The Transport for New South Wales FleetCAT (Fleet Collision Avoidance Technology) Trial: Drivers Attitudes to the Technology

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Abstract

In 2015, Transport for New South Wales undertook a trial of collision avoidance technology in a fleet of 34 vehicles across three government departments for a period of seven months. The technology assessed was the Mobileye 560 CAT system, which provides Headway Monitoring, Forward Collision, Lane Departure and Pedestrian Collision Warnings using both audio and visual alerts. As part of the trial, drivers using vehicles fitted with the system were invited to complete an on-line questionnaire about their experiences with, and attitude to, the system. One hundred and twenty two drivers completed the questionnaire (out of the total 199 individuals who drove the vehicles). In general, the surveyed drivers recognised that the system could improve safety but most did not wish to use the system in future themselves as they found it distracting and felt that it would not prevent them from having a crash.

Background.

Recent years have seen the development of a variety of active in-vehicle safety technologies, which have been designed to reduce the likelihood of a crash occurring. Some of these technologies involve the provision of warnings given to the driver when the system detects the possibility of a collision unless the vehicle's speed or position is altered through driver intervention.

In 2015, Transport for New South Wales undertook a trial of collision avoidance technology (CAT) in which a system was installed in a sample of 34 government fleet vehicles for a period of seven months. The technology assessed was the Mobileye system, which provides auditory and visual warnings to the driver in four situations: (1) insufficient headway to the vehicle ahead, (2) risk of a forward collision, (3) lane departure without the activation of an indicator, and (4) risk of a pedestrian collision. The system is advisory only, requiring intervention by the driver in response to the warnings. The intention of the trial was to determine whether this technology could improve the driving behaviour and safety of government fleet vehicle drivers and whether it may, therefore, be of benefit if introduced more widely in the state's general vehicle fleet.

For vehicle safety technology to be successfully implemented, it has been argued that there has to be a high level of acceptance[1] of it by the drivers who use it (Bordel et al., 2014; Regan, Stevens, and Horberry, 2014). If a technology is unpopular with drivers, they will not use it and vehicle manufacturers will not wish to install it in their vehicles. Moreover, for technologies (such as warning systems) that will only be effective if they elicit appropriate responses from drivers, it is imperative that users' experiences and interactions with the technology are examined carefully. For example, users may come to disregard the warnings, or may find them more distracting than useful. As a result, the technology will not deliver the intended road safety benefits (Regan et al., 2014). Consequently, government employees who drove the vehicles that were fitted with the technology were asked to complete a questionnaire on their experiences of, and attitudes to, the Mobileye

[1] The extent to which drivers approve of a technology after using it is called its 'acceptance', as distinct from their approval of the idea of a technology before trying it, which is called its 'acceptability' (see Adell, Varhelyi, and Horberry, 2014).

system. The present study examined the questionnaire data to determine whether the drivers accepted the technology and whether they thought that it improved their driving.

Methods.

Participants

The Mobileye systems were trialled in the pool fleet vehicles of three NSW government departments: Transport for NSW, NSW State Emergency Services and NSW Public Works. Therefore, the participants for this research were any employees of these three departments who drove the fleet vehicles during the trial period. As per the regulations of the NSW government for driving fleet vehicles, the participants were required to hold a driver's licence for a car (class C licence, entitling a person to drive non-commercial motor vehicles not exceeding 4,500kg). The total sample of individuals who drove the fleet vehicles was 199, while the total sample of those who completed the questionnaire was 122 (a response rate of 61%). Personal background information relating to the participants was not collected, as Workplace Surveillance Laws required that this information remain confidential so that individual participants could not be personally identified. As a result, it was not possible to compare the drivers who completed the questionnaire to those who did not to determine whether they differed demographically.

Materials

Collision Avoidance Technology

Thirty-four vehicles were retrofitted with Mobileye 560 CAT Warning Systems. The Mobileye system uses a forward facing digital camera located on the front windscreen and a specially designed processor to calculate dynamic distances between the vehicle and relevant road objects (i.e. car, cyclist, pedestrian, lane markings). These calculations form the basis for the provision of Forward Collision Warnings (FCW), Headway Monitoring Warnings (HMW), Pedestrian Collision Warnings (PCW), and Lane Departure Warnings (LDW). These warnings are given to the driver using visual and audio alerts on a small display unit. The nature of the alerts are explained below:

- FCW – the visual alert is a red symbol of a car and a measure of headway distance in time (seconds). The headway distance is the number of seconds it would take for the vehicle to reach the current position of the relevant road object (e.g. another vehicle). The audio alert is a loud tone. The system alerts the driver up to 2.7 seconds before a collision occurs.
- HMW – the visual alert is either a green symbol of a car and a measure of headway distance in time (seconds) or a red symbol of a car and the headway distance when the time is 0.6 seconds or less. The audio alert tone increases in volume as the headway distance decreases. Alerts are provided when the headway distance is equal or below a pre-determined level.
- PCW – the visual alert is a red symbol of a person. The audio alert is a loud tone. The system alerts the driver up to two seconds before a collision occurs.
- LDW – the visual alert is a broken white line on the side of the display that corresponds to the left or right side of the lane that the vehicle has departed. The audio alert is a loud tone. An alert is provided when the vehicle crosses over the left or right lane markings.

FleetCAT Driver Questionnaire

The development of the FleetCAT Driver Questionnaire, including many of the items and scales that were used, was informed by two previous studies by Barnes and Johnson (2010) and Cuenca et al. (2010). Both studies evaluated the attitudes and opinions of New South Wales drivers of non-government private company fleet vehicles and privately owned vehicles involved in a trial of Intelligent Speed Adaptation (ISA) technology. This evaluation of ISA had similar objectives to the

current study, namely to examine the acceptance, benefits and concerns about the technology. Therefore, many of the items were applicable to the current project, although the wording usually had to be altered slightly. The current questionnaire was also informed by the constructs that Regan, Mitsopoulos, Haworth, and Young (2002) used to define user acceptance of driver assistance systems, including: usefulness, ease of use, effectiveness, affordability and social acceptability.

The questionnaire was divided into five sections. The *Driver Comfort/Awareness of the Mobileye System* section required participants to indicate whether the Mobileye system bothered or distracted them (four-point scale: from 'strongly disagree' to 'strongly agree'). The *Warnings* section contained questions about the visual and auditory warnings, such as whether the participants understood what they meant, whether they ignored them and whether they received false warnings (five-point scale: 'never' to 'always'); whether the warnings attracted their attention and whether they adjusted their driving to avoid the warnings (four-point scale: from 'strongly disagree' to 'strongly agree'); and whether the warnings had made them more aware of the driving events (e.g. lane departure without indication) that caused them (five-point scale: from 'strongly disagree' to 'strongly agree'). The *Perceived Benefits* section sought information on whether the participants thought the Mobileye system would prevent them having a crash and whether it made them feel safer (four-point scale: from 'not at all' to 'very much'); and whether they thought it could lead to an overall reduction in crashes and whether their driving had improved since using the system (five-point scale: from 'strongly disagree' to 'strongly agree'). The *Acceptance* section asked whether the participants thought all new vehicles should have Mobileye in them (scale from 0 to 10: 'not at all support' to 'totally support') and whether they would like to own a vehicle with Mobileye (scale from 0 to 10: 'not interested at all' to 'very interested'). The final section asked about the participants' *Overall Experience with the Mobileye System*, including whether it was useful, accurate and user friendly (four-point scale: from 'strongly disagree' to 'strongly agree'); how they would rate its overall performance, usability, functionality and acceptability (scale from 0 to 10: 'very poor' to 'excellent'); and whether they thought there were any problems with it (open response field). Care was taken to keep the questionnaire to a reasonable length to ensure participants remained engaged and co-operative, and to maximise the completion rate. It took approximately 20 minutes to complete.

Procedure

FleetCAT Trial

Drivers were assured that their confidentiality would be protected throughout the trial. They drove the vehicles as part of their normal daily work routine. The trial was run in three stages: Baseline (Stage 1), Active (Stage 2), and Silent (Stage 3). In Stage 1 (three months), warnings and events were logged by the system but were not conveyed to the driver either audibly or visually. This phase represented a baseline indication of typical driver behaviour before the introduction of the warning system. In Stage 2 (three months), the Mobileye system was active and drivers received audible and visual alerts warning them of potential forward collisions, reduced headway, lane departures or pedestrian collisions. It was anticipated that this stage would result in gradual changes in driving behaviour from baseline, as drivers recognised the risks in their standard driving behaviours. In Stage 3 (one month), the alerts were again switched off, which allowed for determination of whether any identified behaviour changes between Stages 1 and 2 in response to the warning system had been maintained despite the absence of further warnings. In other words, the data collected in Stage 3 allowed for determination of whether experience with the warning system had resulted in a sustained alteration of driving behaviour or whether any changes in behaviour had regressed to the baseline. The objective driving data collected in the trial (i.e. FCWs, HMWs, PCWs and LDWs logged by the system) will be examined in future research.

FleetCAT Driver Survey

The questionnaire was completed by the fleet drivers online through the Survey Monkey website (https://www.surveymonkey.net). Emails with a link to the questionnaire were sent to the drivers in December 2015. This directly followed the end of Stage 2 of the project, during which alerts were given to the drivers, in late November 2015. Timely delivery of the survey soon after the end of Stage 2 ensured that the experience of the Mobileye system alerts was fresh in the minds of the participants. They were sent a $20 fuel voucher to thank them for their involvement in the project.

Results.

Driver Comfort/Awareness of the Mobileye System

Generally, the respondents were not comfortable with the Mobileye system in the vehicles. Table 1 shows that 60% reported that it 'bothered' them, 67% reported that it 'distracted' them, and 55% reported that it 'is distracting because the warning tones are too loud'.

Table 1. Drivers' agreement (percentages of participants) with statements relating to their comfort with the Mobileye system in the vehicles

	Strongly disagree %	**Disagree %**	**Agree %**	**Strongly agree %**
The Mobileye system bothered me.	5.1	35.0	41.0	18.8
The Mobileye system tended to distract me.	2.6	30.8	42.7	23.9
The Mobileye system is distracting because the warning tones are too loud.	2.6	42.7	30.8	23.9

Warnings

Table 2 shows that there was ambiguity in interpreting the different warnings, with only 33% of respondents able to 'often' or 'always' judge what they meant. Seventy percent suggested that the warnings were 'sometimes', 'often' or 'always' false. Similarly, 76% reported that the warnings were 'never', 'rarely' or 'sometimes' justified. It is therefore not surprising that 70% reported 'sometimes', 'often' or 'always' ignoring the warnings.

Table 2. Responses (percentages of participants) to questions relating to the warnings provided by the Mobileye system

	Never %	**Rarely %**	**Sometimes %**	**Often %**	**Always %**
Could you judge what the different warnings meant?	5.5	16.5	45.0	27.5	5.5
How often did you experience any false alarms?	11.1	19.4	43.5	23.2	2.8
How often were the warnings justified (warned of real risk)?	10.1	35.8	30.3	21.1	2.8
How often did you ignore the warnings?	10.2	19.4	34.3	31.5	4.6

Furthermore, 58% of the respondents did not believe that the 'warnings were reliable and accurate' (see Table 3). Therefore, it is not surprising that 56% reported that they did not alter their 'driving

style in order to avoid receiving warnings'. However, 91% reported that 'the warnings were effective at getting their attention'.

Table 3. Drivers' agreement (percentages of respondents) with statements relating to the warnings provided by the Mobileye system

	Strongly disagree %	Disagree %	Agree %	Strongly agree %
The warnings were reliable and accurate (the system provided warnings when it needed to).	13.3	45.1	38.9	2.7
The warnings were effective at getting my attention.	0.9	8.0	77.0	14.2
I altered my driving style in order to avoid receiving warnings.	8.0	47.8	40.7	3.5

Table 4 shows that the Mobileye system had not increased the participants' awareness of the risk of the driving events that generated the various warnings. In each case, a majority of respondents did not 'agree' or 'strongly agree' that they are now more aware of the event. The data in Table 4 were examined further by combining the number of responses for 'agree' and 'strongly agree'

Table 4. Drivers' agreement (percentages of respondents) with statements regarding awareness of the driving events that generate Mobileye warnings

Since having driven a vehicle with a Mobileye system, I am now more aware of…	Strongly disagree %	Disagree %	No difference %	Agree %	Strongly agree %
The risk of forward collisions.	17.0	17.9	39.3	23.2	2.7
Safe distances between my vehicle and vehicles in front of me.	14.4	16.2	37.8	25.2	6.3
Potential pedestrian collisions.	21.2	17.3	49.0	10.6	1.9
Unintentionally drifting out of my lane.	17.9	19.6	40.2	21.4	0.9

Perceived Benefits

Sixty-five percent of the respondents did not believe prior to using the system that it would actively stop them from having a crash and 48% did not feel at all safer driving a vehicle with the system in it (see Table 5). However, 80% responded with 'somewhat', 'reasonably' or 'very much' when asked about the extent to which the system could 'potentially help to avoid a crash'.

Table 5. Responses (percentages of respondents) to questions relating to driver safety as a result of the Mobileye system

	Not at all %	Somewhat %	Reasonably %	Very much %
Prior to using the Mobileye system, did you expect that it would actively stop you having a crash?	64.5	22.7	10.0	2.7
Do you feel safer driving a vehicle with a Mobileye system in it?	48.2	30.9	17.3	3.6
To what extent could the Mobileye system potentially help to avoid a crash?	19.8	49.5	23.4	7.2

The respondents were optimistic about the broader potential benefits of the Mobileye system. Table 6 shows that 59% 'agreed' or 'strongly agreed' that it 'could lead to a reduction in the number of crashes' and 54% 'agreed' or 'strongly agreed' that it helps drivers 'to notice potential hazards sooner'. However, only 21% 'agreed' or 'strongly agreed' that they are now a safer driver.

Table 6. Drivers' agreement (percentages of respondents) with statements relating to perceived benefits to driver safety as a result of the Mobileye system

	Strongly disagree %	Disagree %	No difference %	Agree %	Strongly agree %
The Mobileye system could lead to a reduction in the number of crashes.	8.0	9.7	23.0	54.9	4.4
The Mobileye system helps you to notice potential hazards sooner.	8.9	11.5	25.7	46.9	7.1
You are a safer driver because you have used the Mobileye system.	17.7	14.2	46.9	18.6	2.7

Acceptance

The respondents were accepting of the technology for general use, but were not as accepting of it for themselves. Figure 1 shows that slightly more of them 'support policy that all new vehicles have Mobileye or similar technology installed in them' than do not support it. However, fewer were interested 'in owning a vehicle with Mobileye installed in it' than not owning one (see Figure 2). The mean rating (4.89, *SD* = 3.28) of support for 'policy that all new vehicles have Mobileye or similar technology installed in them' was significantly higher that the mean rating (3.77, *SD* = 3.45) of interest 'in owning a vehicle with Mobileye installed in it' according to a paired samples *t*-test, $t(112) = 5.77$; $p < .001$.

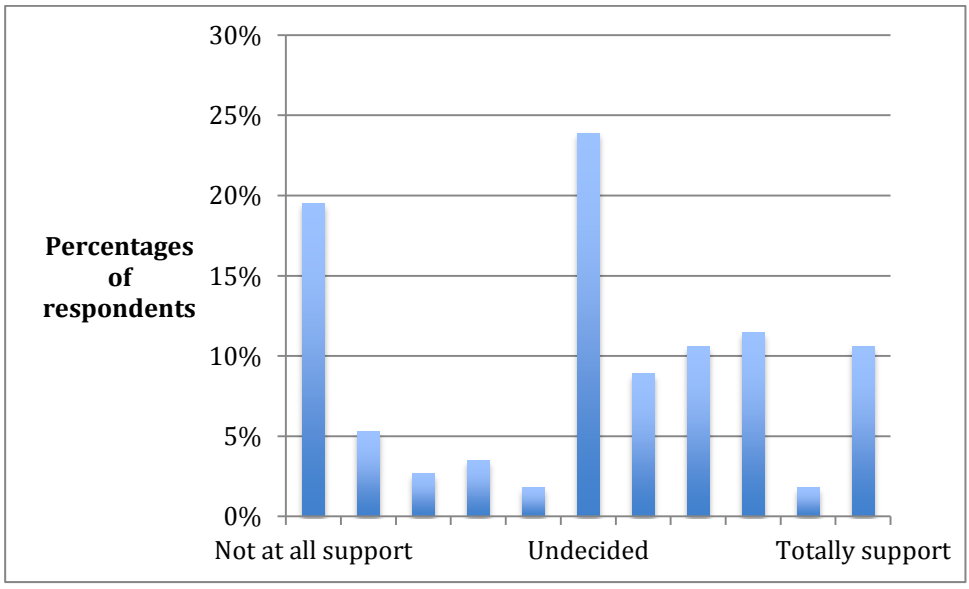

Figure 1. Driver's support on a scale from 0 to 10 for policy that all new vehicles have Mobileye or similar technology in them

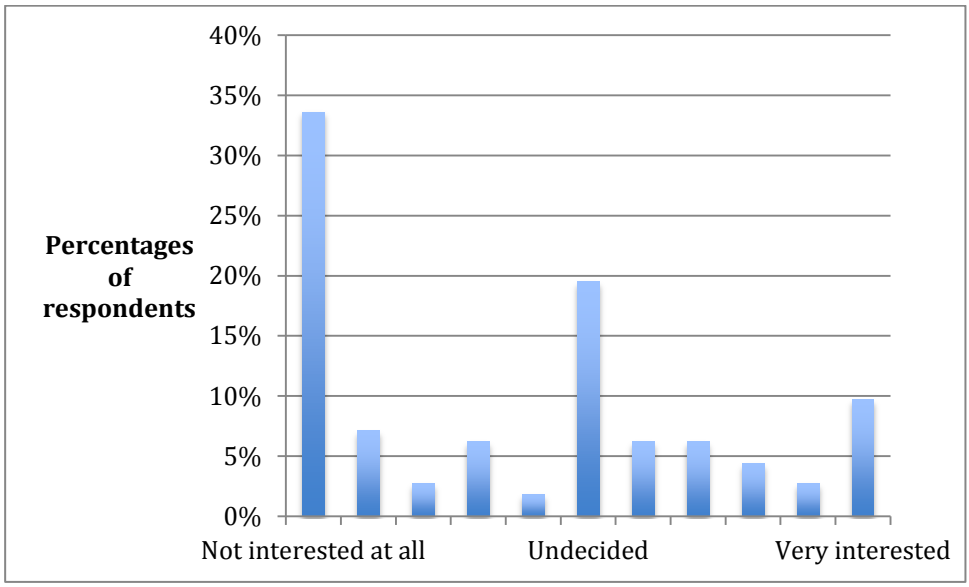

Figure 2. Drivers' interest (scale 0 to 10) in owning a vehicle with Mobileye in it

Overall Experience with the Mobileye System

The respondents were positive with regard to the use of Mobileye in general terms, with 64% 'agreeing' or 'strongly agreeing' that it 'is useful technology to have in a vehicle' and 53% 'agreeing' or 'strongly agreeing' that it 'is user friendly' (see Table 7). However, 67% 'disagreed' or 'strongly disagreed' that it 'has been of great use to them personally' and 53% 'disagreed' or 'strongly disagreed that it 'is reliable and accurate'. The positive view of the general application of Mobileye was again demonstrated in Figure 3, with 58% of the respondents rating 'the overall performance, usability and their acceptance of the system' as good.

Table 7. Drivers' agreement (percentages of respondents) with statements relating to their overall experience with Mobileye

	Strongly disagree %	**Disagree %**	**Agree %**	**Strongly agree %**
Mobileye is useful technology to have in a vehicle.	11.5	24.8	54.9	8.9
Mobileye has been of great use to me.	20.4	46.9	29.2	3.5
Mobileye is reliable and accurate.	18.6	34.5	43.4	3.5
Mobileye is user friendly.	16.8	30.1	47.8	5.3

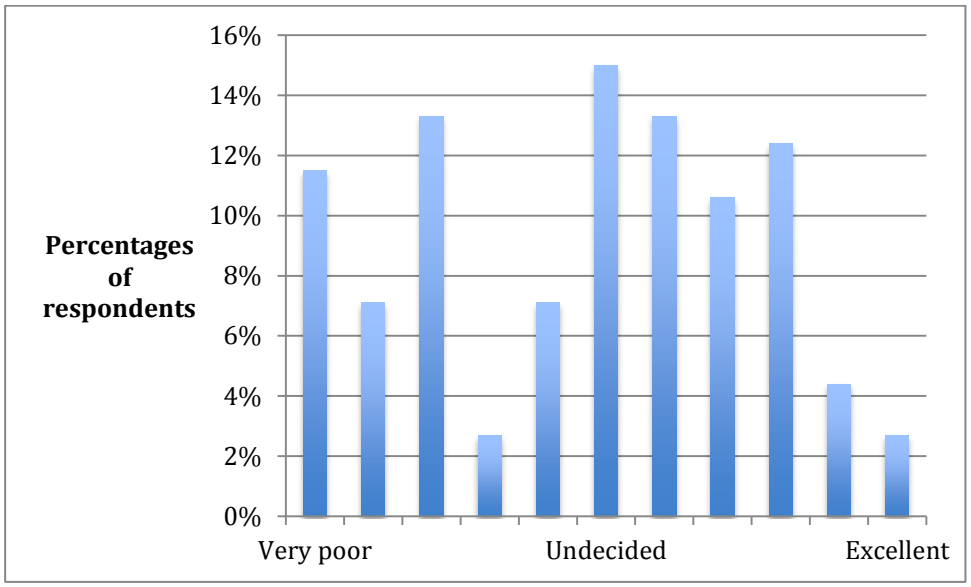

Figure 3. Drivers' ratings of the overall performance, usability and acceptance of Mobileye (scale 0 to 10)

Fifty-two percent of respondents encountered problems with the Mobileye system and 48% did not. They were asked to specify the problems and many related to: the distracting, and therefore potentially dangerous, nature of the audio and visual warnings and the difficulty to interpret them.

Discussion.

This survey of drivers involved in the Transport for New South Wales trial of Mobileye collision avoidance technology in government fleet vehicles examined their experience with, and attitudes to, the technology. The intention was to determine whether they accepted the technology so that it could potentially be introduced more widely into the general vehicle fleet and achieve the eventual objective of delivering road safety benefits. The predominant finding was that the drivers viewed the Mobileye system positively with regard to its general use for the wider public but were negative about its use specifically for themselves. For example, their support for policy that all new vehicles have Mobileye or similar technology installed in them was significantly higher than their interest in owning a vehicle with Mobileye in it. Furthermore, 64% of the respondents believed that it is useful technology to have in a vehicle and 59% reported that it could lead to a reduction in crashes. However, 67% did not believe that the system was of great use to them personally, 65% did not think that it would actively stop them having a crash, 48% did not feel at all safer driving a vehicle with Mobileye in it, 67% reported that it distracted them, and only 21% thought that they were a safer driver because they had used Mobileye. Also, most respondents did not believe that Mobileye had increased their awareness of the driving events that triggered the various warnings.

This finding could be an example of the psychological phenomenon commonly referred to as "Optimism Bias". This is where people consistently believe that negative events, such as involvement in a car crash, are less likely to happen to them than to others (Gouveia and Clarke, 2001; Klein and Helweg-Larsen, 2001; Sharot 2011; Shepperd, Carroll, Grace, and Terry, 2002; Weinstein 1980). It has been shown that people are more optimistically biased when they believe that they have more control over future events than others (Klein and Helweg-Larsen, 2001; Harris 1996). Consistent with this, it has been demonstrated that drivers tend to rate their own skills and ability more favourably than those of other drivers and believe that they are, therefore, at less risk of a crash (Freund, Colgrove, Burke, and McLeod, 2005; Gosselin, Gagnon, Stinchcombe, and Joanisse 2010; Harré, Foster, and O'Neill, 2005; Horswill, Sullivan, Lurie-Beck, and Smith 2013; Horswill, Waylen, and Tofield, 2004; White, Cunningham, and Titchener, 2011). Thus, the drivers

who completed the current survey were likely to believe that they are at less risk of a crash than others, particularly if they perceived themselves as better drivers than other people.

Past research by Barnes and Johnson (2010) and Cuenca et al. (2010) surveyed NSW non-government fleet and private drivers involved in a trial of Intelligent Speed Adaptation (ISA) to determine the acceptance, benefits and concerns of this technology. Consistent with the Mobileye technology, the ISA technology was advisory only (i.e. provided warnings when the driver exceeded the speed limit and allowed them to decide on what action to take). Sixty-five percent of participants in these studies agreed that the ISA technology was of great use to them. However, 67% of the respondents in the current study disagreed that the collision avoidance technology was of great use to them. Therefore, it seems that the drivers in the ISA study viewed the application of ISA to their driving more positively than the drivers in the current research viewed the application of CAT to their driving. While this could be due to different samples, it could also be due to differences in the technology. ISA warnings may occur due to events that justify the warning for the driver (e.g. exceeding the speed limit). In comparison, some of the CAT warnings may be in response to actions that are necessary in certain situations (e.g. driving close to a vehicle when about to overtake). This may frustrate the drivers and make them view CAT less positively. It is also possible that ISA was viewed more favourably because it would reduce the likelihood of being caught speeding, while Mobileye had no such benefit. However, 54% of drivers believed that ISA had increased their frustration levels while driving, and they reported that ISA did not allow a leeway to travel a few kilometres over the speed limit and beeped as soon as the limit was reached.

Correspondence between the ISA research and the current study was demonstrated with the majority of respondents in each study agreeing that the technology would lead to a reduction in crashes, although the proportion of respondents was smaller in the current research (59% compared to 73%). Ratings of the overall performance, usability and acceptability of ISA and CAT were similar between the two studies, with 61% of respondents giving ISA a positive rating and 58% giving CAT a positive rating. Common concerns were noted in both studies, namely that both technologies could be distracting, frustrating and unreliable, and that the warnings were too loud.

Fifty-two percent of the respondents in the present study encountered problems using the Mobileye system. They reported that the system was distracting and annoying. Furthermore, it was often suggested that the distractions of the warnings made driving more dangerous because they took the drivers' focus away from the road. This represents a substantial limitation of the technology. However, Barnes and Johnson (2010) have discussed the notion that warnings have to be annoying in order to change behaviour. Consistent with this, 91% of the participants reported that the warnings were effective at getting their attention. However, only 44% reported that they had altered their driving style in order to avoid receiving warnings.

The respondents questioned the validity of the four warnings. Seventy percent suggested that the warnings were 'sometimes', 'often' or 'always' false, 76% reported that the warnings were 'never', 'rarely' or 'sometimes' justified, and 58% did not believe that the 'warnings were reliable and accurate'. If these reports accurately reflected a high rate of false alarms provided by the Mobileye system then this is another limitation of the technology and would explain why the technology bothered and distracted the participants. This would need to addressed to achieve greater acceptance of the technology. It may be possible to at least adjust the threshold settings of the Mobileye systems to reduce any warnings where the drivers do not perceive them to be necessary (e.g. headway monitoring warnings where they were driving close to a vehicle when about to overtake).

The sample was comprised of government employees. For confidentiality reasons, their demographic information could not be collected and, therefore, the sample could not be compared to the general public. As a result, the findings are not generalisable to the wider public. Future

research could include a broader sample and examine whether CAT would be acceptable to the wider driving population. Also, the drivers of the fleet vehicles who completed the study could not be compared to those who did not. It is possible that certain drivers, or those with stronger attitudes towards the technology, would more readily complete the survey. A final limitation of this study relates to the use of self-report measures, which can be unreliable because participants may be innacurate in their recall of information. However, the survey was purposely delivered soon after the end of Stage 2 (during which alerts were given to the drivers), so that the experience of the Mobileye system was fresh in their memory.

Conclusion

The findings of this study demonstrate that a sample of drivers of government fleet vehicles viewed Mobileye Collision Avoidance Technology negatively with regard to its application to their own driving, despite viewing its wider application to the general community positively. They recognised that the system could improve general driving safety but most did not wish to use it in the future themselves as they found it distracting and felt that it would not prevent them from having a crash. It appears that more effort needs to be targeted at educating drivers about the potential benefits of this technology for their own driving. This could lead to greater acceptance of collision avoidance technologies and the capacity for governments and other organisations to deploy such technologies more widely in their fleets. This, in turn, could lead to greater penetration of collision avoidance technology within the overall vehicle fleet.

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