

Questionnaire for subjective assessment of ride comfort in automated driving: “Automated Ride Comfort Assessment (ARCA)”

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1 Background information

- The questionnaire addresses aspects of ride comfort in automated vehicles that is related to the design of the automated vehicle motion. It deliberately excludes aspects of ride comfort that are determined by characteristics of vehicle suspension, seating ergonomics, design of interior space, air quality etc.
- The questionnaire compiles several relevant physical and mental aspects of comfort/well-being on the basis of a literature research conducted in AP1 of the RUMBA project (<https://projekt-rumba.de/en/>). Apart from „classical“ criteria of ride comfort, the questionnaire also includes aspects of general user experience and technology acceptance.
- Purpose of the tool: post-hoc assessment of a past drive or section of a drive; no explicit focus on single driving situations.
- No assessment of technical parameters (like brake timing, deceleration dynamics, ...), instead a clear focus on subjective experience was chosen.
- 1 “direct“-item per factor and consistent format across all items keeps complexity low and allows multiple usage of the tool within one trial.
- Response format does not only address discomfort (from „negative“ to “neutral”), but the complete spectrum from discomfort to comfort (from „negative“ – red, to „neutral“ – white to „positive“ – green). This reflects the underlying mental model of comfort. In this model comfort is a conscious experience of well-being, when relevant physical and mental aspects surpass the expected level in a positive way. Conversely, discomfort results, when these aspects fall short in relation to the expected level (cf. Carsten& Martens, 2019).
- In case single items do not fit to the conditions of the study they should be removed beforehand.
- The analysis should be done on single item level. In order to assess the overall comfort level of a past automated drive, the last two items can be used. Calculation of total scores is not foreseen and not recommended.

2 Current version of the questionnaire (2022/05/18)

Ride comfort in automated driving	Psychological aspects	Sense of safety	As a user of this system, I felt	unsafe	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	safe.
	Naturalness		Vehicle control appeared	unnatural	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	natural.
	Cooperativity		Vehicle behavior appeared ... towards other road users.	unfriendly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	friendly
	Transparency		Decisions for lane choice were ... to me.	not transparent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	transparent
	Feeling of control		Automated driving felt like ... control.	losing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	gaining
	Travel progress		I had the impression to travel	inefficiently	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	efficiently.
	Workload		Automated driving made me feel ...	stressed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	relaxed.
	Social environment		Other road users probably think ... about my vehicle's behavior.	negative	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	positive
	Predictability		I could ... predict the vehicle's behavior.	hardly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	easily
	System trust		My feeling of trust towards this system is ...	low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	high.
	Interference with NDRT		The driving behavior made it ... to work with the mobile device.	difficult	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	easy
	Physical aspects	G-Forces (braking)		G-forces due to braking were ...	inappropriate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	appropriate.
		G-Forces (accelerating)		G-forces due to acceleration were ...	inappropriate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	appropriate.
		G-Forces (curves)		G-forces in curves/turns were ...	inappropriate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	appropriate.
G-Forces (lane change)			G-forces during lane changes were ...	inappropriate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	appropriate.	
Fatigue			My body feels physically ...	fatigued	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	recovered.	
General	Motion sickness		Concerning motion sickness, I feel	sick	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	well.	
	General comfort		All in all, the automated ride was ...	uncomfortable	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	comfortable.	
	General drivign style		I am ... with the way the automation controlled the vehicle.	unhappy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	happy	

Figure 1: Overview of underlying factors (left; not part of the questionnaire) and single items including response choices (right).

3 Underlying literature

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