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Expectations and Understanding of Advanced Driver Assistance Systems among Drivers, Pedestrians, Bicyclists, and Public Transit Riders

William J. Horrey, Ph.D.
Aaron Benson, MA
AAA Foundation for Traffic Safety

Zhaomiao Guo, Ph.D.
Fatima Afifah, MS
University of Central Florida

Cara Hamann, Ph.D.
University of Iowa

Kelvin Santiago, Ph.D.
University of Wisconsin-Madison

AAA Foundation for Traffic Safety

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Title

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Authors

William J. Horrey, Aaron Benson

AAA Foundation for Traffic Safety

Zhaomiao Guo, Fatima Afifah

University of Central Florida

Cara Hamann

University of Iowa

Kelvin Santiago

University of Wisconsin–Madison

Author ORCID Information

Afifah:	https://orcid.org/0000-0001-8434-8124
Benson:	https://orcid.org/0000-0001-6737-3926
Guo:	https://orcid.org/0000-0002-1665-5437
Hamann:	https://orcid.org/0000-0001-8916-7285
Horrey:	https://orcid.org/0000-0002-9533-4411
Santiago:	https://orcid.org/0000-0001-6897-0351

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Foreword

The advancement of vehicle technology is reaching a point where advanced driver assistance systems and other automation can control many of the driving tasks. While these technologies have clear implications for drivers, they also impact other road users who routinely interact with vehicles as they navigate the transportation network, including pedestrians and bicyclists, among others. In light of this, the knowledge base concerning other road users is relatively sparse compared to that of drivers.

This report seeks to examine the perceptions, understanding, and behaviors of other road users in relation to advanced driving features. The results offer some insights regarding important differences across road users. The report should be of interest to researchers and other stakeholders.

This report is an outcome of a cooperative research program between the AAA Foundation for Traffic Safety and the SAFER-SIM University Transportation Center.

C. Y. David Yang, Ph.D.

Executive Director
AAA Foundation for Traffic Safety

Dawn Marshall

SAFER-SIM Director
National Advanced Driving Simulator
The University of Iowa

About the Sponsors

AAA Foundation for Traffic Safety
607 14th Street, NW, Suite 201
Washington, D.C. 20005
202-638-5944
www.aaafoundation.org

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The universities comprising SAFER-SIM study how road users, roadway infrastructure, and new vehicle technologies interact and interface with each other using microsimulation and state-of-the-art driving, bicycling, and pedestrian simulators.

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Abstract

Vehicle technology has progressed significantly over the past 20 years to the point where automated systems can now take on different aspects of a vehicle's control. While drivers play a central role in the effective and appropriate use of these technologies, these systems do not affect the drivers of such vehicles alone. Other road users must interact with these vehicles safely and, as such, it is important to examine the perceptions, understanding, and expectations concerning these systems. The current study sought to examine whether drivers and non-drivers differ in their perceptions and understanding of advanced driver assistance system (ADAS) technology (i.e., SAE Levels 1 and 2), in their trust and expectations of ADAS technology in specific use cases, and in their outlook of the future of automated vehicle technology. A total of 1,531 participants responded to an online survey and were subsequently identified as belonging to different road-user groups (predominantly in the categories of drivers, bicyclists, pedestrians, public transit riders). The results revealed differences across road-user groups in terms of their understanding, expectations, behaviors, trust, and perceptions of risk. Importantly, differences in perceived expectations and trust were not always associated with changes in perceived risk and behavioral responses. In some cases, non-drivers' responses revealed that they had false expectations of the technology, or that they intended to interact with partially-automated driving systems in the same manner as they interact with conventional vehicles, which might increase their risk. Collectively, the current outcomes underscore the need to better understand all road users' expectations regarding new vehicle technology, as well as their behaviors when interacting with these vehicles. Knowledge of how information and sources influence understanding and accuracy of user's mental models of technology might lend itself to individualized or targeted approaches appropriate for different road-user groups.

Introduction

Vehicle technology has progressed significantly over the past 20 years to the point where automated systems can now take on different aspects of a vehicle's control. Moreover, technologies such as adaptive cruise control (ACC) and lane keeping assist (LKA) are becoming widely offered in production vehicles. Higher levels of automation, in which the vehicle assumes an even greater share of the driving responsibilities, continue to be developed. These and related technologies have great potential to enhance road safety (e.g., Benson et al., 2018; Highway Loss Data Institute, 2015); however, they need to be accepted by the general population before they can achieve a significant market penetration (Schoettle & Sivak, 2014; Kyriakidis et al., 2015; Kim et al., 2019). Because of their complexity and many nuances in terms of their operation (i.e., where and under what conditions they are designed to function reliably) it is also important that drivers understand their systems, their role, and their function—sometimes referred to as a mental model (e.g., Johnson-Laird, 1983; Seppelt & Victor, 2020). Unfortunately, many studies have revealed that drivers have a poor understanding of the vehicle technology, even for technology that is installed in their own vehicle (McDonald et al., 2018).

While drivers play a central role in the effective and appropriate use of these technologies, these systems do not only affect the drivers of such vehicles. Other road users must interact with these vehicles safely and, as such, it is important to examine their perceptions, understanding, and expectations concerning these systems (Nuñez Velasco et al., 2017; Deb et al., 2018). In a recent survey of the safety perceptions of many different types of road users, respondents rated cycling or walking near automated vehicles (AVs) as less safe than driving near them (Pyrialakou et al., 2020).

In another study, Rodríguez Palmeiro et al. (2018) surveyed cyclists' perceptions and behavioral intentions in a variety of different circumstances involving AVs. They used images of different vehicle and bicyclist encounters taken from the bicyclist's point of view and asked respondents whether the vehicle would detect the bicycle and what they would do in the situation if they were the bicyclist. The vehicle was varied in terms of the conspicuity of its AV technology (i.e., the ease with which the vehicle could be identified as an AV). The results showed that participants had greater confidence in being noticed and responded to by an AV that was readily identifiable (e.g., door-mounted decals) than by a traditional (non-AV) vehicle.

While past studies have provided some insight into the perceptions of other road users regarding automated vehicles, many have focused on constructs such as trust and acceptance (e.g., Zhang et al., 2021; Jayaraman et al., 2019). Moreover, those that do examine the user expectations of technology (e.g., Rodríguez Palmeiro et al., 2018) have tended to focus on the behavior of highly automated vehicles (SAE levels 4 or higher). As such, other road users' understanding and expectations regarding lower levels of automation represents an important research gap.

Current Study

The current study sought to examine the perceptions, understanding (mental models), and expectations of other road users related to current ADAS, such as ACC and LKA, as well as more highly automated future technologies. That is, non-drivers and/or individuals that associate predominantly with some other mode of transport (bicycles, motorcycles, etc.), even though they might hold a Driver's License.

Specifically, the study sought to offer insight into the following questions:

1. Do drivers and other road users differ in their perceptions and understanding of ADAS technology (i.e., SAE Levels 1 and 2)?
2. Do drivers and other road users differ in trust and expectations of ADAS technology in specific use cases?
3. Do drivers and other road users differ in their outlook of the future of AV technology?

Method

An online survey approach was adopted for the current study with a sample of road users. Responses to select questions were used to classify them as primarily drivers or as primarily another road user (e.g., pedestrians, cyclists, public transit rider, etc.). Respondents were then asked about their understanding of vehicle technology, how they would expect an automated vehicle to behave, and how they would behave around an automated vehicle in various situations. Responses of participants who identified as drivers were compared with those who identified more as other road users.

Survey Instrument

The survey was created in Qualtrics and designed to be administered via computer or mobile device. The survey included several blocks of questions. The first block gathered information on a variety of demographic items, road use habits, and access to vehicles and technology. Questions related to their typical daily transportation were used to classify respondents according to different types of road users. Second, several questions aimed to glean general understanding of ACC and LKA systems and their function. Next, two different scenarios were presented in which a vehicle equipped with advanced technologies interacted with other road users (see Table 1). Several questions followed each scenario regarding expectations of system behavior, trust, perceived safety, and responsibility for avoiding crashes. Additionally, respondents were asked to indicate how they would act in such a scenario, whether as the driver or as the other road user. Respondents were also asked to consider the same scenario; however, with the vehicle being driven under manual control (i.e., no advanced technology present). In the final question block, respondents were asked to project how the capabilities of the systems would progress in the future. The complete survey is included in Appendix A.

Table 1. Use case scenarios employed in the survey.

Scenario	Description
Bicyclist	A bicyclist is travelling along a two-lane road that has a narrow shoulder. A vehicle is approaching the cyclist from behind. The vehicle is currently operating with some advanced safety features active: lane keep assist (controlling the position of the vehicle in its lane) and adaptive cruise control (controlling its speed and distance to vehicle ahead).
Pedestrian	A pedestrian is walking up to a mid-block crosswalk that traverses a two-lane road. A driver on the far side has already stopped for them. A vehicle is approaching the pedestrian in the opposite direction. This vehicle is still some distance away and if it slows slightly the pedestrian should have enough time to clear its path. The vehicle is currently operating with some advanced features active: lane keep assist (controlling the position of the vehicle in its lane) and adaptive cruise control (controlling its speed and headway). Behind this vehicle are several others, so it would be some time before another gap appears.

Survey Administration

The link to the online survey was appended to multiple email invitations. The invitations were distributed through a variety of channels, including several university-wide or departmental mailing lists (primarily with the authors' home institutions), special interest groups, and professional networks.

Respondents who accessed the link were first presented with a statement of informed consent. Only respondents who agreed could proceed to the survey. In the first question block, if respondents indicated that they were younger than 18 years old, they were thanked for their interest and exited from the survey. There was no remuneration for participation in the survey. The study was approved by the Institutional Review Board (IRB) at the University of Wisconsin–Madison (Protocol 2017-0060) and at the University of Central Florida (Protocol STUDY00001941).

Data and Analysis Notes

Because the sample sizes for motorcyclist and moped/scooter rider are very small ($N \leq 10$), these responses were excluded from further analyses. Thus, the final analysis included the driver, public transit rider, bicyclist, and pedestrian groups.

For selected survey items (or aggregated items), responses from the different road-user groups were compared. Because the data, in many cases, was not normally distributed, the analysis employed non-parametric Kruskal-Wallis tests (H statistic in tables) to compare responses from the different road-user groups, except where noted. Although the majority of respondents completed the entire survey, some completed only a subset of sections or questions. In such cases, if the respondents completed the items germane to a particular analysis, they were included. Otherwise, they were excluded.

Results

Survey Respondents and Road-User Types

Overall, there were 1,569 responses to the solicitation. Surveys were processed and those with an unrealistically fast response rate (i.e., questions answered too quickly or suspected bots; > 24% of survey/minute) were excluded. This filtering yielded a final data set of 1,531. Overall, respondents ranged in age from 18 to 91 (Mean = 39.6 yrs, SD = 17.7) and varied somewhat by gender balance, licensure, and vehicle access (Table 2). For example, cyclists were more likely to be male and pedestrians tended to be younger than other road users. The majority of respondents in each category had a Driver's License and access to a vehicle.

Road-user type was defined based on the participants' response to the question "On a normal weekday, what is your primary way to get places? If you routinely use more than one of the options below, pick the one that you spend the most time using." Sample size and demographic information for each of the resulting groups is provided in Table 2.

Table 2. Demographic information for the different road-user types.

Road-User Type	N	Age (yrs)[1]	Gender (% F / M)[2]	% Valid Driver's License	% Own/ Access Vehicle
All	1531	39.6 (17.7)	56 / 44	96	92
Driver of personal car or truck	1171	42.5 (17.4)	57 / 42	98	98
Motorcyclist	10	35.8 (17.7)	50 / 30	90	90
Moped/Scooter Rider	8	31.5 (15.4)	57 / 43	75	75
Public Transit Rider	92	31.0 (14.2)	64 / 33	79	67
Bicyclist	83	37.8 (17.3)	33 / 66	95	83
Pedestrian (walker)	165	25.8 (12.9)	55 / 42	93	64
Other[3]	2	-	-	-	-

[1] Standard deviation is shown in parentheses.
[2] In some cases, numbers do not sum to 100 due to non-binary and "prefer not to respond" options.
[3] Information for 'Other' category is excluded due to small N.

Do drivers and non-drivers differ in their perceptions and understanding of advanced technology?

Respondent's understanding of ACC and LKA technology was specified by the percent accuracy of responses to the knowledge questions (10 items for ACC; 7 items for LKA; see Appendix A). For questions using the Likert scale, responses of "I don't know" were coded as incorrect.

As shown in Table 3, bicyclists, in the current sample, exhibited a better understanding of the technology than the other road-user groups, including drivers. That said, the accuracy of responses was modest in all cases, ranging from 50% to 60% correct.

Table 3. Average understanding scores (% accurate) for ACC and LKA across different road users.

System	Drivers	Public Transit Riders	Bicyclists	Pedestrians	Test	p-value
ACC	50	50	58	53	H(3) = 9.9	0.02
LKA	52	58	60	57	H(3) = 10.9	0.01

Do drivers and non-drivers differ in expectations and perceptions of behaviors towards new technology in specific use cases?

Bicyclist Scenario

Expectations of the System

Respondents were asked to report their expectations about the behavior of the system in the scenario depicted on a scale from 0 to 100, where 0=extremely unlikely and 100=extremely likely. Generally, the different road-user groups responded to the items correctly (in varying degrees, see Table 4); however, there were some differences across road users. The groups did not differ significantly in terms of their beliefs that the vehicle would detect the cyclist or that the vehicle would veer to give space. Bicyclists, on the other hand, were more accurate in their beliefs that the vehicle would not automatically slow down and, correspondingly, that the vehicle would continue without any adjustments. This is consistent with the results showing that bicyclists had the most accurate understanding of ACC and LKA.

Table 4. Expectations regarding system capabilities and actions across different road users in bicycle scenario.

Item[1]	Drivers	Public Transit Riders	Bicyclists	Pedestrians	Test	p-value
Vehicle sensors will detect the bicyclist (false)	48.4	50.5	42.2	45.8	H(3) = 3.9	0.27
Vehicle will automatically slow down (false)	44.7	46.4	33.6	43.7	H(3) = 9.1	0.03
Vehicle will automatically veer to the left in its lane to give more space (false)	25.5	27.5	21.6	27.6	H(3) = 2.9	0.41
Vehicle will continue to drive without making any adjustments (true)	57.5	56.6	66.8	56.9	H(3) = 7.4	0.06

Note. Ratings were made along a continuum ranging from 0 (extremely unlikely) to 100 (extremely likely).
[1] Correct response shown in parentheses.

Behavior Towards System

In the Bicyclist Scenario, bicyclists were nominally (though not significantly) more likely to say that they would keep riding as they were and less likely to move to the right than other road users (see Table 5). They were less likely to say that they would stop riding and wait until the vehicle moved on.

Put in the role of driver in the scenario, the groups did not differ significantly in their behaviors. Respondents were most likely to say that they would disengage the system and resume manual control followed by leaving system active but paying closer attention to cyclist.

Table 5. User behaviors given bicycle scenario across different road users.

Item	Drivers	Public Transit Riders	Bicyclists	Pedestrians	Test	p-value
If you were the bicyclist in this scenario:						
Move further to the right, even though the shoulder is narrow	78.8	78.1	69.1	79.1	H(3) = 5.0	0.17
Keep riding as you are	35.3	30.8	41.2	32.4	H(3) = 3.4	0.33
Stop riding, watch, and wait for the car to pass	27.2	42.8	14.7	33.1	H(3) = 33.2	<0.001
If you were the driver in this scenario:						
Keep driving as you are, with the advanced features active	24.3	22.2	22.7	24.6	H(3) = 0.7	0.88
Disengage the system and resume manual control	74.4	79.9	67.9	75.3	H(3) = 3.6	0.31
Leave system active, but pay closer attention to the cyclist	54.5	53.8	52.0	51.7	H(3) = 1.3	0.74

Note. Ratings were made along a continuum ranging from 0 (extremely unlikely) to 100 (extremely likely).

Trust and Crash Risk

In order to examine perceived trust and crash risk in the scenarios, response perspectives were matched with the road-user type that the respondent was associated with. For example, responses for non-drivers (bicyclist, pedestrian, public transit) were gathered from the bicyclist's perspective in the scenario and compared to drivers' responses taken from the driver's perspective in the scenario (see Table 6 for further detail).

Table 6. Trust and risk with vehicle technology across different road users in bicycle scenario.

Item	Drivers[1]	Public Transit Riders[2]	Bicyclists[2]	Pedestrians[2]	Test	p-value
Your trust in the vehicle technology	34.6	23.0	23.3	23.4	H(3) = 36.2	<0.001
Overall crash risk	51.6	51.8	44.7	55.0	H(3) = 4.4	0.22

Note. Ratings were made along a continuum ranging from 0 (extremely low) to 100 (extremely high).
[1] From driver's point of view ("If you were the driver in this scenario…").
[2] From bicyclist's point of view ("If you were the bicyclist in this scenario…").

As shown in Table 6, non-drivers tended to indicate lower trust in the vehicle technology than drivers; however, they did not differ in their appraisal of crash risk.

Drivers' trust in their own driving skills when no vehicle technology was present significantly outpaced the other road users' trust of the drivers and rated the scenario to be less risky than other road users (see Table 7).

Table 7. Trust and risk with NO vehicle technology across different road users in bicycle scenario.

Item	Drivers[1]	Public Transit Riders[2]	Bicyclists[2]	Pedestrians[2]	Test	p-value
Your trust in the driver/ trust in own driving skills	85.3	56.3	51.1	51.5	H(3) = 275.2	<0.001
Overall crash risk	31.8	40.7	38.3	45.0	H(3) = 36.8	<0.001

Note. Ratings were made along a continuum ranging from 0 (extremely low) to 100 (extremely high).
[1] From driver's point of view ("If you were the driver in this scenario…").
[2] From bicyclist's point of view ("If you were the bicyclist in this scenario…").

Ratings were compared to evaluate the difference in perceptions when the technology was present versus when the vehicle was fully controlled by the driver. For this analysis, ratings of trust, risk, and responsibility for avoiding a crash when driving with the system were subtracted from the corresponding ratings made for manual driving (i.e., without the system). The difference scores were subjected to Kruskal-Wallis comparisons. As shown in Table 8, when the vehicle was driven under manual control, the groups were more likely to trust the driver than they were to trust the technology when it was present; this gap was more pronounced for drivers. A similar pattern was evident for the perceptions of risk; all groups thought the scenario was less risky when the human driver was in control and this perceived decrease was greater for drivers. Ratings of responsibility did not change much between the scenarios (technology present or not) and there were no group differences.

Table 8. Changes in trust, risk, and responsibility with the removal of technology in bicycle scenario.

Item	Drivers[1]	Public Transit Riders[2]	Bicyclists[2]	Pedestrians[2]	Test	p-value
Trust	50.4	32.0	28.7	28.7	H(3) = 62.7	<0.001
Overall crash risk	−18.5	−10.1	−8.0	−9.6	H(3) = 10.8	0.01
Your responsibility for avoiding a crash	1.6	1.6	0.8	0.8	H(3) = 0.6	0.90

Note. Scores derived by subtracting ratings of technology condition (with system present; Table 6) from manual condition (no technology; Table 7).
[1] From driver's point of view.
[2] From bicyclist's point of view.

Pedestrian Scenario

Expectations of the System

As shown in Table 9, similar to the bicycle scenario, the groups tended to respond to the items in the pedestrian scenario correctly (in varying degrees). However, pedestrians were more likely to falsely believe that the vehicle's sensors would detect the pedestrian in the scenario (while bicyclists rated this lower than the other groups). Pedestrians were also nominally more likely to believe that the vehicle would automatically slow down (a marginally significant effect) or less likely to correctly believe that the vehicle would continue without adjustment.

Table 9. Expectations regarding system capabilities and actions across different road users in pedestrian scenario.

Item[1]	Drivers	Public Transit Riders	Bicyclists	Pedestrians	Test	p-value
Vehicle's sensors will detect the pedestrian (false)	42.8	44.8	35.6	48.5	H(3) = 8.6	0.04
Vehicle will automatically slow down to give more time to cross (false)	36.4	35.8	28.9	39.2	H(3) = 6.6	0.09
Vehicle will flash its high beams at the pedestrian (false)	18.2	20.5	15.6	17.6	H(3) = 3.7	0.30
Vehicle will continue to drive, without making any adjustments (true)	56.9	58.0	64.1	53.9	H(3) = 5.0	0.17

Note. Ratings were made along a continuum ranging from 0 (extremely unlikely) to 100 (extremely likely).
[1] Correct response shown in parentheses.

Behavior Towards System

In the role of a pedestrian in the scenario, non-drivers (public transit, bicyclists, pedestrians) were more likely than drivers to say that they would cross at a usual pace (see Table 10). Also, drivers were more likely to indicate that they would cross more quickly. Bicyclists were least likely to say that they would alter their crossing behavior. Overall, all road users were more likely to cross more quickly or wait for another gap than to cross normally or abort the crossing attempt.

Put in the role of driver in the scenario, respondents were most likely to disengage the system and resume manual control followed by leaving system active but paying closer attention to the pedestrian. Public transit riders were more likely to keep driving with features active, compared to the other road users.

Table 10. User behaviors given pedestrian scenario across different road users.

Item	Drivers	Public Transit Riders	Bicyclists	Pedestrians	Test	p-value
If you were the pedestrian in this scenario:						
Cross the road at your usual pace	28.8	37.8	41.0	36.8	H(3) = 16.6	<0.001
Continue to wait for a gap, even though the opposing lane has stopped for you	61.0	62.6	56.8	56.7	H(3) = 2.3	0.51
Cross the road much quicker than usual	75.8	67.8	63.0	69.3	H(3) = 18.5	<0.001
Decide to not cross mid-block and instead walk to the corner to cross there	46.5	45.9	32.7	42.1	H(3) = 10.2	0.02
If you were the driver in this scenario:						
Keep driving as you are, with the advanced features active	22.7	31.1	24.4	24.2	H(3) = 7.4	0.06
Disengage the system and resume manual control	76.1	76.0	73.8	78.6	H(3) = 1.2	0.75
Leave system active, but pay closer attention to the pedestrian	49.1	56.1	40.4	46.1	H(3) = 5.8	0.12

Note. Ratings were made along a continuum ranging from 0 (extremely unlikely) to 100 (extremely likely).

Trust and Crash Risk

Similar to the bicycle scenario, in order to examine perceived trust and crash risk in the scenarios, response perspectives were aligned with the road-user type that the respondent was associated with. For example, responses for non-drivers (bicyclist, pedestrian, public transit) were gathered from the pedestrian's perspective in the scenario and compared to drivers' responses taken from the driver's perspective in the scenario (see Table 11 for further detail).

As in the bicycle scenario, non-drivers tended to indicate lower trust in the vehicle technology than drivers even though the groups did not differ in their appraisal of risk in the situation (see Table 11).

Table 11. Trust and risk with vehicle technology across different road users in pedestrian scenario.

Item	Drivers[1]	Public Transit Riders[2]	Bicyclists[2]	Pedestrians[2]	Test	p-value
Your trust in the vehicle technology	32.4	28.7	21.9	24.3	H(3) = 15.9	<0.01
Overall crash risk	51.6	51.9	50.9	55.9	H(3) = 1.2	0.76

Note. Ratings were made along a continuum ranging from 0 (extremely low) to 100 (extremely high).
[1] From driver's point of view ("If you were the driver in this scenario…").
[2] From pedestrian's point of view ("If you were the pedestrian in this scenario…").

Drivers' trust in their own driving skills was significantly higher than the other road users' trust of the drivers and drivers felt that the scenario was less risky than the other road users when technology was not present (Table 12). When driving under manual control, the groups believed that the scenario was less risky than with the technology present, although drivers indicated lower levels of risk.

Table 12. Trust and risk with NO vehicle technology across different road users in pedestrian scenario.

Item	Drivers[1]	Public Transit Riders[2]	Bicyclists[2]	Pedestrians[2]	Test	p-value
Your trust in the driver/ trust in own driving skills	84.2	54.3	48.0	52.3	H(3) = 215.3	<0.001
Overall crash risk	31.1	37.5	42.1	41.5	H(3) = 27.0	<0.001

Note. Ratings were made along a continuum ranging from 0 (extremely low) to 100 (extremely high).
[1] From driver's point of view ("If you were the driver in this scenario…").
[2] From pedestrian's point of view ("If you were the pedestrian in this scenario…").

Consistent with the bicycle scenario, removing the vehicle technology from the pedestrian scenario did not lead to meaningful changes in the perceptions of responsibility (Table 13). The groups did however indicate that technology increased the crash risk and this increase was largest for the driver group (matched by a corresponding decrease in trust). It follows that all groups tended to trust the manual driver more than the vehicle under control of automation. Again, the increase in trust was greatest for drivers.

Table 13. Changes in trust, risk, and responsibility with the removal of technology in pedestrian scenario.

Item	Drivers[1]	Public Transit Riders[2]	Bicyclists[2]	Pedestrians[2]	Test	p-value
Trust	51.5	24.1	25.0	26.6	H(3) = 77.3	<0.001
Overall crash risk	−20.3	−11.2	−8.9	−13.4	H(3) = 13.5	<0.01
Your responsibility for avoiding a crash	1.4	0.1	1.0	−1.7	H(3) = 7.7	0.05

Note. Scores derived by subtracting ratings of technology condition (with system present; Table 11) from manual condition (no technology; Table 12).
[1] From driver's point of view.
[2] From pedestrian's point of view.

Do driver and non-drivers differ in their outlook of the future of AV technology?

Respondents were asked a number of questions related to the future capabilities and performance of in-vehicle technology and responsibility. Responses to these questions were analyzed by chi-square tests.

System Capabilities

Respondents were asked when they believed that advanced vehicle technology would be capable of detecting other road users (a pedestrian or cyclist) as effectively as an alert driver. As shown in Figure 1 and Figure 2, there were differences across road users for both the detection of pedestrians ($X(15) = 29.1$, $p = 0.02$) and bicyclists ($X(15) = 33.0$, $p < 0.01$). In general, drivers were more optimistic that technology would match human capabilities sooner than other road users. Across all groups, the most common responses were that vehicles would be able match human capabilities within the next 10 years.

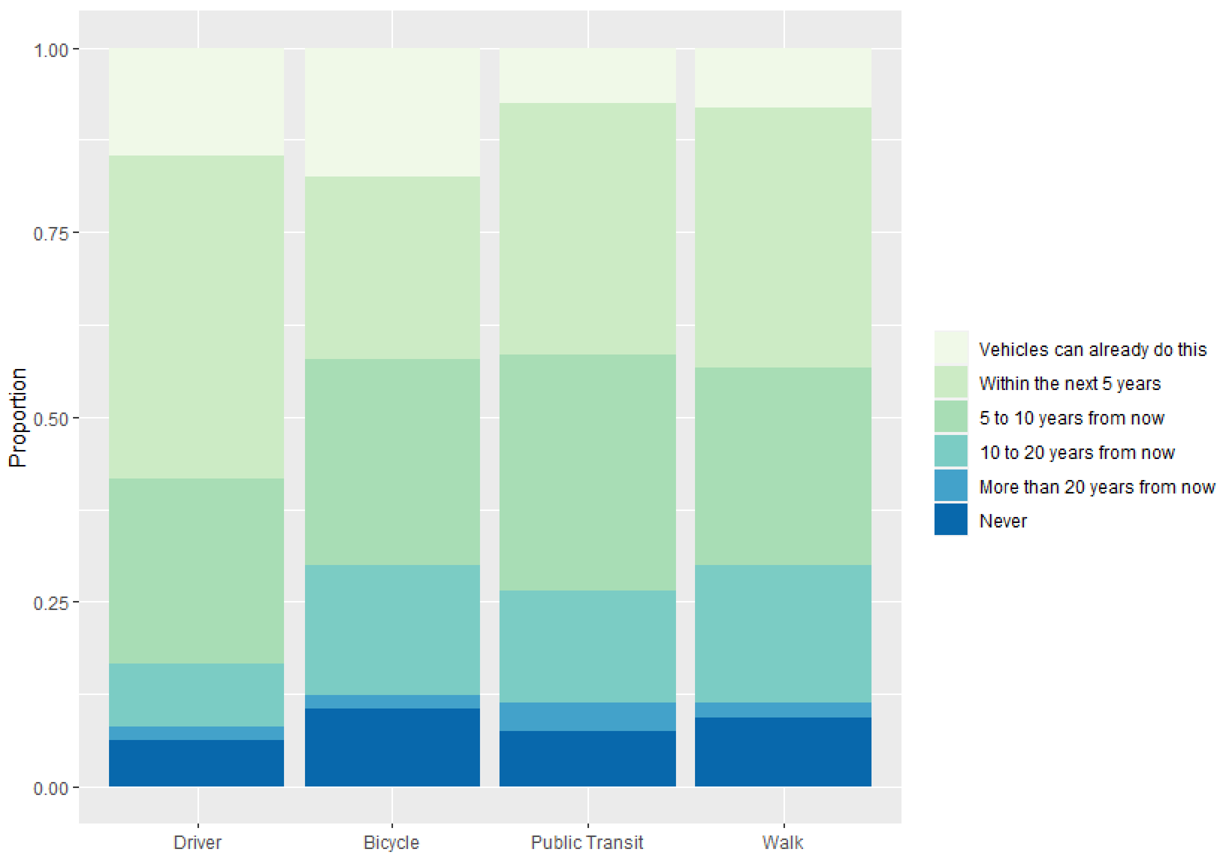

Figure 1. Responses by road-user group to question, "When do you think advanced vehicle technology will be able to detect pedestrians just as effectively as an alert human driver?"

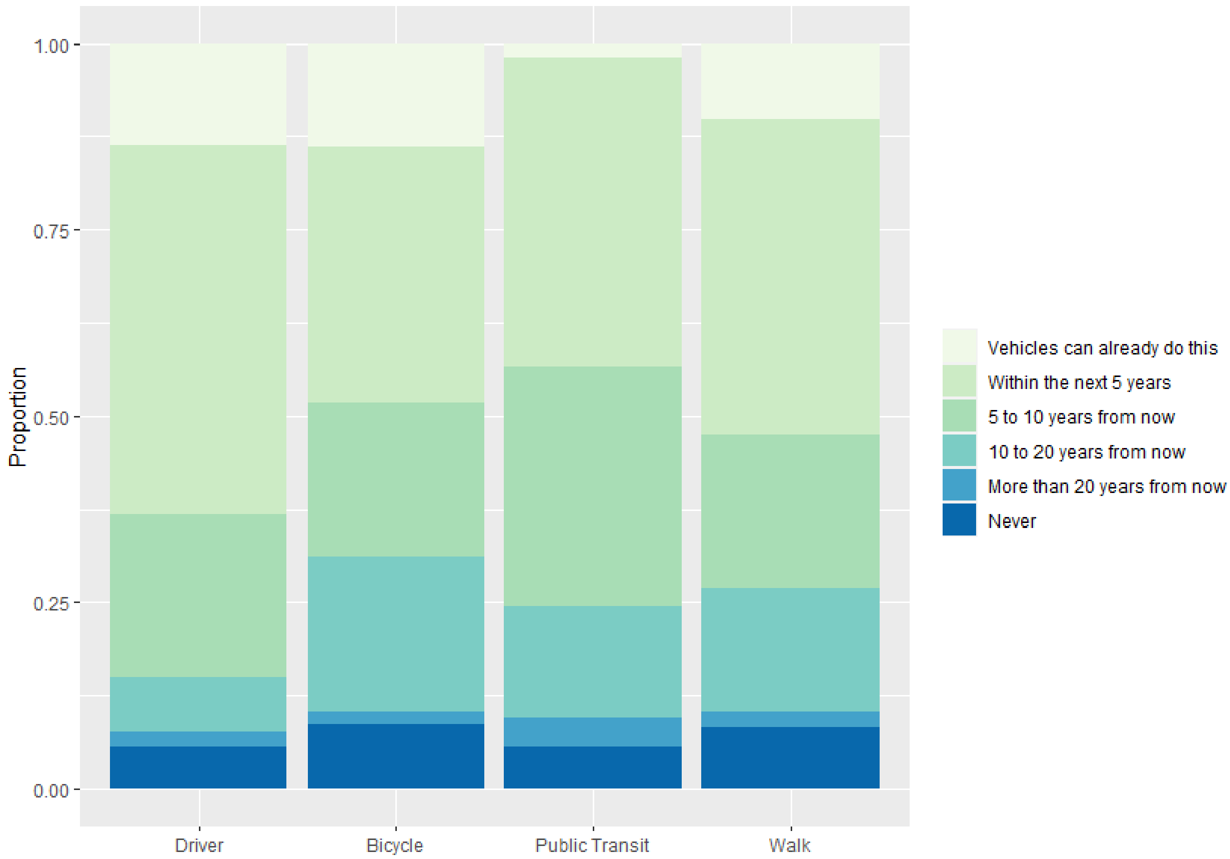

Figure 2. Responses by road-user group to question, "When do you think advanced vehicle technology will be able to detect bicyclists just as effectively as an alert human driver?"

In spite of group differences in terms of their expectations regarding technology capabilities, groups had negligible differences in their projections about pedestrian safety in the near term (X(9) = 13.9, p = 0.13; see Figure 3). Across all road users, nearly half believed that fewer pedestrians would be struck in the next 10 years due to advanced vehicle technology. A substantial number were unsure of the safety impacts of the technology (i.e., those indicating "I don't know" to this question).

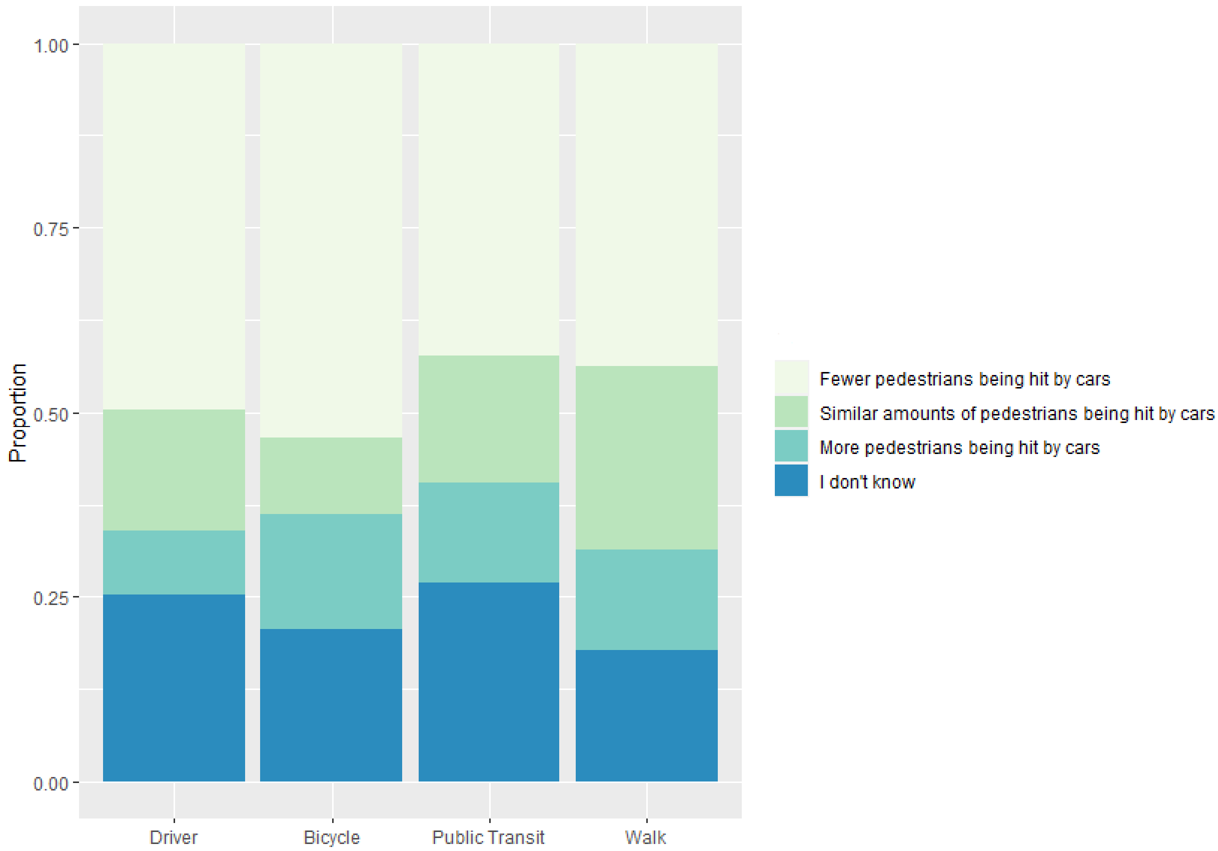

Figure 3. Responses by road-user group to question, "In the next 10 years, advanced vehicle technology will lead to:"

Responsibility

Two questions asked were related to responsibility for the control of the vehicle and costs incurred in cases of crashes. Different road users did not tend to differ in their opinion of when drivers would no longer be required to handle any of the operational aspects of driving (X(15) = 15.9, p = 0.20; Figure 4).

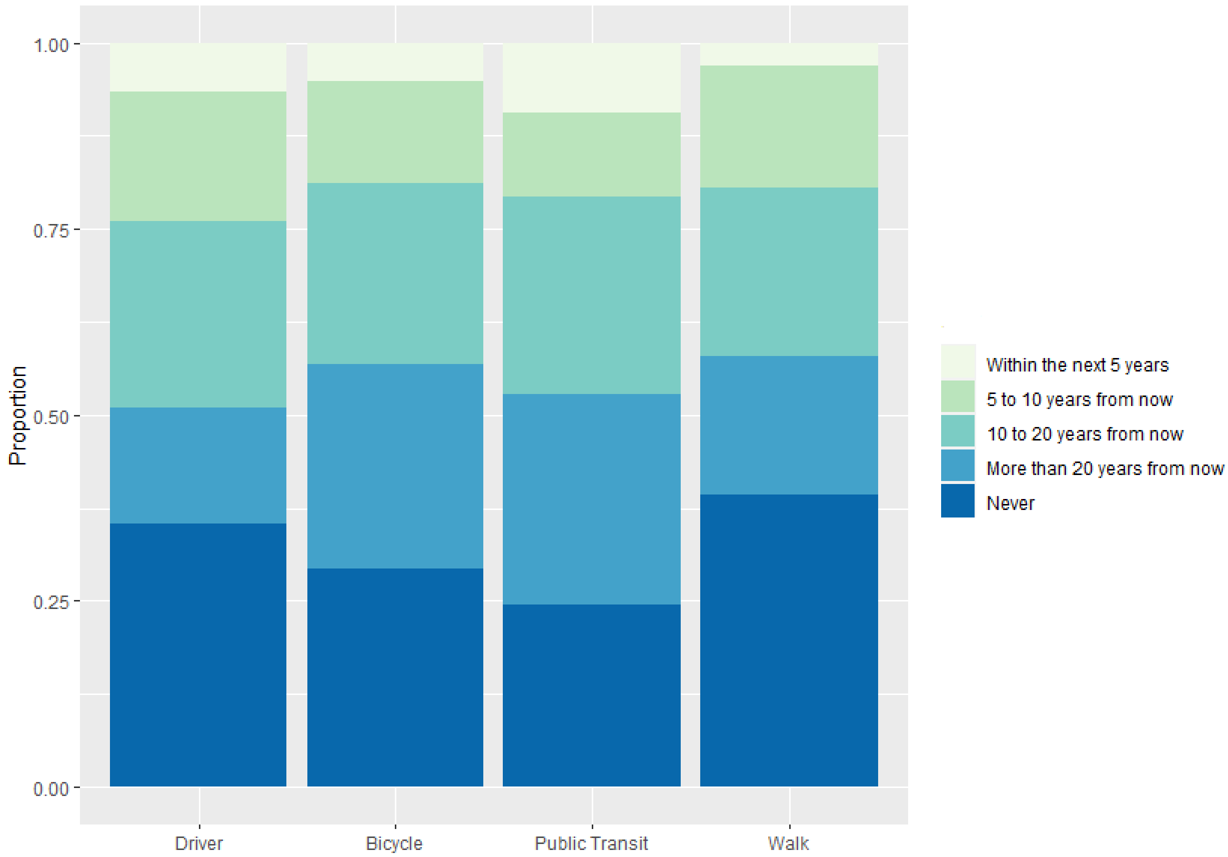

Figure 4. Responses by road-user group to question, "When do you think vehicle occupants will no longer be responsible for any aspect of operating the vehicle?"

With respect to fiscal responsibility, there was a marginally significant association with road-user type (X(9) = 16.0, p = 0.07), with drivers more likely than other road users to believe the driver of a vehicle that strikes a pedestrian should be responsible. Interestingly, pedestrians assigned responsibility to the vehicle manufacturer more often than the other road users.

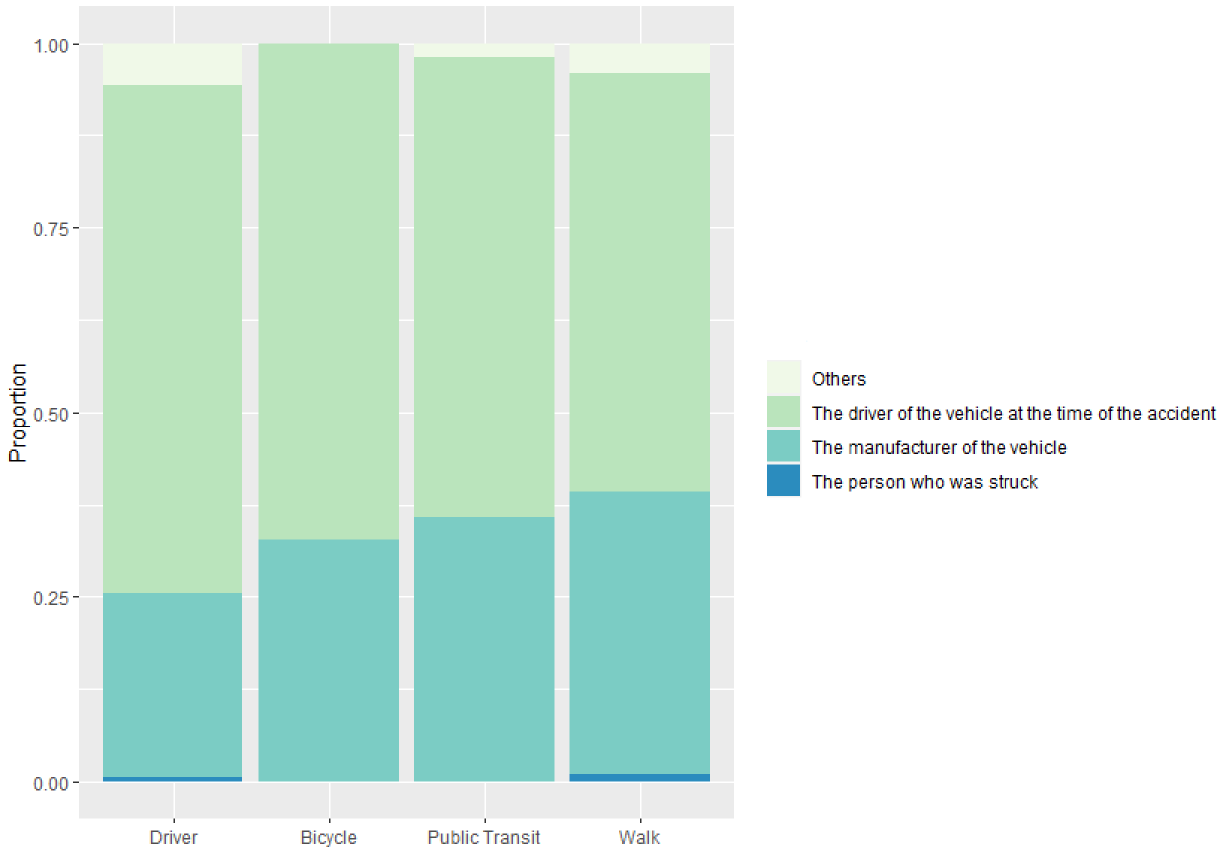

Figure 5. Responses by road-user group to question, "In the next 10 years, if a car operating under control of advanced vehicle technologies strikes a pedestrian the financial responsibility should fall on:"

Discussion

Vehicle technology has advanced to the point automated systems can now take on different aspects of a vehicle's control. Although such systems can help enhance safety, drivers must use the systems appropriately—and such use is influenced greatly by their understanding of the systems. Given that other road users interact (or will interact) with such technology-equipped vehicles, it is also important to consider the perceptions of other road users. The current study purported to examine the understanding and expectations of other road users, including bicyclists, pedestrians, and public transit riders vis-à-vis these new systems. In contrast to other studies, this study focused on lower levels of vehicle automation technology (cf. Rodríguez Palmeiro et al., 2018; Pyrialakou et al., 2020).

More specifically, the study sought to address the questions of whether drivers and non-drivers differ in (a) their perceptions and understanding of ADAS technology, (b) their trust and expectations in specific use cases, and (c) their future outlook of AV technology. With respect to these questions, the common answer is a qualified "yes," the details of which are better elucidated below.

Understanding and Expectations of Technology and Behavioral Responses

Although the accuracy of respondents' understanding of the systems was modest at best (ranging from 50 to 60% accurate), bicyclists in the current sample exhibited a stronger understanding than other road users, including drivers. While not examining other road users, other studies have shown that drivers in general and even owners of vehicles equipped with advanced technology do not necessarily exhibit greater knowledge of these systems (e.g., McDonald et al., 2018; DeGuzman & Donmez, 2021). It is possible that their baseline understanding of ADAS technology led bicyclists in the current sample to have more accurate expectations concerning the behavior of the technology in the bicycle scenario. Specifically, bicyclists were more likely to believe correctly that the vehicle, with automation engaged, would not adjust its behavior when approaching the bicyclist in the vignette.

It is particularly noteworthy that, in spite of this superior knowledge of the capabilities and behavior of the system, bicyclists were *less* likely to report that they would make any changes in their own actions to increase their safety (e.g., move to the right, wait until vehicle passed). Thus, there appears to be a disconnect between perceptions of risk or safety and intended behaviors. What are the reasons for this? It is possible that bicyclists hold strong views about the rights of this group on the roads and opinions about sharing the roads with vehicles. Dill and McNeil (2013) identified different archetypal cyclists, including "strong and fearless," which could also represent an unmeasured factor influencing decisions and risk tolerance in such hypothetical scenarios.

Interestingly, in the pedestrian scenario, the pedestrian road-user group was more likely to believe (falsely) that the vehicle's ACC system would accurately detect the pedestrian in the scenario and were less likely to believe that the vehicle would continue without adjustment compared to other road-user groups. This is concerning as this road-user group would possibly be the most exposed to vehicle interactions such as the one depicted in the scenario, compared to the other groups. That said, all road users tended to indicate that they would be more likely cross quickly or abort the crossing attempt compared to a "normal" cross.

It is somewhat promising that, as respondents considered how they would react as the driver in the bicycle and pedestrian scenarios, they tended to indicate that they would be most likely to disengage the system and resume manual control irrespective of road-user type.

Trust and Risk Perceptions

Non-drivers demonstrated lower trust in the vehicle technology than drivers. This is noteworthy as the groups did not differ in their appraisal of risk in the situation; also, as noted above bicyclists did not report that they would make any behavior changes that could enhance their safety. Interestingly, Rodríguez Palmeiro et al. (2018) found that bicyclists had greater confidence in being noticed by a highly conspicuous AV compared to a traditional (manually driven) vehicle. The current results did not replicate these outcomes for lower-level automated features: respondents indicated increased risk and decreased trust in the scenarios where the technology is present compared to when the driver had full control of the vehicles.

Other studies have found that cycling near automated vehicles was considered by respondents to be the least safe circumstance compared to driving or walking near AVs (Pyrialakou et al., 2020). While the current study did not directly compare the riskiness of different situations, the perceptions of risk in the bicycle and pedestrian scenario in the current study were on par with each other and neither was particularly elevated (ranging from 44 to 56 on a 100-point scale). This could be due to differences in the technologies being explored in the different studies (autonomous [highly automated] versus ADAS) as well as differences in the situations portrayed.

Comparing Technology to Manual Driving

As shown in many past studies, in the two scenarios examined, drivers appeared to exhibit a high degree of confidence in their own driving skills (e.g., Horswill et al., 2004; Horrey et al., 2015), with very high self-ratings compared to those expressed by other road users. In both scenarios, drivers also indicated that they would trust their driving skills much more than the technology and the magnitude of this increase far surpassed ratings of other road users. While not explored directly in the current study, the role and influence of drivers' appraisal of their own driving skills in determining trust and decisions to use vehicle technology is clearly an area where more research is needed.

In general, removing technology from the scenarios (i.e., comparing ratings made with and without the technology present) did not lead to significant changes in the perceptions of responsibility for avoiding a crash. The groups indicated that technology increased crash risk and this increase was largest for the driver group (likely due to the increased confidence (trust) in their driving skills noted above). All groups tended to trust the manual driver more than the vehicle under control of automation. Again, the level of trust in the system (versus the manual driver) might have implications for the overall acceptance and ultimate use of these technologies—even as they become increasingly available.

Future Outlook Regarding Technology

Outside of the scenarios, drivers tended to exhibit more optimism about the progression of capabilities of the technologies compared to the other road users. That is, they indicated that technology that equaled the ability of alert drivers would arrive sooner than the other user groups. That said, compared to other groups, drivers did not believe that the technologies would yield more significant safety gains for pedestrians in the near term. The majority of all road-user groups believed that the technology would significantly progress in its capabilities within the next 10 years.

Collectively, the current results highlight some important outcomes, especially concerning the mismatch of user expectations of the technologies and their behaviors in the different use cases. In some cases, non-drivers could be exposed to greater risk due to false expectations about the technology (in the case of pedestrians) or through willful perseverance of normal behavior (in the case of bicyclists). Moreover, there were patterns of responses that were indicative of some disconnect between different underlying dimensions. For example, perceived levels of trust did not necessarily align with perceived risk or compensatory behaviors.

Limitations

While the current results are informative, the study could be enhanced on several dimensions. First, the current way of categorizing the respondents by road-user type was necessarily simplistic and, as such, these groupings do not represent “pure” reflection of these road users. That is, those who indicated one mode of transport would not use only this means. In fact, a high percentage of the cyclists and pedestrians purported to have a driver’s license as well as access to a vehicle. All that said, our current groupings capture the mode in which these users would be most likely to interact with automated vehicles.

Second, the reliance on survey and self-report information is also a limitation. While past work has generally found good support that behavioral intentions (i.e., statements of what someone would do in a given situation) correspond with actual behaviors (e.g., Ajzen, 1991; Warner & Åberg, 2006), it is possible that real world behaviors would deviate some from those expressed in the survey. Field experiments can be conducted to test and validated the findings in this report.

Third, the use of hypothetical scenarios carries the advantage of being able to clearly convey to respondents details about the encounter, the technology, and its status. However, in situ, other road users would be less likely to be aware of what mode vehicles are in (e.g., whether automated systems are engaged; cf. studies that examine higher level AVs that are far more conspicuous than vehicles equipped with lower-level automated features, e.g., Rodríguez Palmeiro et al., 2018). This does not detract from the current results respecting expectations, intended behaviors, and perceived risk; however, real-world decisions made in similar situations would be widely impacted by other factors.

Lastly, there no doubt was also some uncontrolled variability in respondents’ interpretation of some of the specific details and behaviors of the different agents in the scenario, as well as a consideration of the role and influence of other vehicle safety features that were not called out in the situation, including automatic emergency braking (AEB) and forward collision warning, among others.

Conclusion

The current study examined the understanding and expectations of non-personal vehicle drivers, including bicyclists, pedestrians, and public transit riders regarding ADAS. The results revealed differences across road-user groups in terms of their understanding, expectations, behaviors, trust, and perceptions of risk. Importantly, perceived expectations and trust did not always align with perceived risk and behavioral responses.

Collectively, the current outcomes underscore the need to better understand expectations of new vehicle technology and behaviors of all road users—not just drivers. While some have found that direct experience can increase people’s expectations of automation technology

(Penmetsa et al., 2019), more work is needed to understand how other information and sources influence awareness and accuracy of user's mental models of technology (see e.g., Singer & Jenness, 2020). It follows that individualized or targeted approaches might be appropriate for different road-user groups.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Benson, A.J., Tefft, B.C., Svancara, A.M., & Horrey, W.J. (2018). *Potential Reductions in Crashes, Injuries, and Deaths from Large-Scale Deployment of Advanced Driver Assistance Systems* (Research Brief). Washington, D.C.: AAA Foundation for Traffic Safety.

Deb, S., Rahman, M. M., Strawderman, L. J., & Garrison, T. M. (2018). Pedestrians' receptivity toward fully automated vehicles: Research review and roadmap for future research. *IEEE Transactions on Human-Machine Systems*, *48*(3), 279-290. https://doi.org/10.1109/THMS.2018.2799523

DeGuzman, C. & Donmez, B. (2021). Owners versus Non-owners: How Much Drivers Know About Adaptive Cruise Control: A Survey of Owners and Non-Owners. Poster presented at *2021 Annual Meeting of the Transportation Research Board*.

Dill, J. & McNeil, N. (2013). Four types of cyclists?: Examination of typology for better understanding of bicycling behavior and potential. *Transportation Research Record*, *2387*(1), 129–138. https://doi.org/10.3141/2387-15

Highway Loss Data Institute. (2015). *Subaru collision avoidance features: an update*. HLDI Bulletin, (32)8.

Horrey, W. J., Lesch, M. F., Mitsopoulos-Rubens, E., & Lee, J. D. (2015). Calibration of skill and judgment in driving: Development of a conceptual framework and the implications for road safety. *Accident Analysis & Prevention*, *76*, 25-33. https://doi.org/10.1016/j.aap.2014.12.017

Horswill, M. S., Waylen, A. E., & Tofield, M. I. (2004). Drivers' Ratings of Different Components of Their Own Driving Skill: A Greater Illusion of Superiority for Skills That Relate to Accident Involvement 1. *Journal of Applied Social Psychology*, *34*(1), 177–195. https://doi.org/10.1111/j.1559-1816.2004.tb02543.x

Jayaraman, S. K., Creech, C., Tilbury, D. M., Yang, X. J., Pradhan, A. K., Tsui, K. M., & Robert Jr, L. P. (2019). Pedestrian trust in automated vehicles: Role of traffic signal and AV driving behavior. *Frontiers in Robotics and AI*, *6*, 117. https://doi.org/10.3389/frobt.2019.00117

Johnson-Laird, P. (1983). *Mental Models*. Cambridge, MA: Harvard University Press.

Kim, W., Kelley-Baker, T., Sener, I., Zmud, J., Graham, M. & Kolek, S. (2019). *Users' Understanding of Automated Vehicles and Perception to Improve Traffic Safety – Results from a National Survey* (Research Brief). Washington, D.C.: AAA Foundation for Traffic Safety.

Kyriakidis, M., Happee, R., & de Winter, J. C. (2015). Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. *Transportation Research Part F: Traffic Psychology and Behaviour*, 32, 127-140. https://doi.org/10.1016/j.trf.2015.04.014

McDonald, A., Carney, C., & McGehee, D. V. (2018). *Vehicle Owners' Experiences with and Reactions to Advanced Driver Assistance Systems*. Washington, D.C.: AAA Foundation for Traffic Safety.

Nuñez Velasco, P., Farah, H., van Arem, B., Hagenzieker, M., Nuñez Velasco, P., Farah, H., ... & Hagenzieker, M. (2017). Interactions between vulnerable road users and automated vehicles: A synthesis of literature and framework for future research. *Proceedings of the Road Safety and Simulation International Conference*, 16-19.

Penmetsa, P., Adanu, E. K., Wood, D., Wang, T., & Jones, S. L. (2019). Perceptions and expectations of autonomous vehicles–A snapshot of vulnerable road user opinion. *Technological Forecasting and Social Change*, *143*, 9-13. https://doi.org/10.1016/j.techfore.2019.02.010

Pyrialakou, V. D., Gkartzonikas, C., Gatlin, J. D., & Gkritza, K. (2020). Perceptions of safety on a shared road: Driving, cycling, or walking near an autonomous vehicle. *Journal of Safety Research*, *72*, 249-258. https://doi.org/10.1016/j.jsr.2019.12.017

Rodríguez Palmeiro, A., Van der Kint, S., Hagenzieker, M., Van Schagen, I. N. L. G., & De Winter, J. C. F. (2018). Cyclists' expectations when encountering automated vehicles: Results of an international photo-based questionnaire. *7th International Cycling Safety Conference.* Barcelona, Spain.

Schoettle, B., & Sivak, M. (2014). *A Survey of Public Opinion about Autonomous and Self-Driving Vehicles in the US, the UK, and Australia.* University of Michigan, Ann Arbor, Transportation Research Institute.

Seppelt, B. & Victor, T. (2020). Driver's mental model of vehicle automation. In D. L. Fisher, W. J. Horrey, J. D. Lee, & M. A. Regan (Eds.), *Handbook of Human Factors for Automated, Connected, and Intelligent Vehicles* (pp. 55-66). Boca Raton, FL: CRC Press.

Singer, J. & Jenness, J. W. (2020). *Impact of Information on Consumer Understanding of a Partially Automated Driving System.* Washington, D.C.: AAA Foundation for Traffic Safety.

Warner, H. W. & Åberg, L. (2006). Drivers' decision to speed: A study inspired by the theory of planned behavior. *Transportation Research Part F: Traffic Psychology and Behaviour*, *9*(6), 427-433. https://doi.org/10.1016/j.trf.2006.03.004

Zhang, Y., Yang, L., & Su, R. (2021). Comparison of acceptance of highly automated vehicles between car users and pedestrians. *Poster presented at the 2021 Annual Meeting of the Transportation Research Board.*

Appendix A

The following survey is part of a research project conducted by the University of Wisconsin-Madison and the University of Iowa. The purpose of this survey is to assess your understanding of existing/future vehicle technologies.

You may ask any questions about the research at any time. If you have questions about the research you should contact the Principal Investigator at [number withheld]. If you are not satisfied with response of the research team, have more questions, or want to talk with someone about your rights as a research participant, you should contact the Education and Social/Behavioral Science IRB Office at [number withheld]. Data collected as part of this survey will be shared with researchers outside of UW-Madison.

Your participation is completely voluntary. You can stop participation at any time.
If you decide to participate in this research, you will be asked to fill out a 5-15 minute survey that asks about vehicle technologies and roadway interactions. Due to the nature of the online survey we don't anticipate any risks to you from participation in this study. We also don't expect any direct benefits to you from participation in this study. This study is anonymous. Neither your name or any other identifiable information will be recorded.

If you agree to proceed by selecting **"I Agree to Proceed"** you can proceed to the next page by clicking/tapping the **"→"** button. If you do no want to participate, you can navigate away from this window.

○ I Agree to Proceed (1)

Q13 What is your age?

Start of Block: General Demographics and Road Use

Q14 What is your gender?

○ Male (1)

○ Female (2)

○ Non-binary (3)

○ Prefer not to answer (4)

Q15 Do you have a valid driver's license?

- Yes (1)
- No (2)

Q16 On a normal weekday, what is your primary way to get places? If you routinely use more than one of the options below, pick the one that you spend the most time using.

- A personal car or truck (as passenger or driver) (1)
- Motorcycle (as passenger or driver) (2)
- Moped/Scooter (as passenger or driver) (3)
- Public transit (bus, rail) (4)
- Bicycle (including electric ones) (5)
- Walk (6)
- Other (7)

Q17 How often do you use the following ways to get places?

	Every Day (1)	Most Days (2)	A few times a month (3)	Rarely (4)	Never (5)
A personal car or truck (as passenger or driver) (1)	○	○	○	○	○
Motorcycle (as passenger or driver) (2)	○	○	○	○	○
Moped/Scooter (as passenger or driver) (3)	○	○	○	○	○
Bicycle (4)	○	○	○	○	○
Walk (5)	○	○	○	○	○

Q18 Do you currently own or have regular access to a vehicle or vehicles?

- Yes (1)
- No (2)

If yes, Q19. Do any of these vehicles you have regular access to have any of the following features?

	Yes (1)	No (2)	I'm not sure (3)
Adaptive cruise control (1)	○	○	○
Lane keeping assist (2)	○	○	○
Blind spot warning (3)	○	○	○
Parking assist (4)	○	○	○
Rear-Cross Traffic Alert (5)	○	○	○
Forward collision warning (6)	○	○	○
Automatic emergency braking (7)	○	○	○
Lane departure warning (8)	○	○	○

Start of Block: Adaptive Cruise Control

Q20 The next few questions will ask you about an advanced vehicle technology called Adaptive Cruise Control (ACC). Different vehicle makes and models may refer to this system by another name (e.g., Intelligent Cruise Control).

Q22 Based on your understanding, select which one of these statements most closely describes the capabilities of Adaptive Cruise Control

- ○ Automatically brakes and accelerates to maintain a following gap between your vehicle and the vehicle ahead (1)
- ○ Automatically brakes and accelerates to drive your vehicle at the same speed as the vehicle ahead (2)
- ○ Maintains a set speed but turns off if the system detects a vehicle ahead (3)
- ○ Uses the navigation system to determine the speed limit and automatically drives your vehicle at a speed just under the limit unless the system detects a vehicle ahead (4)

Q23 With Adaptive Cruise Control, the following gap from the vehicle ahead is determined by:

- ○ A setting that is roughly equivalent to a number of "car lengths" (1)
- ○ The two-second rule (2)
- ○ How many seconds it would take to travel the current following gap between your vehicle the vehicle ahead (3)
- ○ Local traffic speed and density (4)

Q24 Adaptive Cruise Control: (please select one)

- ○ Works well in all weather conditions because it relies on radar (1)
- ○ May not work well to detect vehicles such as motorcycles (2)
- ○ Works well in tight curves and on steep hills (3)
- ○ Works well in traffic conditions that require frequent repeated acceleration and deceleration (4)

Q25 Read each statement about Adaptive Cruise Control (ACC) below and indicate whether the system can or cannot do the action described. Please indicate "I don't know" only when you have no idea whatsoever.

	Definitely Not (1)	Probably will not (2)	Probably Will (3)	Definitely Will (4)	I don't know (5)
ACC maintains the speed that you have set when there are no vehicles detected in the lane ahead (1)	○	○	○	○	○
ACC will accelerate if a slower vehicle ahead moves out of the detection zone (2)	○	○	○	○	○
ACC will correctly detect motorcycles and other smaller vehicles (3)	○	○	○	○	○
ACC reacts to stationary objects on the road (construction cone, tire, ball) (4)	○	○	○	○	○
ACC reduces the vehicle speed when approaching tight curves (5)	○	○	○	○	○
ACC detects stopped vehicles in your lane (6)	○	○	○	○	○
ACC will react immediately to vehicles merging onto the road in front of you (7)	○	○	○	○	○

Start of Block: Lane Keeping Assist

Q26 The next few questions will ask you about another advanced vehicle technology called Lane Keeping Assist (LKA). Different vehicle makes and models may refer to this system by another name.

Q28 Read each statement about Lane Keeping Assist (LKA) below and indicate whether the system can or cannot do the action described. Please indicate "I don't know" only when you have no idea whatsoever.

	Definitely will not (1)	Probably will not (2)	Probably will (3)	Definitely will (4)	I don't know (5)
LKA will provide steering input to keep the vehicle in its lane (1)	○	○	○	○	○
LKA can operate in all weather conditions (2)	○	○	○	○	○
LKA can operate where lane lines are faded (3)	○	○	○	○	○
LKA works on curvy roads (4)	○	○	○	○	○
LKA can operate in a work zone where lanes have shifted from their usual location (5)	○	○	○	○	○
LKA can work with direct sun glare ahead (6)	○	○	○	○	○
LKA will change lanes to pass a slower moving vehicle ahead (7)	○	○	○	○	○

Start of Block: Scenario Introduction

Q56 In the following section, you will be asked to read two short scenarios. After each one, you will be asked a few general questions about the situation. You will also be asked a few questions where you imagine you are either the driver in the scenario or the other road user (bicyclist/pedestrian).

Start of Block: Scenario 1

Q36 Please read the scenario below and respond to the questions that follow. Scenario: A bicyclist is travelling along a two-lane road that has a narrow shoulder. A vehicle is approaching the cyclist from behind. The vehicle is currently operating with some advanced safety features active: lane keep assist (controlling the position of the vehicle in its lane) and adaptive cruise control (controlling its speed and distance to vehicle ahead).

Q46 How likely is it that: (place rating along the continuum)

	Extremely unlikely 0	25	50	75	Extremely likely 100
The vehicle's sensors will detect the bicyclist? ()					
The vehicle will automatically slow down? ()					
The vehicle will automatically veer to the left in its lane to give more space? ()					
The vehicle will continue to drive, without making any adjustments? ()					

Q47 If you were the **bicyclist** in this scenario, how likely is that: (select a rating)

	Extremely unlikely 0	25	50	75	Extremely likely 100
You move further to the right, even though the shoulder is narrow ()					
You keep riding as you are ()					
You stop riding, watch and wait for the car to pass ()					

Q48 If you were the **driver** in this scenario, how likely is that: (select a rating)

	Extremely unlikely 0	25	50	75	Extremely likely 100
You keep driving as you are, with the advanced features active ()					
You disengage the system and resume manual control ()					
You leave the system active, but pay closer attention to the cyclist ()					

Q41 If you were the **bicyclist** in the scenario, please rate the following: (select a rating)

Extremely Low Extremely High

	0	25	50	75	100
Your trust in the vehicle technology ()					
The overall crash risk ()					
Your responsibility for avoiding a collision ()					

Q43 If you were the **driver** in the scenario, please rate the following: (select a rating)

	Extremely Low			Extremely High	
	0	25	50	75	100
Your trust in the vehicle technology ()					
The overall crash risk ()					
Your responsibility for avoiding a collision ()					

Q42 If you were the **bicyclist** in the scenario, but the vehicle did not have any advanced features and was being driving manually, please rate the following (select a rating):

	Extremely Low			Extremely High	
	0	25	50	75	100
Your trust in the driver ()					
The overall crash risk ()					
Your responsibility for avoiding a collision ()					

Q45 If you were the **driver** in the scenario, but the vehicle did not have any advanced features and you were driving manually, please rate the following (select a rating):

	Extremely Low			Extremely High	
	0	25	50	75	100

Your trust in your driving skills ()	
The overall crash risk ()	
Your responsibility for avoiding a collision ()	

Start of Block: Scenario 2

D2 Please read the scenario below and respond to the questions that follow.

Scenario: A pedestrian is walking up to a mid-block crosswalk that traverses a two-lane road. A driver on the far side has already stopped for them. A vehicle is approaching the pedestrian in the opposite direction. This vehicle is still some distance away and if it slows slightly the pedestrian should have enough time to clear its path. The vehicle is currently operating with some advanced features active: lane keep assist (controlling the position of the vehicle in its lane) and adaptive cruise control (controlling its speed and headway). Behind this vehicle are several others, so it would be some time before another gap appears.

Q49 How likely is it that: (place rating along the continuum)

	Not at all likely / Extremely Likely: 0 10 20 30 40 50 60 70 80 90 100
The vehicle's sensors will detect the pedestrian? ()	
The vehicle will automatically slow down to give more time to cross? ()	
The vehicle will flash its high beams at the pedestrian? ()	
The vehicle will continue to drive, without making any adjustments? ()	

Q50 If you were the **pedestrian** in this scenario, how likely is that: (place rating along the continuum)

Not at all likely Extremely Likely

0 25 50 75 100

You cross the road at your usual pace ()	
You continue to wait for a gap, even though the opposing lane has stopped for you ()	
You cross the road much quicker than usual ()	
You decide to not cross mid-block and instead walk to the corner to cross there ()	

Q51 If you were the **driver** in this scenario, how likely is that: (place rating along the continuum)

Not at all likely Extremely Likely

0 25 50 75 100

You keep driving as you are, with the advanced features active ()	
You disengage the system and resume manual control ()	
You leave the systems active, but pay closer attention to the pedestrian ()	

Q52 If you were the **pedestrian** in the scenario please rate the following: (place rating along the continuum)

Extremely low Extremely High

0 25 50 75 100

Your trust in the vehicle technology ()	
The overall crash risk ()	
Your responsibility for avoiding a collision ()	

Q53 If you were the **driver** in the scenario please rate the following: (place rating along the continuum)

Extremely low Extremely High

0 25 50 75 100

Your trust in the vehicle technology ()	
The overall crash risk ()	
Your responsibility for avoiding a collision ()	

Q54 If you were the **pedestrian** in the scenario, but the vehicle did not have any advanced features and was being driving manually, please rate the following:

	Extremely low			Extremely High
	0 25	50	75	100
Your trust in the driver ()				
The overall crash risk ()				
Your responsibility for avoiding a collision ()				

Q55 If you were the **driver** in the scenario, but the vehicle did not have any advanced features and you were driving manually, please rate the following:

	Extremely low			Extremely High
	0 25	50	75	100
Your trust in your driving skills ()				
The overall crash risk ()				
Your responsibility for avoiding a collision ()				

Start of Block: Future Technologies

Q30 When do you think advanced vehicle technology will be able to detect pedestrians just as effectively as an alert human driver?

- Vehicles can already do this (1)
- Within the next 5 years (2)
- 5 to 10 years from now (3)
- 10 to 20 years from now (4)
- More than 20 years from now (5)
- Never (6)

Q31 When do you think advanced vehicle technology will be able to detect bicyclists just as effectively as an alert human driver?

- Vehicles can already do this (1)
- Within the next 5 years (2)
- 5 to 10 years from now (3)
- 10 to 20 years from now (4)
- More than 20 years from now (5)
- Never (6)

Q32 When do you think vehicle occupants will no longer be responsible for any aspect of operating the vehicle?

- Within the next 5 years (1)
- 5 to 10 years from now (2)
- 10 to 20 years from now (3)
- More than 20 years from now (4)
- Never (5)

Q33 In the next 10 years, advanced vehicle technology will lead to:

- ○ More pedestrians being hit by cars (1)
- ○ Fewer pedestrians being hit by cars (2)
- ○ Similar amounts of pedestrians being hit by cars (3)
- ○ I don’t know (4)

Q34 In the next 10 years, if a car operating under control of advanced vehicle technologies strikes a pedestrian the financial responsibility should fall on

- ○ The driver of the vehicle at the time of the accident (1)
- ○ The manufacturer of the vehicle (2)
- ○ The person who was struck (3)
- ○ Others: (4)

Start of Block: Block 8

Q59 What is the zipcode of your primary residence?

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