Autonomous Cars, Electric and Hybrid Cars, and Ridesharing: Perceptions vs. Reality

Abstract
Autonomous Cars, Electric and Hybrid Cars, and Ridesharing are all important new technologies in today’s society that can have potentially large impacts on the environment in the future. This study was conducted to determine the differences in perceptions of Gettysburg College students regarding Autonomous Cars, Electric and Hybrid Cars, and Ridesharing and the reality of these topics in the real world. This paper also compares the perceptions of Environmental Studies majors/minors to the perceptions of other majors at Gettysburg College. The primary research was conducted by analyzing questions that were a part of a survey consisting of 16 questions which was administered to Gettysburg College students via Facebook class group pages and the Environmental Studies majors email alias. The study group consisted of 110 students with 31 of them being Environmental Studies majors/minors and 79 of them being non-Environmental Studies majors/minors. It was determined that there were no statistically significant differences between the Environmental Studies majors/minors and students that are other majors/minors at Gettysburg College. From our survey, we found that there is a distinct gap in knowledge on the current and future impacts on the environment from Autonomous Cars, Electric and Hybrid Cars, and Ridesharing. The questions that ask which power method produces more greenhouse gas emissions as well as the questions about the miles per gallon of participants’ personal vehicles were the most accurately answered. Overall, Gettysburg College students regardless of major or minor were found to have mostly inaccurate perceptions on the topics of Autonomous Cars, Electric and Hybrid Cars, and Ridesharing.

Keywords
Autonomous Cars, Ride sharing, Environment, fuel use

Disciplines
Environmental Health | Environmental Studies

Comments
Student capstone paper written for ES 400: Senior Seminar.
Abstract

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Introduction

Cars have been an everyday part of the lives of American citizens for over 100 years. Over these 100 years, cars have changed tremendously and have evolved with emerging technology. With these changes, the public has had many different perceptions on the safety and the environmental impact of cars, however, their perceptions do not always align with the facts. An example of these perceptions differing from reality is given in Hunter Oatman-Stanford’s article *Murder Machines: Why Cars Will Kill 30,000 Americans This Year* where he talks about how younger generations were found to have a more comprehensive understanding than older generations of the impacts that their modes of transportation has on the environment. There has also been found to be relatively poor grasp on the topic of fuel efficiency specifically, with one study finding only 1% of participants understood the curvilinear relationship between miles per gallon and fuel efficiency (Larrick & Soll, 2008).

Autonomous vehicles, electric cars, hybrid cars, and gas-powered cars are all types of automobiles that are popular in the world. An autonomous car can be defined as a vehicle that has the capability to drive without the active physical control or monitoring by a human operator (California Department of Motor Vehicles, 2018). An electric car is one that powered solely by an electric motor that gets its energy from an on-board rechargeable battery (Berman, 2014). A hybrid car uses a similar system of an electric motor and on-board battery in addition to a conventional gas-powered engine (Dunn, 2006). Electric, hybrid, and gas-powered cars are all popularly used in ridesharing, which is any means of transportation in which multiple people use the same vehicle to arrive at a similar destination (Lesson 1: What is Ridesharing?, 2017). Today, there are more hybrid and electric cars on the market than ever before (Baur and Todorova, 2018). Hybrids have been around almost as long as cars themselves with the first
carriage using both an internal combustion engine and an electric motor being built in 1897, however, they might still be thought of as a relatively new initiative in the automobile industry (Sherman, 2016). As climate change continues to be a growing global issue, alternate technologies such as hybrid cars, which shave the annual emissions per vehicle from 11,435 pounds of CO₂ for gas-powered cars to 6,258 pounds for hybrids, will be depended on as part of the solution (Emissions from Hybrid and Plug-In Electric Vehicles, n.d.). This is just one reason why this study on the perceptions, and specifically on perceptions of cars that use different sources of fuel is necessary. There continues to be extensive progress in the development of autonomous cars as well as the availability and use of car sharing and ridesharing. Another reason for this study is the overall lack in information pertaining to the perceptions on these newer technologies of ridesharing and autonomous vehicles. In this study, we will describe what experts on the topics say about the environmental effects of these car technologies, and then evaluate through a survey whether the public’s perceptions are similar to that of the experts.

*Environmental Effects of Car Technology*

The term “environmental impact” that we are going to be analyzing throughout our study will be defined as the energy efficiency of the automobile as well as the amount of greenhouse gas that is a direct product of the automobile. Experts all agree that in the long run autonomous cars, electric and hybrid cars, and ridesharing all have the ability to have tremendous environmental impacts (Litman, 2006). Electric cars have become increasingly popular over the years and can be a big part of the solution to a lot of the climate change problems that the environment currently faces. The number of electric cars has increased over the past several years for various reasons. The increasing impacts from climate change that the earth is dealing with has been a major reason for the increase in electric cars globally. There have been numerous
studies and experiments conducted that have been testing renewable energy sources that can be
tamed and utilized to power an automobile. Scientists have been concerned about the rapidly
approaching finite limit of natural gas and oil and have turned to other sources of energy in
recent years including electricity. People are wary of the increasing prices of gas as well, which
could be another factor as to why the rate of electric car sales has skyrocketed within the past
few years (Jensen and Mabit, 2017).

The autonomous car industry has been a fast-paced sector in recent years with many
different technological advancements. There has also been much debate around autonomous cars
in recent years, mostly revolving around the safety of these cars. The perception of many is that
these cars are not safe, even though at the moment every single one of them has a human inside
who should prevent any crash if the car has a fault. Many of the accidents involving autonomous
cars are not faults but rather the computer making a decision on what is best to prevent an
accident (Lin, 2015). There is some controversy over whether or not these cars will be better or
worse for the environment. One side of the argument is that these cars will be better for the
environment because they have higher energy efficiency, reduce cold starts, reduce idling, and
reduce speed fluctuations. However, the counter-argument to this is that with autonomous cars
people will travel more and thus offset these benefits and possibly even cause a negative
environmental impact (Taiebat et al., 2018).

Car sharing and ridesharing have increased tremendously over the last few years, in New
York City alone ridesharing had tripled between June of 2015 and the fall of 2016. (Schaller,
2017). With the last few years, there has been inventions of apps like Uber, where you can call
for a driver to pick you up, and programs like Zipcar where you can reserve a car to rent at
various locations. There are mixed perceptions about whether ridesharing will have a positive or
negative impact on the environment and traffic in suburban towns and cities. For all of these ridesharing platforms, there is agreement they can have a positive environmental impact due to reducing car ownership (Shaheen et al., 2015). With the availability of services like these, it will no longer be necessary to personally own a car. Thus fewer cars will be produced which means fewer resources are needed to build cars which will benefit the environment (Smith, 2016). The counter-argument to this is that people are using these transportation services more than they would use a personal car and thus burning more fuel and emitting more CO₂. A study by Schaller found that apps like Uber and Lyft currently have a negative impact on the environment. This is because he found that people were traveling more often and found that there were many times that people would have walked or biked somewhere but since one of these services was available, they decided to use it instead (Schaller, 2017). There is still hope that these services can help the environment but there needs to be a noticeable decrease in private car use to counter the increased use of these services (Schaller, 2017).

Over the course of this project, we will be researching how safe and environmentally friendly these different car categories of autonomous vehicles, electric and hybrid cars, and ridesharing are. Environmental friendliness will be assessed and analyzed throughout the survey and data analysis sections of this report. We are going to determine what people, specifically college age students, think of their cars and the emissions that their cars produce. We will then be looking to compare this to the perceptions of how environmentally friendly and safe they are in the United States. This study will also expand on the relatively small amount of research that there currently is on some of these topics.
Research Questions

1. What is the difference between the perceptions of Gettysburg College students and the reality of electric cars, hybrid cars, autonomous cars and ride sharing in terms of environmental impacts and safety?

2. How do the perceptions of environmental studies majors differ from other majors on these topics?

By answering these questions we will be able to determine what Gettysburg College students believe is true about these topics and compare them to what the experts actually know from their research. We will be able to see how educated students of Gettysburg College students are on these topics as well as seeing if an educational background of environmental studies has any impact on students’ knowledge.

Methods

Survey

To begin the research, a lot of secondary research was looked at with many sources being peer-reviewed and scholarly articles about electric cars, hybrid cars, autonomous cars, and ridesharing in order to learn more about these topics. Grey literature from different research organization and reports from car manufacturers was also looked at. All of this information was reviewed and facts about all of these topics were compiled. To answer the first research question we found concrete evidence about what the experts know and decided what specific topics we wanted to survey students on. When creating our survey, relevant data from scholarly articles was used to create questions.
The survey had multiple choice questions, short answer, and Likert scale questions with possible answers being ranked 1-5. The survey is located in the appendix and is broken into four sections. The first section is to find out demographic information about the participants and about the current car they drive the most. The next section focuses on ridesharing programs such as Uber and Lyft. Following this, there is a section on electric and hybrid cars and the last section is on autonomous cars.

The survey was created and administered using the platform Google Forms. The population of study is current Gettysburg College students and the survey was administered by posting it in the Facebook groups for Gettysburg College classes of 2019, 2020, 2021, and 2022. The survey was also sent via email to all Gettysburg College Environmental Studies majors/minors in order to get a representative sample when comparing the responses of Environmental Studies majors/minors to other major/minors. The survey was available to take from 10/15/18 to 11/11/18.

Data Analysis

After the survey was closed, the data was exported to the program, SPSS. The data was cleaned up by assigning proper ranking numbers to Likert scale answers so responses could be analyzed and an example of this being a response of “Never” for Question 5 being assigned a value of 1 and a response of “Most days” being assigned a value of 5. Data containing the accurate miles per gallon for each car that was given with full details (make, model, and year) was gathered from manufacturer websites with the city and highway miles per gallons averaged. The difference between the perceived miles per gallon and actual miles per gallon was calculated. The difference was then ranked from 1-5 with 1 representing a difference of greater than 20 miles per gallon, 2 representing a difference of 10.01-20, 3 representing a difference of
5.01-10, 4 representing a difference of .01-5, and 5 representing no difference between the perceived miles per gallon and actual miles per gallon. To answer the second research question, we conducted a one way ANOVA to compare the responses of Environmental Studies majors/minors to other majors/minors and to see if there were any questions with significantly different responses between the two groups. Descriptive statistics of mean, median, mode, and standard deviation were calculated for each of the quantitative question responses. Following this, all of the responses from Gettysburg College students and their attitudes were compared to the attitudes that the scholarly articles talked about regarding the general public.

**Results:**

**Respon​dent Characteristics**

The survey had 110 responses with 31 being Environmental Studies majors/minors and 79 being non-Environmental Studies majors/minors at Gettysburg College. The students surveyed were mostly from the suburbs (67.3%), while 23.6% were from rural areas and only 9.1% were from cities. When comparing the actual miles per gallon of the car that each student drives, to what they believed the miles per gallon of their car was, the majority of the students, 66%, were within 0.01-5 miles per gallon of the actual car’s miles per gallon rating (Figure 1). Using the scatterplot, with the line of regression through the data, there was a positive correlation between the actual miles per gallon of each students’ car and what they believed the miles per
gallon of their car is (Figure 2).

**Figure 1:** Difference in students' perceptions of their car's miles per gallon vs actual miles per gallon
Figure 2: Scatterplot showing the correlation between the perceptions that students have about the miles per gallon of their current car and the actual miles per gallon that this car has.

**Ridesharing**

When asked “At your primary place of residence outside of Gettysburg College, how many times since the start of 2018 has your form of transportation been ridesharing such as Uber or Lyft?”, the majority of students responded “never” or “rarely” (Figure 3). When asked “If you used ridesharing in 2018, answer the following: Picture the last time you used a ridesharing app. If ridesharing had not been available, how would you have made the trip?” we found that there
was no significant difference between all of their responses (Figure 4). Students had the option to write in responses to this answer as well; two students did this and the first student said “I would be stuck because public transportation does not get to my house” and the second student said “I would have asked a friend for a ride”. When asked “What effects do you think ridesharing apps such as Uber and Lift have on road congestion?” 49.1% of respondents answered that they think ridesharing apps will have a positive impact on road congestion (Figure 5). When asked “If you had reliable access to ridesharing in your primary place of residence, would you be highly unlikely, unlikely, equally as likely, likely, or highly likely to personally own a car?” 37.3% of respondents said that if ride-sharing was available in their area they would be equally as likely to own a car and 28.2% would be more likely to own a car (Figure 6). When asked “If you had reliable access to ridesharing (Uber and Lyft) wherever you are, at any time of day, how often would you travel compared to the amount you currently travel?” 67.3% of people answered that they would travel equally as often if ridesharing was always available in their area (Figure 7).
Figure 3: Summary of results for question 5 asking “At your primary place of residence outside of Gettysburg College, how many times since the start of 2018 has your form of transportation been ridesharing such as Uber or Lyft?”
Figure 4: Summary of results for question 6 asking “If you used ridesharing in 2018, answer the following: Picture the last time you used a ride sharing app. If ridesharing had not been available, how would you have made the trip?”
Figure 5: Summary of results for question 7 asking, “What effects do you think ridesharing apps such as Uber and Lift have on road congestion?”
Figure 6: Summary of results from question 8 asking, “If you had reliable access to ridesharing in your primary place of residence, would you be highly unlikely, unlikely, equally as likely, likely, or highly likely to personally own a car?”
Figure 7: Summary of results from question 9 asking, “If you had reliable access to ridesharing (Uber and Lyft) wherever you are, at any time of day, how often would you travel compared to the amount you currently travel?”

Electric and Hybrid Cars

When asked “Would you create more greenhouse gases by running a gas-powered engine or using an electrical generator to generate the same amount of energy?” 51.8% thought that gas creates more greenhouse gasses than electric in creating the same amount of energy (Figure 8).

When asked “If you could convert your current car to an electric car that got 100 miles per gallon, how would the amount you drive change? I would drive” 58.2% of students responded they would drive equally as much and 31.8% answered that they would drive more (Figure 9).

When asked “Knowing that car companies measure the efficiency of electric-powered cars in miles per gallon equivalent, how many miles per gallon do you think the car you drive the most
would get if it was electric powered?” we found that Gettysburg College students thought that if their car was electric powered they thought their car would get an average of 68.47 miles per gallon (Figure 10). When asked “Knowing that car companies measure the efficiency of hybrid-powered cars in miles per gallon, how many miles per gallon do you think the car you drive the most would get if it was hybrid?” students thought if their car was hybrid they would get an average 52.11 miles per gallon.

![Pie chart showing results]

**Figure 8:** Summary of results for question 10 asking, “Would you create more greenhouse gases by running a gas-powered engine or using an electrical generator to generate the same amount of energy?”
Figure 9: Summary of results for question 11 asking, “If you could convert your current car to an electric car that got 100 miles per gallon, how would the amount you drive change? I would drive…”
Figure 10: Summary of results for questions 12 “Knowing that car companies measure the efficiency of electric-powered cars in miles per gallon equivalent, how many miles per gallon do you think the car you drive the most would get if it was electric powered?” and question 13 “Knowing that car companies measure the efficiency of hybrid-powered cars in miles per gallon equivalent, how many miles per gallon do you think the car you drive the most would get if it was hybrid?”

Autonomous Vehicles

When asked “If you had an autonomous car (same make and model of the car you use the most but autonomous), how much would you drive in this car compared to the car you use the
most?” 47.3% of students responded that if they had an autonomous car they would drive equally as much (Figure 11). When asked “On a scale of 1 to 5, how safe do you think self-driving cars are in 2018? One being much less safe than regular cars, 3 being the same safety level as regular cars, and 5 being much safer than regular cars.” 46.4% of students responded that they believe self-driving cars are less safe than regular cars (Figure 12). When asked “In how many years will autonomous vehicles be as safe as human-driven cars?” there was not one specific answer that had significantly more selections than the rest (Figure 13).

**Figure 11:** Summary of results for question 14 asking, “If you had an autonomous car (same make and model of the car you use the most but autonomous), how much would you drive in this car compared to the car you use the most?”
Figure 12: Summary of results for question 15 asking, “On a scale of 1 to 5, how safe do you think self-driving cars are in 2018? One being much less safe than regular cars, 3 being the same safety level as regular cars, and 5 being much safer than regular cars.”
Figure 13: Summary of results for question 16 asking, “In how many years will Autonomous Vehicles be as safe as human-driven cars?”

Comparison of ES vs. Non-ES Majors

When comparing the answers of the Environmental Studies majors to the answers from the students that are not Environmental Studies majors by running an analysis of variance, it was found that there were no significant differences between the two groups (Appendix B).

Discussion

Comparison of ES vs. Non-ES Majors

There was no significant differences between answers when analyzing the answers from the Environmental Studies majors/minors and the rest of the participants. Considering the survey had an environmental aspect to it, it was surprising to find that there were no significant
differences in the way questions were answered between the two groups of Environmental Studies major/minors and other major/minors (Table 2). However, this finding goes against previous studies examining the impact of previous exposure to environmental education and one’s environmentally conscious thoughts. A study that was conducted at 4 public universities, one of which was the University of Reno-Nevada in the United States found that science and engineering students were significantly more likely to behave in a pro-environmental way compared to students studying social sciences (Vicente-Molina et. al. 2012). This difference could be attributed to the small sample size of 110 for this study as well as the groups used were just looking at Environmental Studies majors/minors and other majors/minors which did not include other majors/minors that deal with the environment such as Biology.

Fuel Efficiency

Fuel efficiency of cars is a measurement that many people did not have accurate answers to. Looking at how accurate the estimates were of each participant for miles per gallon of the car they drive the most, though there were only 5.2% of participants that had an exact knowledge of their miles per gallon, 66% were within .01-5 miles per gallon off of the actual miles per gallon for their car (Figure 1). A misconception of one’s miles per gallon by 5 does not have a large impact when talking about a vehicle that gets 50 miles per gallon but it has a much larger impact for vehicles with miles per gallon of 15. Almost a quarter of participants estimated their miles per gallon to be 5.01-10 miles off from what it actually is, which is a relatively large portion of the students. These misconceptions in one’s vehicle’s miles per gallon can be attributed to the fact that miles per gallon is a misleading representation of fuel efficiency due to the curvilinear relationship between fuel consumption and fuel efficiency (Gamliel & Peer 2016).
There are some cases where the estimates of MPG may be more accurate than the published MPG. For example, one participant had their truck’s suspension lifted which negatively impacts the vehicle’s miles per gallon and the participant took this into account when giving their estimation of their miles per gallon, though it was not taken into account when the actual miles per gallon of the vehicle was calculated. A study found that individuals that were given fuel efficiency of a car in the format of gallons per 100 miles instead of miles per gallon were likely to have an accurate understanding of a vehicle’s fuel efficiency as well as to prefer more fuel efficient vehicles (Gamliel & Peer 2016). As represented now, majority of participants in this study, though not far off, do not have an accurate understanding of their vehicle’s fuel efficiency and a change to using gallons per 100 miles might be a way to become more knowledgeable on the subject.

**Ridesharing**

From our results on ridesharing apps such as Uber and Lyft, we found interesting information when comparing the perceptions of Gettysburg College students to the facts. When looking at how many people use ridesharing apps such as these we found that 66% of students had at least used ridesharing “rarely” in the past year (Figure 3). When comparing this to the average in America, Gettysburg College students use ridesharing apps much more. A study conducted in 2016 by Aaron Smith found that only 15% of Americans have used ridesharing apps (Smith, 2016). This is not very surprising due to the fact that younger populations are more likely to use ridesharing apps (Smith, 2016). There has also been major growth in ridesharing apps in the last two years so the data from Smith’s study may be a little dated and there is potential that more people are using ridesharing apps today.
When looking at the perceived effects of traffic from ridesharing apps from Gettysburg College students, we found a variety of results. According to our study, nearly 50% of respondents think that ridesharing apps are beneficial for traffic congestion (Figure 5). Most people would think this is true because if people are traveling together in these ridesharing apps then it should in theory take more cars off the road. However, there is more to this than one might think. There are things such as what form of transportation would the rider have used if they did not use a ridesharing app or would the rider even have taken the trip if the ridesharing app was unavailable. When looking at the responses from Gettysburg College students we found that if ridesharing was unavailable for their last trip, 32.4% would have taken public transportation and 21.2% would have not taken the ride at all (Figure 4). This totals 53.6% of people who either would not be on the road or would be in public transportation that is more efficient for road congestion (Schaller, 2017).

Schaller conducted a study on the effects of ridesharing apps on the environment and congestion in New York City. Schaller found that the number of people taking the bus declined for the second straight year which he attributed to ridesharing apps (Schaller, 2017). Smith found that over 60% of people who use ridesharing do so because they think it is more reliable than public transportation and taxis. Both studies determined that people are moving away from public transportation and towards ridesharing apps due to the convenience of them as well as the reliability these apps have to get them to their destination. Much like our findings that many would have not taken a trip or used public transportation if ridesharing was unavailable, Schaller states that ridesharing apps do have a chance to help not only road congestion but also CO₂ emissions. However, these rides would need to be offset by people driving less and instead using solely ridesharing apps. Schaller found that ridesharing rides and distance traveled is growing
year by year but there is no decrease in rides taken in private cars or distance traveled in private cars (Schaller, 2017). With this information, ridesharing apps are adding congestion to the roads and do not have a positive effect on traffic which is the opposite of what Gettysburg College students think. This is directly seen where many Gettysburg College students would not have taken a trip at all or used public transportation instead of ridesharing apps. Overall, if people are using ridesharing apps instead of driving, then the apps will have a positive effect on congestion due to reducing the amount of cars on the road. However, if people are taking trips they normally would not have or are using ridesharing apps in place of public transportation then these ridesharing apps have the chance to have a very negative effect on congestion.

When asked about the usage of ridesharing in their area there was a variation of answers, Gettysburg College students reported that they would be equally as likely or even more likely to own a car if ridesharing was available (Figure 6). Since this is such a new topic, there is not much research done on how ridesharing effects car ownership, however the research that has been done says the opposite of what Gettysburg College students say in that car ownership decreases. Susan Shaheen et al. have studied the early implications of ridesharing on different factors. One factor they focus on is car ownership, they found that over 60% of families that have regularly use ridesharing for two years choose to postpone their purchase of their next car due to ridesharing (Shaheen et al., 2015). These are major findings because they concluded that one ridesharing vehicle has the chance of replacing 9 to 13 cars. If these findings are correct, that means that ridesharing could have a huge positive impact on the environment. This is because there will be far less resources put into cars and fewer cars produced so there will be less materials taken from the environment to build cars. Right now the perspective of Gettysburg College students is that they will still want to own a car even if they can use ridesharing instead.
Since this is such a new topic, it takes time for people to change their perspectives so there is potential that over more years of students becoming more use to ridesharing that they will be less likely to own a car and instead rely on ridesharing.

When looking at the effects that ridesharing apps have on how often or how much people travel, there are again differences between the facts and the perceptions of Gettysburg College students. Gettysburg College students overwhelmingly said that if there was reliable ridesharing apps in their area they would travel the same amount as they do now (Figure 7). This, however, is much different than the actual results of ridesharing apps. There is ample research that has been conducted stating that ridesharing apps do not only increase how often people are willing to travel but also it increases how far of trips people are willing to take. Yin et al. conducted a study in Paris looking at the effects ridesharing apps have on the environment. They found that in the short term there were reductions in CO\textsubscript{2} emissions from people traveling together when they normally would have taken private cars of their own. However, over time there was a rebound and that people were willing to take more and farther rides, residents were even willing to commute farther to work if these ridesharing apps were available (Yin et al., 2018). In Schaller’s analysis of ridesharing apps he found that not only were people more likely to travel but also that ridesharing rides were longer than those taken in taxis on average (Schaller, 2017). This all shows that when ridesharing is available people are not only more willing to take trips but also more willing to take longer trips. With these excess trips and longer trips they all have the implications to emit more CO\textsubscript{2} since there will be more time spent traveling overall. There are some limitations to this for the Gettysburg College students because we did not account for if ridesharing is already reliable in their area so then these respondents would automatically choose that they would ride the same amount.
Electric and Hybrid Cars

Though it is a relatively well understood fact that burning fossil fuels such as gasoline contributes greenhouse gasses to the earth’s atmosphere, and a battery by itself does not emit any, only 51.8% of participants in this study stated that they believed that a combustion engine created more greenhouse gasses than an electric generator when producing the same amount of energy (Figure 8). Both options of the electrical generator creating more greenhouse gasses and the electrical generator and combustion engine creating the same amount of greenhouse gasses were chosen by 9.1% of participants totaling 18.2% of participants that think electrical generators create greenhouse gasses (Figure 8). Findings from one study show that people are significantly worse at estimating \( CO_2 \) emissions from a gallon of gas than they are at estimating more common things like calories in a certain food or even uncommon things like estimating the weight of their car as well as estimations of \( CO_2 \) emissions tending to be significantly lower than the actual emissions from a combustion engine (Grinstein et. al. 2011). Assessing the responses in this study with the idea that participants were responding in regards to total greenhouse gas emissions from an electrical vehicle’s lifetime compared to total greenhouse gas emissions from a combustion engine vehicle’s lifetime does impact the accuracy. Battery powered electric vehicles create more greenhouse gas emissions than combustion engine powered vehicles when looking at the vehicle’s entire life cycle due to the emissions that are created during the battery manufacturing (Ma et. al. 2011). Using life cycle assessment can lead to the accuracy of the participants’ perceptions changing from about half of participants being correct that a combustion engine creates more greenhouse gasses to that half being incorrect that a vehicle with a combustion engine creates less greenhouse gas emission in its lifetime than an electric vehicle.
We also asked about the usage of their car if it were converted to an electric powered engine. Question 11 had 58.2% of the respondents answer that they would drive equally as much if the current car that they drive the most was converted to an electric-powered engine that got 100 miles per gallon. Only 31.8% of respondents said that they would drive more with an electric-powered car than they do currently (Figure 9). We hypothesized that people would drive more if their current car was electric assuming that they have a strong knowledge of energy efficiency and the amount of greenhouse gas that electric-powered cars emit. Throughout our study, we found that many people do not realize how environmentally friendly electric-powered cars are in comparison to gas-powered cars. Many studies have estimated that the amount of car usage in the future with the incorporation of electric powered engines, will increase. Many of the participants said the opposite in their survey which means that they either do not realize the environmental benefits, or they simply do not care enough to change their driving habits.

The miles per gallon equivalent for electric-powered vehicles is something that many people seemed to not be familiar with. Helmers discusses this electric conversion factor and the environmental impact of the electric-powered engine in his published article which stated “[t]he electric conversion of a used combustion engine vehicle can save an additional 16 % (CO$_2$-eq) and 19 % (single score endpoints) of the environmental impact over a lifetime...” (Helmers, 2017). The average miles per gallon equivalent that the respondents estimated their car would have if it was electric was approximately 68.47 miles per gallon, which was a very high estimate for fuel efficiency (Figure 2). Many people understand that the energy efficiency of electric vehicles would be much higher than traditional gas-powered engines, but do not realize how much of a difference there is between the two types of engines.
Hybrid cars fuel usage can be just as misunderstood as it is for electric cars, especially since they both use miles per gallon equivalent. Hybrid fuel use can even be potentially more confusing because it takes into account the ideas of both mpg for the gas the vehicle uses and mpge for the electric power the vehicle uses. Though the mean response regarding what participants thought their vehicle’s mile per gallon equivalent would be was typically between the estimated miles per gallon and estimated miles per gallon equivalent, with a mean of 52.11, the high standard deviation of 67.35 reflects how misunderstood fuel use is for hybrid vehicles (Table 1).

**Autonomous Vehicles**

Autonomous vehicles is a fairly new technology that many people are not as familiar with. Nearly 47.3% of the people that took our survey stated that when they had access to an autonomous vehicle at any time of the day, if it was the same make and model of the current car that they currently drive the most, they would travel the same amount as they do now. Only 19.1% of the participants stated that they would travel more than they currently do in their current car. The percentage of people that stated that they would travel the same as they currently do, or slightly less was approximately 76.4% of the respondents (Figure 11). This directly contrasts with the opinions of many scientists and researchers around the world. It has been determined and estimated that more people would travel more often in most areas of the world if their car was autonomous (Fagnant et al., 2018). It has been estimated that semi-autonomous vehicles may save nearly 10 times the number of cars needed for self-owned personal-vehicle travel in the future (Fagnant et al., 2018). This will drastically reduce the amount of personally owned cars around the world. The opinions of the Gettysburg College students that were
surveyed directly clashed with the opinions of Daniel Fagnant and Kara Kockelman, two renowned vehicular scientists that have spent many years studying the effects of autonomous vehicles to all sections of the world.

The opinions of Gettysburg College students about the safety of autonomous vehicles when utilized in a public setting was analyzed and it was found that nearly 46.4% of the participants believed that these vehicles were less safe than human-driven automobiles (Figure 12). This again, contrasts with the extensive research that has been conducted over the years about the usage of autonomous vehicles. Many people speculate that autonomous vehicles are less safe than human driven cars because of news reports and the outrage that has caused amongst the public. In fact, there have only been a handle of accidents on the roads since the creation of the autonomous vehicle, but because it is something that is completely new to humans, and many people are skeptical, it creates a lot more outrage than it should (Litman 2018). In a recently published book by Todd Litman, he stated that autonomous vehicles are going to be drastically more safe than human driven cars, but only when all vehicles are autonomous. He estimated that this will not happen until the 2040s or 2050s (2018). Litman suggests that this is incredibly hard to enforce since many people who have their driver’s license will still be driving around in those years. If there is a way to ensure that all vehicles on the road will be autonomous sooner than 2040, than the overall safety of vehicles will increase dramatically (Litman 2018).

Limitations

One limitation to our study was that our sample size was 110 Gettysburg College students which is roughly 4% of all of the students at Gettysburg College. These students may have
known more information or less information about our topic than the general population of Gettysburg College so this could be a limitation to our study. Another limitation that we had was that we distributed the survey to non-Environmental Studies students via Gettysburg College Facebook groups. These students who regularly check the Facebook groups and have Facebook’s could have different opinions than the general population of Gettysburg College students. Studies have shown that Facebook is not an accurate representation of the general public and instead the individuals who use it are often younger and better educated than the general public (Mellon and Prosser, 2017). This may not be an issue for this study due to that the target population was students of Gettysburg College who fit in both the categories of young and educated. In continuation of this study, the same survey could be given to residents of the town of Gettysburg and the differences in those perceptions and the ones of Gettysburg College students could be assessed. In future studies we would like to ask questions about respondents feeling of safety driving next to an autonomous car and compare it to their feeling of safety if there were riding on a road that was fully autonomous.

Conclusion

In conclusion, we determined that the perceptions of Gettysburg College students in regards to Autonomous Cars, Electric and Hybrid Cars, and Ridesharing were quite different than the facts for these topics. However, we did find that the students perceptions were consistent with expert opinion in terms of questions regarding greenhouse gas emissions and the miles per gallon. This study demonstrates the gap in knowledge on the current and future impacts of vehicles on the environment for the study population of undergraduates at a small liberal arts college, regardless of previous education on environmental topics. Ridesharing and autonomous
cars will be a major part of our future. The perceptions of students was that they would still own cars if ridesharing was available and that autonomous cars are less safe than cars driven by humans. In order to better prepare for the future there needs to be better education about these topics in order to create the most environmental good from ridesharing and autonomous cars. With the education of students about these new car technologies, it will help students understand the environmental impacts that these cars have. This can help lead to a dramatic change in climate change opinions across the world, especially with the younger generations.
Work Cited


Appendix A

Survey:

**Autonomous Cars, Hybrid & Electric Cars, and Ride-Sharing: Perceptions vs. Reality**

* Required

1. Are you an Environmental Studies major or minor? *
   - Yes
   - No

2. What kind of car do you drive most often? (Year, Make, Model) *
   
   Your answer

3. What do you think the miles per gallon of that car is? *

   Your answer
4. Which one of these best describes where you live when you're not at Gettysburg College? *
   - City
   - Suburbs
   - Rural

5. At your primary place of residence outside of Gettysburg College, how many times since the start of 2018 has your form of transportation been ride-sharing such as Uber or Lyft? *
   - Never
   - Rarely
   - At least once a month
   - At least once a week
   - Most days

6. If you used ride-sharing in 2018, answer the following: Picture the last time you used a ride sharing app. If ridesharing had not been available, how would you have made the trip?
   - I would not have taken the trip at all.
   - I would have walked or biked.
   - I would have taken public transportation.
   - I would have driven a private car.
   - Other: __________________________

7. What effects do you think ride-sharing apps such as Uber and Lyft have on road congestion? *
   - Very beneficial
   - Beneficial
   - Neutral
   - Negative
   - Very negative

8. If you had reliable access to ride-sharing in your primary place of residence, would you be highly unlikely, unlikely, equally as likely, likely, or highly likely to personally own a car? *
   - Highly unlikely
   - Unlikely
   - Equally
   - Likely
   - Highly Likely
9. If you had reliable access to ride-sharing (Uber and Lyft) wherever you are, at any time of day, how often would you travel compared to the amount you currently travel? *
   - Much Less Often
   - Less Often
   - Equally as Often
   - More Often
   - Much More Often

10. Would you create more greenhouse gases by running a gas-powered engine or using an electrical generator to generate the same amount of energy? *
    - Gas
    - Electric
    - The same
    - Don't know

11. If you could convert your current car to an electric car that got 100 miles per gallon, how would the amount you drive change? I would drive...
    - Much Less
    - Less
    - Equally as much
    - More
    - Much More

12. Knowing that car companies measure the efficiency of electric-powered cars in miles per gallon equivalent, how many miles per gallon do you think the car you drive the most would get if it was electric powered? *
    Your answer

13. Knowing that car companies measure the efficiency of hybrid-powered cars in miles per gallon, how many miles per gallon do you think the car you drive the most would get if it was hybrid? *
    Your answer
14. If you had an autonomous car (same make and model of the car you use the most but autonomous), how much would you drive in this car compared to the car you use the most? *
   - Much less
   - Less
   - Equally as much
   - More
   - Much more

15. On a scale of 1 to 5, how safe do you think self-driving cars are in 2018? One being much less safe than regular cars, 3 being the same safety level as regular cars, and 5 being much safer than regular cars. *

   1  2  3  4  5
   -

16. In how many years will Autonomous Vehicles be as safe as human-driven cars? *
   - Never
   - In 5 years
   - In 10 years
   - In 20 years
   - In 50 years

17. Any additional comments or concerns (optional)
   
   Your answer
Appendix B

Summary of differences in answers between Environmental Studies majors and minors compared to other majors.

**ANOVA**

<table>
<thead>
<tr>
<th>Question</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>At your primary place of residence outside of Gettysburg College, how many times since the start of 2018 has your form of transportation been ride-sharing such as Uber or Lyft?</td>
<td>.011</td>
<td>1</td>
<td>.011</td>
<td>.009</td>
<td>.923</td>
</tr>
<tr>
<td>If you used ride-sharing in 2018, answer the following: Picture the last time you used a ride sharing app. If ridesharing had not been available, how would you have made the trip?</td>
<td>.400</td>
<td>1</td>
<td>.400</td>
<td>.277</td>
<td>.600</td>
</tr>
<tr>
<td>What effects do you think ride-sharing apps such as Uber and Lyft have on road congestion?</td>
<td>.000</td>
<td>1</td>
<td>.000</td>
<td>.000</td>
<td>.998</td>
</tr>
<tr>
<td>If you had reliable access to ride-sharing in your primary place of residence, would you be highly unlikely, unlikely, equally as likely, likely, or highly likely to personally own a car?</td>
<td>.519</td>
<td>1</td>
<td>.519</td>
<td>.445</td>
<td>.506</td>
</tr>
<tr>
<td>If you had reliable access to ride-sharing (Uber and Lyft) wherever you are, at any time of day, how often would you travel compared to the amount you currently travel?</td>
<td>.066</td>
<td>1</td>
<td>.066</td>
<td>.147</td>
<td>.702</td>
</tr>
<tr>
<td>Would you create more greenhouse gases by running a gas-powered engine or using an electrical generator to generate the same amount of energy?</td>
<td>.505</td>
<td>1</td>
<td>.505</td>
<td>.280</td>
<td>.598</td>
</tr>
<tr>
<td>If you could convert your current car to an electric car that got 100 miles per gallon, how would the amount you drive change? I would drive...</td>
<td>.186</td>
<td>1</td>
<td>.186</td>
<td>.356</td>
<td>.552</td>
</tr>
<tr>
<td>If you had an autonomous car (same make and model of the car you use the most but autonomous), how much would you drive in this car compared to the car you use the most?</td>
<td>1.227</td>
<td>1</td>
<td>1.227</td>
<td>1.186</td>
<td>.278</td>
</tr>
<tr>
<td>On a scale of 1 to 5, how safe do you think self-driving cars are in 2018? One being much less safe than regular cars, 3 being the same safety level as regular cars, and 5 being much safer than regular cars.</td>
<td>.026</td>
<td>1</td>
<td>.026</td>
<td>.023</td>
<td>.879</td>
</tr>
<tr>
<td>In how many years will Autonomous Vehicles be as safe as human-driven cars?</td>
<td>2.784</td>
<td>1</td>
<td>2.784</td>
<td>1.424</td>
<td>.235</td>
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<tr>
<td>How far away from the actual mpg the student’s estimate was...</td>
<td>.477</td>
<td>1</td>
<td>.477</td>
<td>1.094</td>
<td>.298</td>
</tr>
<tr>
<td>Knowing that car companies measure the efficiency of electric-powered cars in miles per gallon equivalent, how many miles per gallon do you think the car you drive the most would get if it was electric powered?</td>
<td>7357.300</td>
<td>1</td>
<td>7357.300</td>
<td>.614</td>
<td>.435</td>
</tr>
<tr>
<td>Knowing that car companies measure the efficiency of hybrid-powered cars in miles per gallon, how many miles per gallon do you think the car you drive the most would get if it was hybrid?</td>
<td>3929.560</td>
<td>1</td>
<td>3929.560</td>
<td>.865</td>
<td>.354</td>
</tr>
<tr>
<td>Which one of these best describes where you live when you're not at Gettysburg College?</td>
<td>.279</td>
<td>1</td>
<td>.279</td>
<td>.901</td>
<td>.345</td>
</tr>
</tbody>
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