Urban Cycling and Automated Vehicles

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1 INTRODUCTION

Connected and automated vehicles (CAVs) will shape traffic patterns in the future and greatly influence urban mobility. A particular challenge for CAVs is to anticipate the movements of other road users [1]. This applies especially to micromobility vehicles (bicycles, small electric vehicles), whose traffic behaviour is difficult to predict and shaped from individual behaviour [2]. The increasing coexistence of CAVs and other, conventionally driven modes of transport thus has a growing impact as well as multiple consequences for urban structures and public space.

The following fundamental trends will shape the way people live together in cities in the coming years:

1. increasing share of CAVs and micromobility,
2. renaissance of the mixed and liveable city,
3. changes in mobility behaviour and the appreciation of public space (especially due to climate change and the Covid 19-pandemic), as well as
4. technical upgrading of infrastructure.

These parallel developments will lead to both conflicts and opportunities for cities.

2 RESEARCH PROJECT – EXAMINATIONS AND RESULTS

The research project "Concepts for the integration of cycling in future urban traffic structures with autonomous vehicles" (RAD-AUTO-NOM) investigates, how the interaction between cyclists and CAVs should be designed in urban spaces of the future. Aspects of the project include the redistribution of traffic areas and public spaces, the conflict-free design of street spaces and measures to promote environmentally friendly transport, especially cycling.

Scenarios and surveys are used to show how CAVs and the increasing share of cycling can change public space and urban structure. Furthermore, it is shown how urban and transport planning can influence future mobility. Due to partially unpredictable human behaviour, it may be difficult for CAVs to interact with cyclists, which has consequences for the drivability of CAVs in different road types of urban areas [3][4]. To facilitate the interaction of CAVs with cyclists, the overall traffic could be slowed down or a separated infrastructure for cycling could be implemented [5]. The solution of a separated infrastructure provides the opportunity to significantly increase the comfort for cyclists. The survey conducted as part of this research shows that cyclists' perception of safety is significantly higher on separated cycling infrastructure than in situations where cycling traffic is routed together with motor vehicle traffic (e.g. routing in mixed traffic or on cycle lanes). This applies especially to traffic consisting of conventional motor vehicles and CAVs which leads to a negative impact on cyclists' sense of safety.

Increasing the subjective safety of bicyclists and reducing conflicts between CAVs and cyclists by guiding them on their own infrastructure contributes to their ability to ride, but it also affects the freedom of movement

in a city, especially of pedestrians, and has a negative impact on the design, aesthetics, as well as the quality of life in cities. Separating different types of traffic, especially CAVs and conventionally guided vehicles, should therefore be targeted and used sparingly, as it can hinder the further development of a mixed and vibrant city.

Slowing down traffic speed of motorized vehicles and matching their speed to slower road users on residential streets is a promising way to increase safety and driveability in all road spaces. The space for these changes towards a harmonious interaction among all traffic participants can be created in part by reducing parking areas if CAVs are used as shared vehicles. This is only possible if future traffic is organized in a way that shared vehicles, public transport and micromobility increasingly replace the use of individual motorized vehicles. The most important task for city administrations will be to limit the rebound effects of CAVs and to design public spaces, including traffic areas, in a way that cyclists, pedestrians and CAVs will coexist without conflicts. The goal should be to use the deployment of CAVs as an opportunity to design streetscapes equitably for all road users.

Equally shared streetscapes can only work if users of micromobility, especially bicyclists, feel safe and comfortable. For this reason, the research project surveyed the impacts for bicyclist's stress and uncertainty feelings to avoid them in future planning. The evaluation of the survey shows several important results due to stress and uncertainty feelings of bicyclists. Ten different bicycle infrastructures and eleven different critical situations were surveyed for three different scenarios with manually controlled and autonomous vehicles. As a conclusion, the participants did not distinguish between stress and uncertainty feelings. Both were equally stated for each infrastructure and situation in every scenario.

Motorized vehicles are found to be the main stressors for bicyclists. Riding on roads without a separated bicycle infrastructure or on bike lanes without protection from motorized vehicles, cars that fall below the safety distance or being parked on the bicycle infrastructure, dooring situations in which car doors are suddenly and unexpectedly opened, cars leaving parking spaces or property entrances and failing to notice bicyclists caused the highest uncertainty feelings of all investigated infrastructures and situations. Participants reported the lowest stress and highest feelings of safety for the scenario with CAVs only. In mixed traffic with manually controlled vehicles and CAVs, stress and feelings of insecurity seem to increase (compare figure 1).

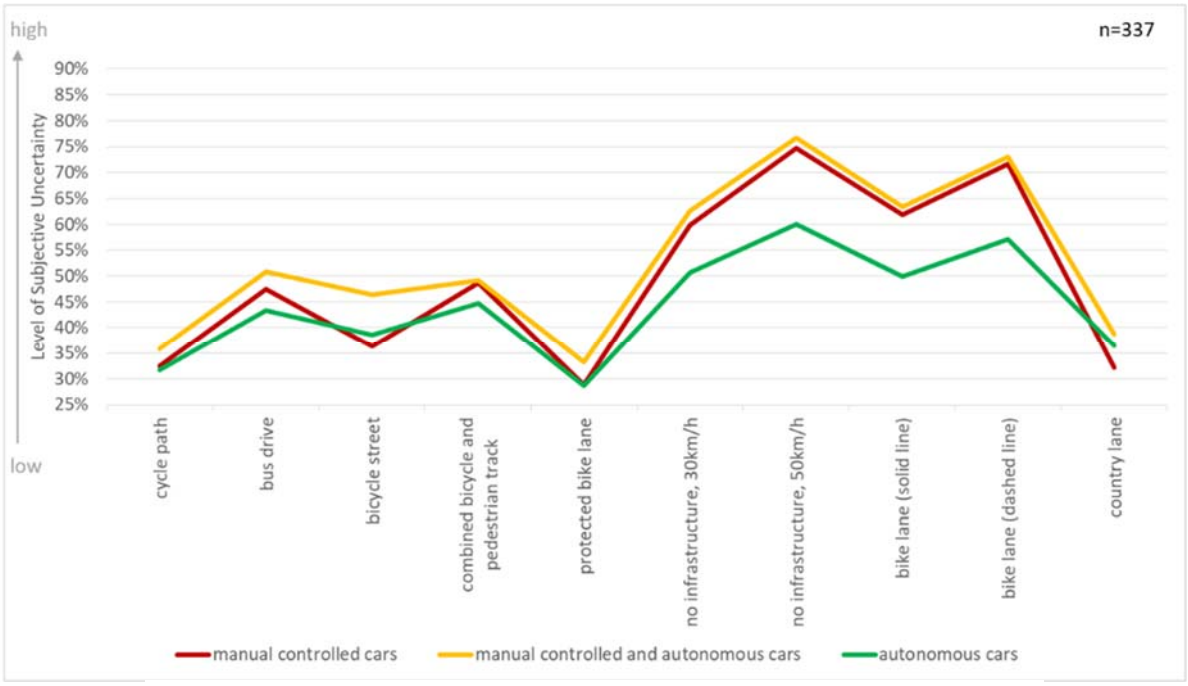

Figure 1: Comparison of the three scenarios "Manual", "Mixed traffic" and "Autonomous"

The research project has highlighted important recommendations of bicyclists for automated driving and coexistence in road space. CAVs can be expected to make huge improvements to the subjective safety of cyclists on the road. Tough, the absence of manually controlled vehicles is crucial. Initial approaches for a future urban design that combines these requirements with the technical hurdles of automated driving were also part of the research and have been summarized in a brochure.

3 CONCLUSIONS

In summary, it can be deduced from the results that it is important to fully implement the applicable regulations and guidelines regarding the safety of cyclists now. This is especially true for cycling infrastructures. Currently, there are many structures that are in poor condition, do not meet the specifications for minimum dimensions, and lack continuity (cycling network). These must be consistently adapted, on the one hand to make today's bicycle traffic more comfortable and safer, and on the other hand to make a smooth coexistence with CAVs possible. Measures that allow motorized vehicles to overtake only if the minimum distances can be maintained, as well as those that prevent the crossing of bike lanes, would have a positive impact on cycling comfort. Also, a lower speed limit, which can be ensured by a simplified designation of zones with a maximum speed of 30 km/h, would facilitate the rideability of CAVs, increase the comfort of cyclists, and contribute to a harmonized traffic flow. Additionally compact and mixed-use development is important to reduce significant commuting between people's daily destinations. The programming of CAVs and their ability to detect cyclists also ensures that the traffic regulations (StVO) are fully complied with. This can result in better and more equal interaction between all road users if intentions to act can be predicted more accurately. The design options for the traffic of the future are therefore diverse and should be used as reversibly as possible so that flexible adjustments are possible.

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