Car-following and lane-changing behavior of human drivers in mixed traffic: A driving simulator experiment

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Abstract

In the coming years, Automated Vehicles (AVs) are expected to be deployed on public roads, therefore driving alongside Human Driven Vehicles (HDVs). Such a "mixed" traffic condition could result in different types of interactions. Some of the AVs may be recognizable in traffic and may also have specific driving styles different to that of human drivers. These differences in the appearance of AVs and in their driving styles can result in changes in the driving behavior of HDVs. Recent studies, including field test experiments, have shown that human drivers adapt their driving behavior in the presence of AVs, such as by maintaining smaller car-following headways and/or by changing the frequency or duration of lane changes. In addition to observable factors such as AV appearance and driving style, there are psychophysical factors such as driver demographics, trust in technology, experience with AVs, and their own driving style that can impact the way they change their driving behavior when interacting with AVs. Such behavioral changes may effect traffic safety and traffic efficiency. With increasing deployment of AVs in traffic, knowledge on such mixed traffic interactions is required, especially crucial aspects of AVs such as their recognizability and driving style. Authorities and decision makers can then take appropriate measures that not only minimize and possibly prevent negative and dangerous effects but also that may drive positive effects.

To understand the effect of such factors on HDV behavior, a driving simulator experiment was set-up where 95 drivers navigated a route that included a motorway section, a motorway section with dynamic speed limits, a provincial road, and three T-intersections. Drivers drove four scenarios which varied on whether AVs were recognizable and what kind of driving style (Aggressive or Defensive or Mixed) they adopted. The Aggressive and Defensive driving styles of AVs was different compared to HDVs with respect to the car-following time headways and their desired speed. Prior to the scenarios, drivers had a familiarization drive to get used to the simulator. In the experiment, the penetration rate of AVs was kept to 50%. The focus of this research is to study the car-following and lane-changing behavior of the drivers when they drive in mixed traffic conditions. Indicators of car-following include following time headway, duration below critical headway, and speed difference with leader. Indicators of lane-changing include number of lane changes, duration of lane change, and lead and lag gap when lane changing. After the analysis, the results will also be compared with existing literature findings.