INVESTIGATING THE EFFECTS OF AUTOMATED DRIVING STYLE AND DRIVER DRIVING STYLE ON DRIVERS' PERCEPTION OF AUTOMATED DRIVING INDICATORS

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INTRODUCTION

With advances in automated vehicles (AV), it is increasingly important to determine how the driving indicators of AV should be designed to enhance driver trust and acceptance. Bellem et al. (2018) investigated drivers' perception of three specific driving indicators (i.e., acceleration, deceleration, lane deviation) with different driving styles via a motion-based simulator. They found that drivers preferred an asymmetrical acceleration profile with a small acceleration rate and a lane change profile with low jerks and early motion feedback. However, Bellem et al. (2018)'s study focused more on the rate of changes for a few driving indicators rather than the differences in the values of these driving indicators on the aggressive-defensive dimension. Different values of automated driving indicators might influence drivers' perception of these indicators. Indicators that are perceived as either aggressive or defensive can be considered inappropriate by drivers. The discrepancy between drivers' and AVs' driving styles might make drivers perceive automated driving indicators as inappropriate, which further impairs their trust and acceptance of AVs. It is still unclear drivers' perception of which automated driving indicators significantly influence their trust and acceptance. The present study aims to investigate the impact of driver's driving style (i.e., aggressive and defensive) and AV's driving style (i.e., aggressive and defensive) on driver's perception of several automated driving indicators, as well as drivers' perception of which automated driving indicators influence their trust and acceptance first.

METHOD

Thirty-two participants (16 aggressive drivers and 16 defensive drivers) were recruited and pre-screened on their driving styles with the Aggressive Driving Scale (ADS; Krahé and Fenske, 2002). All participants were required to be native English speakers and have a U.S. driver's license for at least 2 years. Gender was balanced in each driver group. The experiment made use of a 2×2 between-subjects design with the participant's driving style (aggressive vs. defensive) and the AV's driving style (aggressive vs. defensive) as independent variables. Each of the participants rides with either an aggressive AV or a defensive AV to experience twelve driving scenarios on the driving simulator. The values of the indicators were gotten from different research studies that have previously investigated driving styles on the defensive-aggressive dimension in similar scenarios (Deffenbacher et al., 2003; Hong et al., 2014; Hill et al., 2015; Yan et al.,2007). After each drive, participants were asked to evaluate the designed driving indicators of the AV and their trust, and acceptance of the AV. The automated driving indicators included average speed when driving straightly, deceleration when approaching an intersection, stopping distance when approaching an intersection, left/right turning angle, and left/right turning speed. The total experiment time is 75-90 minutes.

RESULT AND DISCUSSION

The results of the Bootstrap-based two-way ANOVAs suggested a significant main effect of AV's driving style on drivers' perceived aggressiveness of AV's average speed (76.31 vs. 66 ft/s, $p = .003$), stopping distance (340 vs. 455 ft, $p = .03$), and right turn angle (.664 vs. .438 rad/s, $p = .04$) was found. Results revealed that drivers' trust and acceptance of AVs would be significantly diminished when they perceived AVs to have a high speed, large deceleration, small deceleration, or short stopping distance. Moreover, it indicated that defensive drivers perceived significantly higher inappropriateness of aggressive AV indicators than defensive AV indicators. In contrast, aggressive drivers didn't show a significant difference in the perceived inappropriateness of AV indicators with different driving styles. This result was consistent with Zheng and Zhang's (2021) study on the global driving styles of automated vehicles. The implication of the study shows that AV's driving style has a larger impact on defensive drivers than on aggressive drivers.

In summary, this study brought insights into drivers' perception of AV's driving indicators and provided the foundation for the design of these indicators to promote drivers' trust and acceptance of AVs.

ACKNOWLEDGEMENT

This material is based upon work supported by the National Science Foundation under Grant No. (1850002).

REFERENCE

Bellem, H., Thiel, B., Schrauf, M., & Krems, J. F. (2018). Comfort in automated driving: An analysis of preferences for different automated driving styles and their dependence on personality traits. *Transportation research part F: traffic psychology and behaviour*, *55*, 90-100.

Deffenbacher, J. L., Deffenbacher, D. M., Lynch, R. S., & Richards, T. L. (2003). Anger, aggression, and risky behavior: a comparison of high and low anger drivers. *Behaviour research and therapy*, *41*(6), 701-718.

Hill, C., Elefteriadou, L., & Kondyli, A. (2015). Exploratory analysis of lane changing on freeways based on driver behavior. *Journal of transportation engineering*, *141*(4), 04014090.

Hong, J. H., Margines, B., & Dey, A. K. (2014, April). A smartphone-based sensing platform to model aggressive driving behaviors. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 4047-4056).

Krahé, B., & Fenske, I. (2002). Predicting aggressive driving behavior: The role of macho personality, age, and power of car. *Aggressive Behavior: Official Journal of the International Society for Research on Aggression*, *28*(1), 21-29.

Yan, X., Radwan, E., & Guo, D. (2007). Effects of major-road vehicle speed and driver age and gender on left-turn gap acceptance. *Accident Analysis & Prevention*, *39*(4), 843-852.