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INFLUENCE OF CURRENT NONDRIVERS ON THE AMOUNT OF TRAVEL AND TRIP PATTERNS WITH SELF-DRIVING VEHICLES

MICHAEL SIVAK
BRANDON SCHOETTLE

UNIVERSITY OF MICHIGAN
TRANSPORTATION
RESEARCH INSTITUTE

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Michael Sivak
Brandon Schoettle

The University of Michigan
Transportation Research Institute
Ann Arbor, Michigan 48109-2150
U.S.A.

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16. Abstract

This report analyzes the expected changes in the amount of driving and trip-length distributions by personal vehicles, should completely self-driving vehicles become widely available. The analysis is based on two key observations. First, a large percentage of young adults (those between 18 and 39 years of age) currently do not have a driver's license, and this percentage is substantially greater than in the 1980s. Second, a recent survey provides information about the reasons for not having a driver's license. Importantly, some of these reasons would no longer be applicable with self-driving vehicles (e.g., "too busy to get a driver's license"), while other reasons would remain valid (e.g., "concerned about how driving impacts the environment").

The basic approach in this study involves combining all reasons for currently not having a driver's license that would no longer be applicable with self-driving vehicles, and calculating the new percentage of persons who would have access to personal transportation with self-driving vehicles. Finally, the new expanded pool of those eligible to use personal transportation is then used to calculate the new amount of travel, as well as the new distribution of trip lengths.

There are two main findings. First, the availability of self-driving vehicles would increase the demand for private road transportation by up to 11%. Second, range anxiety with battery electric vehicles is unlikely to change substantially with the addition of new users made possible by self-driving vehicles, because the proportion of trips that would exceed the current range of the least efficient battery electric vehicles is unlikely to change substantially in either direction.

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Contents

Introduction

This report analyzes the expected changes in the amount of driving and trip-length distributions by personal vehicles, should completely self-driving (level 4) vehicles become widely available. The analysis is based on two key observations. First, a large percentage of young adults currently do not have a driver's license, and this percentage is substantially greater than in the 1980s (Sivak and Schoettle, 2012). Second, a recent survey (Schoettle and Sivak, 2014) provides information about the reasons for not having a driver's license. Importantly, some of these reasons would no longer be applicable with self-driving vehicles (e.g., *"too busy to get a driver's license"*), while other reasons would remain valid (e.g., *"concerned about how driving impacts the environment"*).

The basic approach in this study involves combining all reasons for currently not having a driver's license that would no longer be applicable with self-driving vehicles, and calculating the new percentage of persons who would have access to personal transportation with self-driving vehicles. Finally, the new expanded pool of those eligible to use personal transportation is then used to calculate the new amount of travel, as well as the new distribution of trip lengths.

The primary focus of this analysis is on young adults—aged 18 through 39—the same age range included in the survey of reasons for not having a driver's license (Schoettle and Sivak, 2014), and it assumes privately owned (not shared) vehicles. Another assumption was that the pattern of travel would not change for current drivers should self-driving vehicles replace conventional vehicles. Finally, it was assumed that current nondrivers would adopt the trip pattern of current drivers in their respective age groups.

Percentage of persons with a driver's license

The most recent data on the percentage of persons with a driver's license for those between 18 and 39 years of age are shown in Table 1. For comparison, Table 1 also includes the corresponding data for 1983. These data show a substantial decrease in the licensure of young adults during the past 30 years. For example for those 18 and 19 years of age, this proportion decreased from 83.9% in 1983 to 66.2% in 2013.

Table 1
Percentage of persons with a driver's license in 2013 and 1983 (adapted from FHWA, 2015).

Year	Age group			
	18-19	20-29	30-39	*18-39*
2013	66.2	81.1	87.2	*82.4*
1983	83.9	93.7	95.8	*93.6*

The reasons for not having a driver's license

In 2013 we performed a survey of 618 young adults (aged 18 through 39) without a driver's license (Schoettle and Sivak, 2014). Table 2 presents the data from that survey for the question *"What is the main reason you do not currently have a driver's license?"* The entries in Table 2 are color coded as follows. In green are reasons that would no longer be applicable with self-driving vehicles; in red are reasons that would still be applicable; and in blue are reasons that may still be applicable.

Table 2
Percentage of responses, by age group, for the question
"What is the main reason you do not currently have a driver's license?"

Reason	Age group			
	18-19	20-29	30-39	*18-39*
Too busy or not enough time to get a driver's license	37.9	26.6	16.5	*26.9*
Owning and maintaining a vehicle is too expensive	16.7	12.1	15.0	*14.6*
Able to get transportation from others	14.6	10.3	11.7	*12.1*
Prefer to bike or walk	12.1	8.9	9.2	*10.0*
Prefer to use public transportation	2.5	13.1	13.6	*9.9*
Disability/medical/vision problem	1.0	6.1	11.2	*6.1*
Other reason	5.1	8.4	2.9	*5.5*
Never learned or still learning to drive	4.5	6.5	2.4	*4.5*
Able to communicate and/or conduct business online instead	3.0	2.8	4.4	*3.4*
Concerned about how driving impacts the environment	1.0	3.3	4.9	*3.1*
Do not like to drive/afraid to drive	1.0	1.4	3.9	*2.1*
Legal issue	0.5	0.5	4.4	*1.8*
Total	*100.0*	*100.0*	*100.0*	*100.0*

Table 3 lists the sums of the percentages of the reasons from Table 2 that would no longer be applicable, plus one half of the percentages of those that may be applicable. The data in Table 3 indicate that about half of the reasons for not having a driver's license would no longer be applicable with self-driving vehicles.

Table 3
Percentages of the reasons for currently not having a driver's license that would not be applicable with self-driving vehicles.

Age group			
18-19	20-29	30-39	*18-39*
54.3	49.8	43.8	*49.2*

Percentage of young adults that would have access to personal road transportation with self-driving vehicles

Table 4 presents the percentages of young adults by age group who currently utilize personal conventional vehicles (the percentages of persons with a driver's license from Table 1), and the corresponding percentages for self-driving vehicles. The latter was derived from the former by applying the percentages of the reasons for currently not having a driver's license (found in Table 3) that would not be applicable with self-driving vehicles. For example, the derivation for the 18 and 19 year olds was as follows:

66.2 + ((100-66.2) * 0.543) = 84.6

Table 4
Percentages of young adults that could utilize personal road transportation with self-driving vehicles as compared with those who currently have access to conventional vehicles.

Type of vehicle	Age group			
	18-19	20-29	30-39	*18-39*
Conventional	66.2	81.1	87.2	*82.4*
Self-driving	84.6	90.5	92.8	*91.1*

Amount of driving

The first row in Table 5 presents the mean amount of driving by age groups for conventional vehicles. These data were calculated from the National Household Travel Survey, and they are applicable to 2009 (FHWA, 2011). The second row in Table 4 lists the number of persons with a driver's license in each age group (FHWA, 2015), while the third row shows the calculated total miles driven by conventional vehicles. The fourth row in Table 5 lists the calculated total distance traveled with self-driving vehicles, using the data in Table 4. For example, the calculation for the 18 and 19 year olds was as follows: 45,062 * (84.6/66.2) = 57,587. The last row shows the percentage increase in the total distance traveled with self-driving vehicles compared with distances traveled in conventional vehicles.

Table 5
Total annual distance traveled by conventional and self-driving vehicles, by age group.

Measure	Age group			
	18-19	20-29	30-39	*18-39*
Mean annual distance driven in miles (FHWA, 2011)	7,849	12,819	15,176	*13,509*
Number of persons with a driver's license (FHWA, 2015)	5,741,162	36,009,480	35,630,581	*77,381,223*
Total distance driven with conventional vehicles (million miles)	45,062	461,606	540,730	*1,045,343*
Total distance traveled with self-driving vehicles (million miles)	57,587	515,109	575,456	*1,155,713*
Increase in total distance from using conventional to using self-driving vehicles (%)	27.8	11.6	6.4	*10.6*

Expected changes in the amount of travel by other age groups

The information in Table 5 indicates that self-driving vehicles have the potential to increase the amount of travel in personal vehicles by young adults—those 18 through 39 years of age—by about 11%. We limited our detailed analysis to this age group because one of the critical sets of data—the reasons for not having a driver's license—was available only for this age group.

Let us now consider what general inferences we can make about the expected changes in the other age groups. Table 6 lists the current percentages of persons with a driver's license and the current average annual distances driven in conventional vehicles.

Table 6
Percentage of persons with a driver's license in 2013 (adapted from FHWA, 2015), and mean annual distance driven in 2009 (calculated from FHWA, 2011), by age group.

Age group	Persons with a driver's license (%)	Mean annual distance driven in conventional vehicles (miles)
16-17	38.1	3,261*
18-19	66.2	7,849
20-29	81.1	12,819
30-39	87.2	15,176
40-49	90.5	15,314
50-59	91.4	13,843
60-69	91.3	11,294
70-79	86.0	7,839
≥80	66.7	5,315

* Applicable to 15-17 year olds.

The youngest drivers (those 17 and younger) drive relatively short distances annually. Furthermore, their access to vehicles would be unlikely to increase substantially with the advent of self-driving vehicles (primarily for economic and parental-control reasons). The oldest persons (those 70 and older) also drive relatively short distances. On the other hand, the other age groups not included in the detailed analysis (those between 40 and 69 years of age) have high licensure rates (above 90%). Therefore, the biggest impact of self-driving vehicles on the amount of travel will likely be in the age group studied in this analysis (18 through 39 years of age). In other words, the obtained increase of 11% in travel with the availability of self-driving vehicles by those 18 through 39 years of age is likely to provide an upper bound for the increase in travel by all persons.

Trip-length distributions

Table 7 presents the distribution of trip lengths in 2009 by age group. The data were tabulated from the National Household Travel Survey (FHWA, 2011), and represent one-way-trip lengths. The longest category of trip length in Table 7 is 30 miles or more, in order for it to correspond to approximately half of the current shortest driving range for a battery electric vehicle in the U.S. (Depending on the model, the minimum current range is 62 miles, while the maximum range is 257 miles [EPA, 2015].)

The data in Table 7 indicate that 5.1% of all trips are longer than the shortest range of current battery electric vehicles. The corresponding percentage is 5.7% for those 40 through 49 years of age, and 5.7% for those 50 through 59 years of age. On the other extreme, the corresponding percentage is 1.5% for those 15 through 17 years of age and 2.0% and for those 80 years of age and older.

Table 7
Distribution of current one-way trip lengths with conventional vehicles by age group. The entries are percentages that sum to 100 for each age group, except that the entries for the median trips are in miles. (Calculated from the information in FHWA, 2011.)

Age group	Trip length (miles)							*Median trip length*
	0.1-5.0	5.1-10.0	10.1-15.0	15.1-20.0	20.1-25.0	25.1-30.0	>30.0	
15-17	65.3	21.6	6.0	3.2	1.5	0.9	1.5	*4.0*
18-19	55.5	21.3	10.8	4.9	2.9	1.9	2.7	*5.0*
20-29	51.3	21.5	9.5	6.4	3.4	2.2	5.8	*5.0*
30-39	56.1	18.1	9.5	5.2	3.3	2.5	5.1	*5.0*
40-49	56.6	18.0	9.1	5.1	3.3	2.1	5.8	*5.0*
50-59	57.5	18.7	8.7	4.9	2.9	2.1	5.3	*4.0*
60-69	60.4	18.2	8.1	4.2	2.5	1.6	4.9	*4.0*
70-79	66.7	17.4	6.9	2.9	1.7	1.1	3.4	*3.0*
≥80	73.9	13.9	5.6	2.5	1.4	0.6	2.0	*3.0*
All	*57.6*	*18.6*	*8.8*	*4.9*	*2.9*	*2.0*	*5.1*	*4.0*

As indicated above, the expectation is that (because of the current driver-licensure rates and the current amount of driving) the biggest impact of self-driving vehicles on the amount of travel will be in the age group that was the primary focus of this analysis—those 18 through 39 years of age. For them, the percentages of one-way trips 30 miles or longer (see Table 7) were as follows: 2.7% for 18 and 19 year olds, 5.8% for 20 through 29 year olds, and 5.1% for 30 through 39 year olds. For the entire group of 18 through 39 year olds this percentage (not shown in Table 7) was the same as for all drivers: 5.1%. Therefore, the availability of self-driving vehicles is unlikely to change, by itself, the overall percentage of one-way trips 30 miles or longer. Thus, range anxiety with battery electric vehicles is unlikely to change with the new users made possible by self-driving vehicles.

Discussion

Privately owned versus shared vehicles

The analysis in this report applies to the situation in which the current predominance of personally owned vehicles would continue. This was a simplifying assumption. To the extent that there might be an increase in the proportion of shared vehicles with self-driving capabilities, the amount of vehicle distance traveled and trip-length distribution would change.

Future trip patterns of current drivers

It is unclear whether and how road travel of current drivers would be influenced by the availability of self-driving vehicles. The present analysis assumed no change.

Future trip patterns of current nondrivers

Another assumption made in the present study was that, should self-driving vehicles become available, current nondrivers would adopt the trip pattern of current drivers in their age group. However, it is possible that the current trip patterns of nondrivers while using other means of transportation might continue even with self-driving vehicles. A blend of these two options is also possible.

Return-to-home-empty capability

The present analysis did not try to estimate changes in distance traveled or in the composition of trips, should self-driving vehicles have the capability to travel while unoccupied (Schoettle and Sivak, 2015).

Range anxiety with battery electric vehicles

This study included a comparison of trip-length distributions with the driving ranges of current battery electric vehicles. Because these ranges are continuously increasing, the analysis is applicable to vehicles available in late 2015 (model years 2015 and 2016).

Implications for suitable future fuel sources

The results of this analysis suggest that new users of personal transportation made possible by self-driving vehicles would not, by themselves, cause major changes in the distribution of trip patterns. Consequently, these new users will not substantially affect the current relative merits of different fuel sources (e.g., hybrids, battery electric, hydrogen fuel cells, etc.).

Summary

This report analyzed the expected changes in the amount of driving and trip-length distributions by personal vehicles, should completely self-driving vehicles become widely available. The analysis was based on two key observations. First, a substantial percentage of young adults (those 18 through 39 years of age) currently do not have a driver's license, and this percentage is substantially greater than in the 1980s. Second, a recent survey provides information about the reasons for not having a driver's license. Importantly, some of these reasons would no longer be applicable with self-driving vehicles (e.g., *"too busy to get a driver's license"*), while other reasons would remain valid (e.g., *"concerned about how driving impacts the environment"*).

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