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Pareidolia and Perception of Anger in Vehicle Styles: Survey Results

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***Abstract*—**Most people see human faces in car front and back ends because of the process of pareidolia. 96 people were surveyed to see how many of them saw a face in the vehicle styling. Participants were aged 18 to 72 years. 94% of the participants saw faces in the front-end design of production models. All participants that recognized faces indicated that most styles showed some degree of an angry expression. It was found that women were more likely to see faces in inanimate objects. However, with respect to whether women were more likely to perceive anger in the vehicle design, the results need further clarification. Survey responses were correlated to the design features of vehicles to determine what cues the respondents were likely looking at when responding. Whether the features looked anthropomorphic was key to anger perception. Features such as the headlights which could represent eyes and the air intake that could represent a mouth had high correlations to trends in scores. Results are compared among models, makers, by groupings of body styles classifications for the top 12 brands sold in the US, and by year for the top 20 models sold in the US in 2016. All of the top models sold increased in perception of an angry expression over the last 20 years or since the model was introduced, but the relative change varied by body style grouping.

***Keywords*—**Aggressive driving, face recognition, road rage, vehicle styling.

I. Introduction

ANTHROPOMORPHISM is attributing human characteristics to non-living objects. A specific aspect of anthropomorphism is pareidolia which is recognizing an object as a face. Previous researchers have shown that women are more likely to see faces in arrangements of food on a plate. [1] Also, it has been demonstrated that seeing the front end of a car activates the same areas of the brain as facial recognition of humans [2]. It is also known that through a process known as mirroring, people copy the facial expressions of people around them [3]. Additionally, people behave in ways that matches what people around them are doing.

It is the perception of this author that current vehicle styling looks like angry faces and the trend is increasing. Therefore, the question has arisen as to whether seeing angry-looking cars affect driving behavior.

Aggressive drivers exhibit behaviors that are more likely to engage them in accidents. There is a relationship between anger and aggressive driving [4]. Therefore, the goal of the research is to determine if vehicles that look angry are more likely to make drivers angry and drive aggressively.

There are many potential factors for why some people drive aggressively. Trends of historical data are not enough to connect cause and effect, or to say if vehicle styling influences it. The first step in evaluating whether design is influencing driving is to see which vehicles are viewed as faces and whether they are seen as angry. A later step is to run simulations to record differences in behaviors.

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II. Methods

The data collection was planned as three phases. The first phase would assess whether people saw vehicles anthropomorphically, and whether the front or back end was viewed more as a face. Additionally, vehicles would be chosen to see if the next two phases were valid. That would also give the chance of refining the questions if necessary. The second phase would be to compare the top auto brands, and styling categories such as car versus truck. The third phase was planned to see how the most popular models had changed in styling over the last 20 years.

It turned out to be easier to collect all data simultaneously. Despite the hesitation that participants might get bored with long questionnaires, two reasons encouraged collecting data at once. First, the study was approved as a complete project so could be done at once. Second, finding 100 participants once was much easier than contacting that number three times.

The vehicles that were chosen to be compared varied between the phases as the questions changed. To determine if people viewed vehicles anthropomorphically, a variety of vehicles were chosen which the author subjectively felt fell on a range of looking like a face or not, and angry or not. The vehicles chosen are shown in Table I.

The second set of questions compared the top automotive brands. The list for 2016 was found at GoodCarBadCar which collected information from many sources [5]. All vehicles were chosen for the top 12 brands sold in the US. Exceptions were that the following vehicles were not studied: cargo vans, and special edition vehicles. Also, vehicles co-manufactured by two automakers and then distributed under different names were not studied. Table II lists the brands and vehicles studied.

The third set of questions compared the 20 top selling vehicles of 2016 as found at GoodCarBadCar [5]. These vehicles are shown in Table V. The vehicles were compared from 1998 or from the time of introduction of the first model, until the 2017 or 2018 if a vehicle was available that year by the time of the survey. Model changeovers happen on average every few years. Additionally, vehicles are sometimes refreshed which may change the exterior styling. Vehicles appear the same between change overs. Therefore, a typical vehicle between refresh cycles is representative of all vehicles

in the time.

A total of 211 photos were used. Photos of cars were taken at several locations such as dealerships for the current models. A sample photo is shown in Fig. 1 for a 2008-2011 Ford Focus. The photos were taken from a crouched position in front or behind the vehicle. All images were converted to grayscale and printed on copier paper. However, it is not possible to completely factor out the effect of vehicle color. Each automaker has proprietary paint tones. Even if a gray paint was found for each model, the gray tones do not exactly match. Having all photos in grayscale partly reduces this effect. Diffuse lighting was preferred.

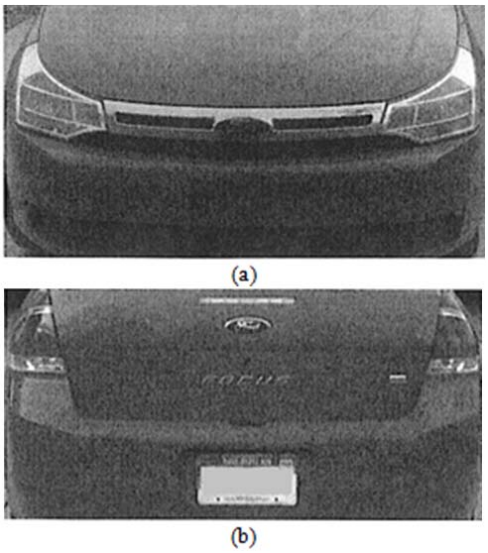

Fig. 1 2008-2011 Ford Focus a) front, b) back

The photos were edited to show only the front end or back end of a vehicle. This was defined on the bottom as the level of the lowest painted surface. On the top it was defined as the highest point of where the front end panel or lighting meets the hood. Some vehicles, such as in Fig. 1, had extensive wrap arounds at the sides. For back ends, the top level was defined differently since some SUVs have full back heights and most cars have a single trunk piece that wraps vertical and horizontal. The top level was defined as the lower between the point where the slope of the back end changes to mostly horizontal, or where the back window is reached.

All photos were scaled so that their width was 82.6 mm (3.25 inches.) The image heights varied because each vehicle has a different aspect ratio of height to width. For example, trucks had greater front end heights than cars.

The question that each participant was asked for the first form was "For each photo below, please answer: Do you think this looks like a face or an angry expression? Which was rated on a 5-point scale as: 1=not at all, 2=a little, 3= some, 4= much, 5= v. much." Two labels, "a face" or "an expression", were under each image with five numbers. For the second and third form, the prompt was "Do you think this looks like an angry expression?"

The forms were collected off the college campus. This produced a pool of participants of an average age of 34 years. However, since the participants were truly volunteers and not captive students, the survey length had to be adjusted.

The forms were broken up into subparts. Previous work has shown that volunteers get tired with long forms [6]. A one page questionnaire is about the level of tolerance of most volunteers. They tend to gloss over questions once they reach the point where they become disinterested in the survey. It is expected that rating photos will go more quickly than a questionnaire. Therefore, each volunteer was given only a few pages of forms and then if they agreed to do more they were given the next set. The first form was relevant to comparing fronts versus backs of vehicles, so all 96 participants answered that set of questions. Response rates were much lower for later parts.

III. General Results

The majority of respondents indicated that they saw at least one vehicle that looked like a face or an angry expression. Out of 96 respondents, four either never saw a face or saw it in only one vehicle. This illustrates that there is variety in natural ability to see faces in abstract objects.

Fig. 2 shows the profile of average responses for men and women for recognizing faces. The p-value for the difference between men and women was 0.006. This confirms previous studies that show women are more likely to see faces in inanimate objects [7].

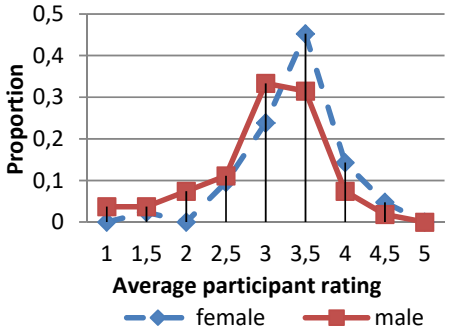

Fig. 2 Average response by gender for face rating

Fig. 3 shows the average scores for men and women on rating the vehicles as looking angry. The p-value for the difference is only 0.16 which is not significant enough to support that there is a difference for men and women. Previous researchers have shown that there are some similarities and differences between men and women related to anger. Men and women report feeling anger at the same level, but men express it more greatly [8]. Yet, the marginal difference in the current study suggests there could be a relationship between gender and ratings of anger, but that maybe this study was not designed to bring out that difference.

Average results for the ratings from all 96 respondents are shown in Table I by vehicle for the first set of photos. Faces were more likely to be seen in the front of vehicle than the

back. The rating average was 3.6 versus 2.4, for front versus back, respectively with an average $p < 0.01$. Average p-values are reported because it is not interesting whether a single vehicle looks like a face in front and back, but whether all vehicles show that trend. For angry expressions, the rating average was 2.6 versus 1.5, front versus back, respectively with an average $p = 0.01$.

Respondents provided statistically significant different ratings of whether the vehicles looked like faces or had angry expressions. The p-values for each vehicle were found for differences in response and the average p-value for front-ends was 0.01. Therefore, respondents rate differently whether asked to reply whether it is a face or angry. That means that vehicles that look anthropomorphic do not necessarily have angry expressions. However, the opposite may need to be true. Nearly all individual ratings (97%) of cars as faces were higher than that of cars as angry. This suggests that for most people, it is important for a vehicle to appear anthropomorphic in order for it to be felt as being angry. The independence of face and anger ratings confirms that later surveys are valid when collecting only ratings of angry expressions. The anger ratings are distinct from ratings as a face.

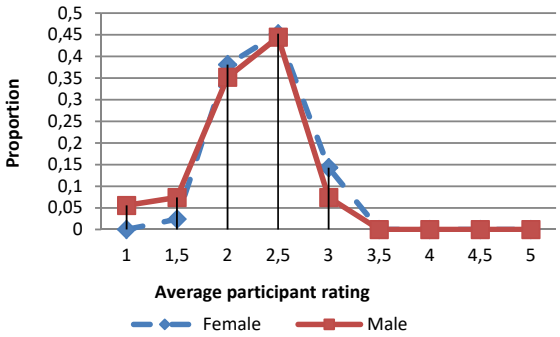

Fig. 3 Average response by gender for anger rating

TABLE I
RATINGS OF VARIED MODELS, YEARS AND VIEWS

Maker	Model	Front-face	Front-angry	Back-face	Back-angry
VW	2007 Beetle A5	4.23	1.12	3.41	1.25
Hyundai	2015 Sonata	3.56	2.80	2.83	2.02
Ford	2017 Fusion	4.14	3.67	1.72	1.28
Ford	2010 Focus	2.72	1.88	1.89	1.09
Mercedes	2017 G-Class	2.37	1.69	1.03	1.02
Mazda	2017 Mazda 3	4.19	3.88	3.45	2.85
Ford	2010 Fusion	3.63	2.87	2.11	1.18

IV. Results Related to Vehicle Rankings

Next, results were found for the top 12 brands sold in the US. See Table II for results from 22 respondents ordered by brand sales. Respondents rated vehicle classes differently. The average ratings across the industry were: cars (2.85, SD 0.71), crossovers (2.44, SD 0.84), minivans (2.20, SD 0.68), trucks (2.01, SD 0.51), and SUVs (2.00, SD 0.66). The vehicle rated as angriest was the 2012-present Toyota 86, a sports car, rated as 4.18, and the lowest was the 2010-2017 GMC Terrain, a crossover, rated 1.05. Despite crossovers being on average 2.44, a crossover has the lowest anger rating of 1.05. This illustrates that within a class of vehicles there is variety. Therefore, it cannot be said that all crossovers look angrier than all trucks even though the averages show this. However, it can be said that respondents think on-average cars look angrier, therefore it is likely vehicle stylists are using visual cues in cars that make them appear angry.

Next the ratings are compared between automakers. Styling is controlled by automakers' vehicle designers. These designers assigned to different brands may or may not be using the same design inspirations. Therefore, each brand was separately evaluated even from the same automaker.

Some vehicle brands focus more on trucks or SUVs, such as RAM, GMC, and Jeep. Since trucks are generally rated as lower in terms of anger, then those brands would have lower ratings than brands with more cars and crossovers such as Kia. Considering this, it is not appropriate to compare brands by using all vehicles, but only groupings of styles. As mentioned above, many automakers do not make vehicles of certain style categories, so there cannot be a single list comparing all brands.

Vehicles in sub-classes are often styled differently, such as compact cars versus sports cars. However, differences were not found to be statistically significant when comparing sub-classes of cars. Ratings of angry expressions in cars are compared in Table III. Results between the car brands were statistically significant. For example, the p value was 0.01 comparing the highest (Toyota) versus lowest (Honda) rated angry cars.

Crossovers show about the same trends as seen for cars above. See Table IV. Again, Toyota is the highest and Honda is near the lowest. Statistical comparisons are not made for this and the remaining vehicles classes because often only one SUV, truck or minivan is available therefore the results would show model comparisons not brand comparisons.

Next, 24 respondents rated the historical styles the top 20 models sold in the US in 2016. The perception of an angry expression was rated over the last 20 years or since the model was introduced. See Table V. All vehicles had a higher rating for anger comparing the last model to the first. For example, see Fig. 4 for the Hyundai Elantra.

TABLE II
VEHICLES IN TOP 12 BRANDS SOLD IN US

Maker	Model	Rating	Maker	Model	Rating
Ford	Fiesta	2.36	Nissan	Maxima	3.00
Ford	Focus	3.22	Nissan	Leaf	2.33
Ford	Fusion	3.50	Nissan	370Z	2.04
Ford	C-Max	2.63	Nissan	Juke	1.61
Ford	Mustang	3.86	Nissan	Rogue	3.52
Ford	Taurus	2.77	Nissan	Murano	3.09
Ford	Edge	2.31	Nissan	Pathfinder	3.33
Ford	Flex	1.45	Nissan	Armada	2.38
Ford	Escape	2.86	Nissan	Quest	2.47
Ford	Explorer	2.72	Nissan	Frontier	1.38
Ford	Expedition	2.00	Nissan	Titan	1.23
Ford	F-150	1.77	Jeep	Renegade	1.19
Ford	Super duty	1.77	Jeep	Patriot	1.09
Toyota	Yaris	2.59	Jeep	Grand Cherokee	2.71
Toyota	Corolla	3.50	Jeep	Cherokee	2.09
Toyota	Camry	3.40	Jeep	Wrangler	1.09
Toyota	Avalon	3.50	Jeep	Compass	3.00
Toyota	86	4.18	Hyundai	Elantra	3.09
Toyota	Sienna	2.04	Hyundai	Sonata	3.71
Toyota	Tacoma	2.40	Hyundai	Azera	1.80
Toyota	Tundra	2.13	Hyundai	Tucson	2.90
Toyota	Rav 4	3.45	Hyundai	Santa Fe	2.80
Toyota	Highlander	2.59	Hyundai	Accent	3.61
Toyota	4Runner	3.50	Hyundai	Veloster	2.95
Toyota	Sequoia	1.63	Hyundai	Ioniq	2.76
Toyota	Land Cruiser	1.59	Kia	Optima	2.81
Toyota	Prius Prime	3.68	Kia	Cadenza	2.86
Chevrolet	Spark	1.81	Kia	K900	1.54
Chevrolet	Sonic	2.72	Kia	Soul	1.36
Chevrolet	Cruze	3.13	Kia	Niro	3.27
Chevrolet	Malibu	3.36	Kia	Sportage	3.09
Chevrolet	Impala	2.31	Kia	Sorento	3.04
Chevrolet	SS Sedan	2.36	Kia	Sedona	2.95
Chevrolet	Camaro	4.13	Kia	Rio	2.22
Chevrolet	Corvette	3.13	Kia	Forte	2.81
Chevrolet	Trax	3.45	Subaru	Impreza	2.00
Chevrolet	Equinox	1.45	Subaru	Legacy	3.36
Chevrolet	Traverse	2.50	Subaru	Forester	3.09
Chevrolet	Tahoe	1.68	Subaru	Crosstrek	3.22
Chevrolet	Suburban	1.77	GMC	Canyon	1.27
Chevrolet	Colorado	2.27	GMC	Sierra	2.00
Chevrolet	Silverado	2.27	GMC	Terrain	1.04
Chevrolet	Volt	3.68	GMC	Acadia	1.50
Chevrolet	Bolt	2.77	GMC	Yukon	1.40
Honda	Accord Sedan	1.80	RAM	Ram 1500	1.68
Honda	Civic	3.00	RAM	Ram 2500	2.95
Honda	CR-V	3.09	RAM	Ram 3500	2.31
Honda	CR-Z	1.61	Dodge	Charger	1.77
Honda	Fit	2.71	Dodge	Challenger	1.45
Honda	HR-V	1.42	Dodge	Journey	1.54
Honda	Odyssey	2.38	Dodge	Grand Caravan	1.13
Honda	Pilot	1.90	Dodge	Durango	2.45
Honda	Ridgeline	2.61	Dodge	Dart	3.68
Nissan	Versa Sedan	1.80			
Nissan	Versa Note	2.95			
Nissan	Sentra	3.85			
Nissan	Altima	3.04			

TABLE III
BRAND COMPARISON AVERAGE OF ANGRY PERCEPTION OF CARS ONLY

Maker	Rating
Ford	3.06
Toyota	3.47
Chevrolet	2.94
Honda	2.28
Nissan	2.72
Hyundai	2.99
Kia	2.45
Subaru	2.86
Dodge	2.30

TABLE IV
BRAND COMPARISON OF ANGRY PERCEPTION OF CROSSOVERS

Maker	Rating
Ford	2.59
Toyota	3.45
Chevrolet	2.46
Honda	2.14
Nissan	3.31
Hyundai	2.85
Kia	2.69
Subaru	3.09
Dodge	1.54

TABLE V
HISTORICAL COMPARISON OF TOP MODELS LISTED BY INITIAL MODEL GENERATION AND YEAR

Maker Model	First	Second	Third	Fourth	Fifth	Sixth
Ford F-series	1997	2004	2009	2015		
	1.00	1.16	1.00	1.29		
Chevrolet Silverado	1999	2002	2007	2014		
	1.45	1.70	1.08	3.12		
RAM Truck	1993	2002	2009			
	1.00	1.16	2.04			
Toyota Camry	1996	2001	2006	2017		
	1.16	1.45	3.70	4.12		
Honda Civic	1995	2000	2005	2011	2016	
	1.12	1.16	3.25	2.83	4.20	
Toyota Corolla	1995	2000	2002	2006	2013	
	1.00	2.54	1.04	3.16	4.08	
Honda CR-V	1995	2001	2005	2006	2011	2016
	1.29	1.25	1.25	1.04	3.20	3.91
Toyota RAV4	1994	2000	2005	2009	2013	
	1.25	1.33	1.66	1.08	3.75	
Honda Accord	1997	2002	2007	2012		
	1.00	1.12	2.50	2.91		
Nissan Rogue	2007	2011	2013			
	1.95	2.58	4.41			
Nissan Altima	1997	2001	2006	2010	2012	
	1.58	1.12	1.00	1.04	4.25	
Ford Escape	2000	2005	2007	2012		
	1.00	1.12	1.08	3.08		
Ford Fusion	2006	2010	2013			
	1.12	2.75	3.79			
Ford Explorer	1995	2002	2006	2011	2016	
	1.08	1.00	1.04	1.95	3.87	
Chevrolet Equinox	2005	2010	2016	2018		
	1.16	1.95	2.29	4.62		
Chevrolet Malibu	1997	2004	2008	2013	2014	2016
	1.20	1.20	1.62	3.25	2.33	4.04
GMC Sierra	1999	2007	2014			
	1.083	1.12	2.45			
Nissan Sentra	1995	2000	2007	2013		
	1.37	1.33	1.25	4.29		
Jeep Grand Cherokee	1993	1999	2005	2011		
	1.04	1.08	1.00	3.16		
Hyundai Elantra	1995	2000	2003	2006	2010	2015
	1.20	1.39	1.12	2.70	4.70	3.41

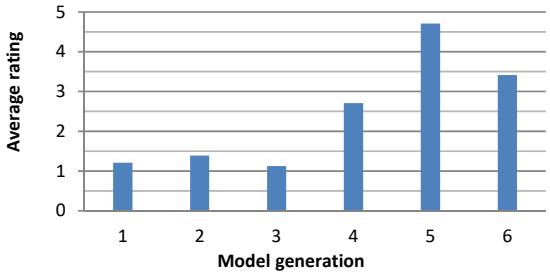

Fig. 4 Trend for Hyundai Elantra

Fig. 5 shows the average of models available in a year. The trend for all vehicles is upward even though specific vehicles go up and down as shown by the Elantra. The p-value for the difference from 1998 to 2017 is essentially 0.00. The industry average rating is low until around 2006 when the rating appears to linearly increase until present. Plotting cars alone would show the same trend. Plotting crossovers alone would show that they do not increase in angry styling rating until 2011. Other classes of vehicles do not have enough models in the top 20 list to make interesting plots because those plots would be of single or a small number of vehicles. However, the trend is upward among all plots because all vehicles are rated as more angry in 2017 versus their year of introduction.

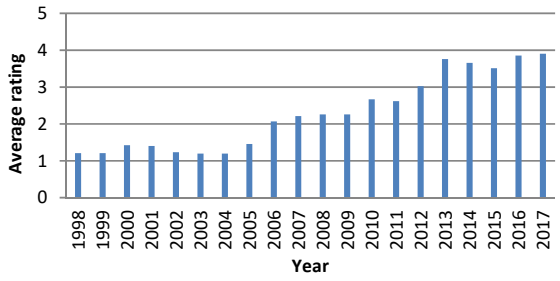

Fig. 5 Historical trend of top models in US

V. Correlation of Results to Vehicle Design Features

In an effort to make an equation that could predict the expected rating of new automobiles, ratings were correlated to design features on vehicle front-ends. From above, it was shown that it is necessary for vehicles to appear anthropomorphic in order to be considered as angry-looking for most people. That emphasizes the importance of defining the vehicle appearance in terms that are anthropomorphic.

First, the details of front-ends were identified and labelled as anthropomorphic terms. Since the primary facial feature in recognition and in determining emotion is the eyes [9], there were several variables related to vehicle headlamp size and shape. Variables are shown in Table VI. Secondly, the mouth is related to emotion so a few variables were made for it. However, most cars do not have distinct noses or ears, and those facial features are not primary in determining emotion, so no variables were created for them. Then the photos for each of the 211 vehicles in the survey were measured and rated according to how well they represented those features. The photos were all scaled to 82.6 mm (3.25") widths, and the features measured to the nearest millimetre or 5 degrees.

Next, composite variables were made. For example, Mouth-Area was determined by taking the air intake width multiplied by height. The aspect ratio of the eye was found by dividing the headlamp width by height. Additional composite variables were created during the analysis. For example, it was thought that a large air intake (mouth) may not necessarily represent anger unless it simultaneously was shaped like a frown. Therefore the relevant variables for the mouth were multiplied to find a Frown-Size-Factor. However, that variable showed no increase in sensitivity of the model, so was not kept.

Additionally, the axis scale was analysed for each design feature. For example, the air intake shape was rated "0" for upward and outward slope like a smile, "1" for flat, and "2" for downward slope like a frown. However, a sensitivity analysis showed a better line fit if a flat mouth was scored as 0.4 instead of 1.0. Since the scoring labels were arbitrary, there was no reason not to change the rating of flat mouths to 0.4. Likewise, non-linearity of response to features was considered. For example, the main light in the headlamp was a variable called the Iris. It is significantly related to angry ratings. It is known that dilation of pupils changes between emotional states [10]. Respondents rated vehicles as angrier if they had smaller Irises. This variable was plotted versus vehicle rating and it was determined from the sensitivity analysis that there was a small but insignificant non-linearity. As the Irises got larger, they did not look angry. Beyond a certain point, 10 mm on the photo, the increasing size no longer lessened the perception of anger. However, accounting for this produced no significance in the prediction of the respondents' ratings. Similarly, non-linearity was found in other variables but was not significant.

Finally, multiple regression analysis was performed on the variables. The total R-squared value was 0.679. This is not accurate enough to be able to predict the rating of new vehicles with any significance. The confidence intervals would be rather wide. However, these results provide confirmation of which variables are significant, so are likely a factor that people were using to rate the vehicles. See the variables and their significance in Table VI.

Many variables were related. For example Mouth-Area was determined from Mouth-Width and Height. Initially Mouth-Width had a low significance. Variables that were insignificant were removed from the final analysis. The effect of removing Mouth-Width was to increase the significance of Mouth-Area since they were two ways of measuring the similar things. The eliminated variables in Table VI were all removed because of low significance or because they were incorporated into other variables. Some variables such as Lightness were kept despite poor significance because there were no other variables thought to be related to them. Therefore, removing them would reduce the accuracy of the model.

TABLE VI
VEHICLE FEATURES AND SIGNIFICANCE IN REGRESSION OF RATINGS

Anthropomorphic variable name	p-value	Definition
Iris-Size	0.000001	Largest circular shape within headlamp. If no circle present, then the height of the lamp (mm). Inverse relationship to anger.
Eyebrow-Factored	0.00001	Eyebrow-Shape (below) multiplied by Eye-Aspect.
Unibrow	0.0004	A second measurement of eyebrows. This is the shape of the connection between the two headlamps which is caused by the grille or lower hood detail. Arching upward (0), none (0.5), flat (0.9), arching downward (3).
Lips	0.0004	Number of sides around the air intake (mouth) that have air dams, spoilers, bumper lips, or differential detailing at least 2 mm in thick (0 to 4).
Mouth-Area	0.004	Mouth-Width multiplied by Mouth-Height.
Eye-Top-Angle	0.01	Average slope of the top of the headlamp (degrees).
Frown	0.01	Whether the shape of the side of the air intake is angled up (0), flat (0.6), or down (2). If it had multiple angles, the median was taken.
Eye-Pinched	0.02	The shape of the bottom of the headlamp on the inner half of the light. Convex (0), Flat (0.1), Concave (2). Thought to represent nose wrinkling.
Cheek-Bulges	0.17	Three-dimensional shapes directly connected to bottom of the headlamps. Concave or into the vehicle (0), None (0.6), Outward extension from headlamp then flat below (1.7), Convex ridge (3).
Lightness	0.21	Munsel Color System's Value as printed on photocopy paper. Scale 0 to 10. Inverse relationship to anger.
Eyebrow-Shape	eliminated	Whether the top of the headlamp fixture is convex (0), flat (1), or concave (2).
Eye-Aspect	eliminated	Eye-Width divided by Eye-Height.
Eye-Width	eliminated	Horizontal extent of headlamp (mm).
Eye-Height	eliminated	Vertical extent of headlamp (mm).
Mouth-Height	eliminated	Vertical extent of main air intake (mm). Some vehicles have multiple air intakes such as side diffusers. However, the main central bottom intake was measured. If it was split into two similarly sized intakes, both were combined. A decorative grille was not combined with the lower intake.
Mouth-Width	eliminated	Horizontal extent of main air intake (mm).
Eye-Bottom-Angle	eliminated	Average slope of the bottom of the headlamp (degrees).
Average-Eye-Slope	eliminated	Average of Eye-Bottom-Angle and Eye-Top-Angle.
Teeth	eliminated	Details in the air intake. Not enough vehicles with this for significance.
Chromed-Lips	eliminated	Chrome around the main air intake. Typically 1 mm thick.
Frown-Size-Factor	eliminated	Mouth-Area multiplied by Frown.

It is interesting that the variable Iris is the most significant determinant of the rating of anger. It is also interesting that the eye aspect is not much of an affect beyond its influence on the Eyebrow-Factored. Squinting is a well-known physical sign of anger, and this would be shown through the aspect of the eye. Additionally, pupils dilate during emotional arousal, including anger. However, it was found that participants strongly based anger perception on smaller irises or pupils, not dilation or increase in size. These two conflicts may be explained by the statement earlier that the vehicles need to be seen as anthropomorphic. Yet, many vehicle headlamps are odd-shaped such as triangular or rectangular which are not very anthropomorphic. Therefore, it is proposed that participants could have been judging eye aspect not only from the headlamp geometry, but also from the variable Iris because human irises do not change size.

Lightness showed an inverse relationship to perception of anger. This is consistent with the well-known black hat phenomena in which dark things are associated with unpleasant emotional states [11]. When taking the photos, vehicles with color closest to middle gray values were chosen. However, since this was limited by automaker offerings, the Lightness variable attempted to correct for it. It was noted that bright colors are often preferred for sports cars. Despite this, the regression suggests that darker is interpreted as angry.

The above analysis was again conducted, but with men and women separated into groups. The results changed which suggests that men and women were relying upon different factors in vehicle design in assigning their ratings of anger. However, this study was not designed for the purpose of evaluating differences between men and women. The data were collected with the intent of evaluating which features on vehicles are considered anthropomorphic. Therefore, it is appropriate to withhold those results until additional investigations can confirm or refute this.

VI. SUMMARY AND CONCLUSIONS

The survey responses showed that people felt front ends appeared more like faces and showed more angry expression than the back ends. Respondents also gave distinct answers for whether they saw the vehicle front or back end as a face or as an angry expression. Generally, respondents felt that most vehicles had some level of anthropomorphic design and the majority of the vehicles looked angry to some extent.

The trend is that all vehicles appear angry and the average rating has gotten angrier looking at each year. However, what is motivating that trend is uncertain. The technology of vehicle design and production for body and lighting components allows for a greater level of design than in the past. Also, the preferences of new vehicle purchasers could have changed. An interview with automotive executives has shown they think angry looking vehicles give drivers confidence to be assertive [12].

Air intakes were correlated to perception of anger in vehicles. It is thought that they represent mouths. This partly explains why the back ends of vehicles were not viewed as

strongly as faces or angry. Likewise, the variable Iris was a major factor in perception of anger, but most tail lights do not have features that appear like irises or pupils.

Vehicles seen at night would likely have a much different rating for perception of anger. The darkness may enhance the effect of anger perception as demonstrated by the variable Lightness. However, many design features would be irrelevant at night because they would not be visible. Headlights would still be visible, or the lamp within them, but the effect of illumination has unknown impacts.

Follow up work is planned in making simulations to see if car drivers react differently to angry vehicles. The survey results show which vehicles are subjectively considered more or less angry in appearance. The survey takers had different responses to vehicle appearance. Some respondents did not recognize any vehicle as a face. This variation means that some participants in a simulation may respond to angry looking cars while others might not. There are many factors involved in why aggressive driving is a problem. Simulations are the most direct means of relating cause and effect. The benefit from the results of the correlation of anger perception with vehicle styling is that a simulation can use vehicles picked with the right features. It was not anticipated before the survey that the size of the circular lamp in the headlight, labeled as the variable Iris, was the top most significant feature in expression of anger in vehicles. Additional work is necessary to determine if men and women have different perceptions of angry expressions.

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