

CoopQ: Questionnaire for measuring the subjective evaluation of cooperation in road traffic encounters

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Funded by

DFG Deutsche
Forschungsgemeinschaft
German Research Foundation

DFG SPP 1835 “Cooperatively interacting automobiles“
www.coincar.de



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Knowledge for Tomorrow



Introduction

- Some traffic situations require communication and cooperation ¹
- Automated vehicles should be able to react to and show cooperative behavior ²
- Development of cooperative driving strategies requires appropriate tools and measures to describe, quantify and evaluate cooperative behavior ²

Research goal:

- Development of a questionnaire that assesses the subjective evaluation of cooperation in a traffic encounter
- The questionnaire should enable answering the following questions:
 - Could a given encounter between road users be considered cooperation? (Part A)
 - Based on different aspects of cooperation: e.g. altruism, coordination, communication, competition, goal orientation, reciprocity, dependence, interference, mutual agreement, negotiation, costs and benefits ^{3, 4, 5, 6, 7, 8}
 - Did road users cooperate successfully? (Part B)
 - Based on motives in road traffic, e.g. safety and efficiency ^{3, 9, 10}



Part A: Could a given encounter between road users be considered cooperation?

Part B: Did road users cooperate successfully?

Method

Item generation

- Part A: 39 statements; reflect different aspects of cooperation, e.g. “The drivers competed with each other.”
- Part B: 40 adjective pairs; reflect motives in road traffic, e.g. “efficient / inefficient”

Online survey to reduce number of items

- n = 123 (55 f, 68 m), m = 37.05 years old (sd = 13.87, range = [20, 80])
- Part A: Participants rated 7 videos of traffic encounters at a narrow passage with varying degrees of interaction on a 7-point Likert scale (“does not apply at all” to “applies perfectly”)
 - Items were divided into five sets of 13 items each*; one set per participant; 23-28 participants per item
- Part B: “Successful cooperation in traffic is...” efficient inefficient, ...
 - Style adopted from questionnaires evaluating systems/behavior ^{11, 12, 13}
- Plus demographics and open questions about cooperation

Item selection

- Based on descriptive statistics, item analysis and factor analysis



Figure 1. Screenshot of video material used in the online survey.

*13 items were formulated in three variants, e.g. [At least one driver / Driver X / Driver Y] acted selfishly.

Method

Item selection – Part A

- Factor analysis (for every set of items)
 - Factor extraction based on Kaiser criterion, scree plot and communalities
 - Item is mapped to factor if factor loading is $\geq .7$
 - Selection
 - At most one item per factor
 - Selection if $\text{rangeMean} - 2 * \text{meanSD} > 0$
 - If more then one item fulfills criterion, item with largest difference is selected
- Items which are not mapping to any factor
 - Selection if $\text{rangeMean} - 2 * \text{meanSD} > 0$

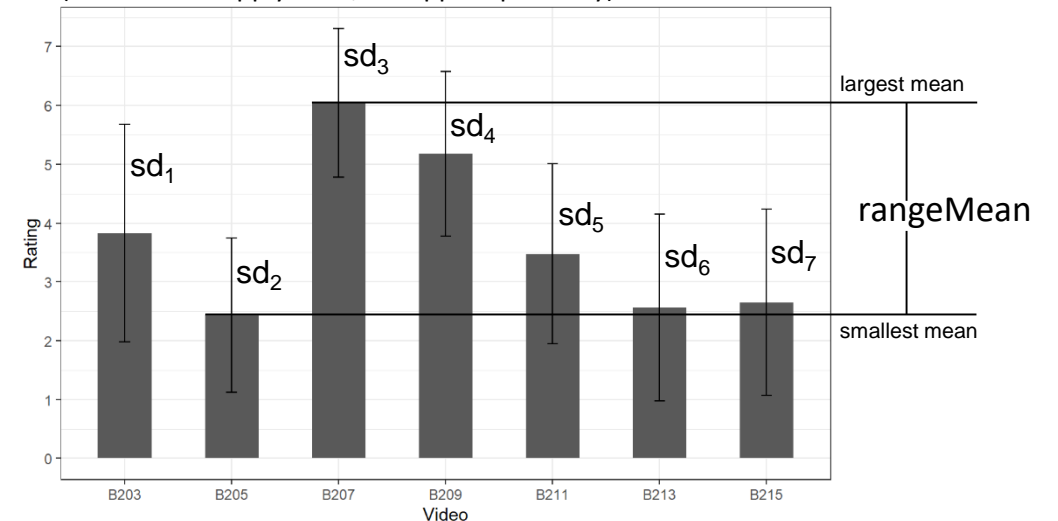
Item selection – Part B

- Selection if median = 1 and modus = 1

positive pole ¹ ² ³ ⁴ ⁵ negative pole

The drivers competed with each other.

(1 = does not apply at all; 7 = applies perfectly)



$$\text{meanSD} = \text{sum}(\text{sd}_{1-7}) / 7$$

→ Idea: Means between videos should vary more than participants' answers for the same video (for a specific item)



Part A: Could a given encounter between road users be considered cooperation?

Part B: Did road users cooperate successfully?

Results and discussion

Selected items and adjectives

Part A

- The drivers wanted to occupy the same space at the same time.
- The drivers have adapted to each other.
- The drivers cooperated.
- The drivers competed with each other.
- The drivers acted amicably.
- [At least one driver / Driver X] showed the other driver consideration.
- [At least one driver / Driver X] acted selfishly.
- [At least one driver / Driver X] were at an advantage because of the situation.
- [At least one driver / Driver X] were at a disadvantage because of the situation.
- [At least one driver / Driver X] acted with foresight.

Part B

- beneficial/obstructive
- supportive/hindering
- relieving/burdening
- enjoyable/unpleasant
- satisfying/frustrating
- pleasant/unpleasant
- relaxed/stressful
- calm/aggressive
- effective/ineffective
- efficient/inefficient
- goal-oriented/unplanned
- coordinated/uncoordinated
- harmonized/not harmonized
- consensual/non-consensual
- fair/unfair
- controlled/uncontrolled
- safe/unsafe
- harmless/dangerous
- risk-free/risky
- understandable/misleading
- unambiguous/ambiguous
- necessary/unnecessary

- Based on factor analysis and descriptive statistics, 10 items and 22 pairs of adjectives were selected for a first version of the cooperation questionnaire (CoopQ)
- The number of adjective pairs should be further reduced based on semantic similarity
- The questionnaire should be tested in future studies to assess its reliability and validity



References

1. StVO §1 and §11
2. Bengler, K. (2019). Prinzipien für kooperatives Verkehrsverhalten-heute und morgen. In *Hands Off, Human Factors Off? Welche Rolle Spielen Human Factors in Der Fahrzeugautomation?* (pp. 91-97). Darmstadt Universitäts- und Landesbibliothek Darmstadt.
3. Benmimoun, A., Neunzig, D., & Maag, C. (2004). *Effizienzsteigerung durch professionelles/partnerschaftliches Verhalten im Straßenverkehr*.
4. Deutsch, M. (1949). A theory of co-operation and competition. *Human relations*, 2(2), 129-152.
5. Düring, M., & Pascheka, P. (2014, June). Cooperative decentralized decision making for conflict resolution among autonomous agents. In *2014 IEEE International Symposium on Innovations in Intelligent Systems and Applications (INISTA) Proceedings* (pp. 154-161). IEEE.
6. Ellinghaus, D. (1986). *Rücksichtslosigkeit und Partnerschaft: Eine sozialpsychologische Untersuchung über den Umgang unter Kraftfahrern im Straßenverkehr*. Köln.
7. Hoc, J. M. (2001). Towards a cognitive approach to human-machine cooperation in dynamic situations. *International journal of human-computer studies*, 54(4), 509-540.
8. Khamis, A. M., Kamel, M. S., & Salichs, M. A. (2006, October). Cooperation: concepts and general typology. In *2006 IEEE International Conference on Systems, Man and Cybernetics* (Vol. 2, pp. 1499-1505). IEEE.
9. Steg, L. (2005). Car use: lust and must. Instrumental, symbolic and affective motives for car use. *Transportation Research Part A: Policy and Practice*, 39(2-3), 147-162.
10. Summala, H. (2007). Towards understanding motivational and emotional factors in driver behaviour: Comfort through satisficing. In *Modelling driver behaviour in automotive environments* (pp. 189-207). Springer, London.
11. Laugwitz, B., Held, T., & Schrepp, M. (2008, November). Construction and evaluation of a user experience questionnaire. In *Symposium of the Austrian HCI and usability engineering group* (pp. 63-76). Springer, Berlin, Heidelberg.
12. Van Der Laan, J. D., Heino, A., & De Waard, D. (1997). A simple procedure for the assessment of acceptance of advanced transport telematics. *Transportation Research Part C: Emerging Technologies*, 5(1), 1-10.
13. Zimmermann, M., Fahrmeier, L., & Bengler, K. J. (2015, June). A Roland for an Oliver? Subjective perception of cooperation during conditionally automated driving. In *2015 International conference on collaboration technologies and systems (CTS)* (pp. 57-63). IEEE.

