The effects of mental workload and duration of automated driving on driver behaviour

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Vehicle automation is likely to have multiple positive effects such as increasing road safety, enhancing driving efficiency or time saving. However, automated driving is also expected to induce modifications on driver state and driver performance.

One of the main areas of interest in automated driving is the analysis of changes in mental workload on driver behaviour. Automation may induce both underload and overload (Young & Stanton, 2002) due to the driver is not responsible for most of the driving tasks but s/he is still necessary when there is a situation that the automation cannot handle. In addition, the changes in mental workload during automated driving may also be induced by the engagement in non-driving tasks. Nevertheless, these effects are not well-known yet (see for example, Neubauer, Matthews, & Saxby, 2012; Radlmayr, Gold, Lorenz, Farid, & Bengler, 2014). The current study aims indeed to examine the impact of different levels of mental workload on the driver behaviour during the automated driving as well as during the transition from automated to manual driving. Moreover, driver behaviour may be affected depending on the time spent on automated driving mode (Feldhütter, Gold, Schneider, & Bengler, 2016). Therefore, the impact of mental workload was analysed according to different time periods of automated driving.

A total of 57 drivers participated in this study conducted in a driving simulator. Half of participants were in automated driving mode during a 10 minutes period, whereas the other half of participants were in automated driving mode during 30 minutes. To evaluate the impact of the mental workload, participants performed a non-driving task presented in the human-machine interface with two levels of mental workload: low versus high mental workload. A baseline condition in which drivers were driving in manual mode and without performing the non-driving task was added in order to evaluate the effects of automation. Eye movements and driver performance data were recorded during the automated driving and during the transition between automated to manual driving to examine driver state and driver performance. We expect drivers to develop different visual strategies during the automated driving depending on the level of mental workload. Specifically, we hypothesised that participants under high mental workload condition would exhibit a poorer processing of the road environment compared to the low mental workload condition. In addition, high mental workload condition would produce a negative effect on driver performance, especially after the longer time exposure to the automated driving.

We expect our results to shed light on the driver state during automated driving based on relevant indicators as well as the take-over quality. Automated systems should ideally adapt the information they provide according to the drivers state and the present results can have implications for the design of human-machine interfaces.

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