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# How Other Drivers' Vehicle Characteristics Influence Your Driving Speed

Russell Brockett
*Claremont McKenna College*

CLAREMONT MCKENNA COLLEGE

# HOW OTHER DRIVERS' VEHICLE CHARACTERISTICS INFLUENCE YOUR DRIVING SPEED

SUBMITTED TO

PROFESSOR GABRIEL COOK

AND

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BY

RUSSELL LEE GOLDEN BROCKETT

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# Table of Contents

Abstract

An analysis of the effect of passing vehicles' characteristics and their impact on other drivers' velocities was investigated. Three experimental studies were proposed and likely outcomes were discussed. Experiment 1 focused on the effect of passing vehicle type (SUV, sedan or truck) on driver speed. Drivers were hypothesized as going faster when the same vehicle type as they were driving passed them versus when no vehicle or a different vehicle passed them. Experiment 2 focused on the effect of passing SUV age on driver's speed. Evidence suggests passing older SUVs will increase the driver's speed more than new SUVs. Experiment 3 focused on the effect of passing SUV color on speed. Drivers were hypothesized to go faster when brighter colors (red and yellow) rather than cooler colors (grey and black) were painted on the vehicle.

*Keywords: Driving, Speeding, Traffic, Color, Vehicle Type*

Automobile speeding is a serious issue on North American roads. In fact, in 2007, speeding was a contributing factor in approximately thirty-one percent of all fatal crashes, and 13,040 lives were lost in speeding related accidents (Traffic Safety Facts 2007). Despite overwhelming evidence of the negative effects of speeding, exceeding the speed limit is still one of the most frequently abused traffic violations (Haglund & Aberg, 2000). Thus, examining the rationales behind individuals' decisions to speed is of the utmost importance.

At a fundamental level, driving can be described as an information processing task in which the driver obtains information from the environment, evaluates it, makes decisions, and acts accordingly (Senders, Kristofferson, Levison, Dietrich & Ward, 1967). This process requires a constant interchange between the driver and the environment, whereby the driver gathers new information (and alters his or her behavior) as the vehicle continues to travel.

One of the central environmental factors a driver must focus on is the driving characteristics of passing drivers. In fact, it has been suggested that drivers tend to influence one another's speed choices (Haglund & Aberg, 2000), which may account for much of the highway speeding on American roads. Connolly and Aberg (1993) found that speed adjustment is the result of a process where the driver's own speed is compared with that of others. In other words, as other cars alter their speeds, drivers' perceptions of an acceptable highway velocity are altered as well.

Several other studies have supported the effect of passing vehicles on driving behavior. According to Horswill and Coster (2002) different types of vehicles have very different accident rates associated with them. This indicates that certain types of automobiles have a greater chance of colliding into you than others. In fact, when driving fatalities were compared for a range of car models, the highest fatality risk was six times the lowest (Horswill & Coster, 2002). While differences in driving behavior may be due to certain types of people choosing specific types of vehicles, it is also possible that the type of vehicle passing you promotes a driving behavior that influences crash risk (e.g. increased speeding).

The present study seeks to investigate this relationship between characteristics of passing vehicles and drivers' speed. In Experiment 1, I will test the effect of passing vehicle type (sedan, truck or SUV) on the passed driver's highway speed. In Experiment 2, I will analyze the effect of a passing sport utility vehicle's condition (old vs. new) on the passed driver's highway speed. Lastly, in Experiment 3, I will analyze the effect of the passing sport utility color on the passed driver's highway speed. All of the passing automobiles will be going fifteen miles in excess of the speed limit, and the extent to which the passed drivers in each experimental condition will break the speeding laws is to be examined.

## **Experiment 1**

The objective of Experiment 1 is to measure the relationship between the passing automobile's type and the passed driver's highway travel speed. The primary research questions I sought to address were: (1) Is there a change in drivers' speed as other vehicles pass you versus when traveling on the open road? (2) Are there significant differences in speed when your own vehicle type passes you (e.g. a sedan driver passed by a sedan) versus when other vehicle types pass you (e.g. a sedan driver getting passed by a truck or SUV)? and (3) Will some types of passing vehicles cause greater speed increases in other passed drivers than others? These questions will be investigated via analysis of previous literature and the proposed results from the present study's driving simulator task.

*Using the Theory of Planned Behavior to Forecast Results*

An overarching model used for predicting driving behavior is the *Theory of Planned Behavior.* This model was proposed by Ajzen (1991) and suggests the stronger the intention to perform a particular behavior, the more likely he/she is to perform that behavior. Ajzen states that intentions are a function of three determinants: behavioral beliefs, salient referents, and perceived behavioral control. These determinants have been shown to specifically impact speeding decisions (Stead, Tagg, MacKintosh & Eadie, 2005; De Pelsmacker & Janssens, 2007; Elliot, Armitage & Baughan, 2007)

Behavioral beliefs link a behavior to certain outcomes. In other words, the attitude towards a behavior is determined by the person's evaluations of the outcomes associated with the behavior. With regards to vehicle speed, the present study expects the perception of negative outcomes associated with speeding to be lessened as other vehicles drive over the speed limit. Thus, as adjacent vehicles drive over the speed limit, the expected result is a subsequent increase in speed of the participant's vehicle as well.

Salient referents are individuals or groups that the person believes will approve or disapprove of performing a behavior. In the present experiment, participants' perception of how family and friends view speeding violations may impact participants' likelihood that they speed. Moreover, the knowledge that a researcher is monitoring their driving behavior in a laboratory may alter their intentions. Although previous studies (Lee, 2002; Kaptein, Theeuwes & Van der Horst, 1996) have found an insignificant variation in driving behavior when driving-simulations versus on-road experiments are conducted, the types of salient referents may be different in simulators versus actual on-road conditions. For example the perceived opinions of the experimenter may play a role in one's behavior in a driving simulator, whereas the presence of friends or family in the passenger seat may play a greater role in one's on-road driving.

The third determinant in the theory of planned behavior is the notion of perceived behavioral control. Ajzen (1991) believed the greater a person's perceived behavioral control, the stronger their intention to perform the behavior should be. For example, in the present query, the likelihood a police officer will pull you over for speeding might affect your level of perceived behavioral control (thus increasing your perceived inability to exert your desired freedom to speed). Similarly, the likelihood that speeding next to other vehicles would cause an accident might also affect your perception of control. All of these determinants affected my proposed values for the effect of adjacent vehicle speeding on participants' driving velocity.

*Previous Findings Regarding Choice*

Based on previous literature regarding the effect of other automobiles and driver speed choice, one's own speeding decisions are expected to be correlated with the presence and speed of other vehicles. Haglund and Aberg (2000) discovered that a driver's behavior is intimately related to the behavior of other drivers. They found that a driver who perceives others as driving at excessive speeds is more likely to drive faster than a driver who perceives others as complying with the posted limits. Thus in the present study if the participants are aware of their own speed being relatively slow in relation to their speeding counterparts, they will be more likely to go over the speed limit as well.

Similarly, Connolly and Aberg (1993) found individuals may adjust their speed by comparing their own speed with that of others. They found that as other adjacent traffic increases or decreases their speed, individuals are likely to increase or decrease their speed as well. The present study will attempt to replicate these findings while also manipulating the type of vehicles driving on the road.

To the best of the experimenter's knowledge, no one has specifically examined the role of passing automobile model types (i.e. sedans, trucks or SUVs) on passed driver speed choice behavior. However, there are numerous studies on social comparison effects that are relevant to a driving context. Other than merely observed speeding of others, certain types of automobiles may cause more behavioral alteration on the part of the passed driver than others.

A large number of investigations have found that attitudinal similarity produces a positive effect on attraction (Insko et al, 1973). In other words individuals with similar personality characteristics are more likely to rate other similar individuals more positively than they will rate those with less analogous traits. Similar research has been conducted with regard to wealth and possessions (Byrne, Clore, & Worchel, 1966; Buss & Barnes, 1986). People with comparable demographic and socioeconomic backgrounds often have closer interpersonal relationships with one another than with their others in society.

The present study will investigate whether the connection between similarity and behavior emulation has an impact with regard to reactance (in terms of passed driver speed) to being passed by various types of automobiles. Literature has shown that different types of vehicles (sedan, SUV, truck) tend to have different types of drivers (Choo & Mokhtarian, 2004). For example, individuals that own sedans are more likely to be females or homemakers and to have higher incomes or larger households(Choo & Mokhtarian, 2004). Moreover, pickup truck drivers tend to feel less in control and less satisfied with their life, and are more likely to be in a lower education middle- income household (Choo & Mokhtarian, 2004). Lastly, SUV drivers are less likely to be frustrated and are overrepresented among highly educated or higher income people (Choo & Mokhtarian, 2004). Thus there are significant demographic differences between drivers of each of the automobile types being investigated.

Not only are there varying characteristics among drivers of different types of automobiles, but people perceive different types of automobiles as driving at different velocities, even when they are traveling at the same speeds. Davies (2009) found that individuals perceived a BMW sports car as going faster than a Volkswagen Polo even when both were going at fixed speeds of 20, 40 and 60 miles per hour. This was likely due to the stereotype of high speeds associated with sports cars versus normal coops.

Furthermore, automobiles rated by the public as being higher in aggressiveness were judged as driving faster, being further across the road, and being more likely to cause an accident than those lower on the aggressive spectrum (Davies & Patel, 2005). In fact, they found that larger vehicles (e.g. trucks and SUVs) were generally rated higher in measures of aggressiveness and thus perceived as going faster. Accordingly the present study factored size of passing vehicle in generating its proposed results on the effect of a driver's speeding behavior.

Lastly, Matthews and Cousins (1980) found that drivers of smaller cars were more accurate at estimating driving speed than those driving larger vehicles. The author hypothesized this could be a result of feeling more vulnerable to external surroundings and thus spending more attention on the other automobiles (as well as factors such as increased ability to hear outside noise, etc.). For the present study this might indicate that smaller vehicle drivers (such as sedan drivers) will be better able to estimate speeds of the passing automobiles. Therefore habitual drivers of smaller vehicles may be better at regulating their own speed towards complying with the legal limit than their truck and SUV driving counterparts.

*Hypotheses*

Based on the above information, the experimenter hypothesizes: (1) the presence of passing vehicle types (SUV, truck or sedan) will cause drivers to increase their speed to a greater extent than those driving on an open road; (2) when the participant is being passed by a vehicle which is of the same vehicle type as they are accustomed to driving themselves (e.g. a sedan driver being passed by a sedan), the passed vehicle participant will have a significantly larger increase in vehicle speed than if they are driving without being passed. Lastly, (3) because of the literature regarding better speed estimation of smaller vehicles, it is expected that when being passed, sedan drivers will limit their speed increase to a greater extent than truck or SUV drivers.

## Proposed Methods

*Participants*

A total of 5,000 United States drivers license holders from the Inland Empire (2,500 males and 2,500 females) will be randomly solicited by mail to participate in the present study. Participant information will be obtained from the Department of Motor Vehicles (DMV) database and approximately 8% of those solicited (200 males, 200 females) are expected to enroll (Elliott, Armitage & Baughan, 2007). The mean age of the sample will be approximately 35 years (range 18-65 years), with all participants having driven for at least one year. The present experiment is a mixed-subjects design, meaning there are both within subject and between-subject variables.

*Design*

The study will be conducted at a psychology research laboratory. In lieu of actually measuring driving speed on local highways, a driving simulator will be used. Previous studies (Lee, 2002; Kaptein, Theeuwes & Van der Horst, 1996) indicate that mid-level and upper-level driving simulators are just as effective at determining speeding behavior as on-road measurements. Moreover, they are a safer and more economical method than on-road testing to assess driving performance (Lee, 2002).

Godley, Triggs & Fildes (2002) did find that individuals may drive faster in an instrumented car than a simulator. Nevertheless, a driving simulator was chosen. Driving simulators enable researchers to simultaneously obtain highly reliable behavioral measures because speed data are recorded on a moment by moment basis along an entire journey (Elliott et al. 2007). This is much more difficult to replicate in actual highway settings because of the manpower involved in multiple radar locations. Furthermore, a driving simulator can ensure superior experimental control, because all drivers will be exposed to the same roadway surroundings. Thus for the present experiment, a driving simulator was deemed preferable.

Upon entering the research laboratory, participants will be asked to fill out a pre-experimental questionnaire. The questionnaire will contain basic demographic information about the participant. The individual's age, gender and years of driving experience will be documented. Furthermore the make, model and year of individuals' regularly driven car will be requested. Individuals without a specific regularly driven car will be dismissed from the study.

*Driving Simulator*

Upon completing the pre-experimental survey, participants will be asked to familiarize themselves with the driving simulator. The simulator will have many of the components of a regular automobile. The acceleration and breaking can be controlled at the floor of the driver's seat in the same fashion as conventional vehicles. There will also be a steering wheel as well as computerized panels on all four sides of the driver. Moreover, a speedometer will be located on the front of the simulator for participants to monitor their driving velocity. The computerized video panels will replicate the feeling of a two lane highway road. The frequency of road signs, curves, and other cars will attempt to duplicate the open stretches of highway on Southern California roads.

The brand of automobile in the simulation was chosen based upon the level of popularity for each type of vehicle. For example, because the Toyota Camry is the bestselling car in the United States (Chicago Tribune, n.d.), the Camry was selected to be the sedan that passes the driver. Similarly the Ford F-series (truck) and the Honda C-RV (SUV) are the most popular vehicles for their respective classes (Chicago Tribune, n.d.), and hence were chosen to represent the "trucks" and "SUVs" that pass the participant. All models presented were that of the newest automobile edition (e.g. 2011 Camry). The most popular cars were chosen to minimize the effect extraneous factors other than automobile type (e.g. a vehicle's distinctive design) might have on the participant's driving speed.

The color of the automobiles passing the driver was also standardized. According to Nancy Lockhardt, the Color Marketing Manager for DuPont Vehicle Paints, the most popular vehicle color in North America is white (Kurczewski, 2010). Therefore, the passing automobiles in the simulators will all be white to mitigate the effect distinctive colors might have on the participant's driving speed.

*Procedure*

The independent variable in Experiment 1 is the type of automobile (sedan, truck, SUV or no vehicle) that is passing the driver. After the participants are situated in the driving simulator, a five minute practice drive will begin. This is necessary for the participants to become acquainted with the handling of the automobile (thereby minimizing the variation in initial control skill). The participants are told to imagine they are using their normally driven automobiles for the duration of the simulation. They are also instructed to drive in the same fashion they would in actual on-road conditions.

After the five minute practice session is concluded, Experiment 1 immediately begins. Participants drive for thirty simulated miles and encounter speed limit signs with the same frequency as seen on open stretches of the California interstate. The California Department of Transportation places a 70mph regulation on many rural interstate routes (California Highways, n.d.), and thus 70 mph speed signs will be given to the driver.

According to Samuel C. Tignor (1990), former chief of the Traffic Safety Research Division of the Federal Highway Administration, the speed limit is set 8 to 12 mph below the prevailing $85^{th}$ percentile speed. In the present experiment the passing automobiles (sedan, truck or SUV) travel at 15 mph over the speed limit (85mph), well beyond the conventional flow of traffic. The speed of these other automobiles will always remain constant and will always pass along an adjacent lane. The simulation is structured to such an extent that the passing automobiles that appear on the screen should not cause a collision.

*Speed Measurements*

Every three miles a randomized type of automobile (i.e. sedan, truck or SUV) will appear in the simulation. In the mile immediately before the passing automobile approaches the participant's vehicle, a baseline speed will be recorded (the average speed for one mile of driving on the open road immediately prior to being approached and passed by another vehicle). This will serve as a control to compare with the velocities as other vehicles pass the driver. The computer will next measure the variation of the participant's driving speed as the different automobiles pass their vehicle. To be able to investigate any potential interaction effect between participant's habitual vehicle type and the passing vehicle type, three observations will be made in each cell. Thus, three habitual SUV drivers will be passed by three SUVs, by three sedans and by three trucks and their subsequent speed recorded. Similarly, three habitual sedan drivers will be passed by three SUVs, by three sedans and by three trucks, and three habitual truck drivers will be passed by three SUVs, by three sedans and by three trucks. The data entered into the data matrix has three rows and three columns (SUV, sedan or truck habitually driven by the participant, and SUV, sedan or truck passing the participant's vehicle) with three observations in each of the cells (repeated measures). The data recorded in the actual matrix will be the speed of the participant's vehicle subsequent to being passed minus the speed for the mile prior to being approached by the passing vehicle (the control). By using the incremental speed (treatment minus control) for each entry we will control for possible effects that might occur (as different drivers may have different baseline speeds which may be correlated with the type of vehicles they have chosen to habitually drive).

Table 1 summarizes the structure of the data to be gathered. The recorded x values in each cell are the observed speeds after being passed minus the control speed. Using this set of observations, a two way Analysis of Variance (ANOVA) with repeated measures per cell will allow us to not only test if there is main effect of the passing vehicle type, or a main effect of the vehicle being passed, but also to test for any possible interaction effect between the vehicle being passed and the vehicle which is doing the passing. Thus, the data will be analyzed as to whether or not certain types of passing vehicles impact habitual SUV, truck or sedan drivers to drive faster than other types of vehicles. As a first step, since all the variables are the speed after being passed minus the control speed exhibited when there are no other cars around, if the presence of other passing automobiles has no effect on the driving speed of the vehicle being passed, then the average value of $x_1$, $x_2$ and $x_3$ should be expected to be zero (the passed speed equals the control speed). This can be statistically tested using the t-distribution with n-1 = (3×3×3)-1 = 26 degrees of freedom. The t-distribution will specifically check whether the presence of other automobiles impacts the likelihood of unlawful speeding. Proposed results will be discussed in the subsequent section.

## Proposed Results

The independent variables in the present study are the type of automobile (SUV, truck, sedan) that is passing the participant and the type of automobile (SUV, truck, sedan) that is habitually driven by the participant being passed. The dependent variable is the speed the participant driver who is passed chooses to drive minus the control speed. The experimenter examined how each passing vehicle type affects the participant's highway speeding decisions as a function of the type of vehicle habitually driven by the participant. The data was analyzed in terms of whether the participant's speed was related to passed passenger's normal vehicle type and the passing automobile type (e.g. a truck driver is being passed by a truck or an SUV driver being passed by a truck, etc.). The two way ANOVA allows us to determine if there are main effects of passed driver vehicle type, or passing driver vehicle type, or an interaction which means that certain passed drivers react differently to being passed by a truck versus a sedan, for example.

Vehicle velocity data were subjected to a 3×3 factorial analysis design with 3 observations per cell (see table 1). The first test to see if there is a significant row effect (no main effect due to passed driver habitual vehicle) can be computed using the two way

ANOVA statistical program and compared to the F distribution having degrees of freedom equal to 2 (= # rows -1) and 18 (=3×3×(3-1)). Similarly, to test the hypothesis that there is not column effect (no main effect due to passing vehicle type) we compute the ANOVA statistic and compare it to the F(2,18) distribution where 2 (= # columns -1) and 18 (=3×3×(3-1)). Finally to see if there is any interaction effect between the type of vehicle driven by the participant and the type of vehicle which passes the participant, we compute the interaction F value using an ANOVA statistical computer program and compare it to the F distribution having degrees of freedom equal to (6, 18), where the value 6 corresponds to [(#rows-1) × (# columns-1)]. All effects are expected to be statistically significant at the .05 significance level.

As Hypothesis 1 projected, there will be a difference in a driver's decision to speed when an automobile passes them versus when one does not. Additionally, the main effect of a passing automobile will yield an F ratio that indicates the mean participant driving speed is significantly greater when vehicles pass the participants (e.g. *M=81.7, SD=*7.2) versus when participants drive alone on the road (e.g. *M=*71.8, *SD=3.3*). Similarly, the main effect of participants habitual vehicle is also expected to be significant at the 1% level by comparing to $F_{.01}(2,18) = 6.013$.

The hypothesis stating participants being passed by their same vehicle type will be more inclined to subsequently speed up after being passed is also expected to be verified via an interaction effect. There will be a significant interaction effect with the F value greater than $F_{.01}(6,18) = 4.015$. This means we will find that SUV drivers being passed by other SUV drivers travel at higher speeds after being passed by an SUV than when they are passed by a truck. Similarly, truck drivers being passed by other truck drivers will subsequently travel at higher speeds than they would when they were passed by other vehicle types. Lastly, sedan drivers being passed by other sedan drivers will travel at higher speeds than they do when passed by vehicles other than their own type. Figure 1 illustrates these hypothetical results.

A Tukey's post-hoc analysis will indicate significant differences between SUV and sedan driving speeds and truck and sedan driving speeds ($p$<.05). However, the difference will not be significant between truck and SUV driving speeds (p>.05). This is in support of hypothesis 3 which posited that drivers of smaller vehicles would be better at regulating their speeds than drivers of larger automobiles such as trucks or SUVs.

## Discussion

The proposed results of Experiment 1 are in agreement with the hypotheses made by the experimenter. In general a significant increase in highway speed was hypothesized when passing automobiles were present versus when drivers were traveling along the open road without intervening passing vehicles. This supports Connolly and Aberg's (1993) previous findings.

Furthermore, the data will strengthen Ajzen's Theory of Planned Behavior (1991). It is possible that the presence of passing cars (traveling at increased speeds) will cause participants to lessen their focus on the negative salient referents associated with speeding. However, because data will not be collected on the decision making processes of participants (only the exhibited behavior), it is not feasible to confirm, as Ajzen posits, that it is an altered *intention* arising from the passing autos that made drivers increase their speeds. Future research focused on driving and attitudinal decision making is necessary to confirm his hypothesis.

The conjecture that being passed by similar vehicle types to that customarily driven by the participant increases the likelihood that the passed driver would subsequently increase their own speed and mimic the speeding behavior of the passing car will be strengthened with these results as well. SUV, truck and sedan drivers that are passed by their respective vehicle type are expected to have significantly faster subsequent highway speeds than those passed by alternative vehicle types. This points to social comparison effects. Previous literature regarding personality (Insko et al, 1973), wealth and possessions (Byrne, Clore, & Worche, 1966; Buss & Barnes, 1986) have shown that people mimic those with similar traits. Mimicking driver behavior of drivers possessing similar automobile traits (auto types) with regard to exhibited vehicle speed can potentially be added to the literature as well.

The investigations from the present study lead to several questions. For example, in Experiment 1 all of the automobiles passing the driver were new models. This was done to standardize automobile age across all conditions. Nevertheless, the age of the passing vehicle (and the perceptions associated with old versus new vehicles) may have also impacted drivers' decisions to speed. Furthermore, all of the automobiles in Experiment 1 were colored white to standardize vehicle color across all conditions. It is possible, however, that a passing vehicle's color type may impact participant's decision to speed. Experiments 2 and 3 of the present study will address these potentially important variables.

Perhaps the most important implication of the present study is the finding regarding the prevalence of speeding violations. In every condition the average participant speed is expected to cause drivers to travel above the legally institutionalized speed limit. Accidents are strongly correlated with excessive speeding (Haglund & Aberg, 2002), and thus finding a means to limit the negative effects of passing vehicles is necessary.

## Experiment 2

As discussed above, Experiment 1 is expected to show that the velocity of adjacent vehicles does, in fact, impact the likelihood of speeding in one's own vehicle. Moreover, it was proposed that habitual sedan drivers are more likely to stay below the speed limit than those who usually drive other vehicle types. Lastly, the experiment suggested that a stronger behavioral speed change would subsequently occur if the car type of the passing automobile was the same as the vehicle habitually driven by the participant.

The present experiment will specifically focus on SUV drivers and SUV passing vehicles. Sport Utility Vehicles were chosen because they have shown to have the greatest potential for rollover at excess speeds. In 2000, SUVs had the highest rollover involvement rate of any vehicle type in fatal crashes -- 36 percent, as compared with 24 percent for pickups, 19 percent for vans and 15 percent for traffic cars. SUVs also had the highest rollover rate for passenger vehicles in injury crashes -- 12 percent, as compared to 7 percent for pickups, 4 percent for vans and 3 percent for passenger cars (Frontline 2002). Moreover, one out of every four vehicles on the road is an SUV, making it the most popular vehicle type in the United States (Frontline 2002). Thus, Sport Utility Vehicles were elected as the focus of Experiment 2.

Experiment 2 will examine the effect of the age of the passing SUV on the subsequent driving speed of the passed SUV. For this experiment, SUVs will be segmented into two categories, old and new passing vehicles, and in both cases the passing SUV will drive at 15 miles per hour above the speed limit like in Experiment 1. The independent variable in Experiment 2 will be the age of the SUV that is passing the driver participating in the experiment. The dependent variable will be the subsequent speed of the participant who is passed while driving in the simulator.

Just as in Experiment 1, the experimenter predicts there to be an impact of passing vehicle driving speed on the participant's velocity. In fact, the $SUV_{driver}$ x $SUV_{newpassingvehicle}$ condition is a replication of a segment of Experiment 1. Therefore, as seen in the proposed results of the first experiment, the author expects there to be a strong positive correlation between SUV passing vehicle presence and SUV driver vehicle speed.

As discussed in Experiment 1, the behavioral change exhibited by a driver in the simulation as an SUV passes can be accounted for by the Theory of Planned Behavior (Ajzen 1991). In this case, individuals will have a greater intention to break the speeding laws because the speeding behavior is being reinforced by the automobiles around them. Moreover, the other (similar) vehicles' excess speeds are not being punished, creating a smaller perceived likelihood of reprimand. The passed driver thus feels a sense of behavioral flexibility in their driving speed, and subsequently increases his/her velocity.

When specifically looking at the differences in results of passing an old versus new SUV, I expect a significant variation in speed change as well. Fosser and Christensen (1998) found that despite better safety features in newer cars, the newer the vehicle the higher the probability of damage and injury accidents. The authors suggest this is because newer cars foster more risky behavior (e.g. speeding) which counteracts the improved safety features of newer automobiles. Newer cars have a lower chance of harm in an accident, and by Wilde's target risk theory (Wilde 1994) drivers have an "optimum" or "target" level of risk such that when environmental influences, such as automobile manufacturing safety advancements, decrease the level of risk, the driver reacts by increasing their level of risky behavior (e.g., speeding) to bring the realized risk level back to the target level of risk for the individual.

Other studies have also found a higher frequency of lawless behavior in newer versus older automobiles. Evans and Rothery (1976) found that the drivers of newer vehicles were more likely to drive into the intersection after the light had turned red. Moreover, they used higher deceleration levels than their older model counterparts. This suggests an increased neglect of the law among new car drivers.

New vehicles have a different stereotype associated with them relative to older vehicles as well. In fact, older vehicles are often associated with lower safety standards and quality (Horswill & Coster, 2002). Therefore, an older speeding passing SUV may have a different effect on an adjacent passed driver than the speeding of a newer SUV.

Wilson and Kelling's Broken Windows Theory (1982) supports this hypothesis. The Broken Windows Theory posits that if broken windows in a building are not repaired, there will be a tendency for tenants to break more windows. They assert small indications of disorder are associated with leniency, which invites more unlawful behavior to ensue.

Phillip Zimbardo (1969) furthers this hypothesis with his investigation of vandalism and automobiles. Zimbardo placed two unlicensed 1959 Oldsmobile cars in either an affluent or impoverished area. In both conditions, after the automobile had a window broken, the cars were quickly stripped. This indicates the effect of a car's exterior on people's association with it. In the Zimbardo experiment, the trashier the car the more likely individuals were to act criminally towards it. Thus it appears the other passing driver's automobile appearance affects the passed driver's perception of acceptable behavior.

In the context of the present experiment, it is possible to equate older vehicles with greater disorder. Older automobiles are widely associated with greater pollution (Dill 1996) and their wear and tear is often perceived as less appealing than a new auto (Horswill & Coster, 2002). Hence, the environmental cues given off by an adjacent (passing) older vehicle is expected to attract more criminal behavior from the vehicles around them (in the present experiment the criminal behavior expected is increased likelihood of speeding).

Based on the above information, Experiment 2 expects to see a relationship between age of the passing sports utility vehicle and the speed of the participant's SUV. In other words, the speed of the adjacent older SUV is more likely to impact other drivers' decisions to increase their vehicle speeds than adjacent new SUVs.

## Proposed Methods

### *Participants*

Participants will be obtained from the same sample of 400 individuals (200 males, 200 females) that elected to participate in Experiment 1. Individuals will all be United States drivers license holders, with at least one year of driving experience. Moreover, the mean age of the sample is expected to be approximately 35 years (18-65 years).

If the sample is representative of the United States automobile buying population, of the 400 participants that partake in Experiment 1, approximately 20% will have indicated in the pre-questionnaire that they drive a Sport Utility Vehicle (Wall Street Journal Online 2011). This means that the sample size for Experiment 2 will be about 80. Because both men and women are equally likely to a drive sport utility vehicle (Choo & Mokhtarian, 2004), an equal distribution of male and female drivers (40 males 40 females) is expected.

*Design*

The average life span of a car is thirteen years. Additionally, less than a third of registered cars in the United States are more than ten years old (Safe Car Guide, n.d.) Therefore, for the present experiment I will define an old car to be one that is thirteen years old. The thirteen year old vehicle will have over 100,000 miles on it with the wear and tear of a vehicle that has been driven approximately five times per week. A new SUV will be operationalized as a model that has come out in the last 12 months.

In order to standardize the results, all old and new passing SUVs will be from the Honda C-RV brand. As discussed in Experiment 1, the Honda C-RV is the most popular SUV in the United States (Chicago Tribune, n.d.). Therefore the distinctiveness of SUV brand will be less likely to impact the driving speed of the participant. Moreover, the Honda CR-V has been manufactured since 1995, meaning this same vehicle type can be used in both the old and new vehicle conditions.

Just as in Experiment 1, all cars were chosen to be white. White is the most popular automobile color in the United States, with approximately 20% of drivers electing to drive a vehicle of this color (Kurczewski, 2010). The most popular color was chosen to limit the effect color of a passing automobile might have on a driver's likelihood to change speeding behavior.

The same driving simulator used in Experiment 1 will be used in Experiment 2. However instead of having different types of vehicles (sedans, trucks and SUVs) pass habitual sedan, truck or SUV drivers, the type of vehicles (driven and passing) will be standardized. All participants will be habitual SUV drivers and all cars passing the participants will be either 2011 or 1998 white Honda C-RVs.

*Procedure*

Every three miles a randomized age of SUV (i.e. old or new CR-V) will appear in the simulation. Just as in Experiment 1, the passing vehicles will go at a constant 15 miles per hour over the conventional 70 miles per hour California rural highway speed limit. The computer will measure the variation of the participant's driving speed for the mile after the passing vehicle passes the participant's SUV. A baseline velocity will be set via the measurement of participant speed with no passing vehicle present. Data will be recorded as to whether or not the age of the passing SUV will impact the drivers' speeding decisions. Investigators will specifically look at whether the presence of older SUVs impacts the likelihood of unlawful speeding differently than new SUVs. Proposed results will be discussed in the subsequent section.

## Proposed Results

The independent variable in the present study is the age of SUV (old versus new) that is passing the participant. The dependent variable is the speed the participant (an SUV driver) chooses to travel. The experimenter examined how each passing vehicle type affected the participant's highway speeding decisions.

Data on the participant's passed vehicle velocity will be subjected to a one way analysis of variance, with two levels of passing vehicle types (new SUV, old SUV) and the entered data being the difference between the velocity observed after being passed and the control (driving speed on the open road) level speed. All effects were statistically significant at the .05 significance level.

My hypothesis projected that there will be a difference in a driver's speed when an old SUV passes versus when a new SUV passes. The significance in a one way ANOVA will show the levels of treatment are not the same. Moreover, an f-test will show the driver does in fact go at significantly higher speeds when an old vs. new automobile passes. Moreover, post hoc analyses using the Tukey's post hoc criterion for significance will indicate that the average speed when there was no passing SUV (the control) was significantly lower than the other two (old and new passing SUVs) conditions. Figure 2 illustrates these proposed results.

## Discussion

The proposed results of Experiment 2 are expected to be in agreement with the hypotheses made by the experimenter. Just as in Experiment 1, there will be a significant increase in highway speed when passing automobiles were present versus when drivers were traveling along the open road. This further supports Connolly and Aberg's (1993) previous findings.

Passing by older SUVs did, in fact, cause the participant to break the speed limit to a greater extent than did being passed by new SUVs. This suggests that the wear and tear associated with older SUVs might be inviting to greater criminal behavior. Previous literature (Wilson & Kelling, 1982) has shown that disorder invites greater criminality. Perhaps the disorder associated with older automobiles (e.g. banged up from 13+ years of use) creates this perception of acceptable speeding violations. An alternative explanation is that competitive effects enter when the participating driver perceives themselves as being passed by an "inferior" older vehicle.

This research has led to several interesting questions. Is there an ideal age of a passing vehicle to minimize its negative effect on other automobiles? Moreover, is the age effect present in other types of vehicles? Future research is necessary to answer these questions.

In Experiment 2, the effect of the color of the passing automobile was held constant. Just as in Experiment 1, vehicle color was standardized to be white among all SUV conditions. It is possible, however, that the color of the passing vehicle might also impact participants' decision to speed. Therefore, Experiment 3 will focus on what effect passing SUV vehicle color has on other drivers' decision to speed.

## Experiment 3

Experiment 1 has illustrated that type of passing automobile will affect a driver's speeding decision. Experiment 2 has shown that the age of passing SUVs can also impact the speeding behavior of passing SUV drivers. Experiment 3 seeks to determine what affect vehicle color might have on likelihood of speeding.

In Experiments 1 and 2 all vehicles passing the driver were colored white. This was done to standardize color among all vehicle conditions and due to the fact that the most popular vehicle color in the United States is white (Kurczewski, 2010). The present experiment, however, seeks to manipulate the passing automobile's color to determine if it has an effect on a driver's decision to speed. In other words will other vehicles' paint jobs (attractiveness or image) impact the likelihood that a passed driver subsequently goes over the speed limit (in conformity with the passing auto)?

Experiment 3 focuses specifically on passing sport utility vehicles (SUVs) and SUV drivers. Just as in Experiment 2, the decision to concentrate on sport utility vehicles was made because SUVs have shown to have the greatest potential for rollover at excess speeds (Frontline 2002) and therefore understanding what might cause speeding could be of practical importance. Moreover, one out of every four vehicles on the road is an SUV, making it the most popular vehicle type in the United States (Frontline 2002). Hence monitoring the impact of SUV drivers' speeds is of the utmost importance for American highway safety and will be further investigated with regard to SUV color.

The author expects to see a small variation in the likelihood of increased speeding as the color of the passing automobile changes. Early work by Karas (1959) provided the bright-color hypothesis. He suggested that autos with brighter colors such as red, yellow and white are more likely to be perceived as driving at higher speeds than cars of less bold pigmentation.

Similar evidence is seen in other research as well. Cherry and Andrade (2001) found that red vehicles were cited for speeding violations at significantly lower speeds relative to brown vehicles. This implies that judgments or attitudes of speed may differ across colors even by authorities.

There is also literature suggesting that certain colors increase arousal more than others. For example, Birren (1950) found that warm colors (e.g. red and yellow) increase arousal more than cooler colors (e.g. blue, gray or black). Birren defines warm colors as those that are vivid in nature, whereas cool colors are those that are more associated with dusk and night. Green et al (1983) furthered this research in his finding that yellow and orange colors elicited greater arousal than darker colors (e.g. black and gray).

The evidence that warmer colors increase arousal more than cooler colors leads to an important question: what is the effect of arousal on driving behavior? Research indicates that arousal is a critical element in behavioral efficiency (Collet, Petit, Priez, Dittmar 2004). In fact, it has long been known that arousal affects performance along an inverted u-curve (Yerkes and Dodson 1908). In other words, too little arousal while driving may limit performance, while too much arousal will likely decrease performance as well.

When compared to other arousing stimuli while driving (car in front of you breaks quickly, icy roads, etc.), adjacent vehicle color produces only a minimal amount of arousal. The author expects the level of arousal created from automobile color to increase awareness rather than negatively affect perception. Therefore it is hypothesized that the arousal producing colors will increase driving performance.

The results are thus expected to show faster speeds subsequently exhibited by drivers who are passed by the cooler colored SUVs (i.e. gray and black) versus those who are being passed by warmer colored SUVs colored red and yellow. This can be explained via the arousal effect which indicates higher arousal invoking colors (red and yellow) are correlated with better driving performance (Collet et al, 2005) (in the present experiment this means staying at the posted speed limit). The bright color hypothesis further strengthens this expectation via the proclamation that brightly colored vehicles are perceived as going at higher speeds than their less bright counterparts. Hence, participants that are passed by a speeding red or yellow SUV are expected to be much more likely to perceive their speed as excessive and regulate their own driving behavior towards the speed limit compared to those who are passed by gray or black SUVs.

## Methods

*Participants*

Just as in Experiment 2, participants will consist of approximately 40 males and 40 females. Individuals will all be United States driver's license holders, with at least one year of driving experience. Moreover, the mean age of the sample is expected to be approximately 35 years (18-65 years). All participants will be self-identified habitual SUV drivers as indicated in the Experiment 1 pre-experimental questionnaire.

*Design/Procedure*

The same driving simulator will be used in the present experiment as were used in Experiments 1 and 2. However, instead of old and new SUVs passing the driver as in Experiment 2, different colored SUVs will pass the driver (all SUVs will be new Honda CR-Vs like the SUV condition in Experiment 1). Colors in the present experiment will consist of some of the most popular SUV paint jobs. According to Dupont (2010), these colors (in order of popularity) are white, gray, silver, blue, red and black. Green and yellow/gold also have 4% and 1% of the market share respectively. Because previous research (Karas 1959; Perry & Andrade 2001) suggests that bright colors are more likely to be noticed than their counterparts, a mixture of bright (red, yellow,) and non-bright (black, gray) will be studied.

Just as in Experiments 1 and 2 the passing car will go 15 miles per hour above the labeled 70 mph highway speed limit. SUVs of different colors will pass the participant driver every three miles in a random color sequence. The participant's driving speed will be measured when the adjacent vehicle passes the driver and for the following one mile after. A baseline speed will also be taken when the participant is isolated from other vehicles (i.e. when no other vehicles are in view).

In the present study the independent variable will be the color of the passing automobile (red, yellow, gray or black). All passing SUVs will go 85 mph. The dependent variable will be the speed of the SUV the participant is driving minus the control speed (the measured speed for the mile just prior to being passed). Experiment 3 will determine whether certain adjacent colored SUVs cause the participant to increase their speed more than other colored SUVs.

## Proposed Results

The independent variable in the present study is the color of SUV (red, yellow, black, gray) that is passing the participant. The dependent variable is the speed the participant (an SUV driver) chooses to travel minus the measured control speed. The experimenter will examine how each passing vehicle color affects the participant's highway speeding decisions.

Vehicle velocity data will be subjected to a one way analysis of variance, with four levels of passing SUV colors (red, yellow, black, gray). As my hypothesis projected, there will be a significant difference ($p<.05$) between the resulting speed of the passed driver depending upon the color of the passing auto. The main effect with regard to color type of a passing automobile will yield an F ratio that indicates the mean driving speed of the passed driver is significantly different depending upon the color of the passing auto (i.e., the hypothesis that all four passing automobile colors resulting in the same driving speed of the passed auto was rejected. Post hoc analyses using the Tukey's post hoc criterion for significance will indicate that the average speed of the gray versus black colored vehicle condition will not be significant ($p>.05$). Similarly, the average speed in the versus yellow colored vehicle conditions will not be significant ($p>.05$). Lastly, just as in Experiments 1 and 2 there will be a significant difference between average speeds when passing vehicles are present versus when there is no vehicle. In other words, the average dependent variable (passed speed – control speed) will be significantly positive using a t-test with $n-1 = 80-1 = 79$ degrees of freedom ($p<.05$). Figure 3 illustrates these results.

## Discussion

The results of Experiment 3 are in agreement with the hypotheses made in the present study. The experimenter proposed that grey and black passing SUVs will cause the passed driver to speed at significantly faster velocities than that produced by being passed by a red or yellow vehicle. This makes sense because bright colors are perceived as going at higher speeds (Cherry & Andrade, 2001). Therefore drivers passing a red or yellow automobile will be less likely to emulate the passing vehicle's driving behavior. Similarly, the red and yellow colors are "warmer pigments" than gray and black. In the present experiment this suggests the passing red and yellow SUVs will produce a high enough level of arousal that they increase the performance of the participant's driving. Thus, drivers passed by these brighter colors will actually stay within the legal speed limits when their counterparts do not.

This research has led to several interesting questions. Is there a specific vehicle color that will minimize a passing vehicle's negative speeding effect on other automobiles? Moreover, is the level of arousal created by automobile color consistent among all vehicle types? Are there gender differences in the level of arousal created? Lastly, is there an optimal level of arousal to improve driving performance that can be elicited via passing automobile characteristics? Future research is necessary to answer these questions.

## General Discussion

The present study has suggested a robust relationship between vehicle characteristics of passing vehicles and drivers' speeding tendencies. The relationship was hypothesized to hold when passing vehicle type, vehicle age and vehicle color were manipulated. The investigation suggests that passing vehicles of the same type as the driver are more inclined to speed faster than those passed by another type of vehicle. Moreover, evidence indicates passing vehicles that are older (13 years old) will cause drivers to speed to a greater extent than newer model passing vehicles. Lastly, analysis of passing SUV color suggests bright colors will lead to greater speed regulation than cooler colors. Obviously, actual experimentation is necessary to verify these hypotheses.

The present proposal addresses a gap in driving literature regarding passing automobile speed. To the best of the experimenter's knowledge, no study has actually tested the effect of passing automobile color on other cars' driving speeds. Similarly, little research has been conducted regarding age of vehicles and their effect on other drivers' speeding decisions. The present study accomplished its aims by providing a methodological framework for others to answer these questions in the future.

It should be noted that the driving simulator used in all three proposed experiments can never completely replicate on-road driving. Individuals may not fully portray their on-road driving behaviors in a simulator, and thus external validity is jeopardized. Nevertheless, because of the cost savings and measurement precision provided by a simulator, it is still believed to be the most efficient option for the proposed experimental designs.

Another confound has to do with the nature of the participants. The pre-experimental questionnaire did not take into account the personality characteristics of individual drivers. Previous literature has indicated that certain personality types are more inclined to drive some automobile types than others (Choo & Mokhtarian, 2004). Therefore, some of the difference between speed and automobile type may be a result of the varying innate propensity to speed. The experiment attempted to mitigate this issue by analyzing each condition as a function of velocity after being passed by a vehicle minus the driver's baseline speed (open road speed). Nevertheless, the mean velocity values for each vehicle condition may be misleading.

As a result of these constraints, the present proposal will not be able to provide a definitive answer as to the effect other drivers' vehicle characteristics will have on your driving speed. However, what the study will provide is a very detailed proposal of how vehicle characteristics of passing cars will affect a driver's decision to break the speeding law.

Because of the interconnectivity between automobile speeding and accident rates (Haglund & Aberg, 2000), future research is advised. If individuals can do actual on-road investigations, a more accurate data set can be obtained. Moreover, if researchers manipulate the quantity of vehicle colors investigated, there will be a better understanding of the color effect in transportation literature. Perhaps most beneficial would be to study the effect of vehicle characteristics on other aspects of driving performance (e.g. tendency to swerve into other lanes, go through stop signs, etc) as opposed to just focusing on speeding behavior. The better handle individuals have on understanding the reasons behind poor driving behavior, the more likely policy makers are to create solutions that will make driving on the road safer.

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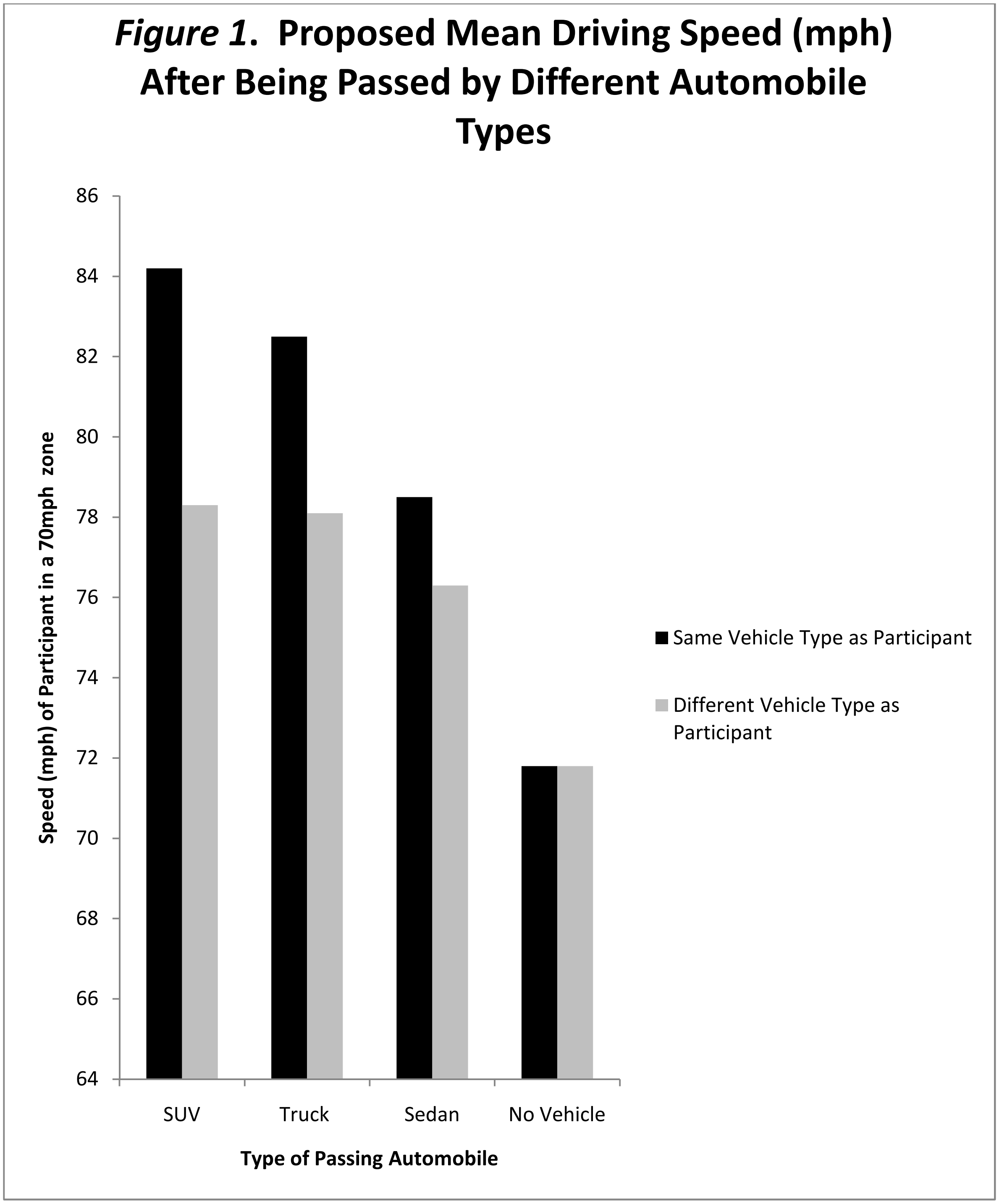
*Table 1.*
Structure of Data in Experiment 1

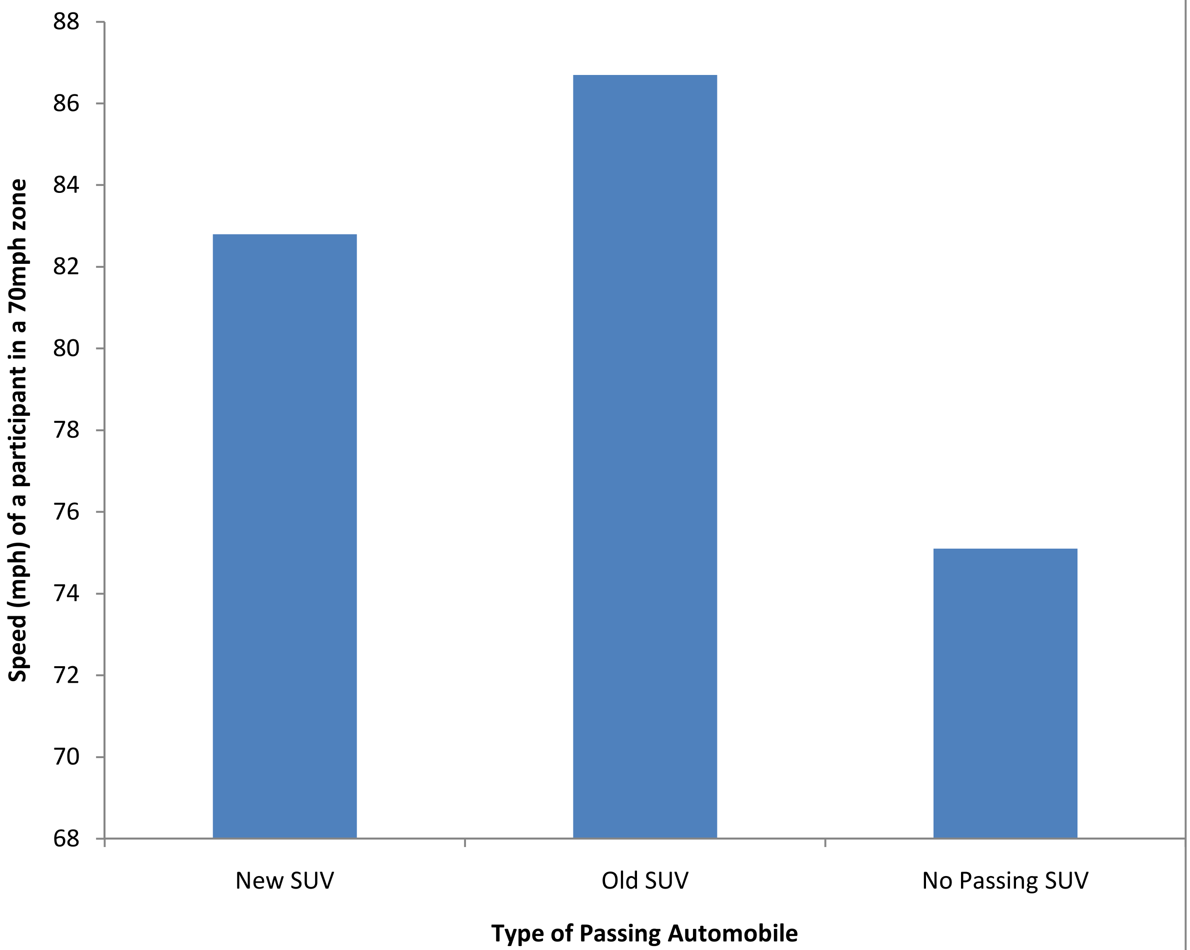
| | **Passing Automobile** | | |
|---|---|---|---|
| **Passed Driver** | SUV | Sedan | Truck |
| SUV | $x_1, x_2, x_3$ | $x_1, x_2, x_3$ | $x_1, x_2, x_3$ |
| Sedan | $x_1, x_2, x_3$ | $x_1, x_2, x_3$ | $x_1, x_2, x_3$ |
| Truck | $x_1, x_2, x_3$ | $x_1, x_2, x_3$ | $x_1, x_2, x_3$ |

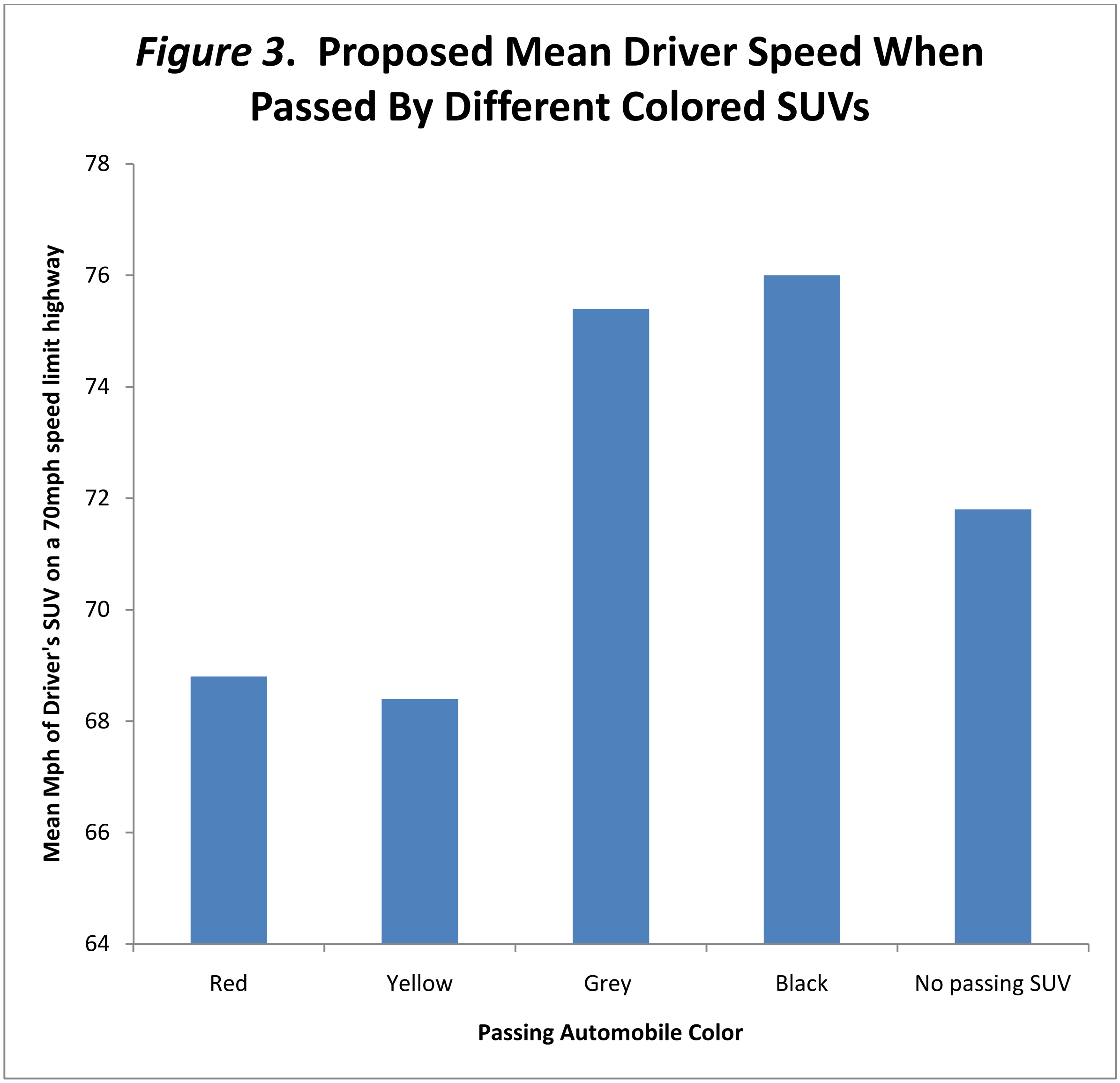
**x values in each cell are the observed speeds after being passed minus the control speed*




*Note: The following graph shows the proposed average highway speeds for each condition. However, as indicated in the methods section, data will be analyzed by measuring the difference in speed in each condition from the no vehicle control (vehicle type speed – no vehicle speed).*

*Figure 2*. **Proposed Mean Driving Speed (mph) of SUV Drivers After Being Passed By Old versus New SUVs**






*Note: The following graph shows the proposed average highway speeds for each condition. However, as indicated in the methods section, data will be analyzed by measuring the difference in speed in each condition from the no vehicle control (vehicle color speed – no vehicle speed).*