

Accessibility and Inclusion: what Automated Vehicles Mean to Users Limited by Age and Physical Disabilities

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ABSTRACT

Automated vehicles are likely to enhance aspects of everyday traffic for many users: Traffic flow, comfort, safety and more efficient driving. And overall: more time for passengers. For users outside the mass market, however, automated vehicles could offer much more than that: They provide more autonomy and participation for temporary, situationally or permanently disabled users, such as elderly who are no longer fit to drive and people with physical disabilities.

We investigated the attitude of elderly people and people with disabilities toward two Human-Machine Interface (HMI) concepts (swiping gestures on the steering wheel and joystick in the centre stack; Sommer, 2019) in focus groups in order to assess the concepts' advantages and disadvantages. One focus group consisted of experts for elderly people ($n = 8$, geriatric nurses) and another of people with physical disabilities ($n = 4$) who use electric wheelchairs daily. In addition, we conducted an expert user test of the HMI concepts in virtual reality with a person with disabilities from the focus group.

The focus group "geriatric nurses" rated the HMI concepts as quite reasonable for elderly people who are no longer fit to drive, as the concepts may compensate for both physical and cognitive shortcomings and reduce the emotional stress of driving. The experts emphasized the importance of HMI concepts' suitability for both younger and older people, so that training of the HMI concepts can happen as early as possible in younger years. Elderly people accept familiar interaction concepts much better. In consequence, our HMI concepts were not rated as such; instead, advice was given to slowly improve existing HMI concepts.

The participants of the focus group "people with disabilities" appreciated the possibility to take part in traffic without support from family members or personal assistants. However, they showed little acceptance of the technology due to concerns of feasibility. They had never seen an automated car (not even level 2). The evaluation of different HMI concepts suffered from this general lack of acceptance. As a general result, they suggested HMI concepts with very little physical demands.

To overcome this methodological limitation, to reduce users' doubts and increase acceptance of automated driving, we had to find a way to experience already existing as well as futuristic automated driving functions and HMI concepts in an immersive environment that could be adapted to users' daily experiences. We developed interactive prototypes in an immersive Virtual Reality (VR) environment for

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typical driving scenarios, based on a VR toolkit from the Drive2theFuture project. In Drive2theFuture, we develop virtual demonstrators of automated vehicles and HMI concepts in order to achieve higher informed acceptance of European users for automated driving systems (Mathis et al, in print). Results of a user study in this immersive environment will be published soon (Bopp-Bertenbreiter, planned).

As a conceptual test, one participant of the focus group with physical disabilities took part in a VR presentation of our HMI concepts. He stated that he could focus much more on the concepts in the VR environment than in the focus group and that he could now understand and accept automated driving better. He particularly appreciated the joystick concept because it is very similar to the control element he uses to move his electric wheelchair and requires less physical effort. Thus, he estimated that the joystick concept might enable 70-80% of the people with similar disabilities to use an AV by themselves.

Overall, AV might serve as a means for inclusion for users limited by age or physical disabilities if their special needs are addressed in the design process and if they can experience the AV in test drives to build trust.

Keywords: accessibility and inclusion through automation, user-centred design for user groups with special needs.