

The Effectiveness of Apple CarPlay on Driver Safety

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Abstract

Manufacturers integrate new technologies in their vehicles for many reasons, including keeping up with competitors and attracting new customers. The creation of the smartphone led to an increase in distracted driving related crashes, which led to demand for an in vehicle solution. These solutions began with bluetooth connectivity options and have now expanded to in vehicle infotainment systems with inclusions such as Apple CarPlay and Android Auto. How has new hands free technology, such as Apple CarPlay, affected the level of driver distraction? This paper analyzes this question using Bijker and Pinch's Social Construction of Technology (SCOT) framework, allowing a thorough understanding of the social groups involved. Three different studies from IAM RoadSmart, AAA, and the University of Copenhagen were used in this analysis. Their findings were used to help determine the ability for drivers to interact with Apple CarPlay, without compromising their attention to driving. The conclusion of this paper is that more governmentally backed testing is needed in order to determine the benefits and risks of hands-free cell phone systems in vehicles. Also drivers need to be educated on the limitations of new technology to ensure the safe operation of vehicles.

Introduction

In 2020, an estimated 7.9% of drivers were using their phone in some way, either hand-held or hands-free (“Driver Electronic Device Use in 2020,” 2020). From 2012 to 2019, the National Highway Traffic Safety Association (NHTSA), estimated that 26,000 people have died in car crashes related to distracted driving (Matthew Lynberg, 2019). NHTSA defines distracted driving as “any activity that diverts attention from the road.” (Currin, 2018) Distracted driving related crashes continue to be a major issue for federal, state, and local governments. Data from the 2016 census showed that 76.3% of commuters drive alone to work and another 9% of commuters carpool to work (Tomer, 2017). This equates to about 115 million cars and trucks on the road every day and means that people all throughout the country spend countless hours driving to work and sitting in traffic every single week. With drivers being in the car for that long, they tend to gravitate towards using their phones. Texting is considered one of the most dangerous types of distracted driving because it combines visual, manual, and cognitive distractions (Matthew Lynberg, 2019). Vehicle manufacturers and government officials alike have made efforts to discourage people from using their cell phones while driving. This includes new laws to discourage phone use while driving as well as new technology integrated in vehicles.

The development of hands free technology began with the introduction of Bluetooth and has now expanded into cell phone integration such as Apple CarPlay and Android Auto. These technologies encourage drivers to put down the phone while driving and instead use integrated tablet-like screens, easily accessible in the dash of their vehicle. The Apple website states that, “CarPlay is a smarter, safer way to use your iPhone while you drive” (*iOS - CarPlay*, 2011). The screens in vehicles are also referred to as the infotainment center. The research and discussion in

this thesis will focus primarily on the effectiveness of Apple CarPlay. An emphasis will be placed on whether or not CarPlay leads to a higher cognitive demand on the driver, leading to higher distraction levels. The Social Construction of Technology (SCOT) framework will be used to analyze how drivers, policymakers, and manufacturers have an impact on hands-free technology creation and use.

Current Phone Related Technology in Vehicles

Contemporary technology integration began in the early 2000s with bluetooth transceivers in vehicles, allowing for drivers to play their own music and make hands-free calls (Laukkonen, 2021). As technology progressed and texting became more popular, developers realized that something else was needed in order to keep drivers hands on the steering wheel and eyes on the road. In 2014, all major car manufacturers began offering Apple CarPlay and Android Auto as a standard inclusion on vehicle models. Today there are over 600 car models that offer Apple CarPlay and seven aftermarket systems available to install (*iOS - CarPlay*, 2011). These technologies are accessible through a tablet-like screen located in the dash of the car. Carplay allows drivers to make phone calls, send and receive text messages, get directions, and play music (*iOS - CarPlay*, 2011). Carplay also allows drivers to use Siri, a virtual assistant that Apple first introduced in 2011 (*iOS - CarPlay*, 2011) Siri can be accessed with the simple press of a button, located on the steering wheel of most vehicles. This allows drivers to send audio messages, listen to incoming messages, and ask for directions without ever having to interact with the touch screen.

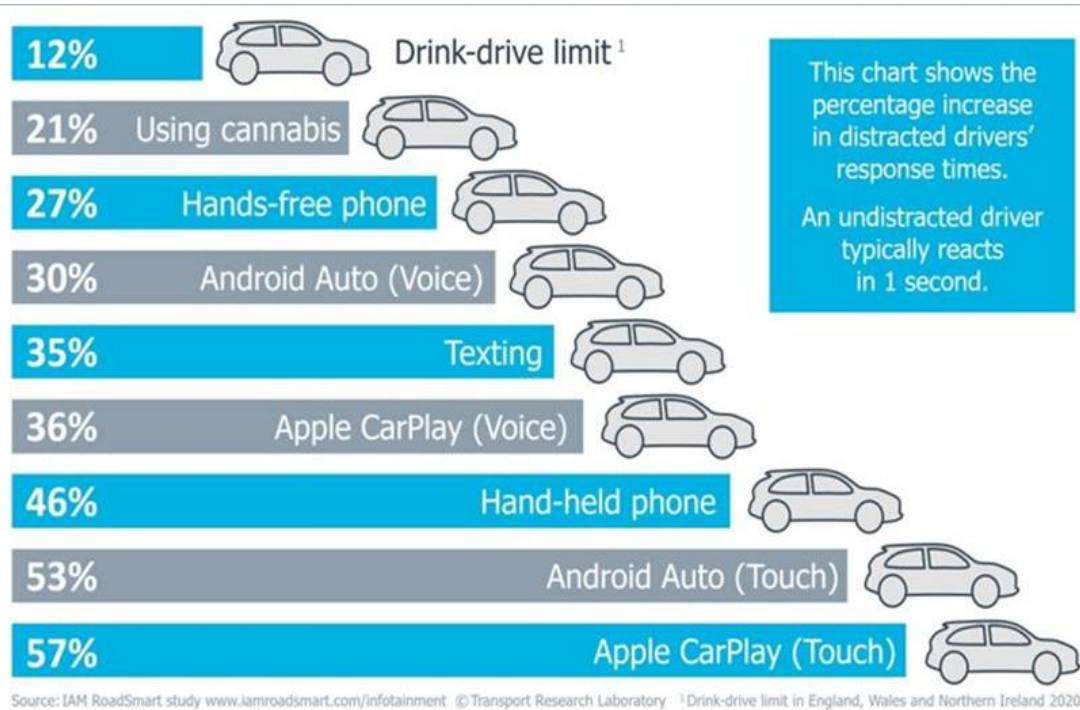
Effectiveness of Apple CarPlay

In 2019, 6% of all drivers that were involved in fatal crashes were reported as distracted at the time of the crashes (Currin, 2018). In 2020, an estimated 7.9% of drivers were reported as either using a handheld device or a hands-free cell phone while driving (“Driver Electronic Device Use in 2020”, 2020). One of the main goals for hands-free technology in vehicles is to decrease the number of distracted drivers on the roads. This in turn is meant to decrease the number of distracted driving related car crashes and deaths. There have been multiple recent studies focused on the effectiveness of hands-free technology decreasing car crashes. All of the available studies were done by independent groups, none were conducted by government affiliated vehicle groups. Research showed that there are currently no regulations in place for the testing of Apple CarPlay and Android Auto at an official government level.

IAM RoadSmart completed a study on how in-vehicle infotainment systems impair reaction times behind the wheel. In this study, drivers completed the same simulated route three times. The first run drivers did not interact with the system, the second run drivers used voice control only, and the third run drivers used the touch control only (*IAM RoadSmart Infotainment Research 2020*, n.d.). Researchers found that stopping distance, lane control, and response to external stimuli all got worse with the use of Android Auto and Apple CarPlay (*IAM RoadSmart Infotainment Research 2020*, n.d.). As seen in Figure 1 below, the research also found that Apple CarPlay can impair driving performance more than alcohol and cannabis use.

Figure 1

How Drivers' Reaction Times Slow



Note: IAM RoadSmart study www.iamroadsmart.com/infotainment Copyright 2020 by Transport Research Laboratory.

The AAA Foundation for Traffic Safety completed a study analyzing the visual and cognitive demands of using in-vehicle information systems, such as Apple CarPlay. Their study included thirty brand new vehicles that came standard with Apple CarPlay, the vehicles were all from the year 2017 and included sedans, trucks, cross overs, and large SUVs. In twenty three, of the thirty total vehicles, hands-free controls were assessed to have required high levels of demand on the drivers (*Visual and Cognitive Demands of Using In-Vehicle Information Systems*, 2017). Seven of the vehicles required moderate levels of demands and none of the vehicles tested required an overall low demand (*Visual and Cognitive Demands of Using In-Vehicle Information Systems*, 2017). The study also assessed which mode of interaction had the highest demand on

drivers. These modes included using voice controls, touch screen, and/or dials. They concluded that all modes of interaction produced a very high overall demand on drivers. Using the touch screen was found to be less demanding than voice controls and voice controls were found to be less demanding than using dials (*Visual and Cognitive Demands of Using In-Vehicle Information Systems*, 2017).

The University of Copenhagen completed a study on the usability of Siri while driving, not Apple CarPlay. Their study found that Siri is likely unsafe for everyday use in the car for most participants. This is in part due to Siri's "over-reliance on visual feedback as well as frequent time-outs by Siri when waiting for a response from a driver" (Larsen et al., 2020). They concluded that interacting with Siri was hands-free but it was not eyes-free nor was it distraction free (Larsen et al., 2020).

The studies discussed above utilized a variety of different methods in order to complete their tests. Meaning, that none of the data collected can accurately be compared to the other studies. It also means that there are some conflicting conclusions. For example, IAM RoadSmart concluded that the least distracting option for Apple CarPlay use was voice controls (Siri is the voice control assistant used by CarPlay) and the University of Copenhagen concluded that Siri was not ready for everyday use in vehicles. One idea of the SCOT framework is citizens as agents, influencing the rules and regulations placed on technology by their governments. A lack of adequate testing in this area leaves room for citizens to voice their concerns and make a change for the safety of everyone. Standardized testing conducted by unbiased groups on hands-free systems in one place to start.

Awareness of Risks

How drivers end up using in vehicle hands-free technology with the level of education they have is a key part of the SCOT framework. Improper education on the effects of hands-free technologies on driver reaction time and attention could lead to an increase in distracted driving related crashes. When manufacturers and technology companies create these tools to use cell phones hands-free while driving, they are making a claim that it is safer than any other phone interaction while driving. Apple's own website claims that their products allow for drivers to be able to "safely use what you love about your iPhone while you drive" (*iOS - CarPlay*, 2011). The IAM RoadSmart study, among others, disproved Apple's claim when they found that using the touch screen in the vehicle led to a longer reaction time than texting while driving and using a hand-held phone while driving (*IAM RoadSmart Infotainment Research 2020*, n.d.). This means that eventually drivers may be involved in a crash and they will find out that the technologies are not necessarily as distraction free as companies claim. Drivers may then be more inclined to use their cell phone rather than the Apple CarPlay system.

Nine percent of drivers fifteen to twenty years old involved in fatal crashes were reported as distracted, this is three percent higher than all other fatal distracted driving crashes (*Distracted Driving 2019*, 2019). Education on this topic will more than likely be difficult but not impossible, starting with technology education during driver's education courses. With the increase in vehicles containing CarPlay, it can be assumed that more teen drivers will have access to CarPlay. If these young drivers are not properly informed of the risks associated with using CarPlay, it can also be assumed that there will be an increase in distracted driving related crashes. Another way to educate drivers easily would be having trained CarPlay experts at dealerships. These experts could walk the driver through the options available to them in their

new vehicle and the risks associated with each. This could lead to a greater number of informed drivers, using the technology safely, over time.

Government officials, another social group based on the SCOT framework, could also play a major role in how citizens are educated on the safe way to interact with hands-free systems. The best way policy makers can do this is by requiring companies to clearly state what the system can and cannot do safely and the potential effects on the drivers ability to operate the vehicles while using said systems. More federal and state regulations could be an easy way to require and provide this information in clear and easy to understand terms. If policymakers fail to step in soon there is a possibility for an increase in distracted driving crashes caused by uneducated drivers manipulating infotainment systems. It is important to note that there is a fine balance between these regulations. The regulations could be designed to inform drivers on the risks to using CarPlay systems while driving, with clear explanations on the limitations. Or they could terrify drivers and unintentionally encourage them to use their handheld devices instead. The regulations would need to highlight how these technologies could be used safely. For example, setting the GPS and music before driving would drastically reduce the driver's interaction with the CarPlay system. Another option for regulations would be to require manufacturers to put a lock into place while the car is moving. This would mean that the CarPlay system would still be up and running, but the driver would be unable to interact with the touchscreen. If done correctly, the driver would still be able to answer phone calls and send text using the buttons on the steering wheel. This is not a perfect solution, it is however, a starting point for better technology options in the future.

Counter Arguments

Currently there are no official studies that prove CarPlay and similar systems have led to an increase in distracted driving related crashes. A study done at the University of Utah aimed to determine how Apple CarPlay use compared to in-vehicle infotainment system use. They concluded that drivers using CarPlay were able to get their eyes back on the road five seconds faster than when making a call and fifteen seconds faster when programming the GPS system (Strayer et al., 2019). This claim assumes that drivers will use their phones one way or another, and that the current CarPlay technology is better than the in-vehicle systems and texting on a handheld device.

Drivers themselves can be argued to be agents of technological change under the SCOT method (Kline & Pinch, 1996). Automobile manufacturers treat drivers as active participants in the social construction of vehicles by taking into account their preferences when designing new technology. Manufacturers assumed that drivers will continue using their phones if a better option was not presented to them, and created Apple CarPlay as that option. I do agree with the claim that most drivers will use their phones in some way while they're driving. However, the assumption that any of these systems are safe is not beneficial to society. Most drivers will look at a study like this and only see the good in it. They will only recognize the conclusion that CarPlay is five seconds faster, without an understanding of how little time it takes to crash when you are distracted. Drivers have the ability to influence the technology that is being developed and integrated into their vehicles. If more drivers understood the risks and spoke up about the lack of options for distraction-free use of cell phones while driving, new technologies would be developed. The lack of education on this topic will lead to problems for many years to come if

not addressed soon. Already there are 240 million cars equipped with Apple CarPlay (*iOS - CarPlay*, 2011). That is potentially 240 million drivers unaware of the risks of this technology.

Solutions and Conclusions

BMW was the first company to introduce gesture control in a vehicle, a technology created by Aptiv. Gesture control allows for drivers and passengers to control the infotainment system without interacting with any buttons or screens (Mobility Insider, 2021). This is done using a camera that can capture hand positions and movements, typically mounted in the roof of the vehicle (Mobility Insider, 2021). Gesture control is one example of manufacturers listening to the needs of consumers and designing new technology to meet those demands. Gesture examples include: “a single finger spun clockwise to turn the radio volume up, a pointing gesture to accept a call, and a swipe gesture to reject a call.”(Mobility Insider, 2021) Since this is relatively new technology, only integrated in a handful of vehicle brands and models, there is very little information on the potential improvement to safety. Aptiv however, claims that “benefits of gesture recognition include improved safety - since drivers do not have to take their attention off the road as much as they would with touch controls.”(Mobility Insider, 2021) The information that is available today shows that gesture control systems may have the potential to decrease distractions while driving. If properly integrated with the vehicle and the CarPlay system, this may mean a substantial reduction in the visual distraction caused by interacting with the touch screens. This technology will only be successful if users are properly educated on the benefits and limitations of it. If not it may lead to drivers resorting to what they know the best, their phone.

The lack of education on proper use of new technologies in vehicles has a potential to negatively affect millions of people. At this point, the best solution is for policymakers to implement regulations focused on the proper use of in vehicle infotainment centers. It is the responsibility of vehicle manufacturers and policymakers alike to educate the drivers of their vehicles. If this is not done, it is reasonable to expect that cities across the country will see an increase in distracted driving related car crashes. New technologies are currently being integrated into a handful of vehicle models, but none of them have been proven to be a safe way to use a cell phone while driving. It is also the responsibility of policymakers to complete safety tests on hands-free technology in vehicles, providing consumers and manufacturers data to analyze the safety of said features. Drivers have the ability to make changes to the technology options in their vehicles if they are willing to put in the effort. If consumers demand changes then manufacturers will find a way to create technology that can be utilized safely while driving. Until this is done effectively however, drivers must be warned of the impact that using Apple CarPlay and similar systems may have on their ability to operate their vehicle safely.

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