Human performance serves as a benchmark against which highly automated driving functions can be compared [1].

Human performance is a product of the driver’s capabilities and the task demands of the driving scenario [2].

Driving simulator studies can be used to study the thresholds of human performance in very critical situations.

Driving simulator studies allow the assessment of thresholds of human performance in critical highway scenarios.

To quantify thresholds of human performance, a method from psychophysics, the method of constant stimuli [6], was used and adapted: A stimulus (e.g. a cutting-in vehicle) is presented repeatedly with randomly varying intensity (e.g. criticality of the scenario).

Criticality was quantified by time to collision (TTC). Tested values were based on BMW’s field operational test results [7]. In cut-in situations, for example, the most critical observed TTC was 1.7 s.

The threshold of human performance is represented by the probability to collide at a certain criticality.

Figure 1. Simplified model of human performance in PEGASUS [3] based on the task-capability-interface model [2], three-level hierarchy of the driving task [4] and levels of human performance [5]. NDS = naturalistic driving study; FOT = field operational test.

Figure 2. Driving simulator used in the two studies. © DLR
Human performance is described by controllability and severity.

In the first simulator study, participants were asked to keep on the left lane with a constant speed of 130 km/h. They encountered a cutting-in vehicle with a speed of 80 km/h (see Fig. 3).

The TTC between two vehicles at the moment, when the cutting-in vehicle is just in the middle between two lanes, was manipulated in six levels: 0.5s, 0.7s, 0.9s, 1.1s, 1.3s and 1.5s.

Controllability: The relationship between collision probability and TTC is presented in form of bar plot and logistic regression (see red line in Fig. 4).

Threshold of human performance: The inflection point, where the collision probability is 50%. In this case, this threshold can be located at TTC = 0.84s.

Severity: The box plot (see Fig. 5) presents the distribution of relative speed at the moment of a collision. A negative correlation between relative speed and TTC was revealed.
The replication of the Cut-in scenario indicates that the threshold of human performance is constant if the same scenario is tested.

Factors influencing the choice of behavior as well as relative speed seem to shift the threshold of human performance. Therefore, differing scenarios should be tested separately.
References


