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Behavioural adaptation in Advanced Driver Assistance Systems (ADAS) use

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ABSTRACT

Advanced Driver Assistance Systems (ADAS) promise to enhance road safety, reduce driver workload, and improve driving comfort. However, their real-world impact is shaped by how drivers adapt their behaviour over time. This study explores the behavioural adaptations associated with the use of ADAS through qualitative analysis of interviews with sixty drivers in Australia. As a result, four interrelated themes emerge: *1. Degradation of driving skills*, *2. Shifting risk perception and tolerance with ADAS*, *3. Reduced cognitive and physical engagement in driving tasks*, and 4. *Adaptation to system warnings*. While ADAS can support safer driving, the findings reveal that over-reliance and complacency are common, potentially undermining the intended safety benefits. We argue that these behavioural adaptations form a dynamic process shaped by trust, perceived system capabilities, and user habits. To address this, integrated strategies that combine adaptive interface design, regulatory oversight, driver training, and real-time monitoring are needed to sustain safety and user competence. This study contributes insights into the emerging behavioural consequences of ADAS adoption in everyday contexts.

1. Introduction

While system designers have designed the technology with the expected manner of use, in practice, users appropriate systems in unanticipated ways, exhibiting behaviours that extend beyond the designers' intended scope (Dix, 2007). This divergence can modify expected outcomes, potentially yielding adverse effects or, magnifying the technology's benefits, in either case, introducing a degree of uncertainty. Recognising and systematically accounting for these uncertainties is important for achieving the system's objectives.

Advanced Driver Assistance Systems (ADAS) comprise an integrated suite of sensor-based perception, decision-making, and control algorithms. It operates at SAE (Society of Automotive Engineers) Levels 1 and 2 of vehicle automation, which partially automate longitudinal and lateral driving tasks (e.g., adaptive cruise control, lane-keeping assistance) to enhance driving comfort, operational efficiency and safety. Despite these intended benefits, drivers may exhibit unexpected behavioural adaptations when using ADAS, which can lead to both positive and negative consequences (Rudin-Brown and Noy, 2002). As drivers adjust their behaviour based on their perceptions of system capabilities and limitations (Stanton and Young, 2005), behavioural adaptation is an inevitable phenomenon when integrating ADAS into driving. Drivers modify their driving habits when using ADAS, which can occasionally lead to misuse of the technology (Metzger and Parasuraman, 2001; Parasuraman et al., 2008). Misuse refers to overreliance on the system, resulting in inappropriate or excessive use beyond its intended scope (Parasuraman and Riley, 1997). As the adoption of ADAS continues to increase, understanding behavioural adaptation is essential for assessing the real-world impact of these systems and developing strategies to mitigate potential risks.

1.1. Behaviour adaptation in automated vehicles

Behavioural adaptation (BA) has been widely studied in the context of road safety and driving automation. Organisation for Economic Cooperation and Development (OECD, 1990) defines behavioural adaptation as "behaviours which may occur following the introduction of changes to the road–vehicle–user system and which were not intended by the initiators of the change". This definition highlights that while driving automation aims to improve safety and efficiency, drivers' responses to these systems can deviate from expected norms, potentially undermining safety outcomes. Behavioural adaptation can occur in response to a variety of road safety interventions, including modifications in highway design, the introduction of in-vehicle technologies, and

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educational campaigns (Brown and Noy, 2004; Smiley, 2000). Rudin--Brown and Noy (2002) proposed a qualitative model of behavioural adaptation, suggesting that driving behaviour depends on an individual's mental model of driving tasks. This mental model is directly influenced by psychological characteristics, feedback from in-vehicle systems, and the extent to which the driver trusts the system to operate as intended.

Behavioural adaptation is particularly important in the context of automated vehicles. As vehicles become automated, drivers delegate tasks to the vehicle and its system, which, in turn, assume tasks previously performed by the driver. In this context, drivers may develop new habits, expectations, and levels of trust in response to system functionality and reliability, which are closely linked to misuse of ADAS. For example, it has been widely observed in automation that reliable systems reduce monitoring behaviour, ultimately increasing the risk of system failures (Mosier et al., 1998; Parasuraman et al., 1993). The misuse can manifest in various ways, including complacency, over-reliance on the system, and misinterpretation of system functions. Billings et al. (1976) defined complacency as self-satisfaction leading to a lack of vigilance, often based on an unjustified assumption that the system is functioning correctly. For example, drivers who frequently use Adaptive Cruise Control (ACC) are more likely to engage in secondary tasks, thereby increasing reaction times in critical situations (Rudin-Brown and Parker, 2004). From a broader policy and research perspective, the substantial safety and efficiency gains long promised by ADAS may be attenuated, or even reversed, if behavioural adaptations systematically emerge. Therefore, before we can responsibly recalibrate our benefit projections and update design guidelines, it is essential to empirically determine the nature of these adaptations under real-world driving conditions.

Previous studies have demonstrated that behavioural adaptations occur across a range of ADAS technologies, with findings that are sometimes aligned and sometimes conflicting, depending on the specific ADAS function examined. For example, early work on braking interventions showed that the introduction of Anti-lock Braking Systems (ABS) led drivers to reduce their following distances, illustrating a classic example of risk compensation, in which drivers increase risky behaviour after perceiving a safety-enhancing technology (Sagberg et al., 1997). Subsequent investigations of lateral control systems revealed residual effects beyond system use. Miller and Boyle (2019) found that drivers exposed to Lane-Keeping Assistance (LKA) continued to exhibit prolonged off-road glances even after reverting to manual control, while Yu et al. (2021) linked greater trust in Lane Departure Warning (LDW) and LKA to drivers' tendency to assume less secure hand positions on the steering wheel. Studies of longitudinal automation have similarly documented both attention shifts and neutral behavioural outcomes. Rudin-Brown and Parker (2004) and Cho et al. (2006) independently reported that ACC users paid less attention to the road ahead and reacted more slowly to hazards. However, Piccinini et al. (2014) detected no significant changes in speed choice or time headway among ACC drivers, and Vollrath et al. (2011) found no increase in secondary-task engagement, despite observing delayed reactions under critical conditions. More advanced collision-mitigation systems also elicit compensatory behaviours. Reinmueller et al. (2020) observed that drivers using adaptive Forward Collision Warning (FCW) maintained shorter time-to-collision margins, whereas Muslim and Itoh (2021) revealed a learning effect, in which prolonged exposure improved driver comprehension and response, through a one-month-long study of an adaptive collision-avoidance system. In the context of higher levels of automation, Xu et al. (2024) showed that although drivers reported stronger intentions to intervene in aggressive automated driving modes, their actual intervention rates remained low, indicating adaptation to challenging scenarios. Similarly, Jamson et al. (2013) linked increasing automation to reduced road-ward attention, underscoring the pervasive influence of behavioural adaptation on driver awareness.

Although previous studies have examined behavioural adaptation to specific ADAS functions, most research has been conducted in controlled simulator environments, focusing on assessing specific operational changes, such as reaction times, braking patterns, or engagement in secondary tasks. Perhaps most relevant to our work is Lin et al. (2018), who explored the impact of assisted driving on driver behaviour and understanding through interviews with Tesla drivers. The results indicated that drivers generally held a positive attitude towards the system and commonly engaged in secondary tasks while using automated driving features. In addition, Metz et al. (2025) conducted an on-road evaluation of prototype Level 3 automated driving to investigate behaviour adaptation. Results showed that although drivers' mental models became more accurate and acceptance and perceived safety improved with repeated exposure, overall trust did not increase, and adaptation patterns varied across operational design domains, suggesting the need for structured, familiarisation phases. While these studies demonstrated behaviour adaptation based on real-world ADAS use, they focused on changes in secondary task engagement, trust, and mental models rather than on shifts in function usage resulting from behavioural adaptation. Research examining how drivers adapt to ADAS in real-world conditions and investigating which particular behaviours change over time remains limited. A comprehensive investigation is needed to understand how drivers integrate ADAS into their daily driving routines and how these adaptations impact overall road safety.

1.2. Research gap and aim

While quantitative research has helped establish patterns of driver behaviour with ADAS, it provides limited insight into the subjective experiences and reasoning that underpin these behaviours. Specifically, little is known about how drivers' trust in ADAS evolves over time, what factors influence changes in their usage, or how psychological and contextual pressures shape their interactions with these technologies. To address this gap, the current study adopts a qualitative approach, using semi-structured interviews to explore drivers' personal experiences with ADAS-equipped vehicles. Participants were asked about their level of trust in the systems, changes in usage since, perceived advantages and disadvantages, safety considerations, social influences, and their views on misuse by others. Through these questions, the study aims to explore how drivers adapt to ADAS over time, what influences their use, and how they evaluate the role of these technologies in everyday driving. This study can contribute insights to the design of driving automation systems, targeted educational strategies, and policies that better support safe and effective ADAS use in real-world contexts.

2. Method

2.1. Participants

This study consisted of 60 participants (27 males and 33 females) aged 19-78 years (Average = 39.6 years, STD = 15.6), with the following age-range distribution: 19–30 years (n = 22), 31-40 years (n = 14), 41-50 years (n = 11), 51-60 years (n = 4), 61-70 years (n = 7), and over 71 years (n = 2). Experience with the current vehicle ranged from 1 month to 10 years (M = 2.3 years, SD = 2.1), with 73% reporting less than 2 years. Weekly driving exposure ranged from 0.7 to 26 h (M = 6.3 h, SD = 4.6). Most participants reported predominantly urban driving (74%), with smaller proportions reporting mixed (23%) or mainly country driving (3%). All participants have a valid driving license in Australia and drove a vehicle that included at least three of the following Advanced Driver Assistance Systems (ADAS) functions: Autonomous braking, Fatigue/distraction warning system, Automatic parallel parking, Intelligent speed adaptation/speed limit warning, Forward collision avoidance system/forward collision warning system, Adaptive cruise control, Blind spot monitor/warning with lane change assist, Lane departure warning system, Following distance warning, Automatic lane change, Rear-cross traffic alert, Rear-view camera, Lane-keep assist/lane centring system. Note that this ownership does not imply active use; This indicates that some participants qualified because their vehicles had ADAS, but they had little or no experience. In this study, a list of ADAS features was referred to the integrated safety chain perspective (Tingvall et al., 2009), in which automated and semi-automated systems contribute to crash prevention and injury mitigation, including behavioural regulation (e.g., speed limit warning), situational warnings (e.g., lane departure or collision alerts), and active control interventions (e.g., autonomous braking or lane assistance).

2.2. Procedure

Participants were required to own a vehicle equipped with at least one ADAS to be eligible for the study. While this ensured that all participants had direct experience with these technologies, it also introduced a potential source of bias. Previous research has shown that many drivers are unaware of the full range of ADAS functionalities in their vehicles or may not even realise that such systems are present (e.g. (Kaye et al., 2022),). As a result, self-reported familiarity and usage may not always reflect actual engagement with the technology. Participants were recruited electronically via Facebook, Gumtree, and university and community email lists, with outreach conducted across Australia. Interested individuals first completed a short demographic and screening survey to confirm their eligibility. Those who met the inclusion criteria were invited to participate in a 1-h telephone interview. The interviews were conducted using a semi-structured schedule covering four core areas: trust in ADAS, the behavioural adaptation process, system advantages and disadvantages, and user recommendations (see Table 1). All participants received a $50 electronic voucher in recognition of their time and contributions. The study protocol was approved by the QUT Human Research Ethics Committee (Approval No: 1800000886).

2.3. Data analysis

All interviews were audio-recorded and transcribed verbatim to ensure the accuracy and completeness of the data. The analysis followed a structured qualitative approach, drawing on the long-table method as used by Lin et al. (2018), adapted for thematic development. First, each transcript was transferred into a long-table-style Excel matrix (one quote per row), including the participant ID, ADAS function, and question. Within ADAS, instances of behaviours indicative of behavioural adaptation were identified and coded. This ADAS-based organisational strategy enabled us to systematically identify recurring behavioural patterns across multiple participants and systems, rather than relying on case-by-case analysis of interviews. These codes were compared across participants and clustered into conceptual categories. Next, similar behavioural patterns were clustered to form preliminary categories. These clusters were iteratively reviewed and refined into broader, overarching themes that captured the trajectories and variations in drivers' experiences with ADAS. In this process, the first author conducted the overall coding, and the two authors discussed and collaboratively resolved any discrepancies in categorisation or interpretation. Throughout the analysis, thematic saturation was monitored to determine whether additional interviews continued to generate novel behavioural insights. Saturation was considered achieved when no new behavioural patterns or thematic elements emerged in the final stages of coding. This systematic approach ensured a robust interpretation of the data, and the development of themes grounded in participants' lived experiences with ADAS-equipped vehicles. This process allowed us to systematically handle the large volume of qualitative material and ensure that themes reflected patterns consistently observed across participants.

Table 1
Interview questions.

	Questions
Trust	Do you fully trust the systems? Why or why not?
BA process	Was there any change in how you use the system now compared with then you first began using it?
	What are the advantages/disadvantages of driving a vehicle with these systems?
	Do you use them safely?
	Have you ever felt pressure to drive in a way you did not want to because of the systems?
	What do you think affects the way you use these systems?
	Is there anything that you see other drivers do while using the systems that you think is 'the wrong thing to do'?
Suggestions	Please share any suggestions regarding the systems.

3. Results

The results reveal several themes related to behavioural adaptation in the use of Advanced Driver Assistance Systems (ADAS). We described the interview results categorised by the following four themes: Theme 1 - Degradation of driving skills, Theme 2 - Shifting Risk Perception and Tolerance with ADAS, Theme 3 - Reduced cognitive and physical engagement in driving tasks, and Theme 4 - Adaptation to system warnings. Since the participant's response is mainly related to a specific ADAS, the corresponding ADAS, along with relevant citations where applicable, was indicated. Note that overreliance and misuse are often intertwined with overall behaviour adaptation. With the use of ADAS, participants often experience declines in attention, decision-making, and driving skills as they become more reliant on the system. In addition, misuse of automation features is a recurring theme observed across several categories. Therefore, behaviours related to overreliance and misuse are classified in the other categories rather than separately.

3.1. Theme 1 - Degradation of driving skills

Theme 1 highlights concerns that the use of ADAS may contribute to a decline in core driving skills, including vehicle control and hazard perception. Participants reported a perceived reduction in their ability to perform fundamental tasks, such as braking, steering, and parking, and, in some cases, a loss of confidence in their overall driving ability. Reflecting these concerns, one participant suggested that reliance on these systems could be particularly problematic for novice drivers, who may not develop essential skills if they begin learning to drive with ADAS already in place.

> "I don't think it (ADAS) would be good for new drivers because it is important to learn to drive without the systems so that you understand what you need to do without them." – P56

While not all ADAS features affect driving performance equally, several participants raised concerns that specific systems, particularly parking-related aids such as rear parking sensors and rear-view cameras, may contribute to a decline in manual driving skills. Many reported relying heavily on these technologies, leading to reduced confidence and diminished ability to perform parking manoeuvres without assistance. This effect was especially noticeable when participants temporarily drove vehicles without such systems, often experiencing difficulty with tasks they had previously performed with ease. The following participant comments illustrate how such reliance manifests in everyday experience:

> "You can become used to the alarm, and if you get into another car that doesn't have those alarms, you can come into a bit of trouble." – P22, Rear parking sensor

> "My wife, when we got our car serviced recently, they gave her a loaner which didn't have a reversing camera, and she was not very happy because she couldn't reverse park properly like she used to." – P15, Rear-view camera

"I can't imagine parking without the rear-view camera" – P51, Rear-view camera

3.2. Theme 2 - Shifting risk perception and tolerance with ADAS

This theme explores how the use of ADAS can alter drivers' perceptions of risk and influence their willingness to engage in behaviours that may compromise safety. Several participants described how, over time, they developed a sense of security in the system's ability to manage critical aspects of driving. This perceived safety margin appeared to reduce their risk sensitivity and, in some cases, encouraged behaviours they would normally avoid when driving manually. Adaptive Cruise Control (ACC), for example, has often been associated with increased driving speed and reduced following distance. Some participants reported relying on the system to maintain legal speed and safe spacing, even though they typically drove more conservatively without automation. Others admitted to following vehicles more closely to avoid disengaging ACC or momentarily removing their hands from the wheel when both ACC and lane-keeping were active.

"I guess I drive faster than normal because if I'm manually driving, I drive 10km/h slower than the speed limit. But with the adaptive cruise control, I set it at the speed limit, so I drive a little bit faster, but still safe." – P56, ACC

"I sometimes take my hands off the steering wheel with ACC and lane-keeping, and the car beeps me about it after a kilometre of driving" – P16, ACC

Forward Collision Warning (FCW) systems also influenced drivers' risk tolerance. One participant described how their partner regularly exceeded the speed limit on rural roads, assuming the system would alert them if a collision risk emerged. Likewise, the use of rear-view cameras, although intended to support safe parking, was associated with drivers positioning their vehicles closer to objects due to their trust in the camera's accuracy.

"Rural road … Speed limited at 100km/h; I know my husband was going faster than that because he doesn't believe in speed limits. Normally, he goes 120km/h on these types of roads. (because he knows the automatic braking will kick, and the forward collision alarm will go off)" – P56, Forward collision warning

"I park way closer to objects than I used to" – P10, Rear-view camera

3.3. Theme 3 - Reduced cognitive and physical engagement in driving tasks

Participants frequently described feelings of passivity, monotony, or detachment, especially during long-distance or repetitive driving. Several participants characterised this experience as becoming "lazy" while using automation, especially when they were tired or attempting to multitask. Some reported relying on the system to regulate speed or maintain distance without continuously monitoring the environment.

For example, some participants reported relying on rear-view cameras as their primary means of parking and assessing their surroundings, often at the expense of traditional visual checks such as using mirrors or turning their head.

"I see my husband using the reverse camera all the time without looking to the left or the right out of the other side mirrors, and I think it's very sad. It's lazy, and I don't think it's safe" – P4, Rear-view camera

This phenomenon is particularly pronounced when using Adaptive Cruise Control (ACC) and Cruise Control (CC). Participants described how these systems, by regulating speed and maintaining following distance, reduce the need for continuous driver input and encourage a passive mode of engagement. Many participants reported removing their feet from the pedals and experiencing a reduced sense of environmental awareness while the system was active. The convenience of these features often led to diminished attentiveness, as drivers no longer felt the need to monitor their speed or spacing manually. In several cases, this disengagement extended to the performance of secondary tasks, such as changing music or using a mobile phone, while driving. The extended use of ACC and CC on long-distance journeys was also associated with increased driver fatigue. Some participants reported episodes of "zoning out," memory lapses, or even falling asleep while the systems were active. Moreover, several participants admitted using ACC in circumstances where they were too tired to drive safely, justifying the decision by citing the system's ability to "take over" or "keep them safe."

"I really noticed it one day when I came to a full stop at the traffic lights one day and I had no memory how I managed to stop realising that I had the cruise control set. Other times it will only bring me to a stop if the vehicle in front brings you to a stop, and I had to quickly brake when I noticed a red light was coming up, and I wasn't stopping. and I was like 'why wasn't the car stopping?' that's because, there's a car in front of me … It's easy to become quite lazy, particularly with the adaptive cruise control." – P29, ACC

"Particularly if I'm driving a little bit tired … I will switch it on because I know it will probably react a bit faster than I will. Even though I know I probably shouldn't be driving in those circumstances. Like most human beings, I do stupid things and I've just got to get to where I'm going, and I'll probably still drive it even though I shouldn't be" – P29, ACC

"Cause people could think, alright, my speed is set, my feet are off the accelerator, and you said they could take their eyes off the road. Try to do something else." – P33, ACC

"I was using the cruise control, and there was a bit of traffic, so I deactivated it, and I was driving slowly. But then the traffic got better, and I decided to turn it back on. And the car accelerated. But since it doesn't accelerate very fast, you almost don't notice. Because it was downhill. So, by the time I realised, I was a little bit over the speed limit" – P7, CC

"I guess the main risk is, when you use it, you're more likely to be distracted from driving. If it's a busy road and you have to brake suddenly, maybe it takes you more time to react to it because you are with the cruise control and the car is driving by itself." – P7, CC

"With cruise, it has made me a bit lazy. I mean it's good because I don't speed, but it could be bad, like you could go to sleep." – P19, CC

3.4. Theme 4 - Adaptation to system warnings

This theme explores how drivers respond to the alerts and notifications generated by ADAS features over time. A clear pattern that emerged was the diversity and strength of participants' reactions to system warnings. For some, these alerts became essential cues for maintaining safety, while others described them as irritating, overly cautious, or easy to ignore. In several cases, participants adapted by developing habits of either dependence or resistance, reflecting how warning systems can shape, intentionally or not, the way drivers monitor and interact with their environment. As drivers became more familiar with their vehicles, some developed a reliance on warnings as substitutes for manual checks, while others reported turning them off altogether. Still others adjusted their driving behaviour specifically to avoid hearing the alerts. These varied responses highlight that behavioural adaptation to warnings is not linear or uniform but rather reflects individual preferences, perceptions of system accuracy, and broader driving contexts. The following subthemes illustrate how this adaptation manifests as reliance, dismissal, deactivation, or heightened attentiveness to system feedback.

3.4.1. Reliance on warning from ADAS

Participants often described ADAS warnings, such as Lane Departure Warning (LDW), blind-spot warning, speed-limit warning, and rear parking sensors, as their primary means of assessing road conditions, effectively replacing their own active monitoring. Over time, many participants reported leaning on LDW to maintain lane position, with less conscious steering or lane-centring. Those who trusted the blind spot warning confessed to forgoing the customary shoulder check, confident the system would flag any vehicles alongside. Likewise, users of speed limit warning systems reported rarely glancing at the speedometer and relying instead on alarms to prevent violations. Dependence on rear parking sensors also emerged. Several participants recounted misjudging clearances, at times stopping mere centimetres from obstacles, after abandoning their habitual visual scans. While participants appreciated the workload reduction and reassurance these warnings provided, they also recognised a new vulnerability when driving cars without comparable ADAS features. The following quotes exemplify these adaptation patterns:

> "Without the system, I drive more carefully, I just don't pay attention as much, I guess there's nothing to really warn me." – P20

> "If you are relying on the lane departure warning system, maybe you are not so particular about where you are driving on the road." – P3, LDW

> "I was so used to the blind spot indicators in particular that when I'm in a vehicle that doesn't have it, you get into the habit of it should turn up, and if I'm not seeing the signal, I'm assuming that there's nothing there when actually that's not the case." – P54, Blind spot warning

> "When you have the system, it will give you warnings or alarms when the speed is high; you don't need to check something else to be reassured about the speed limit." – P2, Speed limit warning

> "I've had a near miss with my son's car that doesn't have systems. I've forgotten that the systems aren't there. Not near misses in terms of car accidents but near misses in terms of beeping or reversing, and then I'll realise this car doesn't have it, and that's when I slam on the brakes just millimetres away from hitting the pole." – P55, Rear parking sensor

3.4.2. Ignore warning

Consciously ignoring ADAS warnings represents a form of misuse that undermines the safety benefits these systems are designed to provide. Drivers who regularly ignore warnings risk reduced overall alertness, especially in high-risk situations where system feedback could help prevent a collision. Despite the intended function of the warnings to draw attention to hazards, some participants override them when they judge the alerts to be overly sensitive or inconvenient, favouring personal judgment over automated cues. For example, participants who relied on rear parking sensors reported silencing alarms when they believed there was adequate clearance, or tuning them out when the beeps became too frequent. Likewise, speed limit warnings were sometimes disregarded by drivers who prioritised maintaining their desired pace over adhering to system recommendations. The following quotations illustrate this tendency:

> "The disadvantages are that you can become lazy and ignore the alarm … I guess I got angry at myself when reversing and hitting the pole. I was reversing and not paying attention to the alarm." – P22, Rear parking sensor

> "But when I'm driving at 100km/h, I'm not following the warning." – P12, Speed limit warning

3.4.3. Disable warning

Drivers sometimes take the extra step of turning off ADAS warnings entirely. While ignoring warnings reflects an immediate response to perceived over-cautiousness, disabling warnings demonstrates a more deliberate rejection of system feedback, often motivated by annoyance or discomfort. Participants mentioned that they disabled Lane Departure Warnings (LDW) and speed limit warnings, citing their perceived irrelevance in specific driving contexts or their tendency to induce anxiety. The comments below demonstrate these perspectives:

> "You do lane changes, and you've got bike lanes, and it makes your own lane a little small, so you would probably get a warning when you get close to it, and it would just be completely irritating, so I only use it in the country driving. It's more aimed at country driving rather than city driving" – P32, LDW

> "When it's beeping (I turn it off) because it's really annoying." – P49, Speed limit warning

3.4.4. Attentiveness to warning

While many adaptations involved overreliance on or dismissal of warnings, some participants reported that positive behavioural changes resulted from system warnings, whereas more reported negative behavioural changes. Rather than tuning them out, these users adjusted their driving to avoid triggering alerts, thereby enhancing their situational awareness. For example, participants using Forward Collision Warning (FCW) described consciously maintaining greater following distances and more vigilant scanning of the road ahead to prevent the system from issuing a warning.

> "I try not to get too close to the car in front of me. (to prevent listening FCW)" – P45, FCW

3.5. Themes integration

While each theme captures a different aspect of behavioural adaptation, they interact to form a process, as illustrated in Fig. 1, that evolves with increasing trust in and reliance on ADAS. As drivers are exposed to ADAS, trust develops, which becomes a necessary condition for engaging with the system. However, when trust exceeds the driver's understanding of the system's capability, it can lead to over-reliance. This, in turn, reduces both cognitive and physical engagement (Theme 3), inflates risk tolerance (Theme 2), and may also erode certain driving skills (Theme 1). System warnings (Theme 4) can modulate this process. For example, a driver who becomes complacent while using Adaptive Cruise Control might turn off speed-limit alerts and maintain a closer following distance, assuming that the system will intervene when needed. Ultimately, a driver loses the manual driving skill required to maintain a safe distance. Therefore, these four themes do not operate independently but represent parallel adaptive pathways that influence one another. Over-reliance encourages both skill degradation and risk compensation, while reduced engagement increases the likelihood of ignoring warnings. As a result, a driver's response to a system warning constitutes an ongoing calibration of trust, thereby completing the loop. Recognising this interdependence highlights the need for ADAS design and training interventions that not only promote appropriately calibrated trust but also help preserve driver skill, maintain risk awareness, and support constructive use of system feedback.

4. Discussion

4.1. Behaviour adaptation in ADAS use and its potential impact

4.1.1. Degradation of driving skills

One significant behavioural adaptation observed in the results is a decline in fundamental driving skills when transitioning between

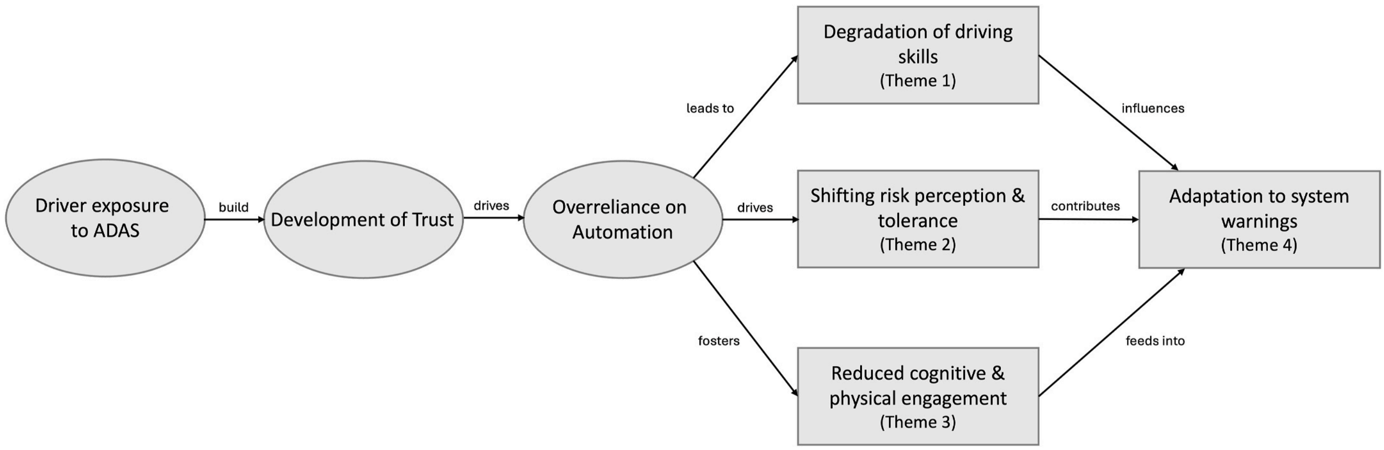

Fig. 1. Formation of behavioural adaptation and interrelations among themes.

vehicles equipped with Advanced Driver Assistance Systems (ADAS) and those without. As drivers become accustomed to ADAS, they habitually rely on automation rather than manual driving skills. This phenomenon is known as skill degradation, and it has been observed in various domains, such as aviation (Haslbeck and Hoermann, 2016), manufacturing (Rashid and Roetting, 2021), and cognitive learning (Volz and Dorneich, 2020), where automation has led to a decline in human skills (Miller and Boyle, 2019). also found that drivers who drive with ADAS not only experience diminished hazard perception but also a decline in manual control skills. In this study, drivers reported difficulty with basic manoeuvres when parking assistance features, such as rear parking sensors or reverse cameras, were unavailable. Importantly, these observations were not generalised across all ADAS functions but appeared concentrated in features that are highly engaging and frequently used. This suggests that the degree of behavioural adaptation may be linked to the level of system interaction and perceived convenience. As these systems become more popular and widely adopted, patterns of behavioural adaptation may evolve, potentially leading to broader changes in driver skill retention and expectations over time. Although this study identified skill degradation primarily in parking-related tasks, the increasing adoption of ADAS raises concerns that similar effects could extend to other driving skills. While ADAS assists drivers with driving, one of the main challenges in the widespread adoption of ADAS is maintaining drivers' fundamental driving skills.

4.1.2. *Increased risk-taking behaviour and decreased driving engagement*

Another effect of ADAS is the alteration of drivers' risk perception, which leads to risk compensation (Hedlund, 2000). Risk compensation occurs when drivers perceive ADAS as a safety net and consequently engage in riskier driving behaviours. For example, the results showed that drivers tended to follow other vehicles more closely when Adaptive Cruise Control (ACC) was activated than when driving manually. Similarly, drivers using ACC and Forward Collision Warning (FCW) relied on automated speed adjustments, leading to higher driving speeds than they would normally maintain. Previous studies have also shown that ACC users are more likely to follow other vehicles at shorter distances than those relying on manual control (Rudin-Brown and Parker, 2004). Additionally, systems such as Automatic Emergency Braking (AEB) can unintentionally encourage less cautious behaviour, as drivers may assume the system will intervene if necessary (Kinosada et al., 2021). Although ADAS features are designed to enhance safety, they can inadvertently promote more aggressive and less cautious driving behaviours. This false sense of security may contribute to behaviours such as excessive speeding, tailgating, and failure to yield in critical situations. Moreover, behavioural adaptation resulting from ADAS use decreases driver engagement. Some participants reported they had little recollection of their driving behaviour while using ACC or Cruise Control (CC). Rather than avoiding driving in such states, several participants reported on relying to automation to compensate for reduced alertness. This behaviour suggests that ADAS may unintentionally enable driving under conditions that drivers themselves acknowledge as unsafe. Unlike traditional risk-taking, this form of behavioural adaptation appears motivated not by thrill-seeking but by a perceived lowering of task demand. Some admitted to using ADAS to compensate for fatigue, which could lead to dangerous situations if the system malfunctions. Furthermore, others engaged in secondary tasks, such as using their mobile phones, while relying on ADAS for speed and lane maintenance. Multitasking while driving further reduces situational awareness and contributes to distraction, a major cause of accidents. Reduced engagement is particularly concerning as it weakens drivers' ability to react swiftly in emergencies, ultimately increasing safety risks (Glaser et al., 2016).

The primary cause of these behavioural adaptations, reduced risk perception and engagement, is a combination of over-reliance on automation and complacency. Repeated interactions with automated features shape drivers' perceptions of system reliability (Hoff and Bashir, 2015). As trust in the system grows, drivers become less vigilant in monitoring their driving environment. Over time, this trust can evolve into over-trust, where drivers delegate excessive responsibility to the system beyond its capabilities (Lee and See, 2004). This phenomenon is particularly evident with features such as ACC and Lane Keeping Assist (LKA), in which drivers disengage from active monitoring and assume the system will maintain safety, even while performing non-driving-related tasks. Such behaviour reduces driver involvement and increases the risk of accidents in situations requiring manual intervention (Miller and Boyle, 2019). Over time, drivers may expect ADAS to intervene in potentially hazardous situations, reducing their sense of responsibility. However, most ADAS features are not designed for full automation and still require human oversight. The discrepancy between driver expectations and system capabilities has been identified as a key factor in automation-related crashes (Endsley, 2017).

These findings highlight a fundamental tension in ADAS design. Trust is typically seen as desirable and is often intentionally cultivated to promote user acceptance and adoption. However, this study suggests that increasing trust can also produce unintended consequences, specifically, riskier behaviours and over-reliance. As such, trust should not be treated solely as a design success metric but as a dynamic, context-dependent factor that can shape driver behaviour in both positive and negative ways. Designers should be cautious in encouraging trust indiscriminately, especially in systems that still rely on driver oversight. Careful calibration is essential: while a lack of trust may limit use, uncritical or inflated trust may ultimately undermine the safety goals these systems are designed to achieve.

4.1.3. Behaviour adaptation on warning

Several behavioural adaptation phenomena were identified in the results as being related to ADAS warnings. Some participants became overly dependent on warnings, failing to fulfil their primary duty of staying attentive. In such cases, drivers expected the vehicle to intervene and gradually lost the habit of continuously monitoring their driving environment. One participant noted: "*Without the system, I drive more carefully; I just don't pay attention as much. I guess there's nothing to really warn me.*" Over-reliance on warnings can be dangerous, as system failures or malfunctions may leave drivers unprepared to react appropriately, increasing accident risks. Conversely, other participants habitually ignored warnings due to repeated exposure. When warnings are issued too frequently, they may overload drivers with information or be perceived as non-essential, resulting in warning fatigue (Lee et al., 1999; Mackie, 2014). This desensitisation can prevent timely responses to genuinely hazardous situations. Additionally, some participants reported disabling warning features altogether, citing them as distracting or annoying, which undermines the intended safety benefits of ADAS. These findings point to the need for better calibrated warning systems that keep drivers engaged without causing frustration or alert saturation.

As vehicles become increasingly automated and the presence of ADAS warnings grows, there is a growing need for human factors research, including context-aware, tiered, or adaptive alert systems. These should aim to preserve driver attention, avoid overload, and reinforce trust without promoting complacency. Proactively addressing alert fatigue in driving is critical to ensure that automation enhances rather than undermines road safety.

4.1.4. Positive safety benefits of behaviour adaptation in the ADAS use

While most behavioural adaptations identified in this study were negative, there were also positive safety benefits associated with the use of ADAS. These systems have the potential to improve road safety by reducing human error, the leading cause of traffic accidents. This was particularly evident in drivers' responses to system warnings. For example, some participants reported adopting safer driving practices to reduce the frequency of FCW and FDW alerts. This proactive response suggests that, when perceived as credible and actionable, warnings can reinforce safe driving practices. By framing warnings as cues for corrective action, these drivers leveraged ADAS feedback to sustain attentive driving, illustrating that system warnings can promote adaptive safety behaviours when appropriately calibrated and trusted. Although this study primarily focused on the safety risks associated with ADAS-related behavioural adaptations, it is important to acknowledge that ADAS can also contribute positively to road safety. For example, features such as AEB (Cicchino, 2022) and Lane Departure Warning (LDW) (Scanlon et al., 2015) have been shown to reduce collision risks, while ACC improves speed consistency and lowers the probability of high-speed crashes (Li et al., 2017).

4.2. Preventing negative impact while allowing ADAS use

Enhancing driver education and targeted upskilling is critical not only for teaching the mechanics of ADAS features but also for correcting inaccurate mental models that underlie misuse and overreliance (Abraham et al., 2017b). Beyond basic tutorials, programs should include scenario-based training, ideally in simulators or controlled on-road settings, that exposes drivers to edge-case failures and system limitations. Such experiential learning helps drivers develop accurate expectations of when and how ADAS will intervene, reinforcing the manual skills needed to take over safely. Currently, drivers have limited opportunities to receive education on the functionalities and limitations of ADAS. In some cases, they do not receive adequate information at the point of sale, and when they do, the information provided is often inaccurate (Abraham et al., 2017a). Currently, trial-and-error is the most common way drivers learn about ADAS, despite concerns over its risks in developing inaccurate mental models (Nandavar et al., 2023). This method could provide accurate information during the trial-and-error phase, helping drivers develop a correct understanding of ADAS functionalities and limitations (Kim et al., Under review).

Manufacturers can also minimise negative behavioural adaptations by designing ADAS that encourage active driver engagement. For example, requiring periodic driver input, such as steering wheel interaction or manual system status confirmation, can help maintain attentiveness. Driver monitoring systems, which detect inattentiveness and issue corrective alerts, have been shown to reduce distraction-related crashes (Louie and Mansour, 2019). In addition, it is suggested that educational interventions improve drivers' awareness of system limitations and encourage appropriate interaction with ADAS (Koustanaï et al., 2012; Manzey et al., 2006).

Although the current study did not specifically examine the impact of terminology, previous research (Abraham et al., 2017c; Teoh, 2020) suggests that misleading terminology can lead to unrealistic driver expectations. The use of ambiguous or overly optimistic terms may cause drivers to overestimate system capabilities, mistakenly believing that ADAS functions are fully autonomous. To prevent this, it is essential to adopt clear and standardised terminology. Any terms that could mislead drivers about system capabilities should be carefully reviewed and replaced with more precise descriptors that reinforce the assistive nature of these technologies.

4.3. Limitations and future studies

This study provides comprehensive insights into driver behavioural adaptation to ADAS use. In particular, the study offers valuable empirical evidence by analysing a relatively large qualitative sample ($N = 60$) and examining behavioural patterns across multiple ADAS functions, thereby contributing to understanding real-world adaptation processes. However, due to the nature of the research, a few limitations are inevitable. The study relies on interviews, which may be influenced by recall bias or social desirability bias. Participants might unintentionally exaggerate or downplay certain behaviours, leading to inaccuracies in their reported experiences with ADAS. Additionally, this study examines the effects of commonly used ADAS features, such as Adaptive Cruise Control (ACC), Forward Collision Warning (FCW), and Lane Keeping Assist (LKA). Examining behavioural adaptation to commonly used ADAS features provides meaningful insights into how the majority of drivers currently interact with these systems and offers practical guidance for improving safety. However, as new ADAS features continue to be developed, existing patterns of behavioural adaptation may evolve differently. Therefore, ongoing research is necessary to track changes in driver behaviour over time. In addition, findings from the current study can be interpreted alongside empirical studies, such as real-world road tests, to gain a more comprehensive understanding of driver behavioural adaptation. Future research can evaluate the effectiveness of such countermeasures in naturalistic settings and explore how emerging levels of automation reshape these adaptation dynamics over longer time horizons. Regarding the analysis method, while each theme of behaviour adaptation was supported by textual evidence and the method was rigorous, we acknowledged that only one coder was used, limiting our ability to report inter-rater reliability. Furthermore, future studies need to explore how ADAS feedback mechanisms, such as adaptive warnings, haptic feedback, and driver monitoring, can be optimised to maintain driver engagement without causing alert fatigue. Investigating how different interaction designs influence driver responses could lead to more effective system improvements. Despite the limitations, by highlighting how behavioural adaptation manifests across a broad ADAS user base, this study provides evidence for future empirical investigation and for informing the design of safer ADAS.

5. Conclusion

Advanced Driver Assistance Systems (ADAS) have the potential to reduce workload and mitigate collision risk. However, our findings highlight a series of behavioural adaptations that may undermine these benefits. Long-term reliance on ADAS can lead to degradation of manual driving skills, shifts in risk perception, and reductions in both cognitive and physical engagement. Furthermore, drivers exhibit a wide range of responses to system warnings, from overreliance to complete deactivation, thereby complicating the safety equation. Addressing these challenges requires a coordinated response. System designers should integrate trust-calibration feedback and engagement prompts that sustain driver attention without inducing warning fatigue. Regulators must mandate clearer labelling and performance standards for ADAS features and warnings to ensure that drivers understand both the system's capabilities and limitations. Educators and fleet managers should develop targeted training programmes to reinforce manual skills, risk awareness, and appropriate adherence to warnings. Finally, manufacturers can use in-vehicle monitoring systems to deliver adaptive warnings or intervene in driving, when necessary, based on the driver's state. By combining technical refinement, regulatory frameworks, and human-centred education, stakeholders can harness the safety potential of ADAS while preserving driver responsibility and competence.

CRediT authorship contribution statement

Soyeon Kim: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Oscar Oviedo-Trespalacios:** Writing – review & editing, Methodology, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Abraham, H., McAnulty, H., Mehler, B., Reimer, B., 2017a. Case study of today's automotive dealerships introduction and delivery of advanced driver assistance systems. Transp. Res. Rec. (2660), 7–14. https://doi.org/10.3141/2660-02.

Abraham, H., Reimer, B., Mehler, B., 2017b. Advanced driver assistance systems (ADAS): a consideration of driver perceptions on training, usage & implementation. Human Fact. Ergon. Soc. Ann. Meet. Los Angeles, CA.

Abraham, H., Seppelt, B., Mehler, B., Reimer, B., 2017c. What's in a name: Vehicle technology branding & consumer expectations for automation. Automotiveui 2017: Proceedings of the 9th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, pp. 226–234. https://doi.org/10.1145/3122986.3123018.

Billings, C.E., Lauber, J.K., Funkhouser, H., Lyman, E.G., Huff, E.M., 1976. NASA aviation safety reporting system. https://ntrs.nasa.gov/citations/19760026757.

Brown, C.M., Noy, Y.I., 2004. Behavioural adaptation to in-vehicle safety measures: past ideas and future directions. Traffic Transport Psychol.: Theory Appl. 25–46.

Cho, J.H., Nam, H.K., Lee, W.S., 2006. Driver behavior with adaptive cruise control. Int. J. Automot. Technol. 7 (5), 603–608.

Cicchino, J.B., 2022. Effects of automatic emergency braking systems on pedestrian crash risk. Accid. Anal. Prev. 172. https://doi.org/10.1016/j.aap.2022.106686.

Dix, A., 2007. Designing for appropriation. In: Proceedings of HCI 2007 the 21st British HCI Group Annual Conference. University, of Lancaster, UK.

Endsley, M.R., 2017. Autonomous driving systems: a preliminary naturalistic study of the tesla model S. J. Cogn. Eng. Decis. Mak. 11 (3), 225–238. https://doi.org/10.1177/1555343417695197.

Glaser, Y., Llaneras, R., Glaser, D., Green, C., 2016. Relationship Between Driver eyes-off-road Interval and Hazard Detection Performance Under Automated Driving. SAE Technical Paper 2016-01-1424, Issue.

Haslbeck, A., Hoermann, H.J., 2016. Flying the needles: flight deck automation erodes fine-motor flying skills among airline pilots. Hum. Factors 58 (4), 533–545. https://doi.org/10.1177/0018720816640394.

Hedlund, J., 2000. *Risky business: safety regulations, risk compensation, and individual behavior* fifth. World Confer. Injury Prevent. Control New Delhi India.

Hoff, K.A., Bashir, M., 2015. Trust in automation: integrating empirical evidence on factors that influence trust. Hum. Factors 57 (3), 407–434. https://doi.org/10.1177/0018720814547570.

Jamson, A.H., Merat, N., Carsten, O.M.J., Lai, F.C.H., 2013. Behavioural changes in drivers experiencing highly-automated vehicle control in varying traffic conditions. Transport. Res. C Emerg. Technol. 30, 116–125. https://doi.org/10.1016/j.trc.2013.02.008.

Kaye, S.A., Nandavar, S., Yasmin, S., Lewis, I., Oviedo-Trespalacios, O., 2022. Consumer knowledge and acceptance of advanced driver assistance systems. Transport. Res. F Traffic Psychol. Behav. 90, 300–311. https://doi.org/10.1016/j.trf.2022.09.004.

Kinosada, Y., Kobayashi, T., Shinohara, K., 2021. Trusting other vehicles' automatic emergency braking decreases self-protective driving. Hum. Factors 63 (5), 880–895. https://doi.org/10.1177/0018720820907755.

Koustanaï, A., Cavallo, V., Delhomme, P., Mas, A., 2012. Simulator training with a forward collision warning system: effects on driver-system interactions and driver trust. Hum. Factors 54 (5), 709–721. https://doi.org/10.1177/0018720812441796.

Lee, J.D., Gore, B.F., Campbell, J.L., 1999. Display alternatives for in-vehicle warning and sign information: message style, location, and modality. Transp. Hum. Factors 1 (4), 347–375.

Lee, J.D., See, K.A., 2004. Trust in automation: designing for appropriate reliance. Hum. Factors 46 (1), 50–80. https://doi.org/10.1518/hfes.46.1.50.30392.

Li, Y., Li, Z.B., Wang, H., Wang, W., Xing, L., 2017. Evaluating the safety impact of adaptive cruise control in traffic oscillations on freeways. Accid. Anal. Prev. 104, 137–145. https://doi.org/10.1016/j.aap.2017.04.025.

Lin, R., Ma, L., Zhang, W., 2018. An interview study exploring Tesla drivers' behavioural adaptation. Appl. Ergon. 72, 37–47. https://doi.org/10.1016/j.apergo.2018.04.006.

Louie, W.Y.G., Mansour, I., 2019. Towards a driver monitoring system for estimating driver situational awareness. In: 2019 28th IEEE International Conference on Robot and Human Interactive Communication.

Mackie, B., 2014. Warning fatigue: insights from the Australian bushfire context. https://ir.canterbury.ac.nz/server/api/core/bitstreams/85f17b9e-cf99-4d8c-87c5-a3d1472cd309/content.

Manzey, D., Bahner, J.E., Hueper, A.D., 2006. Misuse of automated aids in process control: complacency, automation bias and possible training interventions. Human Fact. Ergon. Soc. Ann. Meet.

Metz, B., Wörle, J., Engel, S., 2025. Behavioural adaptation to prototype level 3 automated driving systems on public roads. Transport. Res. F Traffic Psychol. Behav. 109, 1507–1522.

Metzger, U., Parasuraman, R., 2001. Automation-related "complacency": theory, empirical data, and design implications. In: Proceedings of the Human Factors and Ergonomics Society Annual Meeting.

Miller, E.E., Boyle, L.N., 2019. Adaptations in attention allocation: implications for takeover in an automated vehicle. Transport. Res. F Traffic Psychol. Behav. 66, 101–110. https://doi.org/10.1016/j.trf.2019.08.016.

Mosier, K.L., Skitka, L.J., Heers, S., Burdick, M., 1998. Automation bias: decision making and performance in high-tech cockpits. Int. J. Aviat. Psychol. 8 (1), 47–63. https://doi.org/10.1207/s15327108ijap0801_3.

Muslim, H., Itoh, M., 2021. Long-term evaluation of drivers' behavioral adaptation to an adaptive collision avoidance system. Hum. Factors 63 (7), 1295–1315. https://doi.org/10.1177/0018720820926092.

Nandavar, S., Kaye, S.A., Senserrick, T., Oviedo-Trespalacios, O., 2023. Exploring the factors influencing acquisition and learning experiences of cars fitted with advanced driver assistance systems (ADAS). Transport. Res. F Traffic Psychol. Behav. 94, 341–352. https://doi.org/10.1016/j.trf.2023.02.006.

OECD, 1990. Behavioural Adaptations to Changes in the Road Transport System. Road Transport Research, Issue.

Parasuraman, R., Molloy, R., Singh, I.L., 1993. Performance consequences of automation-induced 'complacency'. Int. J. Aviat. Psychol. 3 (1), 1–23.

Parasuraman, R., Riley, V., 1997. Humans and automation: use, misuse, disuse, abuse. Hum. Factors 39 (2), 230–253. https://doi.org/10.1518/001872097778543886.

Parasuraman, R., Sheridan, T.B., Wickens, C.D., 2008. Situation awareness, mental workload, and trust in automation: viable, empirically supported cognitive engineering constructs. J. Cogn. Eng. Decis. Mak. 2 (2), 140–160. https://doi.org/10.1518/155534308x284417.

Piccinini, G.F.B., Rodrigues, C.M., Leitão, M., Simões, A., 2014. Driver's behavioral adaptation to adaptive cruise control (ACC): the case of speed and time headway. J. Saf. Res. 49.

Rashid, Z., Roetting, M., 2021. Evaluation of manual skill degradation due to automation in apparel manufacturing. Appl. Sci. Basel 11 (23). https://doi.org/10.3390/app112311098.

Reinmueller, K., Kiesel, A., Steinhauser, M., 2020. Adverse behavioral adaptation to adaptive forward collision warning systems: an investigation of primary and secondary task performance. Accid. Anal. Prev. 146 (105718).

Rudin-Brown, C.M., Noy, Y.I., 2002. Investigation of behavioral adaptation to Lane departure warnings. Hum. Perform.: Models Intell. Vehicle Initiat. Traveler Advisory Inform. Syst. 1803, 30–37. <Go to ISI>://WOS:000179977100005.

Rudin-Brown, C.M., Parker, H.A., 2004. Behavioural adaptation to adaptive cruise control (ACC): implications for preventive strategies. Transport. Res. F Traffic Psychol. Behav. 7 (2), 59–76.

Sagberg, F., Fosser, S., Saetermo, I.A.F., 1997. An investigation of behavioural adaptation to airbags and antilock brakes among taxi drivers. Accid. Anal. Prev. 29 (3), 293–302. https://doi.org/10.1016/S0001-4575(96)00083-8.

Scanlon, J.M., Kusano, K.D., Sherony, R., Gabler, H.C., 2015. Potential safety benefits of Lane departure warning and prevention systems in the US vehicle fleet. In: Proceedings of the 24th International Technical Conference on the Enhanced Safety of Vehicles (ESV), Gothenburg, Sweden.

Smiley, A., 2000. Behavioral adaptation, safety, and intelligent transportation systems. Hum. Perform.: Driver Behav. Road Design. Intell. Transport. Syst. (1724), 47–51. <Go to ISI>://WOS:000176426900007.

Stanton, N.A., Young, M.S., 2005. Driver behaviour with adaptive cruise control. Ergonomics 48 (10), 1294–1313. https://doi.org/10.1080/00140130500252990.

Teoh, E.R., 2020. What's in a name? Drivers' perceptions of the use of five SAE level 2 driving automation systems. J. Saf. Res. 72, 145–151.

Tingvall, C., Eckstein, L., Hammer, M., 2009. Government and Industry Perspectives on Driver Distraction. CRC Press, Boca Raton.

Vollrath, M., Schleicher, S., Gelau, C., 2011. The influence of cruise control and adaptive cruise control on driving behaviour - a driving simulator study. Accid. Anal. Prev. 43 (3), 1134–1139. https://doi.org/10.1016/j.aap.2010.12.023.

Volz, K.M., Dorneich, M.C., 2020. Evaluation of cognitive skill degradation in flight planning. J. Cogn. Eng. Decis. Mak. 14 (4), 263–287. https://doi.org/10.1177/1555343420962897.

Xu, Z., Jiang, T.H., Xiao, D., Fang, Y.H., Zheng, N., 2024. Analyzing riders' behavioral adaptation to driving patterns of advanced autonomous vehicles: a virtual reality simulation study. Int. J. Hum. Comput. Interact. https://doi.org/10.1080/10447318.2024.2392069.

Yu, B., Bao, S., Zhang, Y., Sullivan, J., Flannagan, M., 2021. Measurement and prediction of driver trust in automated vehicle technologies: an application of hand position transition probability matrix. Transport. Res. C Emerg. Technol. 124. https://doi.org/10.1016/j.trc.2020.102957.

Kim, S., Calvert, S., & Hagenzieker, M. (Under review). Exploring the Learning Strategies of Drivers Using Advanced Driver Assistance Systems (ADAS). http://doi.org/10.2139/ssrn.4974088.