The health benefits of autonomous vehicles: public awareness and receptivity in Australia

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Abstract

Objectives: The substantial public health benefits of autonomous vehicles will be optimised once all vehicles operate in autonomous mode. This form of disruptive technology will need to be widely accepted by the community to facilitate the regulatory and behavioural adjustments required to achieve rapid adoption. The aim of this study was to assess: i) receptiveness to autonomous vehicles; ii) the salience of various health benefits (e.g. crash prevention, emission reduction, driving stress reduction, cyclist safety, increased mobility for those unable to drive); and iii) prompted awareness of these health benefits.

Methods: Quantitative and qualitative data were generated via a national online survey of a broad range of Australians aged 16 years and over (n=1,624).

Results: There were neutral levels of receptiveness and very low salience of health benefits, but more substantial levels of prompted awareness of positive health outcomes.

Conclusions: These results suggest that the public may be interested in information relating to the individual and societal health benefits of autonomous vehicles, which in turn may increase overall support for this innovation.

Implications for public health: Australians are likely to be receptive to autonomous vehicles when provided with information relating to their public health benefits.

Key words: technology, transportation, automation, public support, policy

Technological innovations have the potential to greatly enhance individuals' health and wellbeing,[1] including in the area of transportation.[2] Rapid advancements are occurring in the area of vehicle automation, with extensive trials involving both personal and commercial vehicles taking place around the world. Although autonomous vehicle (AV) technology has progressed rapidly, road rules in most jurisdictions have yet to be modified to permit the use of vehicles in full autonomous mode, and governments have yet to develop comprehensive policy approaches to AVs to capitalise on the health benefits offered by this technology while also applying appropriate standards to ensure safety.[3,4]

AVs are expected to produce important benefits across multiple health-related domains. These include crash prevention, emissions reduction, increased mobility (and therefore quality of life) for those unable to drive, stress reduction and increased safety for cyclists.[5,6] Although these are substantial health issues that contribute to the burden of disease and require enhanced prevention strategies,[7-10] there is very limited recognition among public health researchers of the role that AVs can play in their amelioration.[11] Exceptions include recent efforts to draw attention to the need for the health sector to appreciate the potential for AVs to produce considerable improvements in public health and to develop appropriate strategies to manage the implementation process to optimise these outcomes.[2-5] Consistent with the Technology Acceptance Model,[12] this existing work has emphasised the importance of ensuring the public is aware of the individual- and societal-level health benefits of AVs to: i) increase the likelihood of adoption; and ii) encourage positive social norms about AVs that will be reflected in community support for public policies designed to facilitate and encourage their adoption.

The public health benefits of AVs will be maximised when all vehicles are automated,[13] leading to calls for governments to establish systems to expedite rapid adoption.[14,15] Public support is a critical component of governments' decisions to implement new policies,[16] and as such the relative recency of AVs and a general lack of understanding among the general public of the extent of their health-enhancing potential could constitute substantial barriers to governments and businesses proactively developing policies and programs designed to hasten adoption.[14,17]

Most of the limited work to date on public attitudes to AVs has focused on perceptions of when AVs are likely to penetrate the personal automobile market, preferences for automated vehicles relative to human-driven vehicles and intentions to adopt.[18-20] Little is known about the extent to which the public specifically understands and endorses the health benefits of AVs, meaning there is inadequate information available to guide those seeking to improve public awareness of these benefits to engender support for future policy initiatives in this area. The aims of the present study were thus to assess: i) overall receptiveness to AVs; ii) the salience of various health-related benefits that have been reported in the literature; and iii)

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prompted perceptions of AV benefits across these health domains. Of particular interest were whether any substantial differences exist between prompted and unprompted awareness of health-related benefits and the implications for future efforts to increase receptiveness to AVs over time. The context of the study was Australia where there is a cultural propensity to rapidly adopt digital technologies,[21] suggesting this is a country in which policies to facilitate rapid AV adoption could be especially effective.

Methods

An ISO-accredited web panel provider (PureProfile) was commissioned to recruit the sample for an online survey. PureProfile uses a range of recruitment strategies to populate its large panel, including mass media advertising, online advertising and word-of-mouth referrals. The survey was administered in April 2017 to a national sample of 1,624 Australians aged 16 years and over (i.e. of legal driving age), with quotas applied to achieve an equal gender split and an age distribution similar to that of the Australian population.[22] Both drivers and non-drivers were included in the sample, although quotas by driving status were not pre-specified.

The survey instrument incorporated a wide range of items that included those relating to transport in general (e.g. current methods of transport used for work and leisure trips) as well as those relating specifically to AVs. The first item on the topic of AVs asked respondents about their first thoughts when hearing the term "autonomous vehicles" (i.e. they were not provided with a technical definition). Most respondents reported that they associated this term with vehicles that drive themselves. To assess overall attitudes to AVs, respondents were then asked a closed-ended question: *How do you feel about fully autonomous vehicles being widely used in the future?*, with response options on a 5-point scale ranging from 'Very negative' to 'Very positive'. To assess the salience (i.e. unprompted awareness) of the health-related benefits of autonomous vehicles, this was followed by an open-ended question: *What makes you say that?* Prompted awareness of health-related benefits was then assessed by asking respondents to indicate the likelihood of a range of potential outcomes occurring as a result of the introduction of fully autonomous vehicles. Listed health-related outcomes included: *Fewer traffic accidents; Roads safer for cyclists; Greater independence for those who can't drive; Lower vehicle emissions;* and *Less stressful driving experience* (adapted from Menon et al.[19]). Response options were provided on a five-point scale ranging from 'Very unlikely' to 'Very likely', with an additional 'Don't know' option. All questions were forced response.

The mean ratings and the percentage of respondents reporting positive, neutral or negative responses were calculated for each of the prompted awareness items for the overall sample and across different demographic subgroups. The responses to the open-ended question were imported into NVivo 11 (QSR International) for coding and analysis. A wide variety of topics was raised by respondents, ranging from comments about the perceived positive and negative attributes of AVs to personal desires to own or use an AV (or not). The coding process was undertaken by a single coder due to the highly exploratory nature of the study that resulted in reliance on emergent coding rather than the use of a pre-established coding framework. The focus of the present study was on responses referring to various health-related benefits. Mentions of these benefits were assigned to relevant NVivo 'nodes' to permit calculation of frequency of mention.

Table 1: Feelings about widespread use of autonomous vehicles.

	n	%	Mean (SD)	% negative[a]	% neutral	% positive[b]
Gender						
Males	810	50	3.29 (1.11)**	21	35	44
Females	811	50	3.07 (0.98)	25	44	31
Age (years)						
16-30	531	33	3.22 (1.00)	20	43	37
31-59	729	45	3.19 (1.08)	23	38	39
60+	364	22	3.07 (1.08)	27	40	33
Driving status						
Driver	1,565	96	3.17 (1.04)	23	40	37
Non-driver	59	4	3.29 (1.27)	25	29	46
Total	1,624	100	3.17 (1.06)	23	40	37

Notes:

a: Selected 1 or 2 on a 5-point scale "Very negative" to "Very positive"

b: Selected 4 or 5 on a 5-point scale "Very negative" to "Very positive"

***T-tests conducted within demographic subgroups to test for differences between means. Significant difference found for gender at $p < .01$*

Results

Table 1 shows the demographic distribution of the sample and the results relating to receptiveness to AVs. The overall mean (3.17) indicates generally neutral feelings towards these vehicles. Around one-quarter of respondents indicated that they felt negatively about widespread use of fully autonomous vehicles, with the remaining respondents being almost equally divided between being neutral or positive. Males were significantly more likely to provide a positive response; there were no significant differences by age or driving status.

When offered the opportunity to explain their feelings, many noted other types of benefits including convenience, faster commute times, and/or the ability to engage in other activities because they would be relieved of driving duties. The most common health-related responses related to an expectation that the number of crashes would decrease (21%, n=341: see Table 2). These comments included mentions of reduced drink, drugged and tired driving, as well as explicit statements about fewer crashes. However, a further 13% (n=204) commented that they expected the number of crashes to increase. Very small numbers of respondents mentioned emission reductions, enhanced mobility for the elderly/disabled or stress reduction, and no respondents made reference to improved conditions for cyclists.

The results for prompted awareness were very different to the spontaneous responses (Table 2). Around three-quarters of respondents (73%) believed it was likely or very likely that the elderly and disabled would enjoy greater mobility, and about half (45%–54%) believed that autonomous vehicles would reduce crashes, emissions and stress, and that cyclist safety would be improved.

Discussion

The aim of this study was to assess Australians' attitudes to the advent of autonomous vehicles and the extent of their reported unprompted and prompted awareness of the

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potential health-related benefits arising from this technological advancement. The results indicate an overall neutral level of support, with somewhat higher levels exhibited by males relative to females.

In terms of unprompted awareness of key health outcomes, there appeared to be very low salience of the health benefits under investigation. Few respondents nominated health-related factors as being relevant to their reported attitudes to AVs, and where a health-related factor was mentioned it was almost always in relation to crash reduction (21% of the sample). However, some respondents (13%) were concerned that the introduction of AVs will result in more crashes, illustrating the overall uncertainty associated with the advantages of this new technology. Although salience cannot be equated with knowledge, there appears to be a need for the public to be educated about the mechanisms via which AVs can almost entirely eradicate crashes by eliminating human error.[3,23] It has been estimated that achieving full automation in the Australian transport sector would save more than 1,000 lives, 30,000 hospitalisations and $16 billion in crash-related costs each year.[2] Informing the public of these substantial benefits in terms of human life and economic savings may go some way towards increasing receptivity and encouraging adoption.

The large differences between unprompted and prompted awareness of the five major potential health benefits of AVs highlight the opportunity to make these anticipated outcomes more salient to increase the rate of adoption. In particular, the majority endorsement (73%) of the benefits that will accrue to those who are unable to drive suggests that this outcome is especially intuitively appealing, and hence may constitute an effective anchor point for initial efforts to increase the social acceptability of AVs and reduce any resistance to the legislative modifications necessary to facilitate their use. The other health benefits tested in this study may also be appropriate for public education programs, given the moderate levels of prompted awareness despite almost non-existent unprompted awareness. This large discrepancy suggests that although individuals are generally unaware of these benefits, many may accept the possibility of such outcomes once alerted to their existence.

Ultimately, governments may wish to mandate the use of autonomous vehicles to reduce road deaths, optimise traffic flows and encourage active transport.[24] Such a scenario will require substantial public support because governments are reluctant to introduce disruptive new policies without majority support.[16] Efforts are therefore likely to be needed to overcome barriers to acceptance and to enhance appreciation of the individual and societal benefits that are projected to accrue from full vehicle autonomy. The Technology Acceptance Model draws attention to the various factors that influence whether an innovation is likely to be embraced by individuals.[12] According to the model, intentions to use a new technology are primarily determined by perceived usefulness, perceived ease of use and attitudes towards use. In the context of AVs, this highlights the need for individuals to understand the myriad ways in which AVs will be useful to individuals and society to encourage the formation of positive attitudes to this new technology. The results of the present study suggest these outcomes may be facilitated by efforts to educate the public about the associated quality of life improvements for the elderly and the disabled if they have access to AVs, the vastly superior crash-prevention abilities of AVs, the lower levels of emissions that will result from smoother traffic flows, the eradication of driving stress and enhanced cyclist safety. Private sector actors in the AV industry may also be interested in disseminating public awareness campaigns that address these knowledge deficits to increase demand for these vehicles.

Table 2: Awareness of health benefits of autonomous vehicles (n = 1,624).

Benefit	% unprompted awareness (salience)	% prompted awareness[a]
Crash reduction	21	49
Emission/pollution reduction	1	45
Stress reduction	1	54
Mobility for elderly/disabled	3	73
Cyclist safety	0	45

Notes:
a: Selected 4 or 5 on a 5-point scale "Very unlikely" to "Very likely"

In addition, it may be necessary for key stakeholders to address other attitudinal components that are likely to influence AV adoption that were outside the scope of this study. In particular, issues relating to cost and availability will be critical in determining whether AVs are considered a viable and attractive transportation alternative. Future research could focus on the price sensitivity of various population segments and their preferred AV usage scenarios (i.e. private AV ownership, AV ride-sharing systems, and/or autonomous public transportation).

Primary limitations of this study include confinement to one national context and the use of a web panel sample that may comprise a larger proportion of individuals who are more technology-savvy than the general population. These limitations may be overcome in future research through the use of international samples that are sourced via alternative means. A further consideration is that health-related outcomes such as reduced emissions will differ based on usage scenarios (e.g. personal versus pool vehicles), and future research could expand on the present study by exploring attitudes to these scenarios when investigating the trade-offs individuals are willing to make to achieve the health benefits of AVs.

Other limitations relate to the way in which the AV items were presented. Allowing respondents to provide their own definitions of an AV rather than supplying a single formal definition meant that different respondents may have been conceptualising these vehicles in different ways. In addition, respondents were not asked whether they consider AVs to be a feasible form of transport, and views on this point may have affected their responses. Similarly, the prompted awareness questions did not include potential negative health outcomes that have been recognised in the literature, such as reduced physical activity and increased road congestion.[2] Strengths of the present study include the large national sample and the comparison of unprompted and prompted awareness of the health benefits of AVs, which is a novel contribution of the work.

In conclusion, there is likely to be vast potential to engender more positive attitudes to AVs by informing the public about the ways in which this transport innovation will improve the lives of individuals and enhance societal welfare. Australians appear to be largely unaware of the health benefits of AVs, but many exhibit a willingness to accept these benefits once they are presented to them as possible outcomes. Addressing this knowledge deficit represents a potentially effective means of increasing the demand for AVs once they are widely available.

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