Larger vehicles are perceived as more aggressive, angry, dominant, and masculine

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Abstract

Humans have evolved the cognitive ability to perceive and associate dominance, masculinity, and emotions to animals and humans of larger sizes. Previous research has shown that humans are able to anthropomorphize nonbiological objects such as cars and attribute different characteristics to them. We hypothesized that larger vehicles are perceived and processed in a similar fashion as other biological agents, and are therefore considered more aggressive, dominant, and masculine compared to smaller vehicles. This study investigated the effect of vehicles' size on the perception of dominance, masculinity, anger, and hostility. A total of 221 individuals (139 men and 82 women) participated in the study and rated vehicles of large and small sizes on four dimensions of Submissive-Dominant, Angry-Happy, Masculine-Feminine, and Hostile-Friendly. Results showed that participants rated larger vehicles as more dominant, angry, hostile, and masculine than smaller vehicles, supporting the proposal that, similar to biological agents, large vehicles are more threatening and are associated with higher dominance. Moreover, while men and women responded to size in a similar manner, the ratings of anger, masculinity, and hostility for large vehicles increased with the age of participants. The implications of this work are considered, including ways to enhance the social acceptance of autonomous vehicles.

Keywords: Vehicle perception, size perception, dominance, aggression perception, autonomous vehicles

Larger vehicles are perceived as more aggressive, angry, dominant, and masculine

As the perception of self-driving technology by the general public is an ongoing concern (for a review see Becker & Axhausen, 2017), the development of socially sensitive and considerate vehicles that can communicate and interact effectively with humans in their surroundings is of growing importance to technology designers (Mladenović, Abbas & McPherson, 2014). Anthropomorphising the autonomous cars can increase their humanlike-mental capacities and trust in their competence (Waytz, Heafner & Epley, 2014). External car features (such as smiling vs. neutral front view) can also contribute to pedestrian decision making time (Holländer, 2019).

Humans are sensitive to features resembling faces (e.g., perceiving faces in clouds or a man on the moon) and they tend to anthropomorphize such patterns as a result of a hypersensitivity to faces (Guthrie, 1993; Haxby, Hoffman & Gobbini, 2000). Indeed, previous research has shown that individuals often attribute facial characteristics to the front view of cars (Desmet, Hekkert & Jacobs, 2000; Windhager, Slice, Schaefer, Oberzaucher, Thorstensen & Grammer, 2008). We call this frontal area of cars "fascia", which includes such components as the grille, front bumper, and headlamps. It is speculated that adding facial expressions to the design of the products, such as vehicles, increase their aesthetic appeal (Coss, 2003). Consistent with this, it has been demonstrated that the fascia of cars activates the fusiform area, a brain region responsive to perception of human faces, indicating that car fasciae and human faces are processed similarly by the brain (Erk, Spitzer, Wunderlich, Galley & Walter, 2002; Gauthier, Skudlarski, Gore & Anderson, 2000; Kühn, Brick, Müller & Gallinat, 2014). Convergent with this view is the fact that electrophysiological studies have shown that car fasciae elicit an N170 response of similar amplitude as human faces (Kloth, Itier & Schweinberger, 2013).

Commonalities between car fascia and human faces extends from brain to behaviour. When participants are shown, side by side, a human face and a car's fascia, and they are asked if the two have similar features (e.g., eyes, mouth and ears), participants' gaze behavior on the fascia and faces are comparable (Windhager et al., 2010). Furthermore, Landwehr, McGill, and Herrmann (2011) have demonstrated that an emotional expression can be created for a car merely by changing the placement of its headlights and grill; with a threatening expression being processed more accurately and faster than friendly ones -- mirroring the findings for human expressions (Purucker, Sprott & Herrmann, 2014).

While the effect of the car's fascia has been investigated previously both in perceptual and cognitive studies, showing the attribution of masculinity and dominance (Windhager et al., 2012), as well as emotions to cars (Aggarwal & McGill, 2007), the effect of vehicle size on such dimensions yet remains to be known. The relevance and importance of the question regarding vehicle size is evident when one considers pedestrians, as well as drivers interactions on the daily basis with trucks on the streets and highways (Becker & Axhausen, 2017; Fank, Richardson & Diermeyer, 2019). It should be noted that larger animals, including humans, are more threatening and have higher physical formidability (Parker 1974). Consistent with this, individuals associate larger humans with higher dominance and social status (Ellis 1994; for a review see Sell, Hone & Pound, 2012). Considering the humans ability in anthropomorphizing cars as well as anticipating a (near) future in which self-driving vehicles will become relatively frequent, the perceptions regarding the large size of cars and trucks is both an empirical and theoretical concern.

As a first step towards understanding the perceptions of size as it relates to vehicles, the current study asked participants to rate two categories of vehicles that differed in size (cars and trucks). The measures were the perception of dominance, masculinity, anger, and hostility. We reasoned that humans have evolved the cognitive ability to perceive and

associate dominance, masculinity, and emotion to size, such that, for example, taller, heavier, and more muscular individuals are considered more formidable and threatening (Fessler, Holbrook & Snyder, 2012; Wilson, Hugenberg & Rule, 2017). Because humans routinely interact with vehicles that differ in size, just as they interact with humans and other biological agents (e.g., dogs) that differ in size, we reasoned that vehicle size may be perceived and processed in a similar fashion as humans and other biological agents. The secondary goals are to investigate the effect of sex differences and age in the attributions made to these anthropomorphic features. These aims are grounded in the fact that men and women, and younger and older individuals, have been found to display different sensitivities to cues of dominance and emotions (Eisenberg & Lennon, 1983; Hampson, van Anders & Mullin, 2006; Ruffman, Henry, Livingstone & Phillips, 2008).

Method

Participants

Participants were recruited from Amazon Mechanical Turk workers located in the United States. A total of 221 individuals (139 men and 82 women) aged between 18 and 70 years (M = 36.57, SD = 11.27) participated in this study and completed an online survey. A total of 111 participants (50.2%) reported being married and 18.1% reported being in a relationship. Also, 26.7% reported being single and 5% were either widowed, divorced, or separated. As for their highest educational degree, 21.3% had high school diploma, 8.1% had a post-secondary diploma, 43.4% had undergraduate degree, 24.4% had master's or equivalent graduate degree, and 2.7% of the participants had a PhD degree.

Stimuli

The stimuli consisted of the front views of twenty-seven 3D computer-generated vehicles, representing two categories of cars and trucks (eighteen cars and nine trucks). We

used a variety of different vehicle models to control for potential emotional variances in their fasciae. The vehicles were scaled to their original size and were positioned 15 m away from a virtual camera in the 3D scene. All vehicles were in black and white (to control for color), and the size of the final stimuli was 500 × 500 pixels (see Figure 1 for examples).

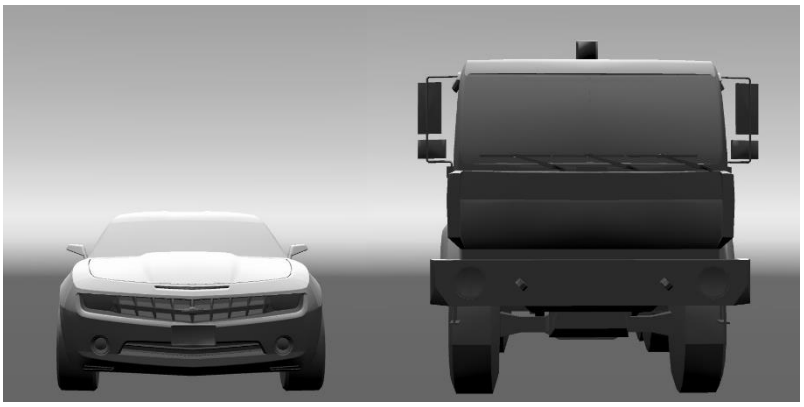

Figure 1. Example of stimuli used for two vehicle categories of cars (left) and trucks (right).

Procedure

After asking the sociodemographic questions, the stimuli were individually presented in a random order and the participants were asked to rate the vehicles on a slider scale from -10 to 10 for the following variables: Submissive-Dominant, Angry-Happy, Masculine-Feminine and Hostile-Friendly. Participants were for example instructed that for " Masculine/Feminine," -10 would be very masculine, 10 would be very feminine, and 0 would be neutral (neither masculine nor feminine).

Results

Sex Difference in Vehicles' Perception

A series of independent t-tests were conducted to investigate for sex differences in the perception of the vehicles. No significant differences between men and women were observed on the four categories of emotion/feature ratings (submissive-dominant, angry-

happy, masculinity-femininity and hostile-friendly) (all *p*s > .191; see Tables S1 and S2 for the details).

Cars vs. Trucks

A series of paired t-tests were conducted to compare the ratings between cars and trucks (Table 1). Results showed that trucks were rated as more dominant, angry, hostile and masculine than cars, while cars were considered as more submissive, happier, friendly and feminine (Figure 2).

We further randomly assigned the cars in two groups of 9 cars and repeated the paired t-tests comparisons between ratings for each of the cars' groups and the trucks'. This extra analysis was conducted to resolve the problem of the unequal number of stimuli per each vehicle category (i.e., 18 cars versus 9 trucks). Our results for each of the groups (N=9 cars) replicated the full sample (N=18 cars) comparisons (see Tables S3 and S4 for the details).

Table 1. Paired Sample t-test Results for Comparing Perceptions from Cars and Trucks (N=221)

	Cars		Trucks				
	M	SD	M	SD	*t*	*df*	*p*
Submissive-Dominant	1.96	3.01	5.47	2.98	13.5	220	< .001
Angry-Happy	3.13	2.74	-0.49	5.06	-14.4	220	< .001
Masculine-Feminine	1.55	3.32	-2.42	5.93	-16.5	220	< .001
Hostile-Friendly	3.31	2.82	-0.30	5.16	-14.9	220	< .001

Age

The correlational analyses for trucks showed a significant negative relationship between age and happiness (r(219) = -.19, p = .003), femininity (r(219) = -.16, p = .015), and friendliness (r(219) = -.18, p = .006), reflecting that as participants' age increased, trucks were rated as angrier, more masculine, and more hostile. For the cars, the relationship between age and dominance was also significant (r(219) = -.16, p = .014), with cars being rated as more submissive as the age of the participants increased. No other relationships were significant.

Discussion

In this study, we investigated the effect of vehicle size on the perception of dominance, masculinity, anger, and hostility and how these perceptions may vary with sex and age. Results showed that participants rated large vehicles more dominant, angry, hostile and masculine than cars, meaning they rated the car category as more submissive, happier, friendly and feminine. This result supported the proposal that similar to biological agents, large vehicles are more threatening and are associated with higher dominance. This finding shows that in addition to fascia's features (Aggarwal & McGill, 2007; Windhager et al., 2012), attributions of masculinity, dominance and emotions can be applied to vehicles' size and has important implications for designers of autonomous vehicles of different sizes.

Moreover, the results showed as the age of participants increased, they rated large vehicles as angrier, more masculine and more hostile, but rated small ones as more submissive. It is known that emotion recognition, especially negative emotions, declines with age (Mill, Allik, Realo & Valk, 2009; Sullivan, Ruffman & Hutton, 2007). Nonetheless, it appears the threatening cues associated with vehicles' size might differently affect the perception than facial expression and emotion, as we found higher in negative ratings as a

function of aging. Therefore, future research should further scrutinize the effect of aging in perception of vehicles' size.

Previous research has shown that women are better perceivers of emotional expressions and men are more responsive to threatening cues such as dominance and aggression (for a review see Kret & De Gelder, 2012). The current study did not find any sex differences in the perception of such cues. That is, the perceptions dominance, masculinity, anger, and hostility were stable across sex, meaning that men and women had similar perceptions of the anthropomorphic features across vehicles of different size. This is in line with the previous research lacking sex difference in response to perceptions from car fascia (Windhager et al., 2008). Altogether, it appears size is a powerful signal that may override any sublte differences in men and women's ability to perceive one type of emotion or cue better than the other.

In the current study, we controlled for the color of the stimuli – they were presented in black and white – however we suggest that the effect of color on perception of size may be an interesting avenue for future investigation. For example, different colors such as red and yellow can influence threat perception and evoke fear as are seen in perception of poisonous species (Darst, Cummings, & Cannatella, 2006; Wauters, Brengman & Mahama, 2014). This raises the question of how size and color may combine. Will, for instance, a small red car be rated more negatively than a large white truck? Similarly, how do size and emotional fasciae combine? For instance, can applying emotions and facial expressions to large vehicles' fasciae reduce or amplify the effect of size?

In conclusion, the current study reveals that larger vehicles such as trucks are perceived as more dominant, angry, hostile, and masculine than smaller vehicles like cars, and these perceptions can be accentuated by an increase in age. This work may also be

relevant to research on vehicle speed and stopping distance estimations (Sun, Zhuang, Wu, Zhao & Zhang, 2015) as these may be affected by emotion (Landwehr et al., 2011; Purucker et al., 2014). Finally, it makes the point that vehicle size will need to be a careful consideration for designers who seek to create autonomous vehicles that are perceived in a positive light with the aim of enhancing their social acceptability (Rasouli & Tsotsos, 2019).

Compliance with Ethical Standards:

Ethical approval: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Supplementary Material

Table S1. Independent Samples T-Test for Comparing Sex Difference

				95% Confidence Interval		
	t	***df***	***p***	**Lower**	**Upper**	**Cohen's d**
Cars_Dominant	-0.37	219	0.713	-0.98	0.67	-0.05
Cars_Happy	0.83	219	0.410	-0.44	1.07	0.12
Cars_Feminine	-0.24	219	0.813	-1.02	0.80	-0.03
Cars_Friendly	1.09	219	0.279	-0.35	1.20	0.15
Trucks_Dominant	1.02	219	0.311	-0.40	1.24	0.14
Trucks_Happy	-1.31	219	0.191	-2.31	0.46	-0.18
Trucks_Feminine	-1.05	219	0.295	-2.50	0.76	-0.15
Trucks_Friendly	-0.84	219	0.403	-2.02	0.81	-0.12

Table S2. Descriptive Results for Sex Difference

	Group	**N**	**Mean**	***SD***	***SE***
Cars_Dominant	Female	82	1.87	3.20	0.35
	Male	139	2.02	2.91	0.25
Cars_Happy	Female	82	3.33	2.66	0.29
	Male	139	3.02	2.80	0.24
Cars_Feminine	Female	82	1.48	3.40	0.38
	Male	139	1.59	3.28	0.28
Cars_Friendly	Female	82	3.58	2.76	0.31
	Male	139	3.15	2.86	0.24
Trucks_Dominant	Female	82	5.74	3.30	0.36
	Male	139	5.32	2.78	0.24
Trucks_Happy	Female	82	-1.08	5.34	0.59
	Male	139	-0.15	4.87	0.41
Trucks_Feminine	Female	82	-2.97	6.05	0.67
	Male	139	-2.10	5.86	0.50
Trucks_Friendly	Female	82	-0.67	5.41	0.60
	Male	139	-0.07	5.01	0.43

Table S3. Paired Sample t-test Results for Comparing Perceptions from Cars Subsample A (N=9) and Trucks (N=9); 221 Participants

	Cars		Trucks				
	M	SD	M	SD	*t*	*df*	*p*
Submissive-Dominant	0.77	3.86	5.47	2.98	-14.7	220	< .001
Angry-Happy	3.44	2.63	-0.49	5.06	14.5	220	< .001
Masculine-Feminine	1.91	3.16	-2.42	5.93	15.8	220	< .001
Hostile-Friendly	3.81	2.68	-0.30	5.16	15.0	220	< .001

Table S4. Paired Sample t-test Results for Comparing Perceptions from Cars Subsample B (N=9) and Trucks (N=9); 221 Participants

	Cars		Trucks				
	M	SD	M	SD	*t*	*df*	*p*
Submissive-Dominant	3.16	2.71	5.47	2.98	-10.2	220	< .001
Angry-Happy	2.83	3.22	-0.49	5.06	13.2	220	< .001
Masculine-Feminine	1.19	3.88	-2.42	5.93	15.6	220	< .001
Hostile-Friendly	2.81	3.35	-0.30	5.16	13.5	220	< .001