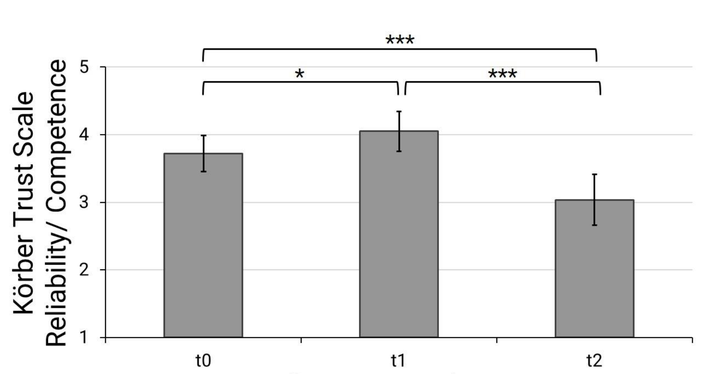
#sub-scales were not assessed within the study

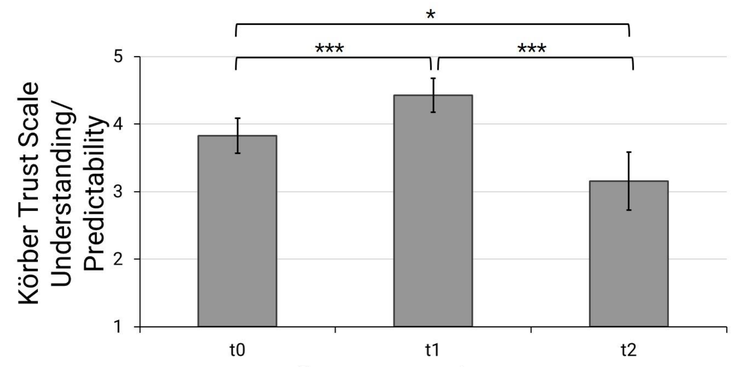
Results

	M_{t0} (SD_{t0})	M_{t1} (SD_{t1})	M_{t2} (SD_{t2})	ANOVA
Jian Trust Scale[a] [4]	4.75 (0.81)	5.32 (0.99)	4.04 (1.39)	$F(1.66, 57.91) = 23.78$, $p < .001$, $\eta^2_p = .40$
Körber Trust Scale [5]: Reliability/ Competence*	3.72 (0.80)	4.05 (0.87)	3.04 (1.12)	$F(2, 70) = 26.92$, $p < .001$, $\eta^2_p = .44$
Körber Trust Scale [5]: Understanding/ Predictability[a,*]	3.83 (0.77)	4.43 (0.75)	3.16 (1.26)	$F(1.68, 58.78) = 20.95$, $p < .001$, $\eta^2_p = .37$

[a] Hyunh-Feldt corrected degrees of freedom are reported; **Reliability/ Competence* refers to the abilities of a system; *Understanding/ Predictability* refers to the appropriateness of a system's actions [5].







***$p < .001$; **$p < .01$; *$p < .05$

- Scores of Jian Trust in Automation Scale and Körber Trust in Automation Scale (Reliability/ Competence; Understanding/ Predictability) are highly correlated (r = .55 - .87, $p < .001$)
- Comparable trends for the (sub-)scales: significant increase of trust after interacting with a valid system; decrease of trust after experiencing invalid system functions

Conclusion

- The inventories revealed comparable *trends* of the results for trust in the investigated automated system
- Jian Trust in Automation Scale [4]: higher internal reliability scores, well-established, unidimensional
- Körber Trust in Automation Scale [5]: partially low internal reliability scores [7], multi-faceted questionnaire allowing for a detailed, multidimensional assessment of trust in an automated system
- When selecting a respective inventory, various aspects should be considered (e.g., research issue, required psychometric criteria, expenditure of time for completing the inventory, etc.)

Acknowledgements

The research Infrastructure was funded by the Bundesministerium für Verkehr und digitale Infrastruktur (BMVI, German Federal Ministry of Transport and Digital; grant no 16AVF2016A) – project "InMotion – Light-based communication between automated vehicles and other road users"; and by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 416228727 – SFB 1410.
Thanks to Sophie H. Lux for providing the poster template.

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Contact:
ann-christin.hensch@psychologie.tu-chemnitz.de