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How Does Adaptive Cruise Control Use Impact Driver Behaviors, Mental Models, and Trust and Perception in the System?

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ABSTRACT

Adaptive Cruise Control (ACC), a system designed to support the vehicle's longitudinal movement, maintaining a driver's selected speed and gap between itself and the vehicle ahead, has been described and offered to drivers as a convenience system (e.g., McGehee et al., 2008), rather than as a safety system. Despite this description, ACC has the potential to have added safety benefits for the driver. This paper provides a review of the literature with respect to the current state of the research on the impact of ACC on human behavior related to driving and to examine the potential safety benefits, as well as current limitations, of ACC. We found that exposure and use of an ACC system impacts driver behavior, trust, understanding, and perception of ACC. Overall, research suggests that although ACC may have some safety benefits, these benefits can be contingent on how the individual uses or misuses the system.

Keywords: Adaptive cruise control, Driver behaviors, Advanced driver assistance systems (ADAS)

INTRODUCTION

The recently increasing proliferation of the inclusion of advanced driver assistance systems (ADAS) in vehicles has the potential to increase driver safety and impact how drivers interact with their vehicles. Research suggests that a subset of ADAS systems, front crash mitigation systems, such as forward collision warning (FCW) and automatic emergency braking (AEB), have resulted in reductions to rear-end crashes (PARTS, 2022).

Systems such as Adaptive Cruise Control (ACC), have been described and offered to drivers as convenience systems (e.g., Lee et al., 2008). ACC is designed to support the vehicle's longitudinal movement, maintaining a driver's selected speed and gap between itself and the vehicle ahead. Although ACC can slow the vehicle to maintain the selected gap between itself and the vehicle ahead, ACC is generally not designed to engage full braking in the event of an emergency (although many vehicles with ACC also have FCW and AEB systems). As an assistance system, the driver is still responsible to be attentive to the forward roadway, maintain safe distances, respond to hazards ahead, and maintain ultimate control of and responsibility for the vehicle.

Despite this characterization, ACC has the potential to have added safety benefits for the driver. The primary focus of this review is to understand the impact of ACC on human behavior related to driving and to examine the potential safety benefits, as well as current limitations, of ACC.

METHODOLOGY

We conducted a literature review using several databases, including Google Scholar, the Institute of Electrical and Electronics Engineers (IEEE), the Human Factors and Ergonomics Society (HFES), SAE International, Transportation Research, International Documentation (TRID), ProQuest, and PsycInfo. We used keywords relating to ACC, ADAS, driver behavior, driver response, and mental models. After reviewing articles, we found themes relating to the following topics: (1) the relationship between ACC and driving behavior, including vehicle control, driver attention and distraction, and behavioral adaptation, responses to system failures; (2) drivers' understanding, or "mental model" of the ACC system, and how these mental models either enhance the safety features of ACC or impart mental confusion or error; (3) how drivers' understanding of the system affects their trust, perception, attitudes and/or beliefs of the system, and how these perceptions could lead to changes in drivers' interaction with the system. Finally, we discuss future directions of driver interaction with ACC.

DRIVING BEHAVIOR

Vehicle Control

As stated above, ACC is designed to maintain vehicle control – specifically the driver's selected speed and gap between their vehicle and the vehicle ahead. Given this, ACC has the potential to provide benefits to the driver on a variety of aspects of vehicle control. Researchers have examined several of these aspects including speed, time headway, lateral control, and passing behavior.

Speed. ACC allows the driver to select their preferred speed and then modulates the vehicle's speed depending on the vehicle ahead. Research examining driver's selected speed is mixed; some research suggests that drivers select higher speeds during ACC use compared to manual driving (e.g., Hoedemaeker & Brookhuis, 1998; Saad, 2004; Martin & Elefteriadou, 2010; Monfort et al., 2022), while other research suggests that this is not the case (e.g., Piccinini et al., 2014; Saad, 2004). Monfort et al. (2022) also found that drivers using ACC drove above the speed limit at a greater rater (95%) than during periods of manual driving (77%). In addition to selected speed, research has also found lower levels of variability in speed than manual driving (e.g., Viti et al., 2008).

Time Headway. In addition to speed, many ACC systems allow drivers to select their preferred gap between themselves and the vehicle ahead (e.g., Honda Motor Company, 2024; Ford Motor Company, 2024). In order to examine the impact of this on driver behavior, researchers examine time headway, which is defined as the time interval between a lead and following vehicle. Overall, the majority of research shows that driving with ACC results in longer time headway when compared to manual driving (Keifer et al., 2005; Lin, Hwang & Green, 2009; Ohno, 2001; Park et al., 2006; Piccinini et al., 2014; Sayer et al., 1997; Viti et al., 2008) and less headway variability (e.g., Martin & Elefteriadou, 2010). This effect, however, may be modulated by speed (Hoedemaeker & Brookhuis, 1998), levels of driver aggression (e.g., Viti et al., 2008), and intent to overtake or change lanes (e.g., Martin & Elefteriadou, 2010; Viti et al., 2008).

Researchers have also examined the impact of ACC on the driver's ability to respond to hazards. Lee et al. (2006) assessed driver performance during ACC and manual driving during mild, moderate, and severe braking events. They found that using ACC resulted in longer time-to-collision and helped drivers to maintain a longer safety margin during mild and moderate braking events.

Lateral Control and Passing Behavior. Although ACC does not have a role in controlling the vehicle lateral movements, researchers have suggested and shown that that using ACC will result in fewer lateral deviations than vehicles operated under manual control (e.g., Ohno, 2001). In addition to lateral deviation, the General Motors and the National Highway Traffic Safety Administration (NHTSA) Automotive Collision Avoidance System Field Operation Test (ACAS FOT) program found that using ACC resulted in increased lane dwelling and decreased passing behavior (Kiefer et al., 2005).

Driver Attention and Distraction

Researchers suggest that ACC results in a decrease in the visual demand required for manual driving, which may in turn free up resources for drivers to misuse the system and allocate those resources to secondary tasks (e.g., Rudin-Brown et al., 2003; Rudin-Brown & Parker, 2004). Consistent with a decrease in visual demand, several studies have demonstrated that ACC may result in decreased attention allocated toward the forward roadway (e.g., Malta et al., 2011; Morando et al., 2016; Morando, 2017; Rudin-Brown, 2010; Rudin-Brown & Parker, 2004; Tivesten et al., 2015) or reduced head movements which may suggest a narrowing of attention (e.g., Lee & Nam, 2003). It is important to note, however, that this reduced attention toward the forward roadway did not necessarily result in drivers misusing the system. For example, Morando et al. (2016) found that most glances off path were driving-related, consistent with Morando (2017), which demonstrated that visual behavior was tied to the driving task and that drivers were responsive to hazard-related cues. Furthermore, other research found that drivers kept their attention on the primary driving task in critical situations (e.g., Malta et al., 2011), that drivers showed anticipatory responses in hazard-related situations (Tivesten et al., 2015), and that driver perceived ACC-induced deceleration as a cue to look ahead in case of an arising conflict (Morando et al., 2016).

Despite these findings, there is always the possibility that drivers will misuse the system and allocate their attention away from the driving task.

For example, Naujoks et al. (2016) found an increase in secondary task engagement when ACC was engaged, but only for participants that had prior experience with ACC. Conversely, however, Reagan et al., (2021) found that drivers secondary task engaged decreased with more ACC experience. Further, Reagan et al., (2021) demonstrated that ACC use was associated with lower levels of secondary task engagement than manual driving overall. For those studies that directed drivers using ACC to engage in secondary tasks, they found that drivers reported lower levels of mental effort and increased processing associated with the secondary task (Naujoks et al., 2016; Rudin-Brown & Parker, 2004); reduced situational awareness (De Winter et al., 2014), reduced driving performance (Borowsky & Oron-Gilad, 2016).

Behavioral Adaptation

Several behavioral adaptations in response to ACC use have already been described above, including speed maintenance, headway time, lateral positioning, and eye movements. Beyond these examples, the use of ACC can potentially lead to other changes in driving behavior. For instance, in a simulator study on a two-lane roadway, there is evidence that the use of ACC can lead drivers to spend more time in the left-hand lane (Hoedemaker & Brookhuis, 1998). This may be linked to drivers selecting higher speeds while using ACC and a desire to avoid slower vehicles in the right-hand lane. Other research has found that a majority of drivers did not change their frequency of lane changes while using ACC (Llaneras, 2007). This too would be consistent with selecting a lane to avoid slower vehicles.

System Failures

Because ACC is an assistive technology and requires drivers to be attentive and be ready to respond to hazards, drivers must be ready to intervene when the system cannot handle the roadway conditions, whether due to sensor failures or suddenly encroaching vehicles. Research on driver responses to system failures or requests to intervene indicate that drivers' understanding and awareness of the system limitations are critical to prompt responses to potential hazards ahead. For instance, drivers who did not receive information on the possibility of ACC system failures took longer to respond to an imminent crash, were more likely to crash, or were more likely to be unaware of system changes (Park et al., 2006; Kikuchi & Fujii, 2005; Horiguchi et al., 2010). Inversely, drivers who received training and instruction on the ACC system were more likely to react more quickly to imminent hazards or intervene prior to approaching the limits of the system (Kikuchi & Fujii, 2005; Kircher et al., 2014). Researchers have emphasized that driver awareness of the limitations of ACC systems can reduce system misuse (e.g., Rudin-Brown & Parker, 2004).

Continuous information as to the state of the automation can assist drivers in understanding when to re-engage with longitudinal control of the vehicle (Seppelt & Lee, 2007). Not surprisingly, multimodal alerts (e.g., auditory, visual, haptic) have been found to be effective means of alerting drivers when the system cannot respond effectively to the roadway conditions (Lee et al., 2006; Saito et al., 2021). However, there are instances in which the ACC system may fail in the absence of any explicit warnings or alerts. In events where the ACC system engaged in unwanted acceleration, most drivers were found to steer rather than brake to avoid a collision (Nilsson et al., 2023). This may be due to the fact that drivers may feel more in control of lateral movements via the steering wheel when the ACC system is engaged and controlling longitudinal velocity.

MENTAL MODELS

ACC presents some limitations, creating the potential for drivers to place excessive trust in the system, especially if their mental model of the system is inaccurate. As a result, dangerous on-road situations can occur. Driver intervention is required in certain situations that cannot be handled by ACC, and so trust, acceptance, and an accurate mental model of the system are crucial for the appropriate use of ACC.

Studies have suggested that many drivers hold misconceptions about the capabilities of their ACC systems, suggesting that drivers' mental models of how these systems function do not always match reality (Llaneras, 2007). Drivers who were either unaware or unsure of ACC limitations were more likely to use ACC when tired or on curvy roads compared to drivers aware of ACC's limitations, suggesting lower levels of awareness coupled with high levels of trust in ACC may correspond to potential misuse of the system (Dickie & Boyle, 2009).

Studies examining drivers' mental models on driving performance and safety found that those drivers with stronger mental models of ACC were quicker to respond in edge-case situations than those with weaker mental models, for example when the ACC system did not detect an object such as a slow-moving motorcycle (e.g., Gaspar et al., 2020; Gaspar et al., 2021). Research suggests that strong mental models reduce uncertainty about how ACC would perform in edge-case situations (Gaspar et al., 2021). For those drivers with weaker mental models, performance deficits seem to mostly be associated with uncertainty about the ACC system's behavior in edge-case situations (Gaspar et al., 2020).

Drivers with more accurate mental models of ACC are associated with increased glancing behavior towards the road ahead compared to drivers with less accurate mental models, although these differences diminished with system exposure (Benson et al., 2021). These findings show that drivers with weaker mental models spend less time with their eyes on the road, suggesting that these drivers tend to rely on the system instead of remaining as aware of traffic conditions (Benson et al., 2021).

Regardless of drivers' baseline knowledge about and mental models of ACC, exposure to ACC systems and training on ACC features have been shown to improve mental models of ACC (Beggiato & Krems, 2013; Pradhan et al., 2023; Hungund et al., 2024; Pai et al., 2023). This is the case especially when drivers are exposed to associated edge-case driving situations, and even when drivers are given inaccurate information about the features and capabilities of ACC systems (Beggiato & Krems, 2013; Pradhan et al., 2023). Additionally, training on ACC systems via text-based training or diagram visualization training has been found to improve mental models, though without any correlation between post-training mental model scores and trust scores (Hungund et al., 2024).

While mental models and trust of ACC can drastically differ across drivers, potentially leading to dangerous misuse, exposure to ACC systems improves mental models, leading to safer use of ACC systems.

TRUST, PERCEPTION, AND BELIEFS

Understanding driver trust and acceptance in ACC is critical for examining appropriate use of the system. Trust in ACC is influenced by several variables, including initial mental models of the system (as described above), driver knowledge, and driver experience. Studies have found that drivers have an incomplete or incorrect understanding of the limitations of ACC, which impacts levels of trust in the system (DeGuzman & Donmez, 2021; Llaneras, 2007). DeGuzman and Donmez (2021) found that non-owners with better knowledge of ACC limitations exhibited lower trust, while those with a bias toward believing in the system's capabilities had higher trust. Additionally, they found that owners tended to overestimate system capabilities even though owners did not necessarily have better knowledge than non-owners. Llaneras (2007) found that 99% of ACC users were unaware that the system does not recognize stationary vehicles, highlighting the need for improved education about the limitations of the system.

In another study, researchers found that drivers who were unaware and unsure of ACC limitations exhibited riskier behaviors, such as using ACC on curvy roads or while driving fatigued (Dickie & Boyle, 2009). In this study, drivers who were aware, unaware, or unsure of ACC limitations all reported high trust in ACC, indicating that misplaced trust, specifically among unaware and unsure drivers, could potentially lead to system misuse. Overall, these findings suggest that trust in ACC is not always built on an accurate understanding of ACC, but instead, perceptions of the system's reliability.

Several studies have found that experience with ACC predicts trust in the system. Interestingly, studies have shown that trust in ACC increases with experience, even when system failures occur (Rudin-Brown et al., 2003; Rudin-Brown and Parker, 2004). Further, research has shown that drivers who were exposed to both routine and rare failures with ACC developed more accurate mental models of the system and adjusted their trust in the system over time and exposure (Pradhan et al., 2023). However, some research suggests that exposure and experience alone is not enough to increase trust in the system. For example, Beggatio and Krems (2013) found that when drivers were provided with overly optimistic information about ACC prior to use, their trust in ACC tended to decrease when they were exposed to limitations in the system.

Individual differences were also found to be related to trust in ACC. For example, drivers with an external locus of control were more likely to over-rely on ACC and react more slowly to system failures, and sensation-seekers were more likely to engage in secondary tasks while using ACC (Rudin-Brown & Parker, 2004).

Finally, external factors have also been found to relate to trust in the ACC system. For example, Reagan et al. (2022) found that trust in the ACC system, as well as awareness and understanding of the system, was higher among new vehicle buyers compared to used vehicle buyers. These findings also suggest that buyers' experience with the vehicle seller may partially contribute to the increase in information received and the increase in buyer understanding of the system (Reagan et al., 2022).

Overall, trust in ACC appears to be high among drivers. However, evidence shows that trust in ACC can be based on misconceptions regarding the capabilities of the system. Additionally, drivers who lack a foundational understanding of the limitations of ACC are more likely to misuse the system, which can lead to unsafe driving behaviors. Based on the overall evidence, it may be essential to increase both exposure and education in order to decrease risk and over-reliance in the system.

CONCLUSION

Despite often being described as a convenience system, ACC has the potential to enhance driver safety by assisting the drivers in maintaining larger safety margins, as well as indirect benefits to traffic flow or a reduction of crash risk (e.g., Lee et al., 2006; Lin, Hwang & Green, 2009; Ohno, 2001). However, the effectiveness of ACC is highly dependent on the driver's understanding and proper use of the system. While ACC can reduce visual demand (e.g., Rudin-Brown & Parker, 2004) and allow for better speed and headway management (e.g., Viti et al., 2008), it also poses risks if drivers misuse the system or have inaccurate mental models. Trust in ACC is generally high (Rudin-Brown et al., 2003; Rudin-Brown and Parker, 2004), but it can be based on misconceptions about the system's capabilities (DeGuzman & Donmez, 2021; Llaneras, 2007). Therefore, increasing driver education and exposure to ACC is crucial to ensure safe and effective use, minimizing the risk of misuse and enhancing overall driving safety.

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REFERENCES

Beggiato, M. and Krems, J. F., 2013. The evolution of mental model, trust and acceptance of adaptive cruise control in relation to initial information. *Transportation research part F: Traffic psychology and behaviour*, *18*, pp. 47–57.

Benson, A., But, J., Gaspar, J., Carney, C. and Horrey, W. J., 2021. Advanced vehicle technology: Mapping mental model accuracy and system exposure to driver behavior. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 65, No. 1, pp. 1072–1076). Sage CA: Los Angeles, CA: SAGE Publications.

Borowsky, A. and Oron-Gilad, T., 2016. The effects of automation failure and secondary task on drivers' ability to mitigate hazards in highly or semi-automated vehicles. *Advances in Transportation Studies*, *1*, pp. 59–70.

DeGuzman, C. A. and Donmez, B., 2021. Knowledge of and trust in advanced driver assistance systems. *Accident Analysis & Prevention*, *156*, p. 106121.

De Winter, J. C., Happee, R., Martens, M. H. and Stanton, N. A., 2014. Effects of adaptive cruise control and highly automated driving on workload and situation awareness: A review of the empirical evidence. *Transportation research part F: Traffic psychology and behaviour*, *27*, pp. 196–217.

Dickie, D. A. and Boyle, L. N., 2009, October. Drivers' understanding of adaptive cruise control limitations. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 53, No. 23, pp. 1806–1810). Sage CA: Los Angeles, CA: SAGE Publications.

Ford Motor Company, 2024, Explorer: Owner's Manual: Ford Motor Company.

Gaspar, J. G., Carney, C., Shull, E. & Horrey, W. J., 2020. The Impact of Driver's Mental Models of Advanced Vehicle Technologies on Safety and Performance (Technical Report). Washington, D. C.: AAA Foundation for Traffic Safety.

Gaspar, J. G., Carney, C., Shull, E. and Horrey, W. J., 2021. Mapping drivers' mental models of adaptive cruise control to performance. *Transportation research part F: Traffic psychology and behaviour*, *81*, pp. 622–638.

Hoedemaeker, M. and Brookhuis, K. A., 1998. Behavioural adaptation to driving with an adaptive cruise control (ACC). *Transportation Research Part F: Traffic Psychology and Behaviour*, *1*(2), pp. 95–106.

Honda Motor Company, 2024, Civic Sedan: Owner's Manual: Honda Motor Company.

Horiguchi, Y., Suzuki, T., Nakanishi, H. and Sawaragi, T., 2010, August. Analysis of time delay in user's awareness of ACC system mode transitions. In *Proceedings of SICE Annual Conference 2010* (pp. 911–915). IEEE.

Kiefer, R. J., Salinger, J. and Ference, J. J., 2005. Status of NHTSA's Rear-End Crash Prevention Research Program.

Kikuchi, K. and Fujii, T., 2005, June. Research on the evaluation method of driver behavior using driving support systems. In *Proc., 19th Int. Technical Conf. on the Enhanced Safety of Vehicles (ESV). Washington, DC: National Highway Traffic Safety Administration*.

Kircher, K., Larsson, A. and Hultgren, J. A., 2013. Tactical driving behavior with different levels of automation. *IEEE Transactions on Intelligent Transportation Systems*, *15*(1), pp. 158–167.

Lee, J. D., McGehee, D. V., Brown, T. L. and Marshall, D., 2006. Effects of adaptive cruise control and alert modality on driver performance. *Transportation Research Record*, *1980*(1), pp. 49–56.

Lee, J. D., McGehee, D. V., Brown, T. L. and Marshall, D. C., 2008. Rear-End Crash Avoidance System (RECAS) Algorithms and Alerting Strategies: Effects of Adaptive Cruise Control and Alert Modality on Driver Performance. *Final report, DOT HS*, *810*, p. 981.

Lee, W. S. and Nam, H. K., 2003, October. A study on driver acceptance of adaptive cruise control using a driving simulator. In *Driving Simulator Conference-North America*.

Lin, T. W., Hwang, S. L. and Green, P. A., 2009. Effects of time-gap settings of adaptive cruise control (ACC) on driving performance and subjective acceptance in a bus driving simulator. *Safety science*, *47*(5), pp. 620–625.

Llaneras, R. E., 2007, Safety Related Misconceptions and Self-Reported Behavioral Adaptations Associated With Advanced In-Vehicle Systems: Lessons Learned From Early Technology Adopters. In *Driving Assessment Conference* (Vol. 4, No. 2007). University of Iowa.

Malta, L., Aust, M. L., Faber, F., Metz, B., Pierre, G. S., Benmimoun, M. and Schäfer, R., 2012. Eurofot deliverable 6.4-final results: Impacts on traffic safety. *European Large-Scale Field Operational Tests on In-Vehicle Systems, Tech. Rep.*

Martin, B. B., and Elefteriadou, L., 2010, Driver behavior and advanced driver assistance systems: An exploratory driving simulator study. *Advances in Transportation Studies,* p. 79

Monfort, S., Reagan, I. J., Cicchino, J. B., Hu, W., Gershon, P.„ Mehler, B., and Reimer, B., 2020, Speeding behavior while using adaptive cruise control and lane centering. *Traffic Injury Prevention, 23(2),* pp. 85–90.

Morando, A., 2017. *Visual response to attentional demand in increasing levels of automation: A situated approach* (Master's thesis, Chalmers Tekniska Hogskola (Sweden).

Morando, A., Victor, T. and Dozza, M., 2016. Drivers anticipate lead-vehicle conflicts during automated longitudinal control: Sensory cues capture driver attention and promote appropriate and timely responses. *Accident Analysis & Prevention*, *97*, pp. 206–219.

Naujoks, F., Purucker, C. and Neukum, A., 2016. Secondary task engagement and vehicle automation–Comparing the effects of different automation levels in an on-road experiment. *Transportation research part F: Traffic psychology and behaviour*, *38*, pp. 67–82.

Nilsson, J., Strand, N., Falcone, P. and Vinter, J., 2013, June. Driver performance in the presence of adaptive cruise control related failures: Implications for safety analysis and fault tolerance. In *2013 43rd Annual IEEE/IFIP Conference on Dependable Systems and Networks Workshop (DSN-W)* (pp. 1–10). IEEE.

Ohno, H., 2001. Analysis and modeling of human driving behaviors using adaptive cruise control. *Applied Soft Computing*, *1*(3), pp. 237–243.

Pai, G., Zhang, F., Hungund, A. P., Pamarthi, J., Roberts, S. C., Horrey, W. J. and Pradhan, A. K., 2023. Frequency and quality of exposure to adaptive cruise control and impact on trust, workload, and mental models. *Accident Analysis & Prevention*, *190*, p. 107130.

Park, J., Sung, D. and Lee, W. S., 2006, October. A driving simulator study on adaptive cruise control failure. In *2006 SICE-ICASE International Joint Conference* (pp. 2138–2141). IEEE.

Partnership for Analytics Research in Traffic Safety (PARTS)., 2022 Real-world effectiveness of model year 2015–2020 advanced driver assistance systems. *The MITRE Corporation (22-3734),* pp. 1–62.

Piccinini, G. F. B., Rodrigues, C. M., Leitão, M. and Simões, A., 2014. Driver's behavioral adaptation to Adaptive Cruise Control (ACC): The case of speed and time headway. *Journal of safety research*, *49*, pp. 77–e1.

Pradhan, A. K., Roberts, S. C., Pai, G., Zhang, F. and Horrey, W. J., 2023. Change in mental models of ADAS in relation to quantity and quality of exposure.

Reagan, I. J., Teoh, E. R., Cicchino, J. B., Gershon, P., Reimer, B., Mehler, B. and Seppelt, B., 2021. Disengagement from driving when using automation during a 4-week field trial. *Transportation research part F: Traffic psychology and behaviour*, *82*, pp. 400–411.

Reagan, I. J., Cicchino, J. B., Teoh, E. R. and Cox, A. E., 2022. New and used vehicle buyers' awareness, understanding, and trust in advanced driver assistance systems. *Transportation Research Part F: Traffic Psychology and Behaviour, 92*, pp. 44–55.

Rudin-Brown, C. M., Parker, H. A. and Malisia, A. R., 2003. Behavioral adaptation to adaptive cruise control. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* (Vol. 47, No. 16, pp. 1850–1854). Sage CA: Los Angeles, CA: SAGE Publications.

Rudin-Brown, C. M., 2010. 'Intelligent' in-vehicle intelligent transport systems: Limiting behavioural adaptation through adaptive design. *IET intelligent transport systems*, *4*(4), pp. 252–261.

Rudin-Brown, C. M. and Parker, H. A., 2004. Behavioural adaptation to adaptive cruise control (ACC): Implications for preventive strategies. *Transportation Research Part F: Traffic Psychology and Behaviour*, *7*(2), pp. 59–76.

Saad, F., 2004, Behavioural adaptations to new driver support systems: Some critical issues. In *2004 IEEE International Conference on Systems, Man and Cybernetics (IEEE Cat. No. 04CH37583)* (Vol. 1, pp. 288–293). IEEE.

Saito, Y., Muslim, H. and Itoh, M., 2021, October. Design of haptic protection with an adaptive level of authority based on risk indicators under hands-on partial driving automation. In *2021 IEEE International Conference on Systems, Man, and Cybernetics (SMC)* (pp. 1613–1618). IEEE.

Sayer, J. R., Mefford, M. L., Fancher, P. S., Ervin, R. E. and Bogard, S. E., 1997. An experimental design for studying how driver characteristics influence headway control. In *Proceedings of Conference on Intelligent Transportation Systems* (pp. 870–875). IEEE.

Seppelt, B. D. and Lee, J. D., 2007. Making adaptive cruise control (ACC) limits visible. *International journal of human-computer studies*, *65*(3), pp. 192–205.

Tivesten, E., Morando, A. and Victor, T., 2015, November. The timecourse of driver visual attention in naturalistic driving with adaptive cruise control and forward collision warning. In *International Conference on Driver Distraction and Inattention, 4th, 2015, Sydney, New South Wales, Australia* (No. 15349).

Viti, F., Hoogendoorn, S. P., Alkim, T. P. and Bootsma, G., 2008, June. Driving behavior interaction with ACC: Results from a Field Operational Test in the Netherlands. In *2008 IEEE Intelligent Vehicles Symposium* (pp. 745–750). IEEE.