

Impact of Trust Formation in Driver Assistance Systems on Drivers' Peace of Mind

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We aim to create a cabin environment that provides drivers with peace of mind while driving. To achieve this goal, we consider fostering trust in the vehicle to be important. Based on the psychological view that trust is a belief that expectations will be met, we propose that a key requirement for driving assistance to foster vehicle trust is the formation of a belief that the assistance will meet drivers' expectations by supporting driving-related decision making. A driving simulator (DS) experiment was conducted to verify whether such assistance fosters vehicle trust and promotes subjective and physiological peace of mind.

The experiment was approved by the institutional ethics committee, and informed consent was obtained from all participants. Fifty experienced drivers (30 males and 20 females; mean age: 37 ± 10 years) were included in the analysis. Participants were divided into three groups: an expectation-fulfilling group ($n = 18$; 12 males and 6 females; mean age: 38 ± 11 years), an expectation-unfulfilling group ($n = 14$; 9 males and 5 females; mean age: 36 ± 9 years), and a control group without driving assistance ($n = 18$; 10 males and 8 females; mean age: 37 ± 9 years). Differences from the control group were treated as dependent variables, and expectation response was treated as the independent variable. The procedure consisted of (1) pre-intervention measurements, (2) an intervention task, and (3) post-intervention measurements.

Participants operated the steering wheel, accelerator, and brake of the DS while performing two driving tasks.

Pre- and post-intervention driving task: Participants drove in a right-turn lane on a two-lane urban road and turned right onto a one-lane road when they judged it safe while monitoring oncoming vehicles and pedestrians.

Intervention driving task: Participants performed a highway merging task at an interchange (IC). The ego vehicle entered an acceleration lane from a ramp and merged either ahead of or behind a target vehicle in the adjacent lane. Two traffic situations were prepared: a high-traffic condition in which merging decisions were difficult and expectations toward assistance increased, and a low-traffic condition in which merging decisions were easy and expectations remained low. In the expectation-fulfilling and expectation-unfulfilling conditions, assistance was provided only in the high-traffic condition. No assistance was presented in the control condition.

Intervention: During the merging task, a head-up display presented an arrow indicating the appropriate action in the current situation, from the start of traveling alongside the target vehicle until merge completion. The displayed actions were acceleration ($\uparrow$), deceleration ($\downarrow$), and lane change to the right ($\rightarrow$). The timing of assistance presentation manipulated the response to driver expectations. In the expectation-fulfilling condition, assistance was presented before the driver made a merging decision; in the expectation-unfulfilling condition, it was presented afterward.

The results of the subjective evaluations and physiological measures are shown in Fig. 1. Compared with the expectation-unfulfilling condition, the expectation-fulfilling condition produced significantly higher ratings for "As Expected?" and "Appreciated?", confirming successful manipulation of expectation response.

Relative to the control group, the expectation-fulfilling condition also showed significantly higher levels of "vehicle trust", "peace of mind", and "pleasantness", as well as significantly lower "anxiety". In addition, the decrease in R-R interval (RRI) was significantly suppressed in the expectation-fulfilling condition.

These results suggest that repeated expectation-fulfilling assistance enhanced vehicle trust. In addition, trust formation suppressed excessive sympathetic activation, resulting in lower negative emotion and greater positive emotion during driving.

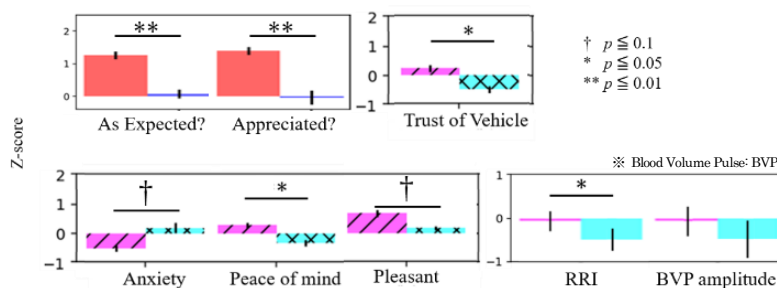


Fig. 1 Condition differences in subjective ratings and physiological measures (red: expectation-fulfilling condition; blue: expectation-unfulfilling condition; magenta: expectation-fulfilling condition minus control condition; cyan: expectation-unfulfilling condition minus control condition).