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Emotional Affect in Response to Judgments Made in a Modified Trolley Dilemma with Automated Vehicles

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EMOTIONAL AFFECT IN RESPONSE TO JUDGMENTS MADE IN A MODIFIED TROLLEY DILEMMA WITH AUTOMATED VEHICLES

By

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This Graduate Capstone Project was prepared under the direction of the candidate's Graduate Capstone Project Chair, Dr. Kadie H. Mullins, Professor, Daytona Beach Campus, and has been approved. It was submitted to the College of Aviation, School of Graduate Studies in partial fulfillment of the requirements for the degree of Master of Science in Aeronautics

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Abstract

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Numerous studies have been conducted with trolley dilemmas to better understand moral decision making. The first classical dilemma was introduced in 1967 as a philosophical thought experiment (Foot, 1967). It observed how humans decided between the lesser of two evils, sacrificing one person to save many or vice versa, by controlling which track a trolley would travel along. Modified versions of the trolley dilemma have been adapted to human-driven cars to help decide how to set an automated vehicle's ethical decisions (Faulhaber et al., 2018). Other recent work has shown that humans, within a simulated environment, prove to be more utilitarian than they claim to be (Patil, Cogoni, Zangrando, Chittaro, & Silani, 2014). Contissa, Lagioia, and Sartor (2017) outlined various submissions and observations that have been discussed regarding what kind of ethical technology should be implemented into automated vehicles to address and solve this issue. Automated vehicles (AVs) continue to increase in today's market and researchers have modified trolley dilemmas to account for them. Decision making analysis of participants within these modified trolley dilemmas has led researchers to propose numerous ethical theories to base algorithms upon that may be programmed into the AV. This will dictate what actions the vehicle will take in an inevitable crash event. One suggestion is for allowing the users of AVs to pre-program their own customizable algorithm, but this may cause unwanted outcomes and a mandatory ethics setting (MES) is suggested as best for society (Gogoll & Müller, 2017). Limited research has been done exploring exactly how the public's affect in choice would react to being given the ability to program their own algorithm. This study has compared differences of affect and willingness to ride (WTR) of participants involved in either a congruent or incongruent group using an AV in a modified trolley dilemma. The congruent group rode in a simulated AV that performed actions consistent with the algorithm the user preselected; the incongruent group rode in a simulated AV that performed actions that were opposite of the algorithm the user preselected. The groups represent either complete control, congruent, in the selection process of the algorithm versus no control, incongruent. The study utilized an experimental, 2 x 2 mixed design using 44 participants. Tests were conducted in the CERTS lab at Embry-Riddle Aeronautical University using STI Sim Drive simulator software and Logitech driving assembly. Statistical analysis included a 2 x 2 mixed ANOVA. Affect and WTR scores were predicted to significantly differ between participants involved in the congruent group versus the incongruent group and emotions of happiness, anger, and fear were expected to significantly differ between groups. Results showed that although the null hypotheses were retained, several two-way interactions were revealed between the following categories:

- SUFES Happiness and congruency group: $F(1, 42) = 5.142$, $p = .029$, $\eta^2 = .109$
- Affect total and congruency group: $F(1, 42) = 4.199$, $p = .047$, $\eta^2 = .091$

- Affect Favorable and congruency group: $F(1, 42) = 10.017$, $p = .003$, $\eta^2 = .193$
- WTR Confident and congruency group: $F(1, 42) = 6.021$, $p = .018$, $\eta^2 = .125$

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Chapter I

Introduction

Due to the increase in the number of automated vehicles in society and its constant development in technology, it is expected that autonomous vehicles (AVs) will play a significant part in the future of the automotive industry (National Conference of State Legislatures, 2018). According to the National Highway Traffic Safety Administration (2018), there are several automated safety technology features that are currently in use on many vehicles today. These include anti-lock brake systems (ABS), back-cameras, and driver assist features that can help drivers stay in lane and maintain the distance between vehicles in front of them. These automated assistance features are paving the way for car companies to produce full-automated vehicles, cars that do not require any input from a driver aside from setting a destination (National Highway Traffic Safety Administration, 2019). Automated vehicles will aim to improve driving safety by removing the human component, the driver (National Highway Traffic Safety Administration, 2018).

New technologies can add an immense amount of value to everyday life and AVs are no different; they also, however, have their own specific concerns. Even though they can be designed to be much safer than human-driven vehicles, AVs still have the potential to be involved in accidents. Under full automation, the vehicle, not a human, must decide how to maneuver itself in an inevitable crash scenario. In this case, it has been argued that it would be unethical to simply ignore this possibility and if the human passenger cannot make a decision for him or herself in the moment of a crash, shouldn’t the AV be prepared for such a scenario? Hence the idea of the potential to have a preprogrammed ethical algorithm within the AV to decide how it should behave in these dilemmas came to be.

Humans have studied ethics for thousands of years and several ethical theories and practices have come about in that time but testing the user reaction to the ability of full control of what ethics setting in place remains a poorly researched subject. This study aims to shed light on the consumer's affect and willingness to ride an AV with full control of this setting versus no control.

Significance of the Study

Conclusions drawn from this study should be found useful by car manufacturers who are looking to develop AVs, legislative bodies who write laws for vehicle regulations, and for potential future AV consumers. This study is not meant to provide an answer to which type of ethical implementation AVs should receive or if a personal ethics setting (PES) should be chosen over an MES. The research from this study should be used as a guideline for future development and further research into the types of ethics programmed into AVs. The research should give insight to consumers' specific reactions, affect and WTR, from having a version of a PES into their AVs and the outcome of affect and willingness to ride after the PES are either followed or not followed in the event of a modified trolley dilemma.

Statement of the Problem

Debates concerning the implementation of ethics into AVs have arisen through previous research. This was a concern because in the event of an unavoidable accident an ability to implement ethical actions would dictate how the AV would react. Ethical theories have been established as possibilities to apply to AVs. Research from Bonnefon, Shariff, and Rahwan (2016) has shown that when it comes to life or death situations in these dilemmas, consumers can have mixed feelings of a utilitarian AV that although is instructed to save as many lives as possible, may do so even at the expense of the life of the user. Cases such as this may severely affect consumer purchase and adoption of these vehicles to society. The possibility has been introduced of a PES where the user of the AV can implement ethical action customizable to them, however, little research has explored how users are affected by this feature.

This may be, in part, from the debate that an MES is best for society because customizable settings may produce unwanted outcomes (Gogoll & Müller, 2017). Without this information, it is difficult to truly justify what is best for the user without properly gauging user feedback from their experience with a PES.

Purpose Statement

The purpose of this study was ultimately to examine if there exists a significant difference in the emotional affect and WTR of the users that are given complete control of preprogramming an ethical setting dictating the actions of their AVs in the event of an unavoidable crash versus those users with no control. Finding a significant difference toward the former may reveal that consumers of AVs are more willing to invest in technology that does not completely remove driver decisions. This research may give insight into the mixed feelings from customers regarding AVs in trolley dilemmas from previous studies (Bonnefon, Shariff, & Rahwan, 2016).

This study aims to look further within the possibility of implementing customizable ethics into AVs and seeing if affect and willingness to ride toward an AV is significantly different if the user experiences full control of the ethics setting versus no control.

Research Question and Hypotheses

This research addresses questions regarding affect and WTR of participants in AVs, it has been guided by the following question.

Research Question: If users of an automated vehicle were actually given full control of preprogramming an ethical setting that would dictate the actions of the vehicle in a modified trolley dilemma versus no control, would the users' emotional affect in response to judgments made in the modified trolley dilemma significantly differ?

The following research hypotheses were tested:

H1: Affect scores will significantly differ between participants involved in the congruent group versus the incongruent group.

H2: WTR scores will significantly differ between participants involved in the congruent group versus the incongruent group.

H3: Happiness, anger, and fear emotions will significantly differ between the congruent and incongruent groups.

Delimitations

The scope of the research was deliberately limited to the amount of time bestowed for the MSA 691 Graduate Capstone Research Project (GCP) course. Within the five-month time period, the researcher needed to ensure the entire study was carried out and properly reported in the GCP template. With this in mind, the researcher decided to limit the time to conduct the actual study within a three-week time period to allow for data analysis and proper reporting.

Another delimitation is presented by the accessibility of participants as the researcher has primary access to students, staff, and faculty of Embry-Riddle Aeronautical University.

Limitations and Assumptions

The following limitations were established for this study:

1. The current state of the industry. Automated vehicles are still evolving and currently in today's market there is not an automated vehicle that exists that

features full automation and the ability for users to preprogram any sort of ethical selection in an unavoidable accident. There is the possibility that current perceptions of participants' views on automated vehicles are affected by the amount of knowledge consumers are exposed to today which may ultimately change in the coming years. Consumers' views may change as the years continue and further knowledge is gained by the increase in technology that automated vehicles receive by research.

2. The sample provided for this study does not accurately represent the entire population of the United States of America. The sample is limited to the convenience sample which stems from the researcher's ability to recruit participants from Embry-Riddle Aeronautical University.
3. Self-reporting and surveying. There is a chance that participants wrongfully respond to any questions provided by the researcher, which has the potential to lead to bias responses and skew the final data.
4. A time limitation may exist as this research must be conducted within the time span of five months.

Definitions of Terms

Trolley Dilemma — The first classical dilemma was introduced in 1967 as a philosophical thought experiment (Foot, 1967). It observed how humans decided between the lesser of two evils, sacrificing one person to save many or vice versa, by controlling which track a trolley would travel along.

Altruistic	Referring to an ethical mode setting for AVs that gives a preference for third parties in dealing with situations in the trolley dilemma (Contissa, Lagioia, & Sartor, 2017).
Egoistic	Referring to an ethical mode setting for AVs that gives preference for passenger(s) in dealing with situations in the trolley dilemma (Contissa et al., 2017).
Impartiality	Referring to an ethical mode setting for AVs that instructs that the lives of AV passengers have equal weight as the lives of other pedestrians in dealing with situations in the trolley dilemma (Contissa et al., 2017).

List of Acronyms

ADS	Automated Driving Systems
AEB	Automatic Emergency Braking
AV	Automated Vehicle
CERTS	Cognitive Engineering Research in Transportation Systems
CIB	Crash Imminent Braking
DBS	Dynamic Brake Support
MES	Mandatory Ethics Setting
MPH	Miles per Hour
NHTSA	National Highway Traffic Safety Administration
PES	Personal Ethics Setting
SPSS	Statistical Package for Social Sciences
STI	Systems Technology Incorporated

SUV	Sport Utility Vehicle
VR	Virtual Reality
V2V	Vehicle-to-Vehicle Communication
WTR	Willingness to Ride

Chapter II

Review of the Relevant Literature

There is little doubt that the automotive industry is in a technological race to innovate and craft the best design of a fully automated, self-driving vehicle. According to the United States Department of Transportation National Highway Traffic Safety Administration (NHTSA), fully autonomous cars and trucks will become a reality (NHTSA, 2018). They define automation levels from zero to five where, at full automation or full autonomy, the vehicle has the capability to perform all driving functions under all conditions in which the driver may have the option to control the vehicle (NHTSA, 2018). Automated vehicles are one of the most important innovations in transportation history because of the development of Automated Driving Systems (ADSs) that have the potential to significantly reduce highway fatalities (NHTSA, 2017). Increased speed in the production of automated vehicles has been speculated due to the expected advantages (Faulhaber et al., 2018).

Benefits of Automated Vehicles and Their Technologies

The evolution of automated vehicle technology has already benefited the roadways with life-saving driver assistance capabilities. Automated systems can analyze information about kinematics such as range, speed, and position relative to other vehicles on the road (Stanton & Salmon, 2009) and use this information in features like automatic emergency braking (AEB), dynamic brake support (DBS), and crash imminent braking (CIB) (NHTSA, 2018). NHTSA stresses the importance of the change this technology brings to society because, in 2015, 33.4 percent of all police-reported crashes involved rear-end collisions with another vehicle (NHTSA, 2018). NHTSA (2018) recommends both CIB and DBS systems that meet the NHTSA's performance specifications, which is an option on many new cars, SUVs, and trucks.

Some studies (e.g., Leong, 2018; Stern et al., 2018) have highlighted how humans have the natural tendency to create oscillations, sometimes identified as stop-and-go waves, within human driving. Stern et al. (2018) demonstrated how the implementation of autonomous cars have the ability to control traffic flow by dissipating these waves that translate positively toward reducing fuel consumption and braking events. The added presence of the autonomous vehicle proved effective when placed to interact with the fleet of 21 passenger vehicles with drivers who were instructed to drive as if they were in rush hour traffic (Stern et al., 2018). A percentage of autonomous vehicles as low as 5 percent reduced total fuel consumption by up to 40 percent and braking events by 99 percent because they dissipated stop-and-go waves in traffic (Stern et al., 2018). Bergmann et al. (2018) mentioned that automated vehicles are not only approaching the capabilities of human drivers but will eventually outperform them.

Vehicle to Vehicle communication (V2V) has been tested by MCity, a public-private partnership with University of Michigan, to allow autonomous prototypes to increase safety by wirelessly sharing location, speed, and direction data (Krishna, 2017). Automated vehicles' ability to communicate with each other allows for the identifying of the most optimal route, smoothing traffic flow, and reducing traffic congestion (Futurism, 2015; NHTSA, 2018).

There are expected advantages to arise from the implementation of automated vehicles in society including higher mobility for those unable to drive or may have difficulty driving (Faulhaber et al., 2018). This includes the elderly, persons suffering from fatigue, or persons with disabilities (Faulhaber et al., 2018). These are some of the benefits that automated vehicles bring to society.

Some automated vehicle technology contains the ability to perceive objects beyond immediate surroundings to include sensing red lights around a blind curve or automatic braking for a vehicle that is running a stop sign (Krishna, 2017). The removal of the human driver could have many promising incentives for consumers, both inside and outside of the vehicle. It can decrease accidents due to its increased precision and situational awareness that easily surpasses human capabilities. Human-induced traffic accidents are one of the largest causes of death and injury in the world; introducing automated vehicles to the roadways can save lives (Bergmann et al., 2018).

This applicable foresight raises questions concerning liability in the event of an accident if the human is no longer expected to be at the wheel. Research has been done regarding automated behavior in moral dilemma situations. This has led to much debate as to what possible algorithms could be programmed into the vehicle that would constitute the series of actions that would take place in unforeseeable events where a crash was inevitable or any situation where harm to persons is deemed unavoidable (Contissa et al., 2017). Studies have experimented with allowing users of automated vehicles to adjust the ethical standards of the vehicle to be more altruistic or egoistic for each drive (Contissa et al., 2017).

Moral Theories

The following moral theories are some of those that have been commonly discussed when proposals for different types of algorithms for automated vehicles have been considered.

The doctrine of doing and allowing. This position identifies that taking action within a situation that can only lead to bad outcomes would make one guilty (Bergmann et al., 2018). Therefore, the reasonable action is to not take any action.

Deontology. This theory does not justify action via consequences (Bergmann et al., 2018). It instead justifies each individual action based on its rightness or wrongness against moral society norms (Bergmann et al., 2018).

Utilitarianism. This theory represents consequentialism, where moral rightness or wrongness of actions depends on the quality of the action's consequences (Bergmann et al., 2018).

Ethical Egoism. This theory implies that the importance of the passengers' lives outweighs the importance of other people's lives (Contissa et al., 2017). Therefore, it is expected the AV should always act so as to sacrifice pedestrians or passers-by rather than its own passengers (Contissa et al., 2017).

Ethical Altruism. This theory implies the importance of other people's lives outweighs the importance of the life of the passenger. Therefore, it is expected the AV should always sacrifice its own passengers in order to save the lives of other people (Contissa et al., 2017).

Ethical Impartiality. This theory implies the lives of AV passengers has equal footing as the lives of other people. Therefore, it is expected the AV determines which life will be saved based on a utilitarian approach that chooses the option which minimizes the total number of deaths (Contissa et al., 2017).

Trolley Dilemma

The moral theories summarized above have been discussed with various versions of the trolley dilemma. The first classical dilemma was introduced in 1967 as a philosophical thought experiment (Foot, 1967). It observed how humans decided between the lesser of two evils, sacrificing one person to save many or vice versa. Modified versions of the trolley dilemma have been adapted to human-driven cars to help decide how to set an automated vehicle's ethical decisions (Faulhaber et al., 2018). Other recent work has shown that humans in practice, within a simulated environment, prove to be more utilitarian than they claim to be (Patil, Cogoni, Zangrando, Chittaro, & Silani, 2014). Contissa et al. (2017) outlined various submissions and observations that have been discussed regarding what kind of ethical technology should be implemented into automated vehicles to address and solve this issue.

The Usefulness of Simulated Environments for Modified Trolley Dilemmas

Navarrete, McDonald, Mott, and Asher (2012) used immersive virtual reality (VR) to place participants into trolley dilemmas to address relationships between moral judgment and moral behavior. VR can create simulated environments that aid in the study of trolley dilemmas in a more ecologically valid manner than a text-based study (Patil et al., 2014). Simulated environments have been shown to replicate trolley dilemma text-based study results for moral judgments, which are central to social behavior (Skulmowski, Bunge, Kaspar, & Pipa, 2014).

Simulated environments can be advantageous over simple text or still image-based questionnaires by being able to elicit stronger emotional engagement (Patil, et al., 2014). The emotional arousal of studies in simulated environments have been proven to be higher than text-based questionnaires and measured by skin conductance response (Patil, et al., 2014) and eye and pupil tracking (Skulmowski, et al., 2014). Simulated environments also allow for the study of ethically difficult to create moral dilemmas due to the violent nature or dangerous situations presented (Patil, et al., 2014).

Affect, Willingness to Ride, and Driverless Vehicles

Affect has been found to be a mediating variable, suggesting that emotions are factors in an individual's WTR in a driverless vehicle (Anania et al., 2018; Winter, Keebler, Rice, Mehta, & Baugh, 2018). Three studies were carried out by Winter et al. (2018); those findings indicated that the participants were less willing to ride in a scenario given where an ambulance had an autonomous configuration rather than traditional. The significant difference identified between the two conditions also demonstrated specifically that anger was the mediated relationship between configuration and WTR for females and that happiness mediated for males (Winter et al., 2018).

The participants were reported to feel better within the hypothetical scenario involving traditional versus automated configuration in an ambulance (Winter et al., 2018). It was speculated that participants who would be the consumers of the automated ambulance require reliability and predictability. Consumers having lesser knowledge of the amount of reliability and predictability of the automated vehicle may cause increased stress levels especially during times where one may require an ambulance (Schwarz, 2000; Winter et al., 2018).

In another study by Anania et al. (2018), participant data was collected to identify the willingness to allow their children to ride in an automated configuration of a school bus versus traditional. Interest on this topic stemmed from possibilities that automated vehicle technology may be applied to mass transport vehicles (Anania et al., 2018). Participants were found to be less willing to have their children ride within automated versus traditional configuration of vehicle and happiness was the only emotion that mediated in all four conditions used (Anania et al., 2018).

When it comes to a life or death situation, where the automated vehicle may have to perform a self-sacrifice and potentially injure or kill the user inside it, it can cause consumers to have mixed feelings towards the vehicle, their WTR in the vehicle, and their willingness to purchase the vehicle for themselves (Bonnefon, Shariff, & Rahwan, 2016). Gogoll and Müller (2017) highlight that, automated vehicle programming to allow consumers the choice on sacrifices made in inevitable crash events, is not the best solution as it may lead to socially unwanted outcomes and that a mandatory ethics setting is considerably best for society. There has been limited research exploring exactly how the public's affect in choice would react to being given the ability to implement their own algorithm.

This study aims to explore that gap in knowledge by giving participants the hypothetical ability in a driving simulation to pre-select a simplified algorithm for a personalized ethical setting that will determine what the automated vehicle will sacrifice if placed into a modified trolley dilemma. This study was conducted as an experimental, 2 x 2 mixed design. The independent variable was defined as the ability of the participant to have full or no control of the algorithm implemented into the automated vehicle. Other factors to consider were the gender of participants. The dependent variable was defined as the participants' WTR and affect measurements with the sacrificial outcome of the driving simulator event. Both groups of participants will be rating judgment of specific emotions, affect, after the automated outcome has been pre-selected and the driving simulation concludes. To operationally define these variables, WTR was measured by using a validated 7 item WTR 5-point Likert scale from Strongly Disagree (1) to Strongly Agree (5) (see Appendix B). Affect was measured by filling out a specific emotions numerical scale from 0 to 10 which is based on images of facial expressions of the six universal emotions (Ekman & Friesen, 1971). This is to explore and analyze how participants feel about sacrifices made based on having or not having control in automated vehicles. Based on the research from Anania et al. (2018) and Winter et al. (2018), predictions for this study were that WTR scores between both the congruent and incongruent groups would demonstrate a significant difference and that the specific emotions of happiness, anger, and fear would also demonstrate a significant difference between groups.

Summary

The trolley dilemma has gone through multiple modifications, especially since the creation of AVs. The trolley dilemma has become increasingly poignant as AV technology progresses toward full automation and the elimination of the human driver. It places a whole new perspective on the decision-making process in life or death situations. Past research has found that humans are uncomfortable in situations where full-automation takes over the decision-making process. Even though the majority of participants come to a consensus and agree on a particular ethical setting for all situations, when it comes to purchasing the vehicle and becoming the user themselves in the scenario, it raises concern and hesitation.

There have been suggestions made toward implementing a PES that could be pre-adjusted, before beginning a drive, in the event of these trolley dilemmas. This suggestion could be a possible benefit toward users with this concern as well as become a possible solution for a newer AV issue concerning who should be held responsible in the event damage occurs from the dilemma. If a PES is pre-adjusted before the drive by the user, the user is taking responsibility in their hands if such an event does occur, which may clear up some confusion as to what may happen if the AV would designate its own actions.

Although various levels of automation exist in some vehicles today, a vehicle with full automation and the ability to select a PES does not exist. Few studies have been made exploring the affect and willingness to ride in such a vehicle. To test if consumers would be willing to ride in an AV of this specificity and examine their affect via pre- and post-test survey, it would be most beneficial to the researcher to provide a simplified and safer experiment with the aid of a virtual environment. Here, participants can experience their control or their lack of control of PES and witness the associated outcome from their decisions via a virtual environmental simulation which has the ability to evoke stronger emotional engagement and arousal than a text-based hypothetical scenario. It is beneficial that it can be used to produce feedback closer toward the true environment and eliminates the ultimate physical danger typically involved within trolley dilemmas.

The simplified PES to be used in this study involved four selections based on moral theories such as ethical egoism, utilitarianism, the doctrine of doing and allowing, and ethical altruism.

Chapter III

Methodology

Research Approach

In order to determine if a relationship exists, and to better understand what that relationship may involve, between full control of the PES of an AV and the participant's WTR, emotional affect, and which specific emotions are being evoked, this study utilized a relational and experimental causal approach.

Design and procedures. The research design focuses on causality as a means to obtain data where the possibility of a significant cause and effect relationship may exist between control levels of a PES (IV) and affect and WTR (DV). The research design is focused upon the research question that if users of an AV were given either full or no control of a PES, would the users' emotional affect in response to judgments made in a modified trolley dilemma and WTR scores toward AVs significantly differ between the groups?

The researcher ensured that every participant experienced the procedures in the same order with the exception of the driving simulation presented to participants based on whether they were placed in either congruent or incongruent groups. Participants who chose to volunteer for the study contacted the researcher to set up an appointment for when they would be available to participate.

The experiment took place over three weeks, where participants were randomized into either the congruent or incongruent group for the experiment. Randomization took place as participants volunteered. This process was completed with the aid of True Random Number Service (Haahr, 2019) where numbers 1 through 48 were randomized into two columns with no repeating values. The numbers 1 through 2 were randomized to determine which column the researcher would first use to begin assigning numbers to participants. The first participant to volunteer would receive the first number on this column and other participants would receive the following numbers in that column until the entire column was used. After this, participants would go on to be assigned the numbers from the second column. Depending on the number the participant was assigned determined which group they were a part of. Odd numbers would be part of the congruent group and even numbers would be part of the incongruent group.

Once the experiment began, participants were escorted into the CERTS lab individually, by the researcher. The researcher then presented the consent form required to be filled out for each individual participant. When the form was completed, the researcher directed the participant to read a laminated sheet that contained instructions for the study and the hypothetical scenario (see Appendix B). After the scenario had been read, both groups of participants received a pen-and-paper survey that contained the Six Universal Facial Emotions, Affect, and WTR scale (Winter et al., 2018) (see Appendix B). Once the survey was completed, participants received a sheet of paper with the fully automated vehicle programming question (see Appendix B).

After the congruent group participant made his or her selection, the researcher then uploaded the pre-recorded driver simulation that was in agreeance with the participant's most preferred preprogrammed selection. Based on the choice that the incongruent group participant selected, the researcher then uploaded the pre-recorded driver simulation that was associated with the participant's least preferred rank. Both groups of participants would only observe the simulation while sitting at the wheel. This was meant to give participants the experience of riding within a fully automated vehicle.

The simulation for both groups contained the participant's vehicle that would accelerate, via automated driving, to 30 MPH. At 1,400 FT driven, the roadway would become blocked

50 FT in front of the vehicle by the following: a large crate blocking the opposing lane, a small child walking across the road from the left side and stopping between both lanes, and two adults walking from the right side of the road stopping in the right lane. The automated vehicle would adhere to the ranking, most preferred for congruent group participants and least preferred for incongruent group participants, made by the participant prior to the simulation beginning (see Appendix B).

For both groups, the vehicle being involved in a collision would end the simulator portion of the test. The researcher would then inform the participant of the consequences of the event from a laminated paper (see Appendix B). The researcher would then give the participant the pen-and-paper surveys consisting of the Six Universal Facial Emotions, Affect, and WTR scales (Winter et al., 2018) (see Appendix B). Once the survey was completed, participants received a sheet of paper with the post-simulator questionnaire (see Appendix B). Data were recorded on both groups of which object was chosen to be collided with during the unavoidable collision: their own person and vehicle, the crate, the small child, or the two adults. Participants were debriefed after completing the post-simulator questions (see Appendix B). Debriefing included the reasons for the study.

Apparatus and materials. The G*Power 3 program was used to calculate the necessary total sample size for the study (Faul, Erdfelder, Lang, & Buchner, 2007). True Random Number Service (Haahr, 2019) was used in order to properly randomize the participants in the study into two groups. This service was also used to randomize the six survey items within the Six Universal Facial Emotions scale (see Appendix B). The laboratory equipment utilized to allow participants to experience a driving simulation includes the STI Sim Drive software (Version 3.09.02; STISIM Drive, 2017) to create and run the simulated environments, a computer to run the software and display simulation visuals, Logitech driving steering wheel, accelerator and brake pedals, and gearshift assembly for participants to experience a more immersive simulation although participants did not need it to operate the simulation. Four pre-recorded simulation runs, created by the researcher from the STI Sim Drive software, simulated the vehicle driving autonomously for participants in both congruent and incongruent groups. The experiment was conducted within the Cognitive Engineering Research in Transportation Systems (CERTS) lab at Embry-Riddle Aeronautical University.

Statistical Package for Social Sciences (SPSS™) software was used for sorting and analyzing the recorded data. During the experiment, the researcher dispersed forms to participants and recollected them after they were completed. This included a hard-copy consent form that participants signed prior to participation in the experiment. Five laminated sheets of paper were used, one contained instructions for the experiment including driving simulator instructions and the scenario synopsis. The other four sheets of laminated paper contained the scenario outcomes displayed separately.

A pen-and-paper survey was issued to participants before and after the driving simulation that contained the Six Universal Facial Emotions, Affect, and WTR scales (see Appendix B). Scales have been chosen using previous research from Winter et al. (2018), showing that significantly different affect scores and several specific emotions were present depending on vehicle configuration. Additional post-simulator questions were asked through a paper and pen survey that included questions regarding satisfaction of driving simulation outcome, feelings of control in the situation, willingness to ride in an automated vehicle if the scenario was redone, and the participant’s age and gender (see Appendix B).

Population/Sample

To recruit participants, the researcher utilized flyers that were posted around various locations at Embry-Riddle Aeronautical University. Participant requirements that the flyers specified included the possession of a valid U.S. driver's license and the need to be of 18 years of age or older. A total of 44 candidates were selected and randomized equally into either the congruent group or the incongruent group. Participants were compensated a sum of $5.00 for their participation in the study.

The population to which the results may be generalized is to Embry-Riddle Aeronautical University Daytona Beach campus students in the United States of America.

Sources of the Data

The raw data for this study was experimentally generated. There were no other outside sources used in addition to this. Quantitative data was collected from both the pre- and post-test surveys to generate means for WTR, affect, and the six universal facial emotions. Quantitative data was collected from the pre-test survey to determine reliability.

Data Collection Device

The data collection device was based on a pre- and post-survey test administered to each participant in both congruent and incongruent groups. Each pre- and post-survey contained the six universal facial emotions scale (Ekman & Friesen, 1971; Winter et al., 2018), Affect scale (Winter et al., 2018), and WTR scale (Anania et al., 2018; Winter et al., 2018). The scales listed were obtained from previous scales used in research via Winter et al. (2018) and Anania et al. (2018) regarding automated vehicles. The pre- and post-survey type allowed each individual participant to be truthful in their responses.

Instrument reliability. The researcher decided to perform the study with as little verbal input as necessary. This was to diminish the effect of speech or tone of voice towards the participant and between each participant. This was chosen to ensure that the information was given to each participant under the exact same conditions. This is why it was chosen to provide the instructions for the study as well as the driving scenario outcome via laminated paper. Especially for the driving scenario outcome of the modified trolley dilemma, which may evoke some minor emotional discomfort, the researcher thought it best to have the participant read their outcome rather than have the possibility of the researcher's tone in verbally announcing the outcome affect the genuine response of the participant.

The exact same survey instruments were administered to both groups to ensure the data collection device did not change to possibly skew results and procedures were standardized to ensure every participant would have the same treatment aside from the IV.

The researcher decided to have the experiment held within the CERTS lab to ensure the participant had little outside distraction that may influence their response to the survey or driving simulation.

Instrument validity. The Six Universal Facial Emotions, Affect, and WTR scales were used from previous research from Winter et al. (2018) and Anania et al. (2018) to increase the validity of this study. Concerning specifically content validity, each scale item contains terminology or images that consist of various facets of the content to aid the scale to cover a greater picture of the construct they would measure. For example, the items within the WTR scale contain wording that differs from each other, but each term contributes an effective part towards feelings of willingness (i.e., comfortability, having no problems toward the action, happiness, feelings of safety, having no fear toward the action, and confidence). Likewise, items within the Affect scale contain various aspects of positive feelings that cover a broader picture of a positive affect rather than focusing on one word to summarize the entire construct. Although the Affect scale may contain only positive terminology to explain affect, when participants choose to select varying levels in the opposite direction, the researcher can get a better understanding of how contrary towards those branches of affect they are experiencing.

In regard to criterion-related validity, this study should provide affect and WTR results much closer to what may occur in the real-world environment versus results that may have been demonstrated using only hypothetical text-based scenarios. The use of the Logitech driving assembly is meant to increase mundane realism and the STI Sim Drive simulator software gives the ability to allow the researcher to increase experimental realism that simply cannot be replicated via hypothetical text scenarios. The software gives the ability to provide further experimental realism in an ethical manner as it is would not be ethical to allow participants to undergo a real-life trolley scenario.

The ability to perform the experiment in a lab setting, however, while decreasing some of the external validity, allowed further control of what the participant would experience and therefore increases internal validity.

Treatment of the Data

All data collected in this experiment were treated confidentially and all analyses performed were done using the SPSS™ software package. Data collected from the paper and pen surveys utilized in the experiment were coded, as necessary, into numerical values.

Descriptive statistics and hypotheses testing. The data collected from each of the participants' pre- and post-test surveys represented the following: The Six Universal Facial Emotions scale (SUFES) total score and individual scores for each specific emotion (i.e., anger, disgust, fear, happiness, sadness, and surprise), the Affect scale total score and individual scores for the various aspects of affect (i.e., good, positive, favorable, cheerful, happy, enthusiastic, and delighted), the WTR scale total score and individual scores for the various aspects of WTR (i.e., willing, comfortable, no problem, happy, safe, no fear, and confident), participants' ranking of each ethical setting (i.e., ethical egoism, utilitarianism, the doctrine of doing and allowing, and ethical altruism), satisfaction, control, willingness, age, and gender. The measures of central tendency were examined for each of the aforementioned data categories and analyzed to see if there was a significant difference between groups.

The design employed was a 2 x 2 mixed ANOVA design with the between-subjects factor of control of the automated vehicle's PES, with two levels (i.e., congruent and incongruent). The second factor was the within-subjects factor of pre- and post-test survey with two levels (i.e., pre- and post-test). The 2 x 2 mixed ANOVA design was used to test each of the research hypotheses H1 through H3 as well as an independent *t*-test that was used in the event a two-way interaction between congruency groups was identified.

Reliability testing. Comparison of means of pre-test scores was done to ensure there was no inherent bias amongst the participants.

Chapter IV

Results

The main results observed in this study consist of measures of central tendency and other statistics drawn from the Six Universal Facial Emotions, Affect, and WTR scale data generated from each participant. Both pre-tests' means gathered from the congruent (i.e., full control of the PES) and incongruent (i.e., no control of the PES) groups were compared to test for significant differences between groups.

For all three hypotheses created in the study, the researcher failed to reject the null. These results are based on the 44 participants that completed the study with a mean age of 22.07. Of these participants, 32 were male and 12 were female.

The study revealed that, although there were no significant main effects of the between-subjects factor congruency (i.e., congruent, incongruent) group as the research hypotheses had mentioned, there were several two-way interactions that were revealed between the following categories listed below. See Chapter V: Significance of Results for more in-depth information about the interaction effects.

- The two-way interaction between SUFES Happiness and congruency group was statistically significant: $F(1, 42) = 5.142$, $p = .029$, $\eta^2 = .109$.
- The two-way interaction between Affect total and congruency group was statistically significant: $F(1, 42) = 4.199$, $p = .047$, $\eta^2 = .091$.
- The two-way interaction between Affect Favorable and congruency group was statistically significant: $F(1, 42) = 10.017$, $p = .003$, $\eta^2 = .193$.
- The two-way interaction between WTR Confident and congruency group was statistically significant: $F(1, 42) = 6.021$, $p = .018$, $\eta^2 = .125$.

Both congruent and incongruent groups demonstrated the same preferential ranking of PES according to mode values. With 1 symbolizing participants' most preferred choice to 4 symbolizing their least preferred choice of ethical setting, the results showed Egoism with a mode value of 1, Utilitarianism with a mode value of 2, Altruism with a mode value of 3, and the Doctrine of Doing and Allowing with a mode value of 4. This means both groups preferred Egoism as their first preferred choice of ethical setting into the AV and the ethical setting following the Doctrine of Doing and Allowing was their least preferred choice.

Descriptive Statistics

The data collected from each of the participants' pre- and post-test surveys represented the following: The Six Universal Facial Emotions scale (SUFES) total score and individual scores for each specific emotion (i.e., anger, disgust, fear, happiness, sadness, and surprise), the Affect scale total score and individual scores for the various aspects of affect (i.e., good, positive, favorable, cheerful, happy, enthusiastic, and delighted), the WTR scale total score and individual scores for the various aspects of WTR (i.e., willing, comfortable, no problem, happy, safe, no fear, and confident), participants' ranking of each ethical setting (i.e., ethical egoism, utilitarianism, the doctrine of doing and allowing, and ethical altruism), satisfaction, control, willingness, age, and gender. The measures of central tendency were examined for each of the aforementioned data categories and analyzed to see if there was a significant difference between groups.

For overall descriptive statistics for each data category collected for each of the groups, see descriptive statistics tables in Appendix C. Table C1 shows the overall descriptive statistics (i.e., N, mean, standard deviation) for the Six Universal Facial Emotions Scale collected in the study. Table C2 displays descriptive statistics for each individual emotion within SUFES. Table

C3 shows the overall descriptive statistics for the Affect scale. Table C4 displays descriptive statistics for each individual aspect of positive feeling within the Affect scale. Table C5 shows the overall descriptive statistics for the WTR scale. Table C6 displays descriptive statistics for each contributive aspect towards feelings of willingness within the WTR scale.

Significance of Results

The SUFES total score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES pre- and posttest total scores for each group. The main effect of the within-subjects factor SUFES total was statistically significant: $F(1, 42) = 65.759$, $p < 0.001$, $\eta^2 = .610$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .186$, $p = .668$, $\eta^2 = .004$. The two-way interaction between SUFES total and congruency group was not significant: $F(1, 42) = .004$, $p = .950$, $\eta^2 < .001$.

SUFES Anger score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES Anger pre- and posttest scores for each group. The main effect of the within-subjects factor SUFES Anger was statistically significant: $F(1, 42) = 88.070$, $p < 0.001$, $\eta^2 = .677$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .123$, $p = .727$, $\eta^2 = .003$. The two-way interaction between SUFES Anger and congruency group was not significant: $F(1, 42) = .196$, $p = .660$, $\eta^2 = .005$.

SUFES Disgust score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES Disgust pre- and posttest scores for each group. The main effect of the within-subjects factor SUFES Disgust was statistically significant: $F(1, 42) = 14.031$, $p < 0.001$, $\eta^2 = .250$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 1.011$, $p = .320$, $\eta^2 = .024$. The two-way interaction between SUFES Disgust and congruency group was not significant: $F(1, 42) = .002$, $p = .968$, $\eta^2 < .001$.

SUFES Fear score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES Fear pre- and posttest scores for each group. The main effect of the within-subjects factor SUFES Fear was statistically significant: $F(1, 42) = 179.045$, $p < 0.001$, $\eta^2 = .810$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 1.453$, $p = .235$, $\eta^2 = .033$. The two-way interaction between SUFES Fear and congruency group was not significant: $F(1, 42) = .176$, $p = .677$, $\eta^2 = .004$.

SUFES Happiness score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES Happiness pre- and posttest scores for each group. The main effect of the within-subjects factor SUFES Happiness was statistically significant: $F(1, 42) = 165.545$, $p < 0.001$, $\eta^2 = .798$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .742$, $p = .394$, $\eta^2 = .017$. The two-way interaction between SUFES Happiness and congruency group was significant: $F(1, 42) = 5.142$, $p = .029$, $\eta^2 = .109$.

SUFES Happiness scores were higher in the pretest incongruent group ($M = 8.32$, $SD = 2.079$) than in the pretest congruent group ($M = 6.77$, $SD = 2.409$). An independent *t*-test showed that the difference between pretest SUFES Happiness congruency was statistically significant ($t = -2.278$, df = 42, $p = .028$). Equality of variance was met. The magnitude of the differences in the means (mean difference = 1.55, 95% CI: -2.915 to -.176) was medium ($d = 0.69$).

See Figure 1 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each pretest congruency condition.

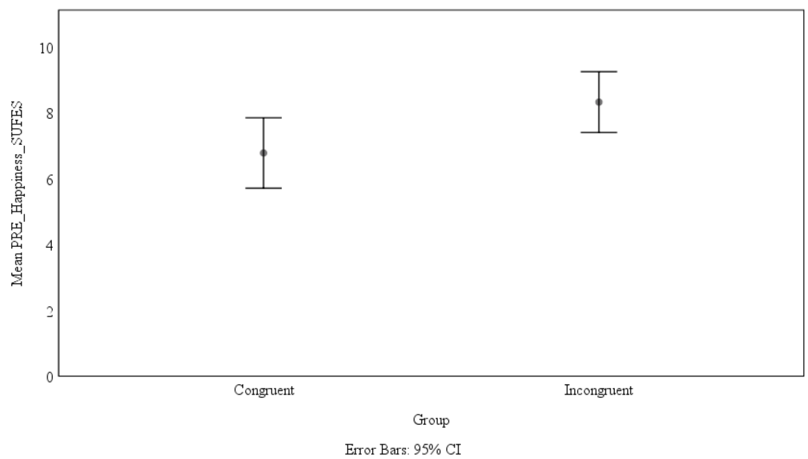

Figure 1. Simple Error Bar Mean of Pretest SUFES Happiness by Congruency Group.

SUFES Sadness score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES Sadness pre- and posttest scores for each group. The main effect of the within-subjects factor SUFES Sadness was statistically significant: $F(1, 42) = 201.540$, $p < 0.001$, $\eta^2 = .828$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .442$, $p = .510$, $\eta^2 = .010$. The two-way interaction between SUFES Sadness and congruency group was not significant: $F(1, 42) = 1.354$, $p = .251$, $\eta^2 = .031$.

SUFES Surprise score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the SUFES Surprise pre- and posttest scores for each group. The main effect of the within-subjects factor SUFES Surprise was not statistically significant: $F(1, 42) = .054$, $p = .817$, $\eta^2 = .001$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 1.411$, $p = .241$, $\eta^2 = .033$. The two-way interaction between SUFES Surprise and congruency group was not significant: $F(1, 42) = .089$, $p = .767$, $\eta^2 = .002$.

The Affect scale total score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect scale pre- and posttest total scores for each group. The main effect of the within-subjects factor Affect total was statistically significant: $F(1, 42) = 229.910$, $p < 0.001$, $\eta^2 = .846$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 1.276$, $p = .265$, $\eta^2 = .029$. The two-way interaction between Affect total and congruency group was statistically significant: $F(1, 42) = 4.199$, $p = .047$, $\eta^2 = .091$.

Affect total scores were higher in the posttest congruent group ($M = 12.77$, $SD = 6.733$) than in the posttest incongruent group ($M = 9.50$, $SD = 3.349$). An independent *t*-test showed that the difference between posttest Affect total congruency was statistically significant ($t = 2.041$, df = 42, $p = .048$). Equality of variance was met. The magnitude of the differences in the means (mean difference = 3.273, 95% CI: .037 to 6.508) was medium ($d = 0.65$).

See Figure 2 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each Affect total posttest congruency condition.

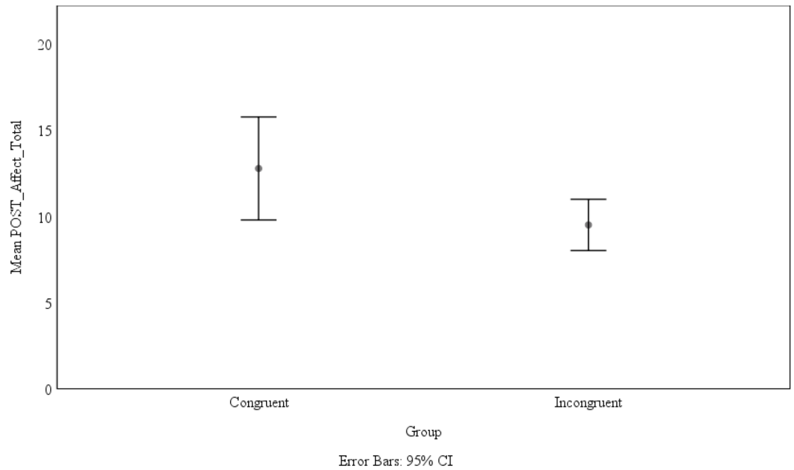

Figure 2. Simple Error Bar Mean of Posttest Affect total by Congruency Group.

Affect scale Good score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Good pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Good was statistically significant: $F(1, 42) = 209.982$, $p < 0.001$, $\eta^2 = .833$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 1.568$, $p = .217$, $\eta^2 = .036$. The two-way interaction between Affect Good and congruency group was not statistically significant: $F(1, 42) = 2.219$, $p = .144$, $\eta^2 = .050$.

Affect scale Positive score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Positive pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Positive was statistically significant: $F(1, 42) = 200.780$, $p < 0.001$, $\eta^2 = .827$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 2.487$, $p = .122$, $\eta^2 = .056$. The two-way interaction between Affect Positive and congruency group was not statistically significant: $F(1, 42) = 2.305$, $p = .136$, $\eta^2 = .052$.

Affect scale Favorable score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Favorable pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Favorable was statistically significant: $F(1, 42) = 163.777$, $p < 0.001$, $\eta^2 = .796$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .290$, $p = .593$, $\eta^2 = .007$. The two-way interaction between Affect Favorable and congruency group was statistically significant: $F(1, 42) = 10.017$, $p = .003$, $\eta^2 = .193$.

Affect Favorable scores were higher in the posttest congruent group ($M = 2.05$, $SD = 1.327$) than in the posttest incongruent group ($M = 1.41$, $SD = .503$). An independent *t*-test showed that the difference between posttest Affect Favorable congruency was statistically significant ($t = 2.104$, df = 26.922, $p = .045$). Equality of variance was not met where Levene's test for equality of variances had a value of .011. The magnitude of the differences in the means (mean difference = .636, 95% CI: .016 to 1.257) was calculated as the square root of the pooled variance (Srpv) with a value of 1.003.

See Figure 3 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each posttest Favorable Affect congruency condition.

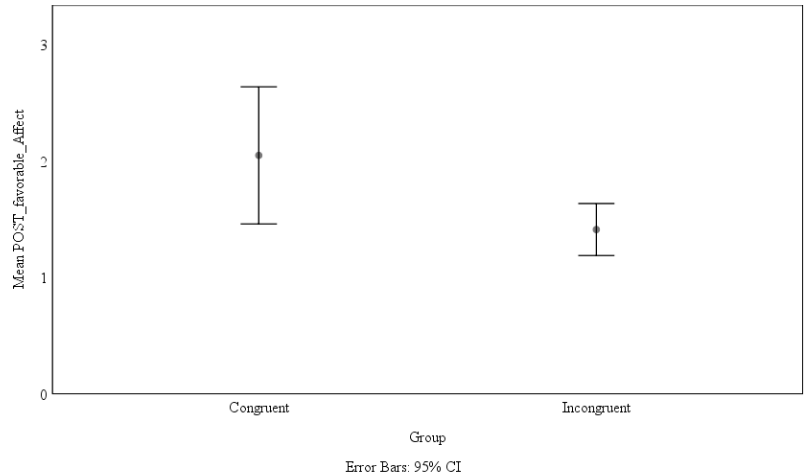

Figure 3. Simple Error Bar Mean of Posttest Favorable Affect by Congruency Group.

Affect scale Cheerful score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Cheerful pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Cheerful was statistically significant: $F(1, 42) = 145.887$, $p < 0.001$, $\eta^2 = .776$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .020$, $p = .889$, $\eta^2 < .001$. The two-way interaction between Affect Cheerful and congruency group was not statistically significant: $F(1, 42) = 1.366$, $p = .249$, $\eta^2 = .032$.

Affect scale Happy score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Happy pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Happy was statistically significant: $F(1, 42) = 175.623$, $p < 0.001$, $\eta^2 = .807$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .717$, $p = .402$, $\eta^2 = .017$. The two-way interaction between Affect Happy and congruency group was not statistically significant: $F(1, 42) = 3.735$, $p = .060$, $\eta^2 = .082$.

Affect scale Enthusiastic score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Enthusiastic pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Enthusiastic was statistically significant: $F(1, 42) = 214.006$, $p < 0.001$, $\eta^2 = .836$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .143$, $p = .707$, $\eta^2 = .003$. The two-way interaction between Affect Enthusiastic and congruency group was not statistically significant: $F(1, 42) = 2.832$, $p = .100$, $\eta^2 = .063$.

Affect scale Delighted score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the Affect Delighted pre- and posttest scores for each group. The main effect of the within-subjects factor Affect Delighted was statistically significant: $F(1, 42) = 143.128$, $p < 0.001$, $\eta^2 = .773$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .570$, $p = .454$, $\eta^2 = .013$. The two-way interaction between Affect Delighted and congruency group was not statistically significant: $F(1, 42) = 2.002$, $p = .164$, $\eta^2 = .046$.

The WTR scale total score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR scale pre- and posttest total scores for each group. The main effect of the within-subjects factor WTR total was statistically significant: $F(1, 42) = 106.709$, $p < 0.001$, $\eta^2 = .718$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .041$, $p = .840$, $\eta^2 = .001$. The two-way interaction between WTR total and congruency group was not significant: $F(1, 42) = 3.447$, $p = .070$, $\eta^2 = .076$.

WTR scale Willing score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR Willing pre- and posttest scores for each group. The main effect of the within-subjects factor WTR Willing was statistically significant: $F(1, 42) = 83.725$, $p < 0.001$, $\eta^2 = .666$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .274$, $p = .603$, $\eta^2 = .006$. The two-way interaction between WTR Willing and congruency group was not significant: $F(1, 42) = .220$, $p = .641$, $\eta^2 = .005$.

WTR scale Comfortable score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR Comfortable pre- and posttest scores for each group. The main effect of the within-subjects factor WTR Comfortable was statistically significant: $F(1, 42) = 70.000$, $p < 0.001$, $\eta^2 = .625$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .137$, $p = .713$, $\eta^2 = .003$. The two-way interaction between WTR Comfortable and congruency group was not significant: $F(1, 42) = 3.657$, $p = .063$, $\eta^2 = .080$.

WTR scale No Problem score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR No Problem pre- and posttest scores for each group. The main effect of the within-subjects factor WTR No Problem was statistically significant: $F(1, 42) = 92.502$, $p < 0.001$, $\eta^2 = .688$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .008$, $p = .927$, $\eta^2 < .001$. The two-way interaction between WTR No Problem and congruency group was not significant: $F(1, 42) = .806$, $p = .374$, $\eta^2 = .019$.

WTR scale Happy score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR Happy pre- and posttest scores for each group. The main effect of the within-subjects factor WTR Happy was statistically significant: $F(1, 42) = 116.891$, $p < 0.001$, $\eta^2 = .736$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .552$, $p = .462$, $\eta^2 = .013$. The two-way interaction between WTR Happy and congruency group was not significant: $F(1, 42) = 1.738$, $p = .194$, $\eta^2 = .040$.

WTR scale Safe score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR Safe pre- and posttest scores for each group. The main effect of the within-subjects factor WTR Safe was statistically significant: $F(1, 42) = 22.701$, $p < 0.001$, $\eta^2 = .351$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .152$, $p = .698$, $\eta^2 = .004$. The two-way interaction between WTR Safe and congruency group was not significant: $F(1, 42) = 2.858$, $p = .098$, $\eta^2 = .064$.

WTR scale No Fear score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR No Fear pre- and posttest scores for each group. The main effect of the within-subjects factor WTR No Fear was statistically significant: $F(1, 42) = 32.323$, $p < 0.001$, $\eta^2 = .435$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .126$, $p = .724$, $\eta^2 = .003$. The two-way interaction between WTR No Fear and congruency group was not significant: $F(1, 42) = 2.494$, $p = .122$, $\eta^2 = .056$.

WTR scale Confident score. With the alpha-level set at .05, the two-way mixed ANOVA was performed on the WTR Confident pre- and posttest scores for each group. The main effect of the within-subjects factor WTR Confident was statistically significant: $F(1, 42) = 58.280$, $p < 0.001$, $\eta^2 = .581$. The main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .026$, *p* = .871, η^2 = .001. The two-way interaction between WTR Confident and congruency group was statistically significant: $F(1, 42) = 6.021$, $p = .018$, $\eta^2 = .125$.

WTR Confident scores were higher in the pretest incongruent group (*M* = 3.55, *SD* = .912) than in the pretest congruent group (*M* = 3.09, *SD* = .971). An independent *t*-test showed that the difference between pretest WTR Confident congruency was not statistically significant (*t* = -1.600, df = 42, *p* = .117). Equality of variance was met. Mean difference = -.455, 95% CI: -1.028 to .119

See Figure 4 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each pretest Confident WTR congruency condition.

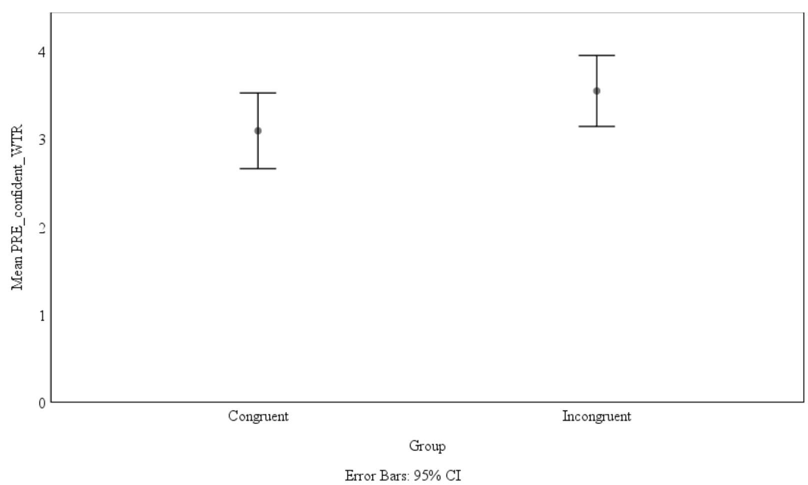

Figure 4. Simple Error Bar Mean of Pretest Confident WTR by Congruency Group.

WTR Confident scores were higher in the posttest congruent group (*M* = 2.23, *SD* = 1.270) than in the posttest incongruent group (*M* = 1.86, *SD* = 1.125). An independent *t*-test showed that the difference between posttest WTR Confident congruency was not statistically significant (t = 1.005, df = 42, p = .321). Equality of variance was met. Mean difference = .364, 95% CI: -.366 to 1.094

See Figure 5 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each posttest Confident WTR congruency condition.

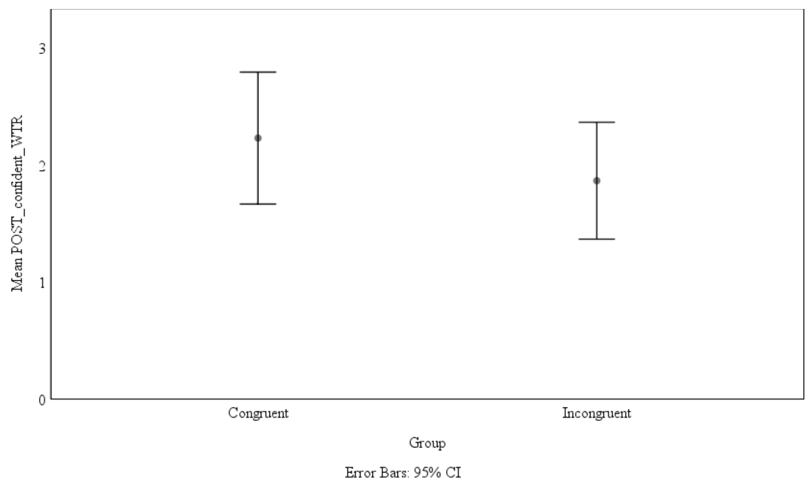

Figure 5. Simple Error Bar Mean of Posttest Confident WTR by Congruency Group.

Participants' ranking of ethical settings. See Appendix D for bar charts containing information for participants' ranking of ethical settings for both congruent and incongruent groups together and individually. Both congruent and incongruent groups contained a similar descriptive statistics outcome. The mode for the selection of Egoism had a value of 1, Utilitarianism had a value of 2, the Doctrine of Doing and Allowing had a value of 4, and Altruism had a value of 3.

Posttest Satisfaction score. Posttest Satisfaction scores were higher in the congruent group (M = 4.82, SD = 3.445) than in the incongruent group (M = 4.77, SD = 3.191). An independent samples t-test showed that the difference between posttest Satisfaction congruency was not statistically significant (*t* = .045, df = 42, *p* = .964). Equality of variance was met. Mean difference = .045, 95% CI: -1.975 to 2.066.

See Figure 6 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each posttest Satisfaction congruency condition.

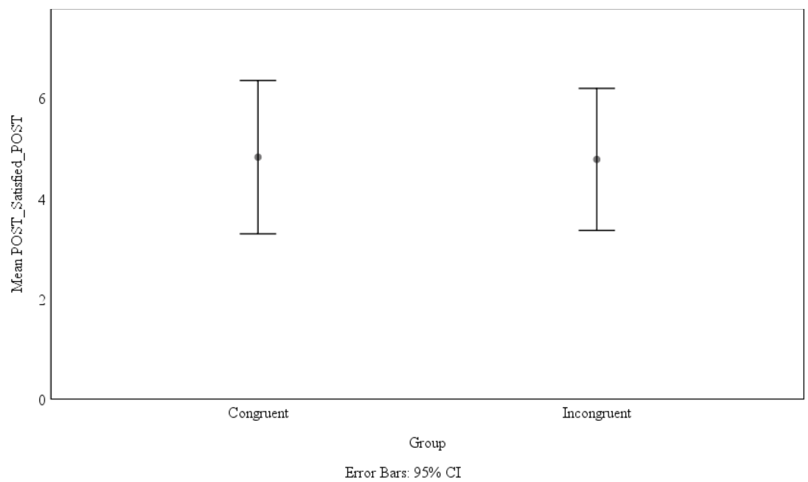

Figure 6. Simple Error Bar Mean of Posttest Satisfaction by Congruency Group.

Posttest Control score. Posttest Control scores were higher in the congruent group (*M* = 2.05, *SD* = 2.459) than in the incongruent group (*M* = 1.27, *SD* = .631). An independent samples *t*-test showed that the difference between posttest Control congruency was not statistically significant (*t* = 1.428, df = 23.755, *p* = .166). Equality of variance was not met where Levene's test for equality of variances had a value of .005. The magnitude of the differences in the means (mean difference = .773, 95% CI: -.345 to 1.890) was calculated as the square root of the pooled variance (Srpv) with a value of 1.795.

See Figure 7 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each posttest Control congruency condition.

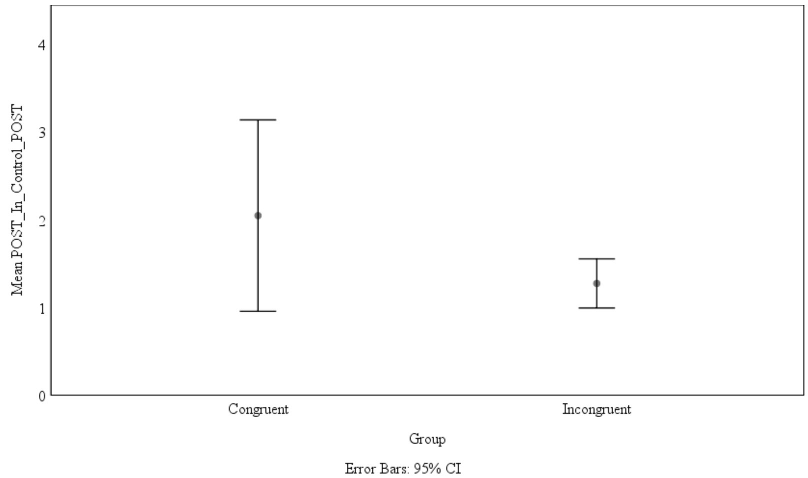

Figure 7. Simple Error Bar Mean of Posttest Control by Congruency Group.

Posttest Willingness score. Posttest Willingness scores were higher in the congruent group (*M* = 4.95, *SD* = 3.062) than in the incongruent group (*M* = 4.86, *SD* = 3.013). An independent samples *t*-test showed that the difference between posttest Willingness congruency was not statistically significant (t = .099, df = 42, p = .921). Equality of variance was met. Mean difference = .091, 95% CI: -1.757 to 1.939.

See Figure 8 error bar graph below for an illustrative representation of the 95% confidence interval for the mean of each posttest Willingness congruency condition.

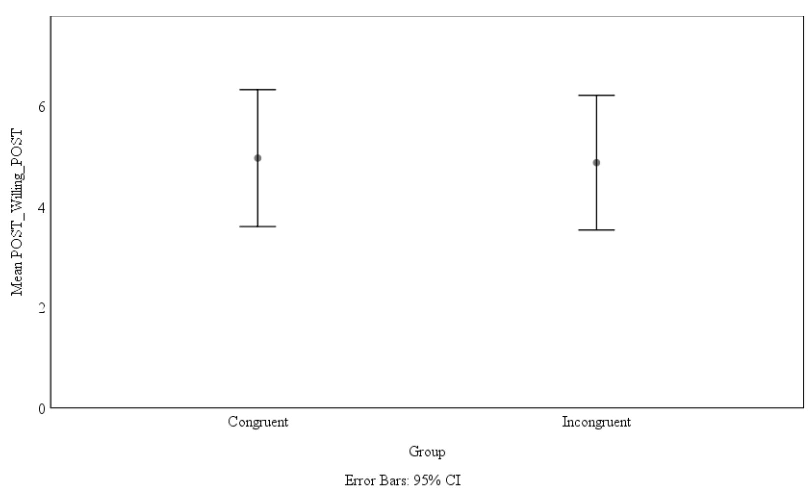

Figure 8. Simple Error Bar Mean of Posttest Willing by Congruency Group.

Age and Gender. Out of the 44 total participants' who completed the study, the mean age value of participants' was 22.07 with a minimum value of 18 and a maximum value of 34. See Figure 9 pie chart below for an illustrative representation of the percentages of participants' ages that were present within the study.

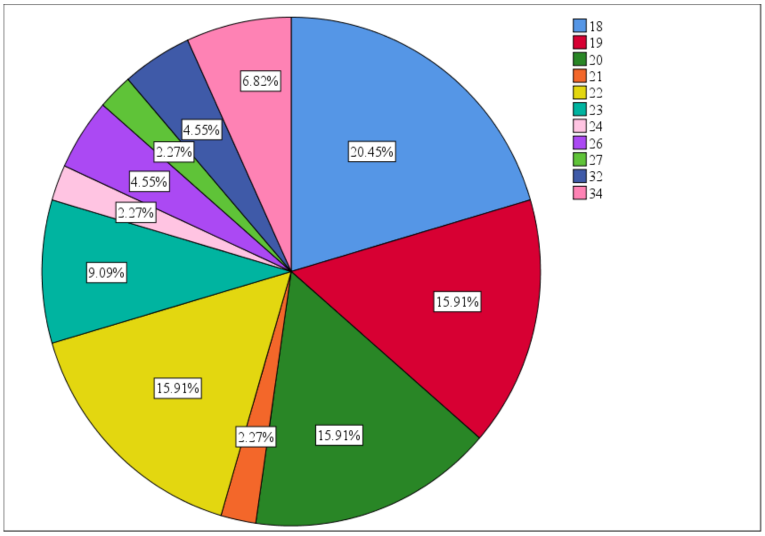

Figure 9. Pie Chart of Participants' Age Data Within Study.

Of the 44 participants who completed the study, a total of 32 were male and 12 were female.

Reliability Testing

Standardization of administration of the pre- and posttest surveys allowed each participant to attain the same knowledge and direction for their questionnaires. The driving scenarios the participants were presented with were prerecorded and administered to each participant in the same way. This included the scenario outcome presented via laminated paper so as not to influence participant survey responses from being affected by the researcher's voice or tone presenting the scenario. These factors remaining constant allowed for an increase in reliability. Previously validated scales used in the pre- and post-test surveys demonstrate that the scale has been developed to be administered among the intended respondents and demonstrate adequate reliability.

Hypotheses Testing

The researcher has failed to reject all three null hypotheses.

In regards to H1, where Affect scores were predicted to significantly differ between congruency groups, the main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = 1.276$, $p = .265$, $\eta^2 = .029$. However, a two-way interaction between Affect total and congruency group was found to be statistically significant: $F(1, 42) = 4.199$, $p = .047$, $\eta^2 = .091$. This interaction was not considered for H1, and therefore, the null hypothesis was still considered as failed to be rejected.

Within the Affect scale, Affect scale Favorable scores also revealed a statistically significant two-way interaction between Affect Favorable and congruency group: $F(1, 42) = 10.017$, $p = .003$, $\eta^2 = .193$.

The second hypothesis involved WTR scores significantly differing between groups which the main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .041$, $p = .840$, $\eta^2 = .001$ and therefore the researcher failed to reject the null.

Within the WTR scale, Confident scores demonstrated a statistically significant two-way interaction between WTR Confident and congruency group: $F(1, 42) = 6.021$, $p = .018$, $\eta^2 = .125$.

The third hypothesis involved specific emotions of happiness, anger, and fear to significantly differ between groups. The researcher has failed to reject the null as SUFES Happiness scores displayed that the main effect of the between-subjects factor congruency (i.e., congruent, incongruent) group was not statistically significant: $F(1, 42) = .742$, $p = .394$, $\eta^2 = .017$. There was, however, a significant two-way interaction between SUFES Happiness and congruency group: $F(1, 42) = 5.142$, $p = .029$, $\eta^2 = .109$.

SUFES Anger scores displayed that the main effect of the between-subjects factor congruency group was not statistically significant: $F(1, 42) = .123$, $p = .727$, $\eta^2 = .003$.

Likewise, SUFES Fear scores displayed that the main effect of the between-subjects factor congruency group also was not statistically significant: $F(1, 42) = 1.453$, $p = .235$, $\eta^2 = .033$.

Qualitative Data

All data collection was done through pre- and post-tests handed out to participants during the study. Pre- and post-tests contained a combination of previously validated scales, scales used in prior research, and a post-questionnaire reviewed from a subject matter expert on survey items. The items in all surveys were not open-ended and did not allow for any form of qualitative data to be recorded aside from the gender demographic question asking participants to circle whether they were male or female. See the discussion section in Chapter V for notable observations the researcher made during the study from participants. These observations did not have any weight, however, on statistical results.

Chapter V

Discussion, Conclusions, and Recommendations

The researcher set out to find if users' emotional affect in response to judgments made in the modified trolley dilemma would significantly differ if given full control of a PES in an AV. The results demonstrated that Affect scores were not significantly different in reference to the first proposed research hypothesis. It may be possible if participant quantity had been increased, the increase in power may have provided a statistical significance in this category. Two significant interactions were identified after statistical tests were run with 44 participants versus 40 participants. WTR scores and specific emotions of happiness, anger, and fear were examined between groups to find that there were no significant differences. These results imply that regardless if participants have full or no control over the PES in an AV, their willingness to ride, happiness, anger, and fear emotions would not significantly differ between either group. The discussion sections below will expand on the significant findings identified from the results.

Discussions for Findings within Groups

Some patterns emerged in the findings of this study. One of the most evident and expected pattern to exist would be significant differences within congruency groups from participants' pre- and post-scores. This makes sense as the pre-test scores represent participants who have not yet been exposed to the driving simulation that involves a simulated accident that is likely to influence a change to SUFES emotion, Affect, and WTR to a more extensive degree. A surprising finding was, that out of the categories of the SUFES total score and individual scores for each specific emotion (i.e., anger, disgust, fear, happiness, sadness, and surprise), the Affect scale total score and individual scores for the various aspects of affect (i.e., good, positive, favorable, cheerful, happy, enthusiastic, and delighted), the WTR scale total score and individual scores for the various aspects of WTR (i.e., willing, comfortable, no problem, happy, safe, no fear, and confident) it was found that the pre- and post-scores of SUFES Surprise were the only scores that did not significantly differ within congruency groups: $F(1, 42) = .054$, $p = .817$, $\eta^2 = .001$. These results indicate that surprise levels remained relatively constant for participants between groups from the pre-test to the post-test. Results also showed that the levels of surprise that participants experienced had, on average, fairly high scores. This may be because participants were equally surprised by the pre-test scenario description and the driving simulation outcome. For descriptive statistics for the SUFES Surprise data category, see Table C2 in Appendix C.

The researcher noted from the conversations held in the debriefing portion of the experiment that participants were inquisitive if the scenario would actually be occurring in real life for the university. This would mean that Embry-Riddle would truly be investing in an AV for student, staff, and faculty transportation services. From the researcher’s observations during the experiment, it appeared that many participants were not expecting the driver simulation trolley dilemma. Noted reactions from participants include abruptly stepping on the break to avoid hitting objects or people, suddenly turning the wheel to avoid the accident, and verbal responses following the accident impact such as “Woah” or “I killed someone.” Many participants admitted openly during the debriefing phase that they were not at all expecting what they had experienced in the study and simulation. From this feedback, it appears that participants were not able to simply predict from the pre-test scenario and survey items what would happen in the driver simulation.

The second pattern resulted from participants’ ranking of ethical settings for the hypothetical PES device. Both congruency groups demonstrated that the most preferred ethical setting was Egoism which emphasizes the passenger's life over others (Contissa et al., 2017). This was an interesting result as well because it appears to concur with prior research from Bonnefon et al., in 2016, which noted how participants prefer self-protective models of AVs for themselves although they found that many agreed the utilitarian ethical view was considered the most moral. In this study, both congruency groups demonstrated that the Utilitarian ethical setting was the second choice for the PES. The researcher notes that the fully automated vehicle programming question from the pre-test section specifically phrases the hypothetical scenario to participants as if they were the user of the AV performing a test drive, and therefore this study's results appear to agree with Bonnefon et al. (2016). Bonnefon et al. (2016) found that when participants place themselves personally in the test drive situation, they sway towards more of a self-preservation mode. Although the number of participants used in this study was much smaller than previous studies and does not accurately represent the entire population of the United States of America, it can give stakeholders insight to what the population of Embry-Riddle Aeronautical University in Daytona Beach, Florida rates from highest to lowest ethical settings from these specific and researched ethical choices that have been discussed for automated vehicles. This population clearly demonstrates that when it comes to ethical settings, if they would ever be considered for implementation into an AV for an unavoidable accident, participant users strongly suggest following ethical egoism first followed by utilitarianism. See Appendix D for bar charts containing participant frequency values for each ethical setting for both congruency groups together and individually.

Discussion for Gender of Participants

Out of the 44 participants who completed the study, 32 were male and 12 were female creating a 27.3% percentage value of female participants which closely resembled the 27.4%

value of Embry-Riddle's female residential campus undergraduate student demographics of Fall 2017 (ERAU, 2017). Randomization was used in order to place participants to each congruency group. This ended up placing 16 male and 6 female participants in each group. This shows that for the results of this particular study males and females each had the same contribution ratio of input for each congruency group.

Discussions for Hypotheses

The research hypotheses for this study included finding Affect scores, WTR scores, happiness, anger, and fear emotions to significantly differ between groups. While the researcher failed to reject the null hypotheses, four significant two-way interactions were identified. Instead of Affect scores significantly differing between congruency groups, a significant two-way interaction occurred between Affect total and congruency group: $F(1, 42) = 4.199$, $p = .047$, $\eta^2 = .091$. Results from the independent *t*-test demonstrated how Affect total scores were significantly higher in the posttest congruent group versus the posttest incongruent group. When Affect total scores are at a higher level, this means that participants reported experiencing more positive feelings than would participants with low Affect total scores. This particular result follows the idea that the congruent group, which had full control of the AV's PES, had much more positive feelings than the incongruent group which had no control over the AV's PES. Perhaps the congruent group felt more in control over their situation and although they too experienced the trolley dilemma accident, the ability to have a say so in the PES made them feel they had a choice in the matter. This may be an interesting find toward AV manufacturers because these results on affect pertain towards the category of user satisfaction, which aids to increase consumer use in the product. It is possible that considering the PES for modified trolley dilemmas in AV's would bring about greater user affect levels.

A significant two-way interaction was also discovered between the Affect Favorable scores and the congruency groups: $F(1, 42) = 10.017$, $p = .003$, $\eta^2 = .193$. Results from the independent *t*-test demonstrated how Affect Favorable scores were significantly higher in the posttest congruent group versus the posttest incongruent group. These results follow along with the same pattern as Affect total where the posttest congruent group experienced higher levels of favorable feelings over the incongruent group. Favorability is considered in the Affect scale as a contributing aspect of positive feeling. These results lend evidence that favorable feelings specifically, may be contributing to Affect total scores in the posttest congruent group being higher than the posttest incongruent group. These results may have occurred because participants that were given full control of the PES felt like they could have a decision that would work in their favor should an unavoidable collision occur versus the incongruent group.

Discussion for WTR Confident Scores

While WTR scores did not significantly differ between congruency groups, a significant two-way interaction was identified between WTR Confident scores and congruency groups: $F(1, 42) = 6.021$, $p = .018$, $\eta^2 = .125$. WTR Confident scores were higher this time in the pretest incongruent group than in the pretest congruent group and an independent *t*-test showed that this difference was not significant. Randomization had been used for the placement of participants to each group and because of this the researcher deems these results as a confound that the participants within the pretest incongruent group happened to score somewhat higher ($M = 3.55$, $SD = .912$) than the pretest congruent group ($M = 3.09$, $SD = .971$).

WTR Confident scores were also higher in the posttest congruent group than in the posttest incongruent group. Although the independent *t*-test found the difference was not statistically significant, these results would lean towards supporting the idea that participants with full control of the AV's PES experience higher confidence feelings that contribute toward their overall willingness to ride in an AV. The researcher has noticed that as the number of participants increased in the study, the more significant two-way interactions were found when running the tests on SPSS. Because of this, the researcher suspects that if this study was replicated with more participants that it may lend further power to finding this particular result significant in the independent *t*-test.

Discussion for SUFES Happiness Scores

A statistically significant two-way interaction between SUFES Happiness and congruency group was found: $F(1, 42) = 5.142$, $p = .029$, $\eta^2 = .109$. An independent *t*-test found that the pretest incongruent group was significantly higher than the pretest congruent group. Because randomization was used to place participants in groups, the researcher deems this result as a confound.

Conclusions

Two additional significant two-way interactions surfaced from the results when the sample size was increased from 40 to 44. This leads to a recommendation that, if the study is replicated, the researcher might consider using a greater sample of participants as this may contribute enough power in the analyses to find a significant difference in WTR Confident scores between the posttest congruency groups. This information would benefit AV stakeholders, specifically manufacturers and consumers as WTR Confident levels are a contributing aspect toward overall willingness to ride. Previous findings suggest that, due to a low WTR on automated buses (Anania et al., 2018), public transportation should not be automated, but if this study could be replicated with a higher power from a higher sample size it may be able to see an outcome of a higher WTR influenced from higher WTR Confident scores between congruency groups which could shift recommendations to being more agreeable toward using automated vehicles in public transportation.

The two most important significant two-way interactions that occurred were between Affect total scores and congruency group and Affect Favorable scores and congruency group. For both of those significant two-way interactions, it was found that the posttest congruent group had higher scores than the posttest incongruent group. The results show the participants' ability to have full control of the AV's PES gives them more positive feelings and greater feelings of favorability regardless that they have undergone the driver's simulation of an unavoidable accident over participants that had no control of the PES whatsoever.

There were two confounds identified in the study regardless that randomization was used to place participants in congruency groups. These findings, though unfortunate, were out of the researcher's ability to control. Recommendations from this would be to continue to use randomization as a method to combat these occurrences if more participants are used.

Recommendations

In the context of the bigger picture, if AV manufacturers are looking to gauge a larger populations' outlook on the use of a PES for AVs, it is very possible they could repeat this study and use outside survey resources to create fully online surveys. This may help the researcher by being able to more conveniently reach out to larger demographics tailored to the specific demographics their company aims to market to. They may use results from this study as an idea for what specific interactions to monitor for significant outcomes and confound possibilities to avoid. Online survey abilities also allow the researcher to select the number of individuals needed to fill each gender category that would allow a more equal display of males and females per congruency group. Since Embry-Riddle Aeronautical University is primarily male based, results from this study reflected the gender percentage as such which is something to consider when comparing results if the study is redone with a more equal dispersion of male and female participants. It should also be considered that findings from Anania et al. (2018) demonstrated significant interactions occurring for WTR ratings affected by both gender and nationality of the participant.

Although this study's results appear to agree with prior research that a majority of participants prefer ethical egoism or self-preservation when presented with the hypothetical situation in which they are the user of the AV, there is always the possibility that the population's responses may change over time as the ideals of society change.

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Appendix A

Institutional Review Board Approval

Embry-Riddle Aeronautical University
Application for IRB Approval
Determination Form

Principal Investigator: Bee-Ling J.A. Lim

Other Investigators: Kadie Mullins

Role: Faculty **Campus:** Daytona Beach **College:** Aviation/Aeronautics

Project Title: Emotional Affect in Response to Judgments Made in Modified Trolley Dilemma with Automated versus Traditional Vehicles

Review Board Use Only

Initial Reviewer: Teri Gabriel **Date:** 01/08/2019 **Approval #:** 19-078

Determination: Exempt

Dr. Michael Wiggins
IRB Chair Signature: Michael E. Wiggins, Ed.D. **Date:** 01/11/2019

Brief Description:

This study aims to fill a gap in existing knowledge by exploring the perceptions of consumers in automated vehicles (AV); specially, how consumers feel about being in control of decisions that result in deaths or not being in control of those actions. The study seeks to compare differences of affect and willingness to ride (WTR) of participants involved in either a congruent or incongruent group that will be using an AVs in a modified trolley dilemma. The congruent group will ride in a simulated AV that will perform actions that are opposite with the algorithm the user preselects. The groups represent either complete control, congruent, in the selection process of the algorithm versus no control, incongruent. The experiment will be conducted in the Cognitive Engineering Research in Transportation Systems (CERTS) Lab. A pen and paper survey will be used as well as simulation.

Appendix A

Institutional Review Board Approval (Continued)

This research falls under the **EXEMPT** category as per 45 CFR 46.101(b) under:

☐ (1) Research, conducted in established or commonly accepted educational settings, that specifically involves normal educational practices that are not likely to adversely impact students' opportunity to learn required educational content or the assessment of educators who provide instruction. This includes most research on regular and special education instructional strategies, and research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

☑ (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures (of adults), interview procedures (of adults), or observation of public behavior if at least one of the following criteria is met:

(i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects;

(ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation.

☐ (4) Research involving the collection or study of **existing** data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to subjects.

☐ (6) Taste and food quality evaluation and consumer acceptance studies:

(i) If wholesome foods without additives are consumed, or

(ii) If a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the Food and Drug Administration or approved by the Environmental Protection Agency or the Food Safety and Inspection Service of the U.S. Department of Agriculture.

An exempt research project does not require ongoing review by the IRB, unless the project is amended in such a way that it no longer meets the exemption criteria.

Appendix A

Human Subject Protocol Application

EMBRY-RIDDLE
Aeronautical University
FLORIDA | ARIZONA | WORLDWIDE

7 January 2019

Human Subject Protocol Application

Campus:	**Daytona Beach**	College:	**COA**
Other Institution Name & Address:			
Applicant:	**Bee-Ling Lim**	Degree Level:	**Master**
ERAU ID:	**2346919**	ERAU Affiliation:	**Student**
Project Title:	**Emotional Affect in Response to Judgments Made in a Modified Trolley Dilemma With Automated Vehicles**		
Principal Investigator:	**Bee-Ling J. A. Lim**		
Other Investigators:	**Kadie Mullins - Research Advisor**		

Submission Date:	**11/18/2018**		
Beginning Date:	**01/09/2019**	Expected End Date:	
Type of Project:	**Other**		
Type of Funding Support (if any):	**No**		

Questions:

Appendix A

Human Subject Protocol Application (Continued)

1. Background and Purpose: Briefly describe the background and purpose of the research.

Background: Numerous studies have been conducted with trolley dilemmas to better understand moral decision making. The first classical dilemma was introduced in 1967 as a philosophical thought experiment (Foot, 1967). It observed how humans decided between the lesser of two evils, sacrificing one person to save many or vice versa, by controlling which track a trolley would travel along. Modified versions of the trolley dilemma have been adapted to human-driven cars to help decide how to set an automated vehicle's ethical decisions (Faulhaber et al., 2018). Other recent work has shown that humans, within a simulated environment, prove to be more utilitarian than they claim to be (Patil, Cogoni, Zangrando, Chittaro, & Silani, 2014). Contissa et al. (2017) outlined various submissions and observations that have been discussed regarding what kind of ethical technology should be implemented into automated vehicles to address and solve this issue.

Automated vehicles (AVs) continue to increase in today's market and researchers have modified trolley dilemmas to account for them. Decision making analysis of participants within these modified trolley dilemmas has led researchers to propose numerous ethical theories to base algorithms upon that may be programmed into the AV. This will dictate what actions the vehicle will take in an inevitable crash event. One suggestion is for allowing the users of AVs to pre-program their own customizable algorithm, but this may cause unwanted outcomes and a mandatory ethics setting (MES) is suggested as best for society (Gogoll & Müller, 2017). Limited research has been done exploring exactly how the public's affect in choice would react to being given able to program their own algorithm. This study seeks to compare differences of affect and willingness to ride (WTR) of participants involved in either a congruent or incongruent group that will be using an AV in a modified trolley dilemma. The congruent group will ride in a simulated AV that will perform actions consistent with the algorithm the user preselects; the incongruent group will ride in a simulated AV that will perform actions that are opposite with the algorithm the user preselects. The groups represent either complete control, congruent, in the selection process of the algorithm versus no control, incongruent.

Purpose: This study aims to fill a gap in existing knowledge by exploring the perceptions of consumers in automated vehicles; specifically, how consumers feel about being in control of decisions that result in deaths or not being in control of those decisions.

Appendix A

Human Subject Protocol Application (Continued)

2. Design, Procedures, Materials and Methods: Describe the details of the procedure to be used and the type of daa that will be collected.

Design: This will be an experimental, 2 x 2 mixed-design. Between-subjects design will apply to the groups of congruent (control) versus incongruent (no-control). Within-subjects design will apply because both congruent and incongruent groups will undergo a pre- and post-test.

Procedure: The experiment timeline will last for up to two weeks where participants will be randomized into either the congruent or incongruent group for the experiment. Once the experiment begins, participants will be escorted into the CERTS lab individually, by the researcher. The researcher will present the consent form required to be filled out for each individual participant. When the form has been completed, the researcher will direct the participant to read a laminated sheet that contains instructions for the study and the hypothetical scenario (see Appendix C). After the scenario has been read, both groups of participants will receive the pen and paper survey that will contain the six universal facial emotions, affect, and WTR scale (Winter et al., 2018) (see Appendix A). Once they have completed the survey, participants will receive a sheet of paper with the fully automated vehicle programming question (see Appendix D).

After the congruent group participant makes his or her selection, the researcher will then load up the pre-recorded driver simulation that matches with the participant's most preferred preprogrammed selection. Based upon the choice that the incongruent group participant will select, the researcher will then load up the pre-recorded driver simulation that associates with the participant's least preferred rank. Both groups of participants will only be observing the simulation while sitting at the wheel. This should give participants the experience of riding within a fully automated vehicle.

The simulation for both groups will contain the participant's vehicle that will be accelerated, via automated driving, to 50 MPH. At 2,500 FT driven, the roadway will become blocked 50 FT in front of the vehicle by the following: a large crate blocking the opposing lane, a small child walking across the road from the left side and stopping between both lanes, and two adults walking from the right side of the road stopping in the right lane. The automated vehicle will adhere to the ranking, most preferred for congruent group participants and least preferred for incongruent group participants, made by the participant prior to the simulation beginning (see Appendix E).

For both groups, the vehicle being involved in a collision will end the simulator portion of the test. The researcher will then inform the participant of the consequences of the event from a paper (see Appendix F). The researcher will then give the participant the pen and paper surveys consisting of the post-simulator questionnaire (see Appendix B) and the WTR, Affect, and Six Universal Facial Emotional Scales (see Appendix A). Data will be recorded on both groups of which object was chosen to be collided with during the unavoidable collision: their own person and vehicle, the crate, the small child, or the two adults. Participants will be debriefed after completing the post-simulator questions (see Appendices A and B). Debriefing will include the reasons for the study.

Appendix A

Human Subject Protocol Application (Continued)

3. Measures and Observations: What measures or observations will be taken in the study?

All measures collected during the experiment will be done on paper by participant submission. Data collected will consist of participants filling out Likert scales on Willingness to Ride (WTR), Affect, and Six Universal Emotion scales. A questionnaire will be used to measure their ratings on level of control of the situation, satisfaction of the outcome of events, and if they would be willing to ride in an automated vehicle if the situation was redone.

Expected Results: Analyses will be completed using SPSS™ software. Measurements collected from the following will be recorded as scale variables: WTR scale, affect scale, the six universal facial emotions scale, satisfaction, control, and willingness to ride in an automated vehicle if the situation was to be redone. Gender will be classified as a nominal variable. When comparing data of congruent and incongruent groups, the congruent group will be coded as "1" and the incongruent group as "2".

A t-test will be conducted to test the differences in group means for the WTR scale. The researcher predicts a lesser WTR for the incongruent group. A t-test will be conducted to test the differences in group means for the affect scale. This will be performed to see if participants show more negative or positive responses towards the congruent versus incongruent automated configuration of the vehicle. The researcher predicts that the incongruent group will show more negative responses because of the lack of control. A t-test will be conducted to test differences in group means for specific emotions under the six universal facial emotions scale. This will be performed to analyze exactly which emotions are enacted when using an automated vehicle with control of the algorithm versus no control. Participants may have differing emotions between the congruent versus incongruent groups; the researcher predicts happiness, anger, and fear may be the primary emotions that differ significantly between the two groups. SPSS™ will be used to find the standardized regression coefficient between the congruent and incongruent group and affect as well as affect and WTR. This will help determine which emotions, if any, are affecting the relationships between WTR and the congruent and incongruent group. A t-test will be conducted on the satisfaction, the control measurements, and willingness to ride in a repeat of the situation to find the differences in group means. The researcher predicts greater levels of satisfaction, feelings of control, and willingness to ride in an automated vehicle in a repeat situation for the congruent group.

3b. If any questionnaires, tests, or other instruments are used, provide a brief description.

The G*Power 3 program will be used to calculate the necessary total sample size for the study. The laboratory equipment that will be utilized to allow participants to experience a driving simulation includes the STI Sim Drive software to create and run the simulated environments, a computer to run the software and display simulation visuals, Logitech driving steering wheel, accelerator and brake pedals, and gearshift assembly for participants to operate the simulation. Four pre-recorded simulation runs, created by the researcher from the STI Sim Drive software, will simulate the vehicle driving autonomously for participants in both congruent and incongruent groups. The experiment will be conducted within the Cognitive Engineering Research in Transportation Systems (CERTS) lab at Embry-Riddle Aeronautical University.

Statistical Package for Social Sciences (SPSS™) software will be used for sorting and analyzing the recorded data. During the experiment, the researcher will be the one to disperse forms to participants and recollect them after they have been filled. This will include a hard-copy consent form that participants will sign prior to participation in the experiment. Five laminated sheets of paper will be used, one will contain instructions for the experiment including driving simulator instructions and the scenario synopsis. The other four sheets of laminated paper will contain the scenario outcomes.

A pen and paper survey will be issued to participants before and after the driving simulation that will contain the WTR scale, affect scale, and the six universal facial emotions scale (see Appendix A). Scales have been chosen using previous research from Winter et al. (2018), showing that affect and several specific emotions did mediate between vehicle configuration and WTR. Additional post-simulator questions will be asked through a paper and pen survey that will include questions regarding satisfaction of driving simulation outcome, feelings of control in the situation, willingness to ride in an automated vehicle if the scenario was redone, and the participant's age and gender (see Appendix B).

Appendix A

Human Subject Protocol Application (Continued)

4. Risks and Benefits: Describe any potential risks to the dignity, rights, health or welfare of the human subjects. Assess the potential benefits to be gained by the subjects as well as to society in general as a result of this project. Briefly assess the risk-benefit ratio.

There is a very minor possibility that some participants will feel a temporary emotional discomfort due to the situations presented in the scenarios. There are no direct benefits for participants in this study. The potential benefits to society would be a better understanding of how consumers feel about automated vehicles being in total control of an unavoidable crash. Should any participant experience any emotional discomfort they will be provided time by the researcher to pause from the experiment until they are ready to continue or if they choose to exercise the option to discontinue from the experiment. If they choose to do so they will be thanked for their participation and the researcher will escort them from the CERTS lab after they have been given the time needed to recover from their discomfort.

5. Informed Consent: Describe the procedures you will use to obtain informed consent of the subjects and the debrief/feedback that will be provided to participants. See Informed Consent Guidelines for more information on Informed Consent requirements.

I will follow the guidelines of informed consent provided by the IRB. I have provided below a .pdf of my informed consent document. The researcher will present a hard-copy of the consent form to each participant prior to the beginning of the experiment when they enter the Cognitive Engineering Research in Transportation Systems (CERTS) lab at Embry-Riddle Aeronautical University. After the participant has agreed to the terms on the consent form, they will sign and date it as the instructions on the form state, and the researcher will then collect the paper form immediately afterward.

6. Anonymity: Will participant information be anonymous (not even the researcher can match data with names), confidential (Names or any other identifying demographics can be matched, but only members of the research team will have access to that information. Publication of the data will not include any identifying information.), or public (Names and data will be matched and individuals outside of the research team will have either direct or indirect access. Publication of the data will allow either directly or indirectly, identification of the participants.)?

Confidential

6b. Justify the classification and describe how privacy will be ensured/protected.

Aside from the mandatory consent form where participants must sign their name, the names of participants will only be collected and known to the researcher to ensure that the same participant does not attempt to test multiple times. When data will be reported, names will not be mentioned or tied to the data. This is how the names of participants will not be tied to their responses in the report. Other personal information collected in the study will be gender and age. This data will be shown in the report, however, will not be tied to any names.

7. Privacy: Describe the safeguards (including confidentiality safeguards) you will use to minimize the risks. Indicate what will happen to data collected from participants that choose to "opt out" during the research process. If video/audio recordsings are part of the research, please describe how that data will be stored or destroyed.

Personal and identifying information will not be connected to any participant's response in any way via the report. Only the researcher will have access to the participants identified responses.

Data collected by participants who choose to "opt out" during the research process will not be used in the final study. The data will be removed from the dataset.

8. Participant Population and Recruitment Procedures: Who will be recruited to be participants and how will they be recruited. Note that participants must be at least 18 years of age to participate. Participants under 18 years of age much have a parent or guardian sign the informed consent document.

Participants will be recruited by posting flyers around Embry-Riddle Aeronautical University. Flyers will specify a requirement of being at least 18 years of age and possessing a valid US driver's license. A total of 40 candidates will be selected and randomized, equally, into either the automated driver group or the traditional driver control group. Participants will be compensated a sum of $5.00 for participation in the study.

Appendix A

Human Subject Protocol Application (Continued)

9. Economic Considerations: Are participants going to be paid for their participation?

Yes

9b. If yes, describe your policy for dealing with participants who 1) Show up for research, but refuse informed consent; 2) Start but fail to complete research.

Participants who refuse informed consent will not be compensated. Participants who start but decide to discontinue during the course of the study will still be compensated.

10. Time: Approximately how much time will be required of each participant?

The expected individual participant time required for this study is no more than 30 minutes.

By submitting this application, you are signing that the Principal Investigator and any other investigators certify the following:
1. The information in this application is accurate and complete
2. All procedures performed during this project will be conducted by individuals legally and responsibly entitled to do so
3. I/we will comply with all federal, state, and institutional policies and procedures to protect human subjects in research
4. I/we will assure that the consent process and research procedures as described herein are followed with every participant in the research
5. That any significant systematic deviation from the submitted protocol (for example, a change in the principal investigator, sponsorship, research purposes, participant recruitment procedures, research methodology, risks and benefits, or consent procedures) will be submitted to the IRB for approval prior to its implementation
6. I/we will promptly report any adverse events to the IRB

Electronic Signature:

Bee-Ling Jacqueline Anita Lim

Appendix B

Data Collection Device

Instructions for Study

Please read the scenario description at the bottom of the sheet.

After the scenario has been read, instruct the researcher and you will receive a pen and paper survey to complete.

After completing the survey, notify the researcher so they may collect the materials and you will then complete the driving simulation.

Upon completion of the driver simulation, the researcher will hand the participant a debriefing sheet and a pen and paper survey.

After the pen and paper survey have been completed, inform the researcher so materials will be collected. The researcher will inform you of the reasons for the study. This will end the experiment. You will be compensated for your time and participation and will be escorted from the CERTS lab.

Scenario Description

Imagine a situation where you are asked to test drive the newest model of Embry-Riddle's student and staff pickup services vehicle. The school is looking for participants to give feedback on the vehicle performance before it goes into full service to ensure it can make any adjustments for student and staff quality and comfort. It is a fully automated, self-driving vehicle you must test through a scenario containing typical pedestrians, vehicles, roadways, etc.

Pretest

Six Universal Facial Emotions Scale

On a scale of 0 to 10, with 1 being "I do not feel this way at all" and 10 being "I extremely feel this way," how strongly do you feel like the image shown based on the scenario?

	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10

Pretest (Continued)

Affect Scale

Please respond how strongly you agree or disagree with the following statements.

1. I feel good about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. I feel positive about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. I feel favorable about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. I feel cheerful about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. I feel happy about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. I feel enthusiastic about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. I feel delighted about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Pretest (Continued)

WTR Scale

Please respond how strongly you agree or disagree with the following statements.

1. I would be willing to ride in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

2. I would be comfortable riding in this situation

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. I would have no problem riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

4. I would be happy to ride in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. I would feel safe riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

6. I have no fear riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

7. I feel confident riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Pretest (Continued)

Fully Automated Vehicle Programming Question

The automated vehicle you will be testing allows the user to preprogram at the beginning of each drive, one out of four selections to determine the vehicles actions in the event of an unavoidable collision. Please rank these options, from 1 being most preferred to 4 being least preferred, as you would if you were the user of the automated vehicle performing a test drive. Please use each number only once.

- You would prefer your vehicle to limit and reduce damage to itself and injury to its occupants in all situations.

  Rank: ____ (rank from 1—4)

- You would prefer your vehicle to attempt to reduce the total number of injuries in an accident even if it means damaging itself and its occupant.

  Rank: ____ (rank from 1—4)

- You would prefer your vehicle to take no corrective action in the event of an unavoidable collision.

  Rank: ____ (rank from 1—4)

- You would prefer your vehicle to take any and all action to not cause any harm or damage to any third party, even if it means damaging itself and its occupant.

  Rank: ____ (rank from 1—4)

Appendix B

Data Collection Device (Continued)

Posttest

Six Universal Facial Emotions Scale

On a scale of 0 to 10, with 1 being "I do not feel this way at all" and 10 being "I extremely feel this way," how strongly do you feel like the image shown based on the scenario?

	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10
	0	1	2	3	4	5	6	7	8	9	10

Posttest (Continued)

Affect Scale

Please respond how strongly you agree or disagree with the following statements.

8. I feel good about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. I feel positive about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. I feel favorable about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. I feel cheerful about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. I feel happy about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

13. I feel enthusiastic about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

14. I feel delighted about this.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Posttest (Continued)

WTR Scale

Please respond how strongly you agree or disagree with the following statements.

8. I would be willing to ride in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

9. I would be comfortable riding in this situation

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

10. I would have no problem riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

11. I would be happy to ride in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

12. I would feel safe riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

13. I have no fear riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

14. I feel confident riding in this situation.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Posttest (Continued)

Post-Simulator Questionnaire

On a scale of 1 to 10, with 1 being least satisfied and 10 being most satisfied, how satisfied are you with your choice of actions? (circle one)

1 2 3 4 5 6 7 8 9 10

On a scale of 1 to 10, with 1 being not in control and 10 being completely in control, how in control of the situation did you feel? (circle one)

1 2 3 4 5 6 7 8 9 10

On a scale of 1 to 10, with 1 being definitely not willing and 10 being definitely willing, how willing would you be to ride in an automated vehicle if the driving simulation could be completed again? (circle one)

1 2 3 4 5 6 7 8 9 10

Age: ____ (state your age in years)

Gender: Male Female (circle one)

Preprogrammed Choice Outcomes

- If the participant chose to limit damage to itself and injury to its occupant, the vehicle will swerve to hit the small child.
- If the participant chose to reduce the total number of injuries it will swerve and hit the large crate.
- If the participant chose to take no corrective action in an unavoidable collision the vehicle will remain on course and collide with the two adults.
- If the participant chose to prefer to cause no harm or damage to any third parties the vehicle will attempt to swerve to the right where there is a wall.

Scenario Outcome Descriptions

- If the small child is struck there is no damage to the vehicle or to the participant, but the child has not survived.
- If the crate was struck the vehicle has been totaled and the participant is currently in intensive care with severe internal injuries.
- If the two adults are struck there is minor cosmetic damage to the vehicle and no injuries to the participant, one of the adults is in the hospital with a broken leg, and the other adult has a collapsed lung and three broken ribs.
- If the vehicle veers into the wall the vehicle is destroyed along with all occupants.

Appendix C

Tables

Table C1

Descriptive Statistics: Six Universal Facial Emotions Scale

	N	Mean	SD
Pretest SUFES Total	44	16.39	5.393
Pretest SUFES Congruent	22	16.00	6.422
Pretest SUFES Incongruent	22	16.77	4.242
Posttest SUFES Total	44	30.95	11.459
Posttest SUFES Congruent	22	30.45	10.918
Posttest SUFES Incongruent	22	31.45	12.211

Note. Created from "SPSS" software by Lim, B.
The smallest value is shown.

Table C2

Descriptive Statistics: SUFES Specific Emotions

	N	Mean	SD
Pretest Anger Total	44	.36	.780
Pretest Anger Congruent	22	.59	.959
Pretest Anger Incongruent	22	.14	.468
Posttest Anger Total	44	5.66	3.685
Posttest Anger Congruent	22	5.64	3.416
Posttest Anger Incongruent	22	5.68	4.016
Pretest Disgust Total	44	.57	1.561
Pretest Disgust Congruent	22	.86	2.054
Pretest Disgust Incongruent	22	.27	.767
Posttest Disgust Total	44	2.68	3.381
Posttest Disgust Congruent	22	2.95	3.498
Posttest Disgust Incongruent	22	2.41	3.319
Pretest Fear Total	44	1.36	1.906
Pretest Fear Congruent	22	1.09	1.601
Pretest Fear Incongruent	22	1.64	2.172
Posttest Fear Total	44	7.89	3.179
Posttest Fear Congruent	22	7.41	3.246
Posttest Fear Incongruent	22	8.36	3.110
Pretest Happiness Total	44	7.55	2.357
Pretest Happiness Congruent	22	6.77	2.409
Pretest Happiness Incongruent	22	8.32	2.079
Posttest Happiness Total	44	1.09	2.331
Posttest Happiness Congruent	22	1.45	2.444
Posttest Happiness Incongruent	22	.73	2.208
Pretest Sadness Total	44	.64	1.432
Pretest Sadness Congruent	22	1.09	1.849
Pretest Sadness Incongruent	22	.18	.588
Posttest Sadness Total	44	7.57	2.991
Posttest Sadness Congruent	22	7.45	3.004
Posttest Sadness Incongruent	22	7.68	3.045

Note. Created from “SPSS” software by Lim, B.
The smallest value is shown.

Table C2 (Continued)

Descriptive Statistics: SUFES Specific Emotions

	N	Mean	SD
Pretest Surprise Total	44	5.91	2.908
Pretest Surprise Congruent	22	5.59	2.922
Pretest Surprise Incongruent	22	6.23	2.927
Posttest Surprise Total	44	6.07	3.572
Posttest Surprise Congruent	22	5.55	3.674
Posttest Surprise Incongruent	22	6.59	3.473

Note. Created from "SPSS" software by Lim, B.
The smallest value is shown.

Table C3

Descriptive Statistics: Affect Scale

	N	Mean	SD
Pretest Affect Total	44	27.11	4.172
Pretest Affect Congruent	22	26.59	4.458
Pretest Affect Incongruent	22	27.64	3.898
Posttest Affect Total	44	11.14	5.509
Posttest Affect Congruent	22	12.77	6.733
Posttest Affect Incongruent	22	9.50	3.349

Note. Created from "SPSS" software by Lim, B.
The smallest value is shown.

Table C4

Descriptive Statistics: Affect Scale Individual Aspects of Positive Feeling

	N	Mean	SD
Pretest Good Total	44	4.07	.625
Pretest Good Congruent	22	4.05	.653
Pretest Good Incongruent	22	4.09	.610
Posttest Good Total	44	1.64	.917
Posttest Good Congruent	22	1.86	1.125
Posttest Good Incongruent	22	1.41	.590
Pretest Positive Total	44	4.18	.657
Pretest Positive Congruent	22	4.18	.733
Pretest Positive Incongruent	22	4.18	.588
Posttest Positive Total	44	1.64	.990
Posttest Positive Congruent	22	1.91	1.231
Posttest Positive Incongruent	22	1.36	.581
Pretest Favorable Total	44	3.84	.776
Pretest Favorable Congruent	22	3.64	.848
Pretest Favorable Incongruent	22	4.05	.653
Posttest Favorable Total	44	1.73	1.042
Posttest Favorable Congruent	22	2.05	1.327
Posttest Favorable Incongruent	22	1.41	.503
Pretest Cheerful Total	44	3.61	.813
Pretest Cheerful Congruent	22	3.50	.859
Pretest Cheerful Incongruent	22	3.73	.767
Posttest Cheerful Total	44	1.50	.762
Posttest Cheerful Congruent	22	1.59	.796
Posttest Cheerful Incongruent	22	1.41	.734
Pretest Happy Total	44	3.73	.694
Pretest Happy Congruent	22	3.64	.727
Pretest Happy Incongruent	22	3.82	.664
Posttest Happy Total	44	1.55	.848
Posttest Happy Congruent	22	1.77	1.066
Posttest Happy Incongruent	22	1.32	.477

Note. Created from “SPSS” software by Lim, B.
The smallest value is shown.

Table C4 (Continued)

Descriptive Statistics: Affect Scale Individual Aspects of Positive Feeling

	N	Mean	SD
Pretest Enthusiastic Total	44	4.16	.861
Pretest Enthusiastic Congruent	22	4.05	.999
Pretest Enthusiastic Incongruent	22	4.27	.703
Posttest Enthusiastic Total	44	1.59	.816
Posttest Enthusiastic Congruent	22	1.77	.973
Posttest Enthusiastic Incongruent	22	1.41	.590
Pretest Delighted Total	44	3.61	.784
Pretest Delighted Congruent	22	3.55	.739
Pretest Delighted Incongruent	22	3.68	.839
Posttest Delighted Total	44	1.50	.762
Posttest Delighted Congruent	22	1.68	.945
Posttest Delighted Incongruent	22	1.32	.477

Note. Created from "SPSS" software by Lim, B.
The smallest value is shown.

Table C5

Descriptive Statistics: WTR Scale

	N	Mean	SD
Pretest WTR Total	44	24.77	5.089
Pretest WTR Congruent	22	24.05	4.786
Pretest WTR Incongruent	22	25.50	5.387
Posttest WTR Total	44	14.91	6.951
Posttest WTR Congruent	22	15.95	6.492
Posttest WTR Incongruent	22	13.86	7.383

Note. Created from “SPSS” software by Lim, B.
The smallest value is shown.

Table C6

Descriptive Statistics: WTR Scale Contributive Aspects of Feelings of Willingness

	N	Mean	SD
Pretest Willing Total	44	4.07	.846
Pretest Willing Congruent	22	4.09	.750
Pretest Willing Incongruent	22	4.05	.950
Posttest Willing Total	44	2.30	1.250
Posttest Willing Congruent	22	2.41	1.297
Posttest Willing Incongruent	22	2.18	1.220
Pretest Comfortable Total	44	3.64	.942
Pretest Comfortable Congruent	22	3.50	1.012
Pretest Comfortable Incongruent	22	3.77	.869
Posttest Comfortable Total	44	2.05	1.120
Posttest Comfortable Congruent	22	2.27	1.120
Posttest Comfortable Incongruent	22	1.82	1.097
Pretest No Problem Total	44	3.68	.883
Pretest No Problem Congruent	22	3.59	.908
Pretest No Problem Incongruent	22	3.77	.869
Posttest No Problem Total	44	1.98	1.110
Posttest No Problem Congruent	22	2.05	1.133
Posttest No Problem Incongruent	22	1.91	1.109
Pretest Happy Total	44	3.75	.892
Pretest Happy Congruent	22	3.73	.935
Pretest Happy Incongruent	22	3.77	.869
Posttest Happy Total	44	1.89	1.083
Posttest Happy Congruent	22	2.09	1.065
Posttest Happy Incongruent	22	1.68	1.086
Pretest Safe Total	44	3.20	.851
Pretest Safe Congruent	22	3.14	.889
Pretest Safe Incongruent	22	3.27	.827
Posttest Safe Total	44	2.50	1.267
Posttest Safe Congruent	22	2.68	1.249
Posttest Safe Incongruent	22	2.32	1.287

Note. Created from “SPSS” software by Lim, B.
The smallest value is shown.

Table C6 (Continued)

Descriptive Statistics: WTR Scale Contributive Aspects of Feelings of Willingness

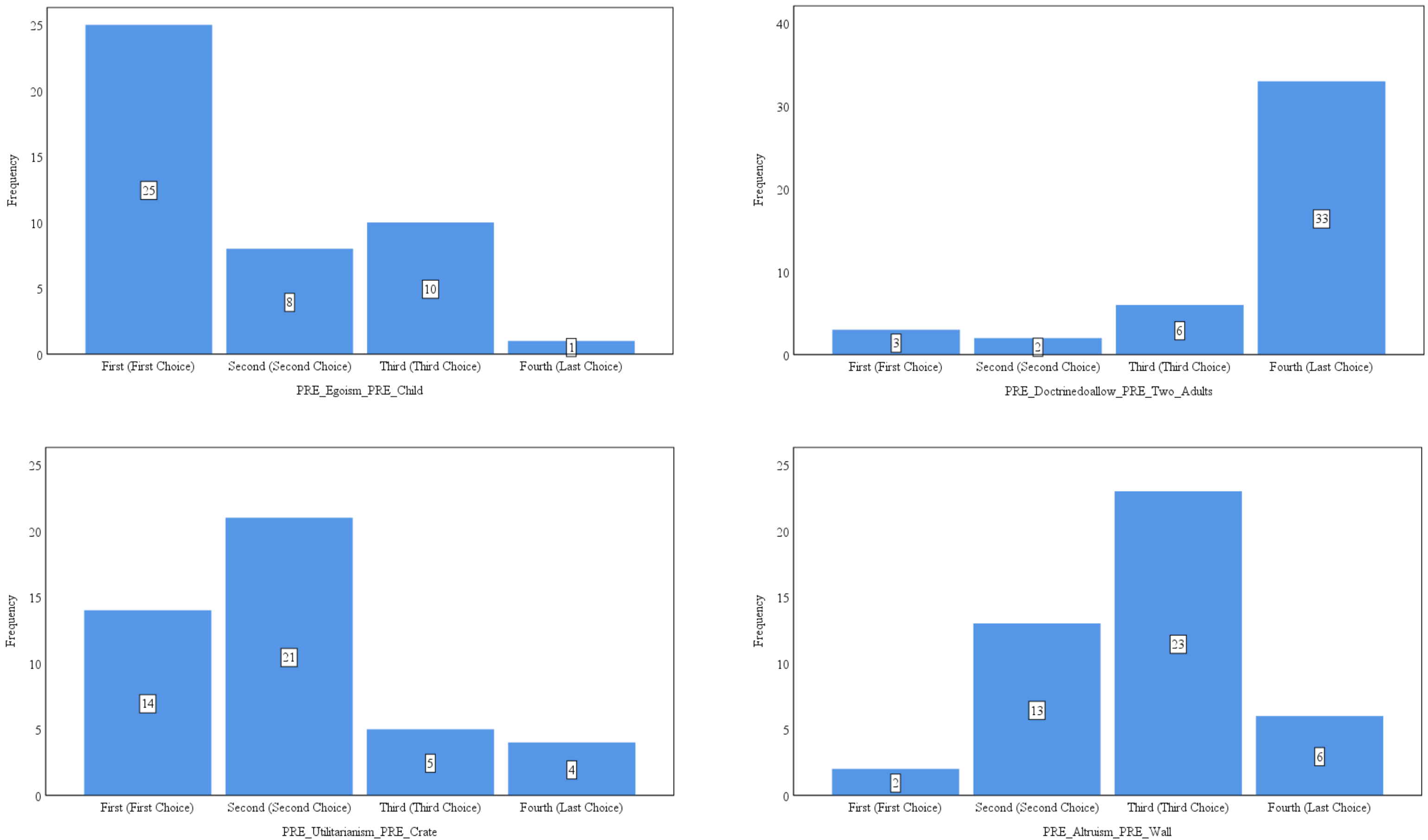
	N	Mean	SD
Pretest No Fear Total	44	2.98	.902
Pretest No Fear Congruent	22	2.82	.795
Pretest No Fear Incongruent	22	3.14	.990
Posttest No Fear Total	44	2.16	1.033
Posttest No Fear Congruent	22	2.23	1.066
Posttest No Fear Incongruent	22	2.09	1.019
Pretest Confident Total	44	3.32	.959
Pretest Confident Congruent	22	3.09	.971
Pretest Confident Incongruent	22	3.55	.912
Posttest Confident Total	44	2.05	1.200
Posttest Confident Congruent	22	2.23	1.270
Posttest Confident Incongruent	22	1.86	1.125

Note. Created from "SPSS" software by Lim, B.
The smallest value is shown.

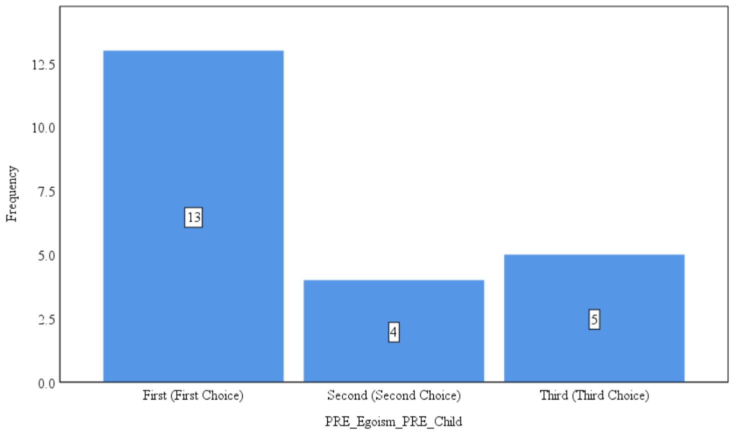
Appendix D

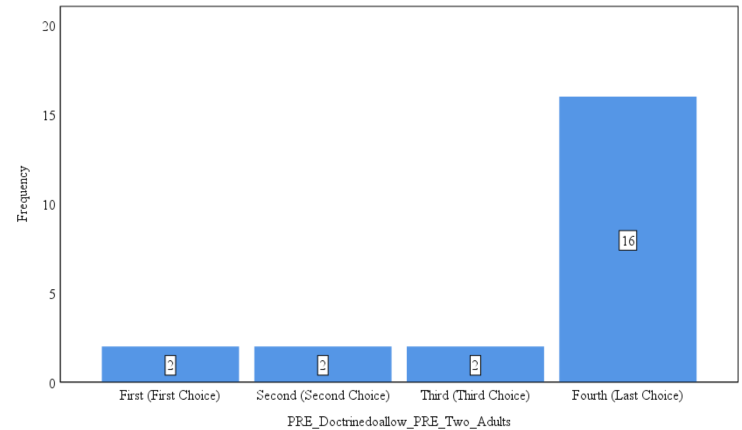
Figures

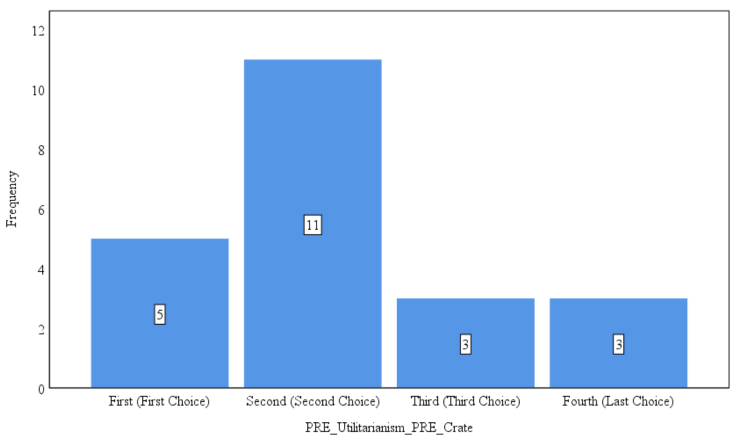
D1 Participants' Ranking of Ethical Settings: Both Congruent and Incongruent

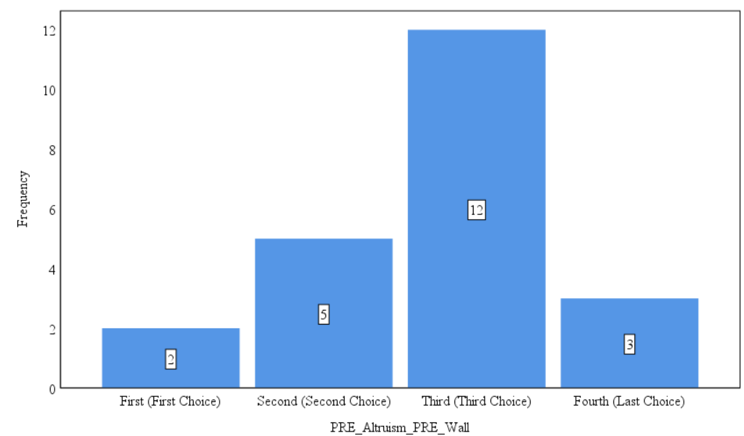


D2 Participants' Ranking of Ethical Settings: Congruent









D3 Participants' Ranking of Ethical Settings: Incongruent