Motorists' Preferences for Different Levels of Vehicle Automation

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OF VEHICLE AUTOMATION

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16. Abstract

This report builds on a recent series of reports addressing public opinion, human factors, and safety-related issues with self-driving vehicles (Schoettle and Sivak, 2014, 2015; Sivak and Schoettle, 2015a, 2015b). A survey was developed for this study to examine motorists' preferences among levels of vehicle automation, including preferences for interacting with and overall concern about riding in self-driving vehicles. The survey yielded completed responses from 505 licensed drivers in the U.S.

The main findings are as follows:

- The most frequent preference for vehicle automation was for no self-driving capability, followed by partially self-driving vehicles, with completely self-driving vehicles being the least preferred choice.

- Concern for riding in self-driving vehicles was higher for completely self-driving vehicles than for partially self-driving vehicles.

- Respondents overwhelmingly want to be able to manually control completely self-driving vehicles when desired.

- Preferences were generally divided between touchscreens or voice commands to input route or destination information for completely self-driving vehicles.

- Most respondents prefer to be notified of the need to take control of a partially self-driving vehicle with a combination of sound, vibration, and visual warnings.

The levels of concern for riding in completely self-driving vehicles found in this study are similar to those found in our previous survey that was administered in June 2014. Currently, as in the previous study, concern about riding in completely self-driving vehicles remains high.

17. Key Words Autonomous vehicles, self-driving vehicles, driverless vehicles, survey, U.S., public opinion, driver preferences		18. Distribution Statement Unlimited	
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Contents

Introduction

Self-driving vehicles are often discussed in regard to their potential safety, energy-consumption, and environmental benefits, or the existing technical challenges that must be overcome for their successful implementation. However, less attention has been paid to considering the actual level of automation (if any) that drivers desire in their vehicle.

This report builds on a recent series of reports addressing public opinion, human factors, and safety-related issues with self-driving vehicles (Schoettle and Sivak, 2014, 2015; Sivak and Schoettle, 2015a, 2015b). A survey was developed for this study to examine motorists' preferences for having different levels of vehicle automation, including preferences for interacting with and overall concern about riding in self-driving vehicles.

Method

Survey instrument

An online survey was conducted using SurveyMonkey (www.surveymonkey.com), a web-based survey company. A questionnaire was developed to examine several questions related to motorists' preferences regarding control of both partially and completely self-driving vehicles, as well as overall preferences for having self-driving versus conventional (non-self-driving) vehicles. The text of the questionnaire is included in the appendix. The survey was performed in June 2015.

Respondents

SurveyMonkey's Audience tool was used to target and recruit licensed drivers 18 years and older from SurveyMonkey's respondent database in the U.S. Fully completed surveys were received for 505 respondents. The margin of error at the 95% confidence level for the overall results is +/- 4.4%. Demographic breakdowns for the respondents are presented in Table 1.

Table 1
Demographic breakdown for the 505 respondents.

Demographic aspect		Percent
Age group	18 to 29	20.8
	30 to 44	23.8
	45 to 59	28.5
	60 or older	26.9
Gender	Female	52.9
	Male	47.1
Income	$0 to $24,999	14.3
	$25,000 to $49,999	19.4
	$50,000 to $74,999	14.5
	$75,000 to $99,999	12.7
	$100,000 to $124,999	8.7
	$125,000 to $149,999	4.8
	$150,000 to $174,999	3.2
	$175,000 to $199,999	1.8
	$200,000 or more	3.6
	Prefer not to answer	17.2
U.S. region	New England	5.2
	Middle Atlantic	12.6
	North Central	20.0
	South Atlantic	20.2
	South Central	13.2
	Mountain	9.2
	Pacific	19.4

Results

Preferred level of vehicle automation

When respondents were asked about which level of vehicle automation they preferred (see the appendix for the definitions of each level of automation that were provided to respondents), the most frequent preference was for no self-driving (43.8%), followed by partially self-driving (40.6%), with completely self-driving being the least preferred (15.6%). Figure 1 summarizes the results for all respondents, while Table 2 presents a complete summary of responses by gender and age.

Females most frequently preferred no self-driving (47.6%), while males preferred partially self-driving (41.2%).

Preference for having vehicle automation generally decreased as respondent age increased.
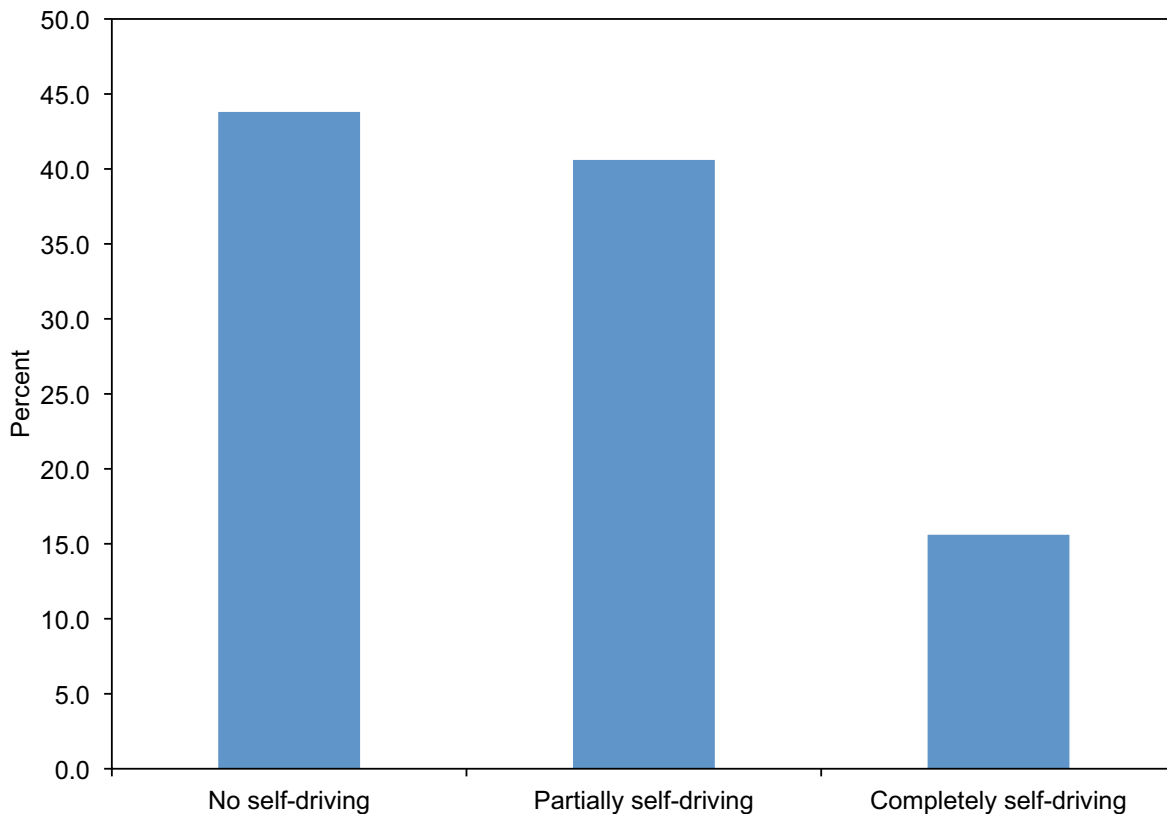

Figure 1. Summary of responses to Q1: "*Vehicle manufacturers are considering using one of three levels of automation in future vehicles. Which level would you prefer to have in your personal vehicle?*"

Table 2
Percentage of responses, by gender and age, to Q1: "*Vehicle manufacturers are considering using one of three levels of automation in future vehicles. Which level would you prefer to have in your personal vehicle?*"

Response	Gender		Age				Total
	Female	Male	18-29	30-44	45-59	60+	
No self-driving	47.6	39.5	35.2	37.5	49.3	50.0	*43.8*
Partially self-driving	40.1	41.2	47.6	41.7	36.1	39.0	*40.6*
Completely self-driving	12.4	19.3	17.1	20.8	14.6	11.0	*15.6*

Concern about riding in self-driving vehicles

In two different questions, respondents were asked how concerned they would be about riding in a completely self-driving vehicle (Q2) and a partially self-driving vehicle (Q5). The respondents were more concerned about riding in a completely self-driving vehicle than in a partially self-driving vehicle. For example 35.6% were very concerned about riding in a completely self-driving vehicle (and 68.3% were very or moderately concerned), as opposed to 14.1% for a partially self-driving vehicle (with 48.8% being very or moderately concerned). Conversely, 10.6% were not at all concerned with riding in a completely self-driving vehicle, as opposed to 16.2% for a partially self-driving vehicle. Figure 2 summarizes the results for all respondents, while Tables 3 and 4 present complete summaries of responses by gender and age.

Females expressed greater concern than males for riding in completely self-driving vehicles (very concerned: 40.1% versus 30.7%), but the difference was smaller for partially self-driving vehicles (very concerned: 15.7% versus 12.2%).

Older respondents tended to have greater concern than younger respondents for riding in self-driving vehicles. This was the case for completely self-driving vehicles (very concerned: 21.0% for 18-29 year olds versus 41.2% for those 60 and older), and partially self-driving vehicles (very concerned: 10.5% for 18-29 year olds versus 17.6% for those 60 and older).
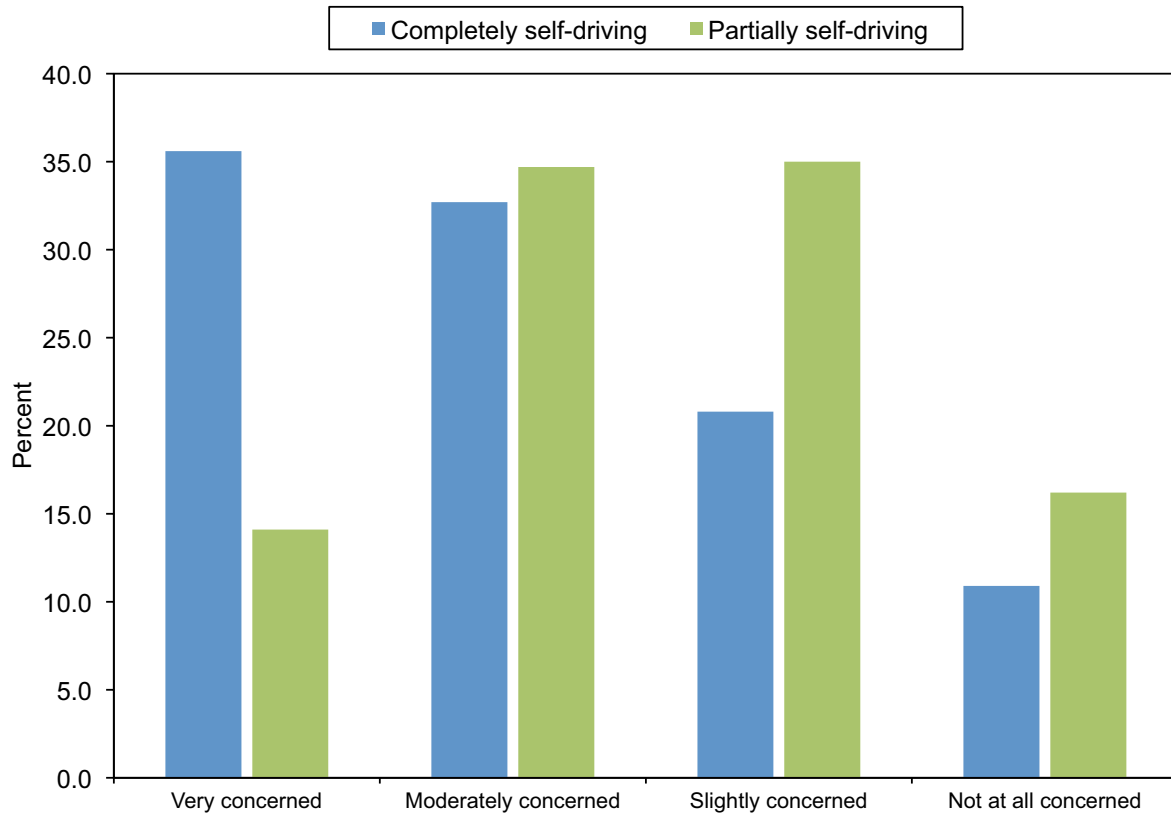
Figure 2. Combined summary of responses to Q2 and Q5: "*If the only vehicles available were completely self-driving (Q2) or partially self-driving (Q5), how concerned would you be about riding in such vehicles?*"

Table 3
Percentage of responses, by gender and age, to Q2:
"If the only vehicles available were <u>completely self-driving</u>, how concerned would you be about riding in such vehicles?"

Response	Gender		Age				Total
	Female	Male	18-29	30-44	45-59	60+	
Very concerned	40.1	30.7	21.0	36.7	40.3	41.2	*35.6*
Moderately concerned	34.5	30.7	41.9	25.8	29.2	35.3	*32.7*
Slightly concerned	18.7	23.1	21.9	21.7	21.5	18.4	*20.8*
Not at all concerned	6.7	15.5	15.2	15.8	9.0	5.1	*10.9*

Table 4
Percentage of responses, by gender and age, to Q5:
"If the only vehicles available were <u>partially self-driving</u>, how concerned would you be about riding in such vehicles?"

Response	Gender		Age				Total
	Female	Male	18-29	30-44	45-59	60+	
Very concerned	15.7	12.2	10.5	11.7	15.3	17.6	*14.1*
Moderately concerned	37.8	31.1	23.8	35.8	39.6	36.8	*34.7*
Slightly concerned	35.2	34.9	43.8	34.2	30.6	33.8	*35.0*
Not at all concerned	11.2	21.8	21.9	18.3	14.6	11.8	*16.2*

Preferences for controlling completely self-driving vehicles

Availability of vehicle controls. Nearly all respondents (96.2%) would want to have a steering wheel plus gas and brake pedals (or some other controls) available in completely self-driving vehicles. Figure 3 summarizes the results for all respondents, while Table 5 presents a complete summary of responses by gender and age.

No notable gender differences were observed, with similar percentages of females and males preferring to have controls on self-driving vehicles (97.4% and 95.0%, respectively).

Likewise, no meaningful age differences were observed, with each age group expressing a high degree of preference for having controls on self-driving vehicles (ranging from 94.4% to 98.1%).
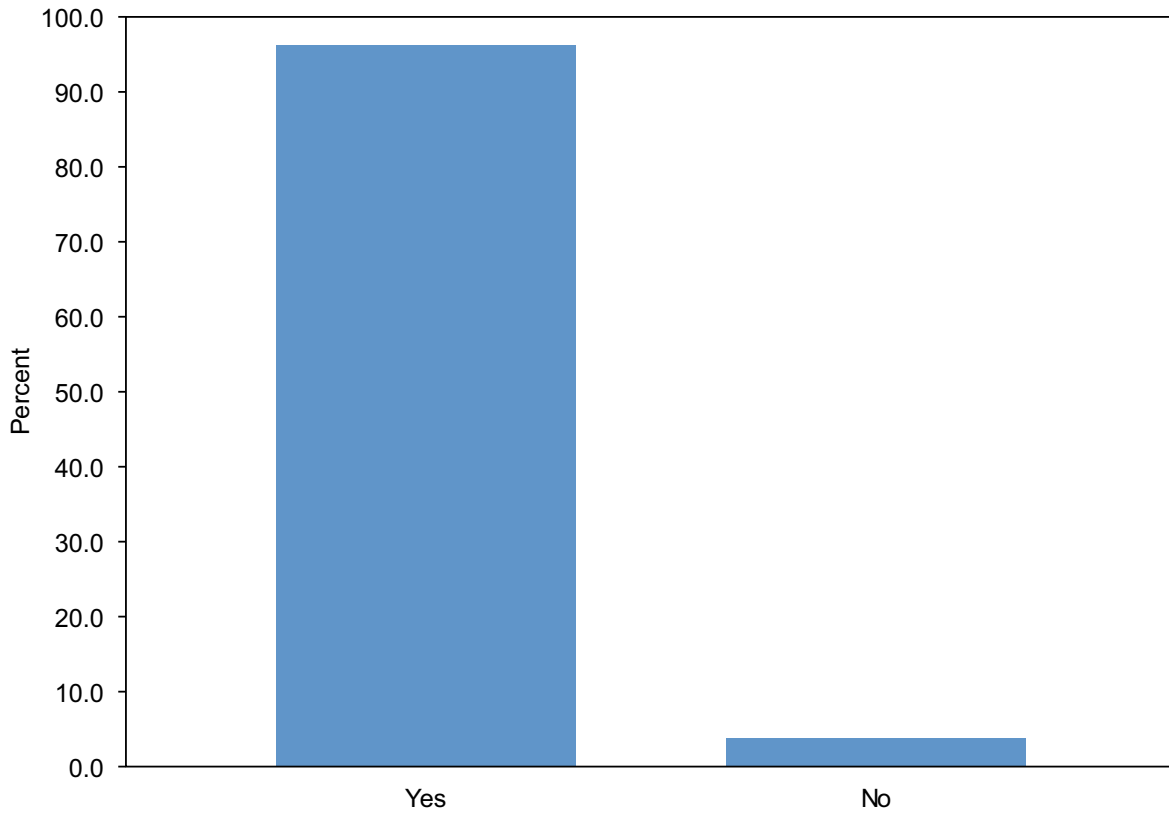
Figure 3. Summary of responses to Q3: "*Would you prefer that a completely self-driving vehicle still have a steering wheel plus gas and brake pedals (or some other controls) to enable a driver to take control if desired?*"

Table 5
Percentage of responses, by gender and age, to Q3: "*Would you prefer that a completely self-driving vehicle still have a steering wheel plus gas and brake pedals (or some other controls) to enable a driver to take control if desired?*"

Response	Gender		Age				Total
	Female	Male	18-29	30-44	45-59	60+	*Total*
Yes	97.4	95.0	98.1	95.8	94.4	97.1	*96.2*
No	2.6	5.0	1.9	4.2	5.6	2.9	*3.8*

Route or destination input. The most preferred method for inputting a route or destination was nearly equally divided between touchscreens (37.8%) and voice commands (36.2%). Figure 4 summarizes the results for all respondents, while Table 6 presents a complete summary of responses by gender and age.

The method most preferred by females was voice commands (41.2%), while the most preferred method for males was touchscreen (37.4%).

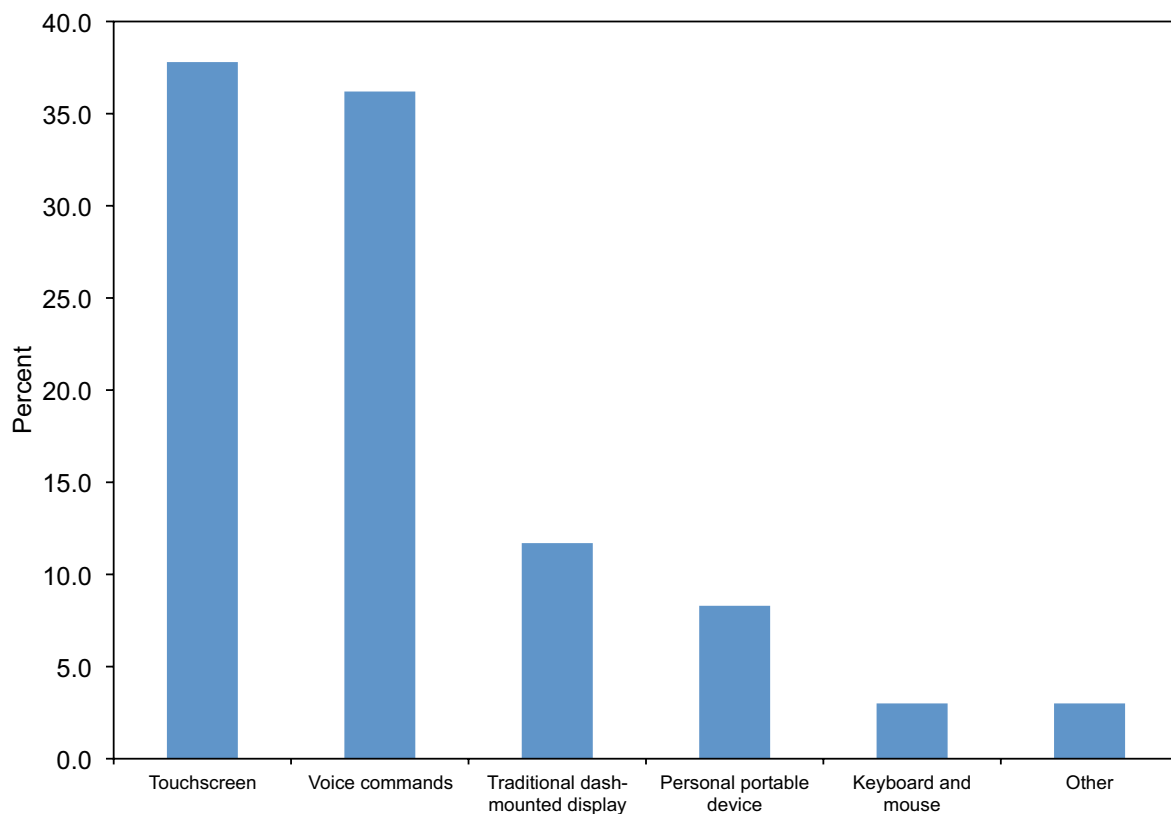Younger respondents tended to prefer touchscreens, with preferences shifting to voice commands for older respondents.

Figure 4. Summary of responses to Q4: "*In a <u>completely self-driving</u> vehicle, how would you prefer to tell the vehicle your route or destination?*"

Table 6
Percentage of responses, by gender and age, to Q4: "*In a <u>completely self-driving</u> vehicle, how would you prefer to tell the vehicle your route or destination?*"

Response	Gender		Age				Total
	Female	Male	18-29	30-44	45-59	60+	
Touchscreen	38.2	37.4	42.9	37.5	38.2	33.8	*37.8*
Voice commands	41.2	30.7	21.9	36.7	43.8	39.0	*36.2*
Traditional dash-mounted display	12.7	10.5	12.4	11.7	6.9	16.2	*11.7*
Personal portable device	4.1	13.0	19.0	8.3	4.9	3.7	*8.3*
Keyboard and mouse	1.9	4.2	1.0	2.5	4.2	3.7	*3.0*
Other method	1.9	4.2	2.9	3.3	2.1	3.7	*3.0*

Preferred driver intervention notification for partially self-driving vehicles

When respondents were asked about how they preferred to be notified when a partially self-driving vehicle requires the driver to take control of the vehicle, the majority (59.4%) preferred a combination of three warning modes (sound, visual, and vibration). Figure 5 summarizes the results for all respondents, while Table 7 presents a complete summary of responses by gender and age.

Similar percentages of females and males prefer to be notified with a combination of all three modes (57.3% and 61.8%, respectively).

A majority of each age group indicated they prefer to be notified with a combination of all three modes (ranging from 55.6% to 63.8%).
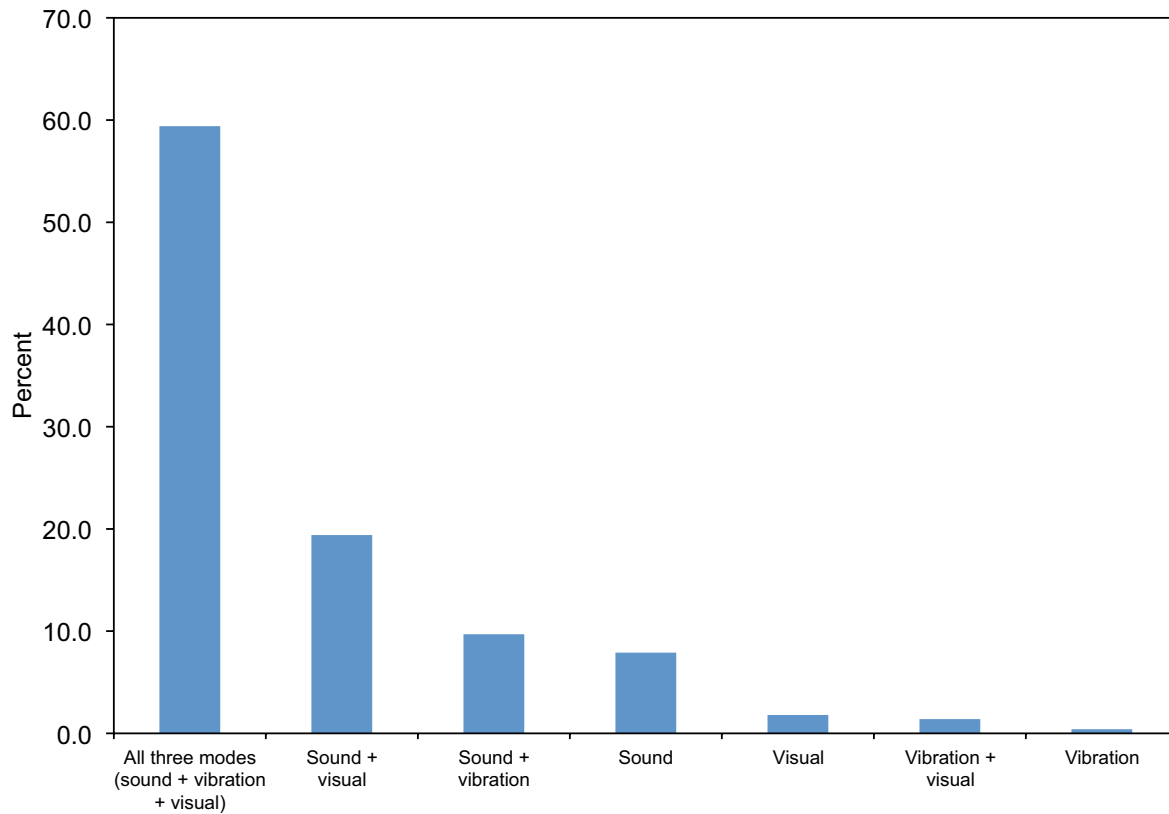
Figure 5. Summary of responses to Q6: "*When a partially self-driving vehicle requires the driver to take control of the vehicle, how would you prefer to be notified?*"

Table 7
Percentage of responses, by gender and age, to Q6: "*When a partially self-driving vehicle requires the driver to take control of the vehicle, how would you prefer to be notified?*"

Response	Gender		Age				Total
	Female	Male	18-29	30-44	45-59	60+	*Total*
All three modes (sound + vibration + visual)	57.3	61.8	63.8	60.8	55.6	58.8	*59.4*
Sound + visual	22.8	15.5	16.2	19.2	20.1	21.3	*19.4*
Sound + vibration	8.2	11.3	10.5	10.8	10.4	7.4	*9.7*
Sound	7.5	8.4	6.7	6.7	7.6	10.3	*7.9*
Visual	1.9	1.7	1.9	0.8	4.2	0.0	*1.8*
Vibration + visual	1.9	0.8	0.0	1.7	1.4	2.2	*1.4*
Vibration	0.4	0.4	1.0	0.0	0.7	0.0	*0.4*

Key Findings

Preferred level of vehicle automation

- The most frequent preference was for no self-driving (43.8%), followed by partially self-driving (40.6%), with completely self-driving being the least preferred (15.6%).

Concern about riding in self-driving vehicles

- The respondents were more concerned about riding in a completely self-driving vehicle than in a partially self-driving vehicle. For example, 35.6% were very concerned about riding in a completely self-driving vehicle, as opposed to 14.1% for a partially self-driving vehicle.

- The levels of concern for riding in completely self-driving vehicles in this survey are similar to those found in a previous survey that asked the same question of U.S. drivers in June 2014 (Schoettle and Sivak, 2014). Table 8 presents both sets of results for comparison. Currently, as in the previous study, concern remains high, with about two thirds of respondents feeling either very or moderately concerned about riding in completely self-driving vehicles.

Table 8
Concern for riding in a completely self-driving vehicle, Schoettle and Sivak (2014) versus the current study. (Entries in the table are percentages.)

Response	Schoettle and Sivak (2014)	Current study
Very concerned	35.9	35.6
Moderately concerned	30.9	32.7
Slightly concerned	21.8	20.8
Not at all concerned	11.4	11.5

Preferences for controlling completely self-driving vehicles

      - Respondents overwhelmingly (96.2%) want to have a steering wheel plus gas and brake pedals (or some other controls) available to control completely self-driving vehicles when desired.

      - The most preferred method for inputting a route or destination was touchscreens (37.8%), followed closely by voice commands (36.2%).

Preferred driver intervention notification for partially self-driving vehicles

      - Most respondents (59.4%) prefer to be notified of the need to take control of a partially self-driving vehicle with a combination of sound, vibration, and visual warnings.

References

Schoettle, B. and Sivak, M. (2014). *Public opinion about self-driving vehicles in China, India, Japan, the U.S., the U.K., and Australia* (Technical Report No. UMTRI-2014-30). Ann Arbor: University of Michigan Transportation Research Institute. Available at:

http://deepblue.lib.umich.edu/bitstream/handle/2027.42/109433/103139.pdf

Schoettle, B. and Sivak, M. (2015). *Potential impact of self-driving vehicles on household vehicle demand and usage* (Technical Report No. UMTRI-2015-3). Ann Arbor: University of Michigan Transportation Research Institute. Available at:

http://deepblue.lib.umich.edu/bitstream/handle/2027.42/110789/103157.pdf?sequence=1&isAllowed=y

Sivak, M. and Schoettle, B. (2015a). *Road safety with self-driving vehicles: General limitations and road sharing with conventional vehicles* (Technical Report No. UMTRI-2015-2). Ann Arbor: University of Michigan Transportation Research Institute. Available at:

http://deepblue.lib.umich.edu/bitstream/handle/2027.42/111735/103187.pdf?sequence=1&isAllowed=y

Sivak, M. and Schoettle, B. (2015b). *Motion sickness in self-driving vehicles* (Technical Report No. UMTRI-2015-12). Ann Arbor: University of Michigan Transportation Research Institute. Available at:

http://deepblue.lib.umich.edu/bitstream/handle/2027.42/111747/103189.pdf?sequence=1&isAllowed=y

Appendix: Questionnaire

Driver preferences for controlling and interacting with automated vehicles

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We are conducting a survey of opinions about vehicle automation and self-driving vehicles.

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1)   Vehicle manufacturers are considering using one of three levels of automation in future vehicles. Which level would you prefer to have in your personal vehicle?

☐ <u>Completely self-driving</u>. The vehicle will control all safety-critical functions, even allowing the vehicle to travel without a passenger if required.

☐ <u>Partially self-driving</u>. The driver will be able to hand over control of all safety-critical functions to the vehicle; only occasional control by the driver will be required.

☐ <u>No self-driving</u>. The driver will always be in complete control of all safety functions, but the driver will be assisted with various advanced technologies.

The next 3 questions are about <u>completely self-driving</u> vehicles.

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2)   If the only vehicles available were <u>completely self-driving</u>, how concerned would you be about riding in such vehicles?

☐ Very concerned

☐ Moderately concerned

☐ Slightly concerned

☐ Not at all concerned

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3)   Would you prefer that a <u>completely self-driving</u> vehicle still have a steering wheel plus gas and brake pedals (or some other controls) to enable a driver to take control if desired?

☐ Yes

☐ No

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4) In a <u>completely self-driving</u> vehicle, how would you prefer to tell the vehicle your route or destination?

☐ Keyboard and mouse

☐ Personal portable device (smart phone, tablet, etc.)

☐ Touchscreen

☐ Traditional dash-mounted display with physical buttons

☐ Voice commands

☐ Other (please describe): _____

The next 2 questions are about <u>partially self-driving</u> vehicles.

5) If the only vehicles available were <u>partially self-driving</u>, how concerned would you be about riding in such vehicles?

☐ Very concerned

☐ Moderately concerned

☐ Slightly concerned

☐ Not at all concerned

6) When a <u>partially self-driving</u> vehicle requires the driver to take control of the vehicle, how would you prefer to be notified?

☐ Sound (such as a chime, alarm, or voice warning)

☐ Vibration (usually in the seat and/or steering wheel)

☐ Visual indicator (such as a light or symbol on the dash or information display)

☐ Sound + vibration

☐ Sound + visual

☐ Vibration + visual

☐ All three notifications (sound + vibration + visual)

Thank you for taking the time to complete this survey!