Aggressive Driving and Road Rage:
A Series of Driving Simulation Experiments

Amended Protocol for Experiment 2
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Research Protocol

I. Objective

This research will examine the effects of risk and protective factors for aggressive driving in six driving simulation experiments. We will also conduct an experiment to develop a standardized measure of aggressive driving.

II. Background and Rationale

Driving a car is the most dangerous behavior most people engage in every day.[1] According to the National Highway Traffic Safety Administration, over 37,000 Americans were killed in motor vehicle crashes in 2016.[2] They are the leading cause of death among 15 to 29 year olds.[3] Although there are several causes of traffic crashes (e.g., texting, alcohol consumption, inclement weather), the leading cause is aggressive driving. Aggressive driving accounts for more than half of all traffic fatalities.[4] Thus, aggressive driving is an important applied health topic, especially for young drivers.

It is important to determine the causes of aggressive driving, which requires the experimental method. Because it is unethical to conduct experimental studies of aggressive driving using real vehicles on the road, researchers use driving simulators. Previous research has shown that driving behavior in simulators closely mirrors driving behavior in actual vehicles. A review of the available evidence concluded that driving simulators "provide a valid tool for assessing a variety of driving performance measures such as speed, lateral position, brake onset, divided, attention, and risky traffic behaviors." (p. 13-1).[5]

Unfortunately, we could find only six driving simulator experiments,[6, 7, 8, 9, 10, 11] and one of those experiments was conducted in our lab. Thus, additional experimental research on this topic is sorely needed. The proposed research will use state-of-the-art driving simulator technology to determine some important causes of aggressive driving and road rage.

III. Procedures

A. Sample

A.1. Experiment 1

Participants in Experiment 1 will be a nationally representative sample of 200 American adults (*n*=100 men, *n*=100 women) in terms of age and race. Participants will be recruited by Qualtrics, which is an online survey company. Participants will be paid a small amount of money for completing the survey. The sample size was determined using power analysis.[12] A sample this size will give sufficient power (> .80) to detect relatively small effects (*d* = 0.30, *r* = .20).

A.2. Experiments 2-7

Participants in Experiments 2-7 will be adults 18-21 years old, with the exception of Experiment 2, which has no upper age limit, and Experiment 5, which requires participants to be at least 21 years old. They will be recruited from Central Ohio (Franklin County) through advertisements (e.g., newspaper, Internet) and paid $50 for their participation. All participants must have a current driver license. Participants who have motion sickness will be excluded. There will be *n*=30 participants per group. Driving simulation experiments are quite expensive to conduct ($400 per participant; $350 for the equipment plus $50 for participant payment). According to NHTSA, the minimum acceptable number of participants for driving simulation experiments involving driver distraction from in-vehicle devices (e.g., texting) is 24 participants per group.[13] Our sample size is 25% larger than the recommended size, and should give us sufficient power

to detect hypothesized effects. Our previous experiment used 30 participants per group, and we were able to detect effects ranging from *d* = 0.43 to *d* = 0.61.[7]

B. Detailed study procedures

B.1. Measures

B.1.1. Individual Difference Measures

In addition to reporting their gender and age, participants will complete the following individual difference measures after they sign the consent form.

B.1.1.1. Driving experience. Participants will report the number of years they have had a driver's license. Of course, driving experience will be positively related to age, but we will measure both.

B.1.1.2. Driving frequency. Consistent with opportunity theory, research has shown that the more frequently people drive, the more opportunities they have to be involved in acts of aggressive driving and road rage.[14] Thus, participants in the proposed research will report: (1) the average number of times they drive each week, (2) the average number of miles they drive each week, and (3) the average amount of time spent on the road each week.

B.1.1.3. Trait anger. It is useful to distinguish between state and trait anger.[15] State anger is an acute emotional-physiological reaction that ranges from mild irritation to intense fury and rage. Trait anger is a personality dimension that reflects the person's chronic tendency to experience the emotion of state anger with greater frequency, intensity, and duration. Trait anger is an important antecedent of state anger and aggression.[16] There is a large body of work linking trait anger to aggressive driving. In the proposed research, trait anger will be measured using the Trait Anger Scale,[16] which contains 10 items (e.g., "I have a fiery temper") that are rated on a 4-point scale (1 = *Almost never*; 2 = *Sometimes*; 3 = *Often*; 4 = *Almost always*; Cronbach α = .86; see Appendix).

B.1.1.5. Narcissism. The term narcissism comes from the Greek myth about a handsome young man named Narcissus who fell in love with his own image reflected in the still water. Narcissism is characterized by excessive self-love and a selfish orientation. Narcissists think very well of themselves and are willing to take advantage of others. Narcissists are egotistical, self-focused, vain, etc. Previous research has shown that narcissism is a risk factor for aggressive driving.[17] Narcissism will be measured using the Single Item Narcissism Scale (SINS): "To what extent do you agree with this statement: 'I am a narcissist.' (Note: The word "narcissist" means egotistical, self-focused, vain, etc.)," which is scored using a 7-point scale (1 = *Not very true of me* to 7 = *Very true of me*; see Appendix).[18]

B.1.1.6. Empathy. Empathy involves feeling compassion for others and imagining how they feel. We expect empathy to be negatively related to aggressive driving. Empathy will be measured using the Single Item Trait Empathy Scale (SITES): "To what extent does the following statement describe you: 'I am an empathetic person.' (Note: An empathetic person understands others' feelings, and experiences care and concern for them.)," which is scored using a 5-point scale (*Not very true of me* to 5 = *Very true of me*; see Appendix).

B.1.1.7. Mindfulness. Mindfulness is a state and trait characterized by a receptive and non-evaluative awareness of present experiences.[19] Recent research shows that mindfulness is a protective factor for aggressive driving.[20] My colleagues and I are developing a Single Item Mindfulness Scale[21] that will be included in the battery of individual difference

measures. The item is: “To what extent do you agree with this statement: ‘I am often aware of myself, others, and my environment, and I accept things as they are,’” which is rated on a 7-point scale (1 = *Do not agree at all* to 4 = *Moderately agree* to 7 *Strongly agree*; see Appendix).

B.1.1.8. Self-reported aggressive and prosocial driving. Although a number of self-report measures of aggressive driving exist, they are highly correlated with each other. The proposed research will use Prosocial and Aggressive Driving Inventory, because it is the only scale that measures both prosocial and aggressive driving (see Appendix).[22] The prosocial driving subscale contains 17 items (e.g., “Drive with extra care around pedestrians” and “Slow down in a construction zone”; Cronbach α = .90), whereas the aggressive driving subscale contains 12 items (e.g., “Make rude gestures at other drivers when they do something I do not like” and “Speed up when another vehicle tries to overtake me”; Cronbach α = .86). All items are rated on a 6-point scale (1=*never* to 6=*always*).

B.1.2. State Anger

In the proposed research, state anger will be measured using the State Anger Scale (Spielberger, 1988), which contains 15 items (e.g., “I feel angry”) that are rated on a 4-point scale (1 = *Not at all*; 2 = *Somewhat*; 3 = *Moderately so*; 4 = *Very much so*; Cronbach α = .93; see Appendix).

B.1.3. Hostile Appraisals

Research has shown that the hostile attribution bias can influence appraisal and decision processes. The *hostile attribution bias* is the tendency to perceive ambiguous actions by others as aggressive.[23] For example, if a driver cuts you off in traffic, a hostile attribution would be that the driver did it purposely (rather than accidentally). Research has shown that attributing causality to an offending driver predicts aggressive driving.[24] In the proposed research, we will measure whether people assign blame to other drivers using a measure successfully used in previous research on aggressive driving.[25] For each provocative event, participants will be asked whether the actions of the other driver were intentional or accidental. For example, “Do you think the other driver deliberately cut you off?” versus “I think the other driver cut me off by accident” (1=*Not at all* to 7=*Very much so*). In Experiments 2-7, we expect hostile appraisals to be positively related to aggressive driving.

B.1.4. Aggressive Driving

The two primary measures of aggressive driving will be tailgating and speeding. We will use three tailgating measures based on the number of seconds between the participant’s car and the car in front of them. It is widely recommended that drivers use a 4-second following rule at speeds above 30 MPH (48.3 KPH), in heavy traffic, or when there are many obstacles (Nationwide, n.d.), as in the present driving scenario. Under normal driving conditions and speeds below 30 MPH, a 3-second rule is recommended. For speeds above 30 MPH, a 3-second rule is considered risky and dangerous. We also will consider a 2-second rule, which is considered extremely risky and dangerous. Tailgating will be calculated as the proportion of time participants breaks each of the three rules (i.e., 4-second, 3-second, 2-second).

Average speed is a poor measure of speeding because it depends heavily on random influences. Instead, we will use a relatively high-speed cutoff (e.g., 50 MPH) before averaging because it removes the variability due to traffic when the participant is not travelling at a high speed.

Other measures of aggressive driving will be combined to reduce the probability of Type I errors that could occur by conducting multiple tests for separate measures. These will include off-road driving (e.g., crossing the double solid yellow lines into oncoming traffic, driving on the shoulder), horn honking, verbal aggression, and aggressive gestures (e.g., giving another driver the middle finger).

B.1.5. Road Rage

Road rage is an extreme form of aggressive driving and is a criminal offense. The three primary measures of road rage will be colliding into other vehicles, bicyclists, and pedestrians. Acts of road rage are expected to occur far less frequently than acts of aggressive driving.

B.2. Driving Simulator

The proposed research will be conducted at the Ohio State Driving Simulation Laboratory, which uses a Realtime Technologies Inc. driving simulator. The car is a 2010 Honda Accord cab mounted on a 6-degrees of freedom motion-base platform. The vehicle is surrounded by a cylindrical projection screen lit by five projectors, which gives a 260° edge-blended field of view. The rear-view mirror reflects an additional projected screen to the rear of the car. Liquid crystal displays (LCD) provide a realistic view in the side mirrors. The interior of the vehicle is the same as for the original car (e.g., automatic transmission, gas pedal, brake pedal, turn signal, headlights, steering wheel, horn). A simulated dashboard displays speed, gear, and turn signal, and headlight information. Three cameras are mounted in the interior of the vehicle, to capture both the participant and the simulated driving scenario. The cameras allow us to record verbally aggressive comments participants make to other drivers. Speakers external to the vehicle provide simulated environmental audio (e.g., engine noise, wind noise, passing vehicles).

B.3. Driving Scenario

To measure aggressive driving and road rage, our research team constructed a driving scenario. The Ohio State driving scenario was created using SimCreator (RTI, Inc.) software. The driving scenario mimics a two-lane road with occasional curves, and has a posted speed of 60 miles per hour (MPH) [96.6 kilometers per hour (KPH)]. The simulated traffic is programmed to have an average speed of 55 MPH (88.5 KPH) — 5 MPH slower than the posted speed. Five frustrating events are programmed to take place at pre-determined spots in the driving scenario: (1) a car pulls out in front of the participant from a side-road, (2) traffic jam (i.e., complete road blockage with many cars in front of the participant. After the participant stops and waits 10 seconds, the other cars slowly pull ahead. After the participant starts driving again, the other cars stop again for 10 seconds), (3) construction zone (i.e., one lane was closed, and traffic slowed down as the lanes merged), (4) a mimic car that copies the participant's car, and (5) a short traffic light (i.e., 60 seconds red and 5 seconds green). In addition, some of the other vehicles will honk at the participant. The other driving events are random. Although all the other cars are computer generated and controlled, participants will be told that other participants are driving some of the other vehicles. This will make the driving situation more realistic, and will give participants targets for their anger and aggression. There will also be triggered bicyclists and pedestrians on the course to slow participants down. Each participant will practice driving for 3-5 minutes to get used to the simulator and to indicate whether he or she experiences motion sickness. Next, the participant will drive the simulated scenario, which takes 15-25 minutes.

B.4. Procedures

B.4.1. Experiment 1: Development of a Standardized Measure of Aggressive Driving for Driving Simulation Experiments

The aim of Experiment 1 is to develop a standardized measure of aggressive driving for driver simulation experiments. Participants will be a nationally representative sample of 200 American adults (n=100 men, n=100 women) in terms of age and race. Participants will be recruited by Qualtrics, which is an online survey company. After giving their consent, participants will complete the personal variables described in section B.1.1 above (i.e., gender, age, driving experience, driving frequency, trait anger, self-reported aggressive and prosocial driving). Next, participants will watch several short videos from our driving simulation lab experiments.

Because speeding and tailgating are our two primary measures of aggressive driving, the videos will differ in terms of how fast the car is traveling over the posted speed limit, and how closely the car is following another vehicle. We will also show videos containing less common measures of aggressive driving (e.g., driving on shoulder, crossing a solid yellow line to pass another vehicle), as well as videos depicting road rage (e.g., hitting another vehicle, cyclist, or pedestrian). Participants will indicate whether the driver's behavior was aggressive (coded 1) or nonaggressive (coded 0), and will rate how aggressive it was on an 11-point scale (0=*not at all aggressive* to 10=*extremely aggressive*). After participants rate the videos, they will be debriefed.

B.4.2. Experiment 2: Violent and Nonviolent Racing Video Games

Experiment 2 tests whether participants actually drive more aggressively after a playing a violent or nonviolent racing video game. Participants will be 40 American college students 18 and older. There will be 20 participants in each of the two conditions. After giving their consent, participants will complete the personal variables described in section B.1.1. In Experiment 2, we will also ask participants how many hours per week they spend playing video games, whether they have played the video games used in this experiment, and what their three favorite video games are. Next, participants will be randomly assigned to play one of two types of video games for 15 minutes: (1) a racing game that rewards players for engaging in violent actions such as hitting other vehicles, or (2) a nonviolent racing video game. The participants in both conditions will play the video game *Mario Kart 8: Deluxe* on the Nintendo Switch to control for other dimensions that could be related to aggressive driving (e.g., competition, frustration). All participants will play the game using the same character and vehicle and they will race on the same courses. In condition 1, players will have the option to use items to attack other racers, while in condition 2 the items will be turned off. After videogame play, participants will rate the game they played on several dimensions (i.e., how absorbing, action-packed, "addicting," arousing, boring, challenging, difficult, enjoyable, entertaining, exciting, frustrating, fun, involving, stimulating, stressful, and violent it was). The violence rating will be used as a manipulation check. The other ratings will be used as possible covariates. After participants complete the driving scenario, the state anger measure (section B.1.2), and the hostile appraisal measure (section B.1.3), they will be thoroughly debriefed.

B.4.3. Experiment 3: Racial Tension on the Road

Experiment 3 tests the impact of racial bumper stickers on aggressive driving in black and white motorists. Participants will be 120 adults (*n*=60 black, *n*=60 white) from a community sample. After giving their consent, participants will complete the personal variables described in section B.1.1. In Experiment 3, participants will also complete the race Implicit Association Test (IAT) from the *Project Implicit* website (https://implicit.harvard.edu/implicit/). In this IAT, photos of White and Black male and female faces are paired with "good" words (e.g., *joy, love, peace*) or "bad" words (e.g*., terrible, horrible, evil*). Slower responses to the "White / Bad" and "Black / Good" pairings than to "White / Good" and "Black / Bad" pairings are considered to be indicative of more negative attitudes about black people than white people. Participants will also report their political party (i.e., Republican, Democrat, Neither/Independent). Some of the other cars in the driving scenario will contain bumper stickers. Experiment 3 contains four conditions: (1) white participants / "All Lives Matter" bumper sticker, (2) black participants / "All Lives Matter" bumper sticker, (3) white participants / "Black Lives Matter" bumper sticker, (4) black participants / "Black Lives Matter" bumper sticker. Assignment to the bumper sticker condition will be random. After participants complete the driving scenario, the state anger measure, and the hostile appraisal measure. Finally, participants will report their attitudes toward the Black Lives Matter and All Lives Matter movements (-10=*extremely unfavorable* to 10=*extremely favorable*). A debriefing will follow.

B.4.4. Experiment 4: Political Tension on the Road

Experiment 4 tests the impact of political bumper stickers on aggressive driving in Republicans versus Democrats. Participants will be 120 adults (*n*=60 Republicans, *n*=60 Democrats) from a community sample. After giving their consent, participants will complete the personal variables described in section B.1.1. Some of the other cars in the driving scenario will contain bumper stickers. Experiment 4 contains four conditions: (1) Republican participants / "Donald Trump for President 2016" bumper stickers, (2) Republican participants / "Hillary Clinton for President 2016" bumper stickers, (3) Democrat participants / "Donald Trump for President 2016" bumper stickers, (4) Democrat participants / "Hillary Clinton for President 2016" bumper stickers. After participants complete the driving scenario, the state anger measure, and the hostile appraisal measure. Finally, participants will report their attitudes toward Donald Trump and Hillary Clinton (-10=*extremely unfavorable* to 10=*extremely favorable*), and who they voted for in the 2016 presidential election (if they voted). A debriefing will follow.

B.4.5. Experiment 5: Alcohol Cues

Experiment 5 will test whether the mere presence of alcohol-related cues can increase aggressive driving. Participants will be 60 adults (aged 21+) from a community sample. After giving their consent, participants will complete the personal variables described in section B.1.1. Next, participants will be randomly assigned to one of two conditions: (1) a twelve pack cardboard container of beer cans on the passenger seat, or (2) a twelve pack cardboard container of sparkling water on the passenger seat. In actuality, both containers will hold water cans to avoid bringing alcohol into the lab. Participants will be told that the object on the seat is part of a different experiment that the other experimenter forgot to clean up, and that they should ignore it. After participants complete the driving scenario, the state anger measure, and the hostile appraisal measure, they will be thoroughly debriefed.

B.4.6. Experiment 6: Violent Music

Experiment 6 will test the effects of music with aggressive versus prosocial lyrics on aggressive driving. The tempo of the music will also be manipulated because it might influence arousal levels. Participants will be 150 adults from a community sample. After giving their consent, participants will complete the personal variables described in section B.1.1. Music will be played over the car's sound system. Participants will be randomly assigned to one of five conditions: (1) violent lyrics / upbeat tempo, (2) violent lyrics / calm tempo, (3) prosocial lyrics / upbeat tempo, (4) prosocial lyrics / calm tempo, or (5) no music control. After participants complete the driving scenario, the state anger measure, and the hostile appraisal measure, they will be thoroughly debriefed.

B.4.7. Experiment 7: Roadside Objects

Experiment 7 tests whether roadside vegetation can decrease aggressive driving, and whether roadside trash can increase aggressive driving. Participants will be 90 adults from a community sample. After giving their consent, participants will complete the personal variables described in section B.1.1. Next, they will complete the Enjoyment of Nature Scale, which contains 7 items (e.g., "I like to see wild flowers in nature" and "Being in the natural environment makes me feel peaceful"), which are scored using a 5-point scale (1=*strongly disagree* to 5= *strongly disagree*; Cronbach α = .87; see Appendix).[26] Next, participants will be randomly assigned to one of three driving scenarios: (1) roadside vegetation, (2) trash, or (3) control (no roadside vegetation / no trash). After participants complete the driving scenario, the state anger measure, and the hostile appraisal measure, they will be thoroughly debriefed.

C. Internal Validity

The present research is high in internal validity because all studies use experimental designs in which participants are randomly assigned to conditions

D. Data Analysis

The data will be analyzed in R.

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Effects of Video Game Violence on Driving Aggression

Analysis plan

1 Research Questions

1.1 Hypotheses

1. It is predicted that drivers who have just played a video game with cartoon violence will have higher measures of aggressive driving than drivers who have just played a video game without cartoon violence.
2. It is predicted that state anger mediates the relationship between the engaging in video game violence and aggressive driving.

2 Design Plan

2.1 Study Type

This is an experiment with a mixed between-subjects, within-subjects design.

2.2 Blinding

The participants are not told of the true purpose of the study before it is completed. The experimenters are not blinded as to which group the participants belong to.

2.3 Study Design

The experiment is a between-subjects, two group design. In the violent video game group, participants will be asked to play the video game Mario Kart with standard settings before driving in the simulator. In the non-violent video game group, participants will be asked to play the video game Mario Kart with attack items turned off before driving in the simulator. Each participant will drive the same scenario in the driving simulator. The driving scenario mimics a two-lane road with a posted speed limit of 60 mph (96.6 km per hour). The simulated traffic was programmed to have an average speed of 55 mph (88.5 kph). Five frustrating events were programmed to take place at pre-determined spots in the driving scenario: (1) a car pulled out in front of the participant from a side-road, (2) a traffic jam, (3) a construction zone, (4) a mimic car that copied the participant's car, and (5) a short traffic light. Each frustrating event occurred once. The frustrating events were programmed to take place at pre-determined locations in the driving scenario.

3 SAMPLING PLAN

3.1 DATA COLLECTION PROCEDURES

Participants will need to hold a driving license. They will also be screened for car or simulator sickness.

Participants will come to the Driving Simulation Lab, read and sign the consent form, and be assigned to play the violent or nonviolent video game. They will then drive on the simulator, where driving data will be recorded.

3.2 SAMPLE SIZE

The target participant size is 60, with 30 participants in the violent video game group and 30 participants in the non-violent video game group. This sample size was based on a previous study.[1] With driving simulation studies, simulator sickness is a possibility, and individuals who decide to stop due to simulator sickness will be replaced.

3.3 STOPPING RULE

Data will stop being collected when full data for 30 participants in both groups has been collected.

4 VARIABLES

4.1 MANIPULATED VARIABLES

The only manipulation is the level of violence in the video game played before the participants drive in the scenario.

4.2 MEASURED VARIABLES

4.2.1 Driving behavior

A primary measure of driving aggression is following distance. A very close following distance (tailgating) can indicate aggressive driving. Following distance is often measured in headway time, meaning the number of seconds it takes for the driver's car to get to the position of the vehicle ahead of it. This corresponds to the greater safety margins that are needed when driving at higher rates of speed. Four variations of following distance metrics will be used: the proportion of time driving over 30 MPH where a participant had a following distance of less than one second, two seconds, three seconds, or four seconds.

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A second primary measure of driving aggression is speed. Faster speeds are often associated with higher aggression. We will use mean speed of all speeds above 50 MPH to exclude parts of the drive where the participant is stopped or going very slowly.

A third measure of driving aggression is collisions with other vehicles. We expect the number of collisions to be small overall, but they will be measured.

A fourth measure of driving aggression are grouped into "other aggressive actions." These include commonly accepted aggressive driving actions that do not fit into another category. These are off-road driving (e.g., crossing the double solid yellow lines into oncoming traffic, driving on the shoulder), attempting to honk the horn, verbal aggression (e.g., "This guy's a dickhead"), and aggressive gestures (e.g., giving another driver the middle finger).

All of these measures will be calculated in regions. These regions are defined as between the time points for the start of the scenario, each frustrating event, and the end of the scenario, resulting in five regions.

4.2.2 State anger

After driving in the simulator, participants will complete a state anger measure. We test whether it mediates the link between type of video game played and aggressive driving.

4.2.3 Individual differences

Before driving in the simulator, participants will fill out a Trait anger survey, the Prosocial and Aggressive Driving Inventory (PADI), a single item narcissism scale, a single item empathy scale and a single item mindfulness scale. They will also report gender. These self-report items will be included in the analysis as control variables.

4.2.4 Game-related differences

After driving in the simulator, participants will answer some questions related to the video game they played. This includes:

1. A measure of general exposure to violent video games, determined by the number of violent games listed as their three favorites. A violent video game is one that the ESRB has rated as violent.
2. A measure of general exposure to violent racing video games, determined by the number of violent games listed as their three favorites. A violent video game is one that the ESRB has rated as violent and that is in the racing genre.
3. Identification with the character of the game.
4. Indication of realism of the game played.
5. Hours playing video games.
6. Prior experience with the Mario Kart game series.

5 ANALYSIS PLAN

5.1 STATISTICAL MODELS

5.1.1 Manipulation check

We expect that the survey result of game violence will differ significantly between the two game options. Ordered logistic regression using the `polr` function in the `MASS` R package will be used to report the results of a chi-square test for goodness of fit and the 95% confidence interval for the log odds for the formula `violence_rating~Game`.

5.1.2 Primary hypothesis testing

We will conduct a linear mixed model analysis of the main aggressive driving effects using R, the `afex` package and the `lme4` package. In the `lme4` package syntax, our proposed models are of the form:

*DV ~ Game*Region + individual_covariates + game_covariates + (1|Participant)*

individual_covariates = Gender + trait_anger + prococial_driving + aggressive_driving + narcissism + empathy + mindfulness

game_covariates = exposureToViolentGames + exposureToViolentRacingGames + identificationWithCharacter + gameRealism + hoursPlayingGames + experienceWithMarioKart

(1|Participant) designates Participant identity as a random effect in the model. DV is the dependent variable, which in this case are the following distance and speeding variables. Game is which game they played (violent or non-violent). Region refers to the previously defined aggravating event regions.

We will have a similar model extended to a generalized linear mixed model with a Poisson function for the incidence of collisions and other aggressive actions, since that is count data.

For hypothesis 1, we will use `afex`[2] and `lme4`[3] to report a type III sum of squares ANOVA-like analysis for each of the linear mixed models, including the beta and p-values for all predictors.

For hypothesis 2, we will use `mediation`[4] and `lme4` to compare models for each dependent variable and including state anger with a model that has state anger as the dependent variable:

*DV ~ Game*Region + individual_covariates + game_covariates + StateAnger + (1|Participant)*

*StateAnger ~ Game*Region + individual_covariates + game_covariates + (1|Participant)*

We will report on the average causal mediation effect (ACME) value and if it is significant or not.

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[2] Henrik Singmann, Ben Bolker, Jake Westfall, Frederik Aust and Mattan S. Ben-Shachar (2021). afex: Analysis of Factorial Experiments. R package version 1.0-1. https://CRAN.R-project.org/package=afex

[3] Bates D, Mächler M, Bolker B, Walker S (2015). "Fitting Linear Mixed-Effects Models Using lme4." *Journal of Statistical Software*, **67**(1), 1–48. doi: 10.18637/jss.v067.i01.

[4] Dustin Tingley, Teppei Yamamoto, Kentaro Hirose, Luke Keele, Kosuke Imai (2014). mediation: R Package for Causal Mediation Analysis. Journal of Statistical Software, 59(5), 1-38. URL http://www.jstatsoft.org/v59/i05/.

5.2 INFERENCE CRITERIA

p-values will be used to determine if the values seen are statistically significant from those expected if the null hypothesis is correct. The alpha level for all analyses is set to .05. Adjustment for multiple hypothesis testing will be done by the false discovery rate adjustment method by Benjamini and Hochberg.[5]

5.3 TRANSFORMATIONS

Numerical predictor variables (Trait Anger and PADI scores) will be centered on the mean.

5.4 MISSING DATA

If we do not have full driving data, due to a participant stopping before the end of the scenario or due to equipment error, we will exclude data from that participant.

[5] Benjamini, Y., and Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society Series B*, **57**, 289–300. doi: 10.1111/j.2517-6161.1995.tb02031.x. https://www.jstor.org/stable/2346101.