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The effect of safety attire on perceptions of cyclist dehumanisation

Mark Limb [a,*], Sarah Collyer [b]

[a] Queensland University of Technology, GPO Box 2434, Brisbane, QLD 4001, Australia
[b] Flinders University, Australia

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ABSTRACT

Increasing the uptake of active, carbon neutral forms of transport is indicated for both population health and environmental conservation. Efforts to increase cycling uptake are hindered by negative attitudes towards cyclists. Recent research from Australia has found that many people consider cyclists to be less than fully human. There is currently a lack of empirical evidence that explains these dehumanising perceptions. Most people who ride bicycles in Australia wear safety helmets as required by mandatory helmet laws. We hypothesised that people wearing bicycle helmets are perceived as less human compared to people without helmets due to reduced visibility of eyes and hair. We tested this hypothesis through a survey (n = 563) comprised of two-paired alternate forced choice questions to identify which image of a cyclist respondents consider to be less human. We then analysed the results using a Bradley-Terry probability model. We found images of cyclists wearing helmets or safety vests to have a higher probability of being selected as less human compared to images of cyclists wearing no safety equipment. The results have implications for research on cyclist dehumanisation and its mitigation.

1. Introduction and literature review

Increasingly, efforts to decrease carbon emissions and increase population health focus on encouraging the uptake of active forms of transport such as cycling (Pucher & Buehler, 2017). However, in many countries, cycling infrastructure is in its infancy and cyclists must ride on roads designed for motorised vehicles, placing cyclists in a position of vulnerability with numerous threats to their safety (Mayers & Glover, 2021). For example, research has found that a large proportion of drivers hold negative views about cyclists and these attitudes result in more aggressive driving (Basford et al., 2002; Fruhen & Flin, 2015; Johnson et al., 2014). These studies have reported such attitudes as being in response to perceptions of cyclists hindering driver mobility and knowledge/adherence of road rules. More recent research has found that perceptions of cyclists are also dehumanising (i.e. cyclists are considered to be less than fully human) and that the strength of this perception predicts aggressive behaviour towards cyclists (Delbosc et al., 2019). Research of this nature is still in an exploratory state and further research is needed, especially on potential factors that explain why cyclists are perceived as less than fully human. Understanding such factors can inform approaches to reduce dehumanising attitudes and aggressive behaviours towards cyclists, enhancing the safety of these vulnerable road users. As we review in the following sections, there is some evidence that cyclist attire contributes to perceptions of cyclists and how drivers interact with them. In this paper, we add to the recent research on cyclist dehumanisation by testing whether wearing safety attire contributes to perceptions that cyclists are less than human.

* Corresponding author.
E-mail address: mark@mlpd.com.au (M. Limb).

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1.1. Dehumanisation

To dehumanise is to deny a person (or group) their full humanity. Dehumanisation involves the denial of higher order traits including self-control, intelligence, rationality, morality, and/or the denial of attributes of human nature such as complex emotions and individuality, that differentiate humans from animals and inanimate objects (Haslam, 2015). Recently, Kteily and Landry (2022) describe dehumanisation as a spectrum, ranging from subtle (e.g., attributing fewer complex emotions to a target group), to blatant forms of dehumanisation (e.g., openly likening a target group to vermin), and indicate that dehumanisation pervades everyday life. Indeed, there is evidence for dehumanisation across a range of domains including ethnicity and race, gender, sexuality, disability, technology, law, political groups (Haslam, 2006; Haslam & Stratemeyer, 2016), health (Diniz et al., 2019) and education (Bruneau et al., 2021). Whether subtle or blatant, dehumanisation can lead to treating target groups differently to how one would treat those to whom the full spectrum of human qualities is ascribed. To dehumanises implies that a person or group has lesser value, and renders them more subject to being discounted, ignored, mistreated, or deliberately harmed (Kteily & Landry, 2022). Further, the experience of dehumanisation by the target group, can lead to reciprocal dehumanisation toward the offending group, escalating aggression and hostility (Kteily and Bruneau, 2017). Dehumanisation has been found to introduce a range of cognitive biases that contribute to the propensity to commit violence and aggression (Kteily et al., 2015) as well as unfairly assigning blame (Bastian et al., 2011).

Both subtle and blatant dehumanisation can be measured via implicit, explicit, indirect (e.g., asking about attributes of a group) and direct (e.g., specifically rating target groups' humanity) means. While traditionally dehumanisation has been measured using indirect and direct implicit measures to tap into subtle forms of dehumanisation and counter social desirability bias, recent research has explored explicit and direct measures of blatant dehumanisation (e.g., Kteily & Bruneau, 2017). Such measures have found that blatant rather than subtle dehumanisation is more strongly linked to hostile behaviour (Kteily & Landry, 2022), with blatant dehumanisation found to more strongly predict outcomes of aggression and hostility than subtle dehumanisation (Bruneau et al., 2018; Kteily et al., 2015).

1.2. Dehumanisation and cycling

Delbosc et al. (2019) have undertaken the first study that links dehumanisation and aggressive driving behaviour toward cyclists. While it has been previously determined that negative views about cyclists are related to more aggressive and dangerous driving (Basford et al., 2002; Fruhen & Flin, 2015; Johnson et al., 2014), the link to dehumanisation is an important finding that contributes to explanations of why some motorists commit this violent and aggressive behaviour. If dehumanisation is a key driver of motorists' aggression towards cyclists, it may be possible to reduce such aggression through approaches that attempt to rehumanize cyclists. Little is currently known about why cyclists are considered less than fully human. However, Delbosc et al. (2019) have suggested it may be due cyclists being consider as "others" partly based on their attire.

Research connecting cycling attire to perceptions of cyclists and/or associations of this to aggressive behaviour are rare. In countries with low cycling rates, there is some evidence that cyclists are considered as "non-mainstream 'fringe' individuals" partly due to "alienation" induced by specialised riding attire such as lycra (Daley & Rissel, 2011). Social distinctions of this nature are also apparent in countries with high cycling rates such as the Netherlands, where attire serves to differentiate people as either "normal" *fietser,* who ride in everyday clothes and no helmets, or more marginalised lycra-clad and helmeted *wielrenner* (Oldenhave, 2013). People's perceptions of cycling risk, experience, and appearance are known to change based on simple alterations to attire such as whether a cyclist is wearing a helmet or not (Hjuler & Krag, 2013).

Some studies have attempted to link cyclist appearance and attire to changes in driver and cyclist behaviour. In such studies passing distance is commonly used to naturalistically test whether the appearance of a cyclist alters drivers' behaviour. The results of such studies based on cyclist appearance have been mixed (Rubie et al., 2020) however there is some evidence that cyclists wearing helmets are passed more closely than cyclists without (Walker & Robinson, 2019; Walker, 2007). There are few other rigorous studies that specifically consider helmet use in these terms.[1] Comparisons with differing cycling clothing styles are also not common. Haworth et al. (2018) found that cyclists dressed in street clothes (as opposed to the lycra based sport cycling clothes) are offered more space by drivers, while Debnath et al. (2018) could not identify such an association.

Gender often features as another appearance-based variable in these types of studies. Walker (2007) found that apparent cyclist gender influenced motorist passing however other studies did not find such a relationship in either passing distance (Debnath et al., 2018; Haworth et al., 2018) or self-reports of aggressive behaviour and attitudes (Fruhen et al., 2019).

The general lack of studies and consensus naturally limits explanations of why cyclist appearance may change driver perceptions and behaviour. Walker (2007) initially theorised that drivers were adapting their behaviour based on what a cyclist's appearance suggested about their likely skill level, with helmetless cyclists being perceived as generally less experienced and skilled. However when tested in a subsequent study designed to assess motorists reactions to perceived skill level based on categorisations of cyclists types, no association with cyclists appearance was found (Walker et al., 2014). What was found however were changes based on subtle differences in cyclist appearance such as changes between the words "POLICE" or "POLITE" printed on a high-visibility vest. Perceived cyclist vulnerability may also be factor with drivers changing behaviour based on the absence of a helmet or the presence of a child,

[1] For example, while no statistically significant correlations with helmet use and legal passing distances were found in an Australian based study, compulsory helmet laws in Australia meant there were insufficient observations of non-helmeted cyclists to disprove such an association (Debnath et al., 2018).

although this effect depended on relative traffic levels (Ampe et al., 2020).

The association between levels of cyclist dehumanisation and dangerous driving behaviour adds a further possible explanation (Delbosc et al., 2019). However, it is currently unknown why cyclists are considered less human. While Delbosc et al. (2019) suggest that the dehumanisation of cyclists may be due to appearance based factors such as helmets obscuring hair and facial features, there is currently no evidence to support this.

This study aims to address this lack of evidence by determining if people perceive cyclists as less human based on their attire, with a particular focus on safety helmets and items that obscure the hair and facial features. By doing so, the study contributes to the emerging research on cycling dehumanisation and the factors that explain it.

2. Research method

We hypothesised that people wearing bicycle helmets are perceived as less human compared to people without helmets due to reduced visibility of their eyes and hair. To test this, we used a two-paired alternative forced choice questionnaire to assess perceptions of dehumanisation for different types of cycling attire. Participants self-selected after being exposed to media reports of the study and/or targeted Facebook advertisements. Respondents were presented with a series of randomly ordered paired photographs of cyclists wearing different attire and asked to select which photograph they felt appeared less human than the other. The results of the paired comparisons were then analysed using a Bradley-Terry probability model (Bradley & Terry, 1952) to identify which photographs were more likely to be selected as less human. The responses were also modelled to determine associations with a range of potential explanatory variables including perceptions of cyclist's humanity in general, aggressive driving behaviour towards cyclists, and basic demographic variables such as gender, age, and income.

In this section we firstly describe the rationale for the overall survey design and measures, before describing the procedure for its completion and deployment. We also describe how the results of the survey were analysed.

2.1. Survey measures and procedures

The survey was designed to determine if types of cycling attire, specifically safety helmets that obscure the face and hair, are perceived as less human than non-cycling specific attire. As research on cyclist dehumanisation is still emerging, we also included questions on attitudes towards the dehumanisation of cyclists more generally to determine if the findings of Delbosc et al. (2019) could be replicated.

2.1.1. Survey measures

We used a series of paired forced choice photo comparisons of cyclists in different attire to measure the primary research question. To assess perceptions of humanisation of this nature it is necessary to record subjective judgements. The extent of these subjectivities is likely to be subtle and vary considerably between different people. In such circumstances the use of questionnaires using Likert like scales can generate inconsistencies in the results. Approaches using paired comparisons overcome these limitations by asking respondents to make a series of judgements on two objects at a time (Maydeu-Olivares & Böckenholt, 2008). This approach is commonly used for studies that assess differences in judgement when respondents need to discriminate between objects based on sensory input (Jian, 2015). It is especially suitable when there may be only minor differences between objects, with paired comparisons making it easier for respondents to make judgements on fine scales (Cattelan, 2012; Maydeu-Olivares & Böckenholt, 2008; Perez-Ortiz & Mantiuk, 2017).

While analysis of the forced choice paired comparison approach can determine the probability of one object being selected over another, the approach is limited in that it cannot provide an indication of how strong the aspect of comparison is for each object. For

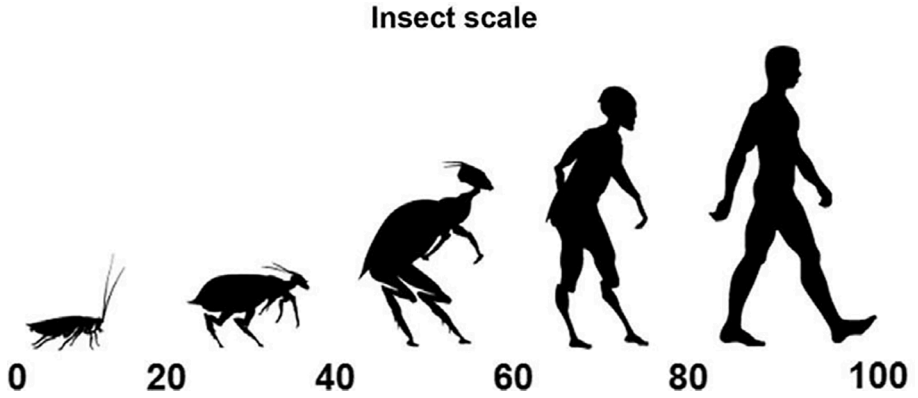


Fig. 1. Insect based ascent of man scale (Delbosc et al., 2019, p683) – "Some people believe that people can vary in how human-like they seem. According to this view, some people seem highly evolved whereas others seem no different than lower animals. Using the image below as a guide, [enter a value for] how evolved you consider the average cyclist to be".

example, respondents may consistently select a particular object over another, but the strength of the preference that informs this choice is unknown (i.e., the selection could be due to either small or large differences in perceptions of the object). As this study is focussed on the initial question of establishing whether a difference exists between perceptions of dehumanisation and different attire types, the paired comparison approach was considered appropriate for this purpose despite these limitations.

To test the more general attitudes around the dehumanisation of cyclists we used a selection of questions from the Delbosc et al. (2019) study. This included a question using an insectoid "ascent of man" style scale (Fig. 1) to assist the respondents to visualise a consistent concept of blatant dehumanisation, and to record the extent to which they feel cyclists are fully human. Previous research has established that a scale representing the "ascent of man" is effective at capturing evidence of blatant dehumanisation (Kteily et al., 2015). Modified versions of this scale, such as an insectoid style scale, calibrate well with results of the ascent of man scale (Delbosc et al., 2019).

A range of other data such as general demographic data (gender, age, income, postcode of residence, education, employment status, number of dependents), frequency of bicycle use, attitudes to bicycle safety equipment, and questions describing harassment based interactions with cyclists adapted from previous research (Delbosc et al., 2019; Heesch et al., 2011) were also included in the survey to allow for a description of the survey sample, and to provide covariates for analysis.

A single, open ended qualitative question was also included to allow participants to express their views on the topic and survey.

2.1.2. Survey procedure

The survey was available online for approximately-three months in April to July 2021. Participants self-selected and the survey could be accessed by anyone with the online link. The link was initially disseminated via a university press release calling for participants. The survey link was also distributed via Facebook advertisements in a two-week campaign valued at $250(AUD) in June 2021.[2] The survey was anonymous, and no identifiable data was collected. Any Australian resident aged 18 and over was eligible to participate. Survey participants could opt into a prize draw to win one of two $50 (AUD) gift cards. Prize draw entrants were recorded in a separate survey to maintain anonymity, and 287 participants (approx. 51 %) opted into the draw.

The survey was titled "The effect of cycling attire on perceptions of dehumanisation" and consisted of three parts. The first part of the survey was introductory; respondents were given a description of the study for the purpose of providing their informed consent to participate, were shown the insectoid scale (Fig. 1) as a measure of dehumanisation, and asked three practice questions to acquaint them with the paired comparison question format.

The second part of the survey consisted of the paired photo comparison questions. Respondents were informed they would be shown a series of paired photographs and instructed to select the image they thought looked less human. They were asked to select as quickly as possible, within at least five seconds, however they could still complete the question if they took longer to select. A five second count-down timer was shown next to each question to encourage fast responses.[3] The photographs depicted cyclists with differing attire. Eight different photographs were used consisting of four photographs of two models (one male and one female). Each model wore four different attire types:

- no headwear.
- a baseball cap (to test if obstruction of the hair and face impacts humanisation as hypothesised by Delbosc et al. (2019)).
- a standard bicycle helmet (to test if there was a difference in perceptions between safety equipment obscuring head and eyes compared to non-safety equipment (the baseball cap)
- a high visibility vest without a helmet (to further test whether any dehumanisation perception is related to headwear or safety equipment more generally).

Except for the above attire and the differences between the models themselves, all other details in the photographs were kept constant. The same bicycle was held by the models in all photographs to show that the model is a cyclist in the absence of cycling specific apparel such as helmets. Fig. 2 provides an example of the photographs, with the full catalogue of photographs shown in Appendix 1 – Survey images.

The photographs were paired and displayed in a random order. All possible combinations of photographs were paired resulting in a total of 28 paired judgements.

An additional two comparisons were inserted randomly among the main series of photographs comparing the male and female helmeted cyclist images with public domain images of male sports cyclists wearing helmets and Lycra. While this study was not intended to specifically consider the impact of sports cycling attire and dehumanisation, these comparisons were included to gauge the potential of future research.[4]

In the third section of the survey, respondents were asked to rate cyclists on the blatant dehumanisation scale (Fig. 1), and to answer the behaviour and demographic questions previously described. The respondents were also asked to provide their thoughts on the topic and survey in a final open-ended question.

[2] 81.3% of completed responses were received prior to this campaign's start date.

[3] Mean response time was 3.4 s.

[4] This was informed by the existing literature on perceptions of different types of cyclists, which frequently make comparison between cyclists in sports attire compared to everyday attire.

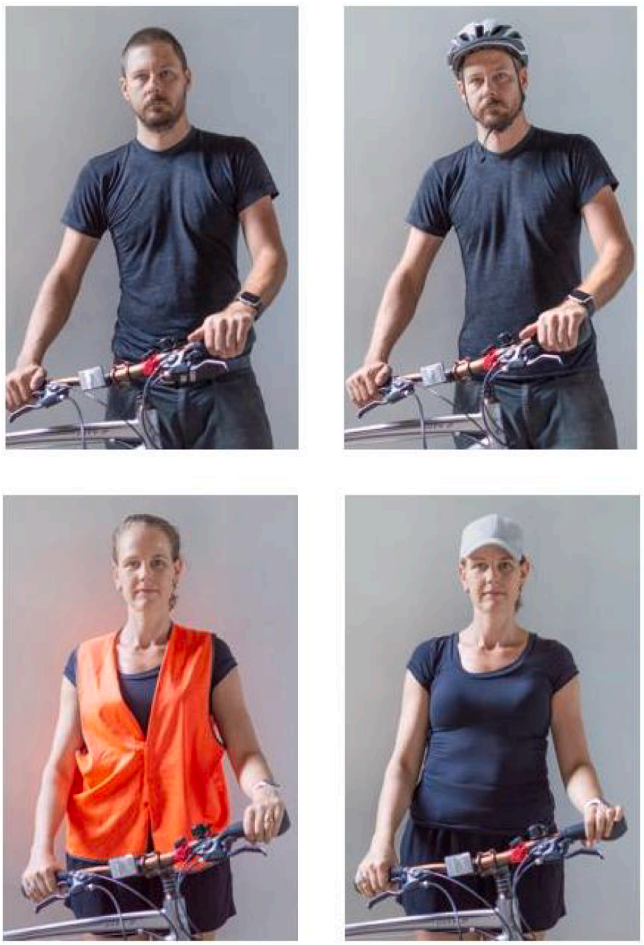


Fig. 2. Example photo comparisons – Row 1: The male model without a helmet vs the male model with a helmet. Row 2: The female model with a safety vest vs the female model with a cap.

2.2. Analysis

The responses were firstly checked for duplication or evidence of ballot box stuffing, with no completed surveys being identified. The image comparison component of the survey was analysed using a Bradley-Terry probability model (Bradley & Terry, 1952). This approach is specifically designed to calculate probabilities associated with binary outcomes of paired data. The results of the model show the probability of each photograph being selected compared to others.[5] If respondents did not find differences between the photographs and were forced to select at random, the model would be expected to show little variation in probability between photographs. The photograph comparison results were also correlated against subject covariates using recursive partitioning (Strobl et al., 2011) to determine if there were associations with different patterns of comparison results.[6] We also attempted to reproduce some of the associations between aggressive driving behaviour and the blatant dehumanisation scores reported by Delbosc et al. (2019) using negative binominal regression. Finally, we used inductive coding to analyse and report on the respondents' qualitative comments about the survey.

3. Results

In this section we firstly provide an overview of the survey respondent's characteristics, before describing both quantitative and qualitative results. Our sample of 563 respondents is not representative of the Australian population with some notable differences, especially in terms of cycling frequency. Our results confirmed the initial hypothesis that people wearing bicycle helmets are perceived by the respondents as less human compared to people without helmets, however this was not due to the obstruction of hair and eyes as

[5] Calculations were performed using the 'BradleyTerry2' package in R (Turner & Firth, 2012).
[6] Calculations were performed using the 'psychotree' package in R (Zeileis et al., 2021).

originally proposed and instead appeared to be more related to safety attire more generally. This result remained consistent with robustness-checks and did not substantively vary based other respondent characteristics. We found weak correlations between ratings of dehumanisation and aggressive and harassing behaviour.

3.1. Respondents

Five hundred and sixty-three respondents completed the survey. A total of 836 eligible respondents consented to the research and commenced the survey, with 40 respondents not proceeding past the initial practice questions, and 233 respondents dropping out during the forced comparison section. While the primary analysis only considered the completed surveys, we included an additional robustness test that randomised dropped respondents to account for non-completed responses.

The respondents are not a representative sample of the Australian population due to the sample size and the respondent's characteristics (Table 2). Compared to the Australian population, the survey respondents were more likely to be male, earn higher incomes, be employed full time, be middle aged, and more highly educated. The survey respondents were also far more likely to be regular cyclists with 72 % of our respondents riding at least weekly compared to only 12 % of the Australian population. We theorise this is due to cyclists being more likely to self-select for a survey about cycling attire.

3.2. Quantitative results

3.2.1. Photo comparison results

The results of the forced paired comparisons are shown in Table 3. This matrix shows the count of the respondent's selection for each of the paired comparisons so that the count reflects the number of selections for the row name when compared with the column name. Each comparison asked the respondent to select which image they felt looked less human. For example, when comparing the images of the female model wearing a cap (FemCap) vs the female model wearing a safety vest (FemVest), 165 respondents thought the image with the cap looked less human compared to 398 respondents who thought the vest looked less human. The general trend for preference of images with less attire can already be observed in this table.

Table 2
Respondent characteristics.

Variable	Variable category	Survey respondents	Population [a,b]
Gender	Female	33 %	51 %
	Male	66 %	49 %
	Non-binary / third gender	1 %	–
	Prefer not to say	0 %	–
Income	$0 - $40,000	9 %	17 %
	$40,001 - $80,000	12 %	22 %
	$80,001 - $120,000	23 %	24 %
	Over $120,000	44 %	26 %
	Prefer not to say	12 %	11 %
Age	18–24	9 %	12 %
	25–34	16 %	19 %
	35–44	30 %	17 %
	45–54	20 %	17 %
	55 or older	25 %	35 %
	Prefer not to say	–	–
Has children	No	44 %	28 %
	Yes	56 %	72 %
Employment status	Employed full time	63 %	43 %
	Employed part time	12 %	20 %
	Home duties	1 %	–
	Other	3 %	26 %
	Retired	12 %	–
	Student	8 %	7 %
	Unemployed	1 %	4 %
Education level	Less than high school	0 %	16 %
	High school	11 %	21 %
	Technical / Diploma	20 %	33 %
	Bachelor's degree	33 %	20 %
	Post graduate degree	36 %	9 %
Cycling frequency	5–7 days per week	29 %	–
	3–4 days per week	25 %	12 % (weekly)
	1–2 days per week	18 %	–
	At least monthly	9 %	17 %
	Less than monthly	8 %	32 %
	Not in past year	12 %	40 %

Demographic data from the 2016 Australian Census (2016)
Cycling frequency data from Austroads (Munro, 2017) cited in (Delbosc et al., 2019)

Table 3
Count of the selected image for each paired comparison.

	Attire Type	Male Vest	Fem Vest	Male Helm	Fem Helm	Male Cap	Fem Cap	Male Bare	Fem Bare	Lycra Blue	Lycra Gray
Each row shows the number of respondents who chose the row attire type (as less human) compared to a given column attire type	**MaleVest**	–	299	344	350	415	404	446	437	–	–
	FemVest	264	–	342	332	374	398	419	441	–	–
	MaleHelm	219	221	–	316	377	357	392	384	167	–
	FemHelm	213	231	247	–	371	376	374	397	–	153
	MaleCap	148	189	186	192	–	323	403	375	–	–
	FemCap	159	165	206	187	240	–	355	385	–	–
	MaleBare	117	144	171	189	160	208	–	307	–	–
	FemBare	126	122	179	166	188	178	256	–	–	–
	LycraBlue	–	–	396	–	–	–	–	–	–	–
	LycraGray	–	–	–	410	–	–	–	–	–	–

The photographs of each attire type can be viewed in Appendix 1 – Survey images.

We applied a Bradley Terry model to these results to determine the probabilities of respondents selecting a particular image as being less human, using the FemBare image as the reference category. The output from this model is plotted in Fig. 3 (and tabled in Appendix 2 – Additional results, Table 6). The model is statistically significant with a stronger fit than the null model (Chi-Squared Statistic = 2215.5, $p < 0.001$).

We hypothesised that the respondents would be more likely to identify the helmeted images as less human than non-helmeted images due to helmets obscuring the head and hair. While the results do demonstrate that the helmeted images are more likely to be selected as less human, the images with models wearing vests (and no headwear) were the most likely to be selected as less human. Additionally, the images with models wearing caps were less likely to be selected as less human compared to both the vest and helmeted images. These results suggest the respondents' preference was less related to obstruction of the head and hair by headwear, and more related to the presence of overt safety equipment.

Converting the model estimates to worth parameters (Strobl et al., 2011) enables a direct comparison of the how likely any one image is to be selected as less human over another (Table 4). These worth parameters have a range of 0 to 1 and their sum is forced to 1. The worth parameters show the respondents thought the helmeted images were approximately 2.5 times less human than the non-helmeted images, while the vested images were 3.7 times less human.

The results show the selections are associated with the difference in attire in each photo, rather than differences between the male and female models. Prior to commencing the comparison, respondents were asked to select which of the models (with no special attire and not holding a bicycle) appeared less human. This question was intended to determine if there was an overall bias towards one of the models over the other, finding a slight bias in favour of the female model (269 vs 294). This bias for the female model is seen

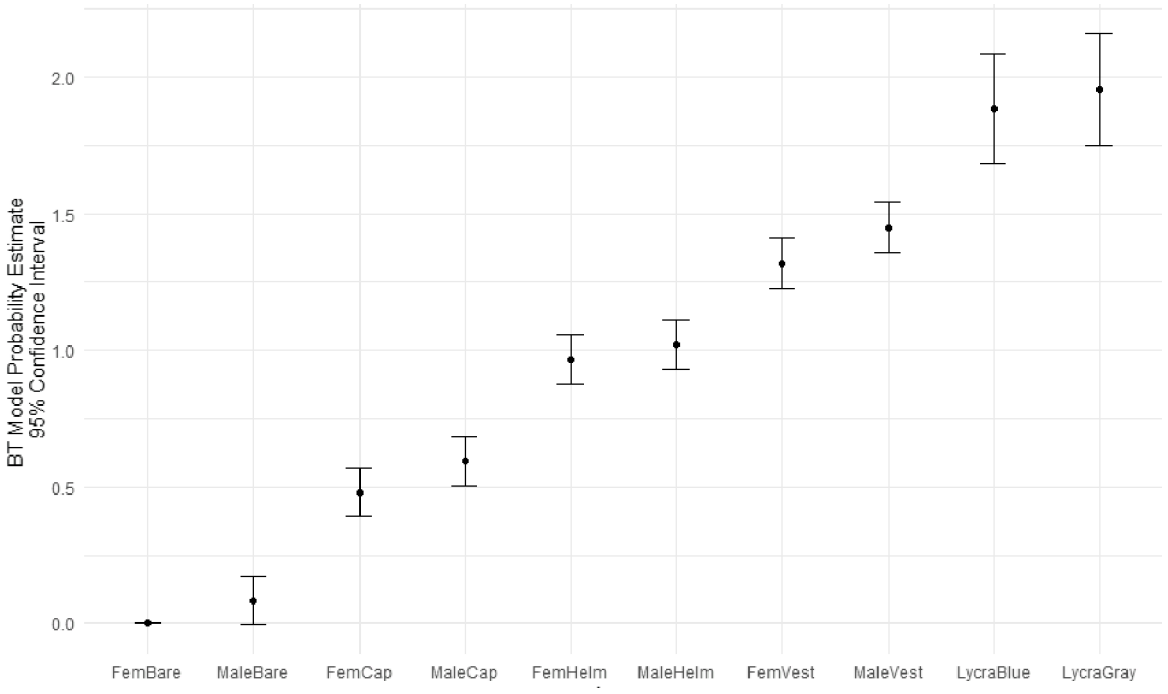


Fig. 3. Plot of BT Model Probability Estimates.

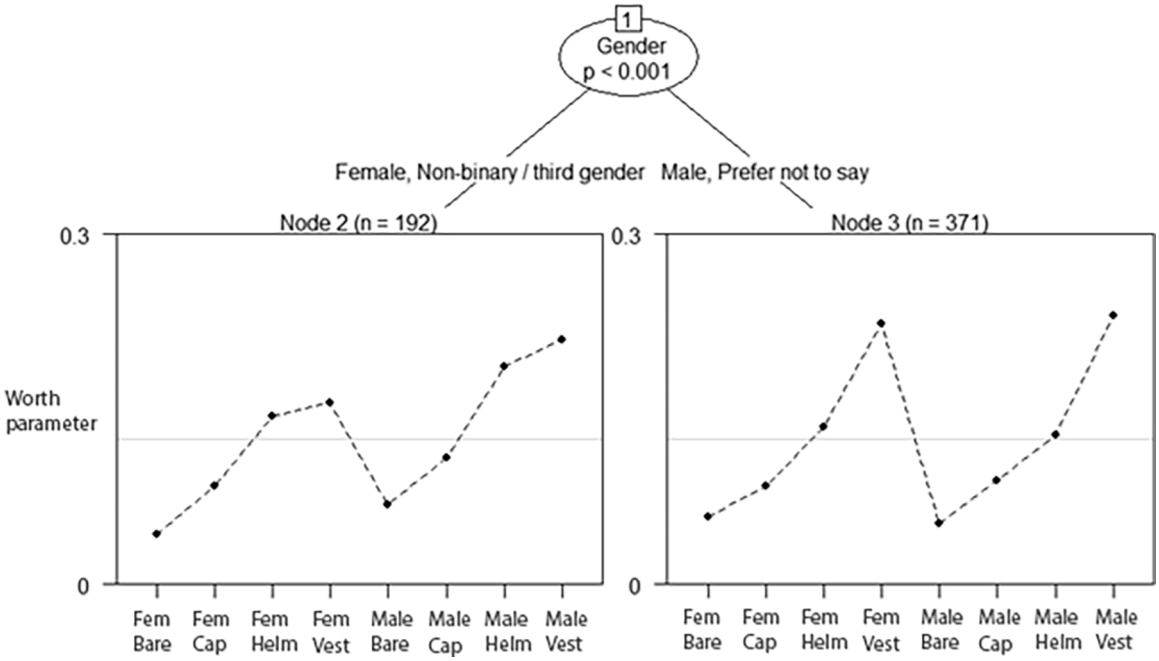


Fig. 4. Plot of worth parameters with the influence of respondent gender.

throughout the cyclist comparisons, however it is not statistically significant within each attire type. This indicates it was attire that was a key influence in the respondent's overall selections rather than differences between the models.

The comparisons also included two public domain images of sports cyclists wearing Lycra-like attire and helmets. These images were the most likely to be selected as less human overall, however as described earlier, they were not compared with all possible image combinations, and were instead included to assess whether there are grounds for further consideration of this form of attire.

Two hundred and seventy-three respondents failed to complete the forced choice photo comparison section of the survey. The results of the survey were remodelled to include these participants as a "worst-case" robustness test that allocated their responses as though they could not discern any difference between the images; splitting their choices evenly (rounded up) between each possible choice of photograph. Even with this data included, the model remained stronger than the null model (Chi-Squared Statistic = 1458.2, $p < 0.001$), with selections between the attire types continuing to show statistically significant differences in the same pattern as the main model (Appendix 2 – Additional results - Table 7 and Fig. 5).

Next, we added the respondent's covariates to the model to determine whether these characteristics were associated with photo selection choices. We used recursive partitioning (Strobl et al., 2011) to model variables for the respondents' blatant dehumanisation for cyclists (Fig. 1), their interactions with cyclists (Table 1), cycling frequency, their familiarity with cyclists, attitude to cycling safety equipment, driving frequency, driving experience, gender, income, age, parenthood status, employment status, and education level. Of these, only the respondent's gender showed a statistically significant association with photo selection. While the overall pattern of selections remained similar to the main model, women and nonbinary/third gendered respondents tended to consider the vested image slightly less human compared to the helmeted images, while men/non-specified respondents found a greater difference between the vested and helmeted image.[7]

These results are illustrated in the plot of the model's worth parameters in Fig. 4 (and tabled in Appendix 2 – Additional results, Table 8).

3.2.2. Dehumanisation scale results

Although not directly related to the research objective, we were interested to compare the results of our survey with those obtained by Delbosc et al. (2019). Our respondents had a similar distribution of responses but were overall less likely to consider cyclists less than fully human compared to the original study. We found approximately 30 % of our respondents gave a less than fully human rating compared to 37 % in the original study (Table 5).

When making these comparisons it is important to note that, like the Delbosc et al. (2019) study, we have not used a representative sample of the population, and differences in results could be due to the different compositions of our samples. For example, our respondents had a much higher proportion of weekly cyclists compared to the other study (72 % vs 32 %). We did however share a

[7] Note: The grouping of these gender categories is the result of the recursive partitioning method which allocates groups based on best fit.

Table 4
Estimate of worth parameters.

	FemBare	MaleBare	FemCap	MaleCap	FemHelm	MaleHelm	FemVest	MaleVest	LycraBlue	LycraGray
Estimate of worth parameter	0.031	0.033	0.05	0.056	0.081	0.085	0.115	0.131	0.202	0.216

statistically significant difference in blatant dehumanisation scores between cyclists and non-cyclists,[8] at similar proportions (28.5 % vs 30 % of cyclists considered cyclists less than fully human which increased to 50 % vs 55 % for non-cyclists). It would therefore be expected that the higher proportion of regular cyclists in our sample would result in lower overall dehumanisation scores.

We found weak negative correlations between the blatant dehumanisation scores and combined scores of self-reported aggression and harassment[9] as predicted by Delbosc et al. (2019) however we were unable to replicate their statistically significant results using our data in a negative binominal regression model using similar variables (Appendix Table 9).[10]

3.3. Qualitative results

Inductive thematic analysis of 194 qualitative responses found major themes primarily related to perceptions of humanness and the aspects from the photographs that influenced preference, and cyclist's perception of driver's behaviour based on appearance and gender. These themes provided insight into how respondents approached the task of discerning which model was less human, as well as providing some anecdotal support for the hypothesis.

Respondents discussed what they considered to be more/less human when judging the paired photos. Some equated the appearance of more skin with humanness, others equated athletic attire as a sign of health and fitness and therefore greater humanness, while others noted that the more safety gear a person wore, the less human they were perceived. Others found choosing between the male and female model to be difficult, also noting the disparity in appearance between the male and the female model impacted their perception of humanness.

Respondents who commented on cyclist's perception of driver behaviour based on appearance made comments supportive of some of the cited background literature, noting they felt they are treated differently by road uses depending on the attire they wear (with full cycling gear attracting more abuse than casual wear), and females perceiving less abuse from other road users. As one respondent noted: *"I find when I am… wearing shorts and shirt I am less likely to be targeted by motorists"*. Another purposefully highlighted their femininity to avoid aggression: "*I think as a female I don't get treated as badly as my male friends (who have had things thrown at them). I actually purposely have my long hair showing to help!*".

4. Discussion and conclusion

Our study found support for the hypothesis that people wearing bicycle helmets are perceived as less human compared to people without helmets. However, it did not support suggestions that dehumanisation of cyclists is due to helmets obscuring hair and facial features. The current study found that whilst obscuring a similar amount of hair and facial features, cyclists wearing caps were perceived as more human than those wearing helmets. Conversely, cyclists without helmets but wearing high visibility vests were more likely to be perceived as less human compared to all other attire types tested. This finding, and the overall trend of attributing less humanness to cyclists wearing safety attire, indicate the likelihood that safety attire itself may contribute to dehumanisation, rather than the obscuring of hair and facial features.

Explanations such as "othering" may be one possible reason for this result (Riggins, 1997). Activity specific items of clothing mark an individual as being more committed to a particular group. When that group is already considered in a negative way, as cyclists are (Basford et al., 2002; Fruhen & Flin, 2015; Johnson et al., 2014), the greater the overt expression of group membership through attire, the more likely the group's negative reputation may be assigned to that individual. This line of reasoning is consistent with research that has found that cyclists are 'othered' in a variety of ways including being portrayed as a minority group (Prati et al., 2017), an 'out group' (Aldred, 2013), being characterised as 'hazards' (Fevyer & Aldred, 2022), and being perceived as having lower social status than car drivers (Daley & Rissel, 2011). Correspondingly, research indicates that low status groups are dehumanised – viewed as less civilised and evolved than groups afforded a higher status (Bruneau et al., 2018).

Cyclists are vulnerable road users (Constant & Lagarde, 2010). Efforts to increase the uptake of cycling and decrease the incidence of injuries and fatalities of cyclists often focus on increasing the visibility of cyclists (e.g., through high visibility clothing) and protecting the cyclist's body (e.g., through introducing mandatory helmet laws). Research is mixed on the efficacy of these safety measures (Aldred & Woodcock, 2015; Kwan et al., 2006) while other research that indicates the use of such safety equipment acts as a deterrent to the uptake of cycling (Aldred & Woodcock, 2015). Our findings add to this growing research, suggesting that cyclists wearing safety attire, particularly high visibility vests, may be dehumanised more so than cyclists without safety attire. As dehumanisation has been

[8] Kruskal-Wallis H test: $\chi^2(1) = 16.018$, $p < 0.001$.
[9] Respectively: Spearman's rho – $r = -0.121$, $p < 0.01$ & $r = -0.182$, $p < 0.001$.
[10] This result should not be interpreted as an invalidation of their conclusions. There are key differences in sample compositions and survey designs which may contribute to the different results.

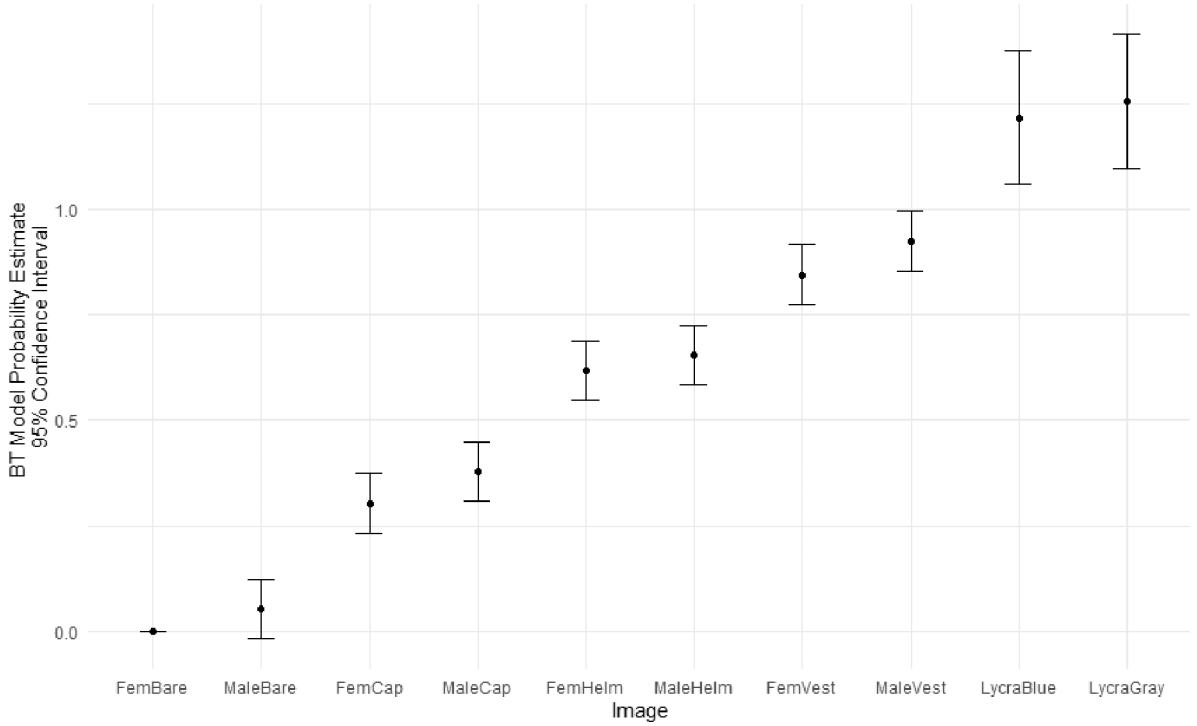


Fig. 5. Plot of BT Model Probability Estimates including a "worst-case" choice of respondents who did not complete the survey.

Table 1
Interactions with cyclists questions.

Have you ever:	
Shouted at a cyclist?	Yes/No
Made a rude gesture at a cyclist?	Yes/No
Used your car to deliberately block a cyclist?	Yes/No
Deliberately drove a car close to a cyclist?	Yes/No
Used your car to deliberately cut off a cyclist?	Yes/No
Thrown an object at a cyclist?	Yes/No

Table 5
Comparison of blatant dehumanisation results.

	Blatant dehumanisation scale results	Delbosc et. al (2019) Blatant dehumanisation scale (insectoid) results
0 % human	0.7 %	4 %
1–10 %	0.2 %	4 %
11–20 %	0.5 %	2 %
21–30 %	0.4 %	0 %
31–40 %	0.4 %	2 %
41–50 %	0.7 %	3 %
51–60 %	1.4 %	3 %
61–70 %	1.4 %	3 %
71–80 %	3 %	5 %
81–90 %	7.5 %	6 %
91–99 %	13.7 %	6 %
100 % human	70.2 %	63 %
Average	93.6	83.6
n	563	222

found to be predictive of hostile and aggressive behaviour (Kteily & Landry, 2022), our finding highlights a potential conflict around the perception and utility of safety gear such as high visibility vests; although designed for safety, they may inadvertently increase levels of hostility and aggression toward this group of vulnerable road users.

While many of our respondents noted concerns when comparing the different models and how physical differences between the man and woman model altered their preference, the overall results presented limited evidence of this view beyond a slight preference for the female model, with the type of attire generating a consistent pattern of preferences regardless of the model. Instead, the gender of the respondent themselves had the greater impact on the results. In this study, men were less likely to note differences between the models, while women displayed a stronger preference for the female model. While the general order of preference from non-helmet (most human) through to safety-vest (least human) was consistent between both men and women, men found the difference between the helmeted models and the vested models to be much greater compared to the women respondents (Fig. 4). One possible explanation for this may relate to the differing levels of risk aversion commonly observed between men and women (Eckel & Grossman, 2008), whereby men's high risk tolerance may result in them perceiving those taking more "extreme" safety mitigations, to be less human than those who do not.

We must also acknowledge the possibility that this study was assessing a selection preference other than dehumanisation. While each comparison asked the respondent to choose the image they felt looked less human, the forced choice approach may have led to the respondents making their selection based on some other consideration. The results are clear that the respondents were indicating *a* preference for the different attire types (we would observe a more random pattern in the results if this did not exist), but there is a possibility that the observed pattern in selections is a matter of more general aesthetics or some other aspect, rather than dehumanisation as asked. The other key limitation of the forced comparison approach is that it can only indicate the probability of a picture being selected over another, and not the strength of that preference and whether it may influence actual changes in behaviour or actual choices.

These limitations should be kept in mind when considering the policy implications of the study. The topic of whether bicycle helmets ought to be worn or their use mandated for example, is highly controversial and generates strong emotional responses from individuals and groups advocating mandatory/voluntary helmet positions (Network, 2018). While our study shows that the respondents found safety attire such as helmets to be less human than bare heads, we caution against using these results, at this stage, to support a position that measures such as mandatory bicycle helmet laws reduce ridership due to dehumanisation.

None the less, our study does contribute to ongoing research into the effects of cyclist appearance and attire. We find support for the notion that cycling attire has an influence on perceptions of cyclists. The higher perception of humanisation of people wearing less safety equipment aligns with the results of previous observational studies of driving behaviour (Walker & Robinson, 2019; Walker, 2007) and was echoed in some of the qualitative responses about cyclist's perception of driver's behaviour based on appearance and gender. If perceptions on safety equipment are in fact contributing to the dehumanisation of cyclists, and the dehumanisation in turn contributes to increased levels of aggressive behaviour from drivers (Delbosc et al., 2019), then there are possible implications for both public safety and the wider adoption of healthy, carbon neutral, active transportation modes like cycling.

The pilot study approach used here, and in the study by Delbosc et al. (2019), provide a strong indication that dehumanisation may be an important lens through which to consider cycling issues. We therefore reiterate their call to confirm these findings with approaches drawing from randomised, representative samples of the population to resolve potential sampling bias. Expanding the paired comparison method to other combinations of attire types may also prove of interest. The partial inclusion of the Lycra clad models in our comparisons for example, suggests that sports cycling attire may strongly contribute to perceptions of dehumanisation. Further comparisons could also resolve potential issues related to the types of attire compared such as whether the cyclist without a vest appears less human because of the vest, or because of the lack of a helmet.

The agreement on the different levels of dehumanisation observed between cyclists and non-cyclists in both this and the Delbosc et al. (2019) study would also be of interest to explore. Would places with more cyclists see reduced levels of dehumanisation, or is there something more complex at play where the answer varies based on the broader opinion of cyclists as a group in that location? Would the sense of dehumanisation from safety equipment increase or decrease depending on the type of attire typically worn by cyclists in that location? Gathering the attitudes of residents in countries such as The Netherlands and Denmark, where there are high levels of commuter cyclists who predominantly wear everyday clothes and no safety equipment, would be ideal for such comparisons. It would also be valuable to attempt to measure the relative strength of cycling and attire-based dehumanisation. The use of brain imaging methods (Harris & Fiske, 2006, 2009) may be of value here should the dehumanisation of cyclists be the result of implicit biases that are difficult to identify using traditional forms of survey. Such approaches may also assist with avoiding priming of respondents through surveys that necessarily introduce dehumanisation in their questions.

The above lines of inquiry would be valuable to build on the results of preliminary studies on cyclist dehumanisation such as ours, and to better understand the extent, implications, and reasons for negative attitudes towards cycling.

CRediT authorship contribution statement

Mark Limb: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Sarah Collyer:** Conceptualization, Formal analysis, Investigation, Methodology, Investigation, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

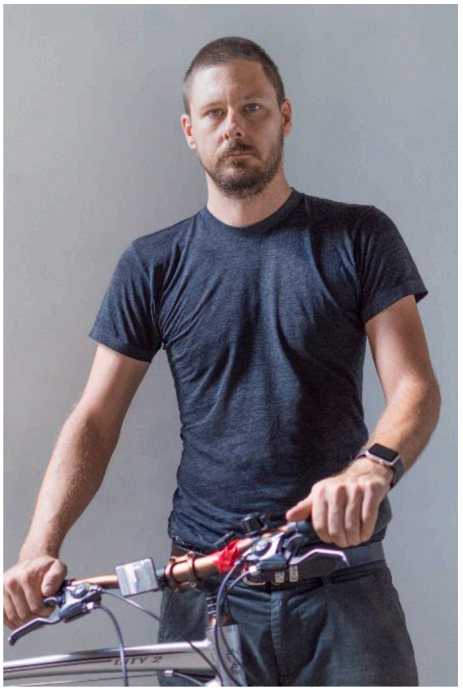
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

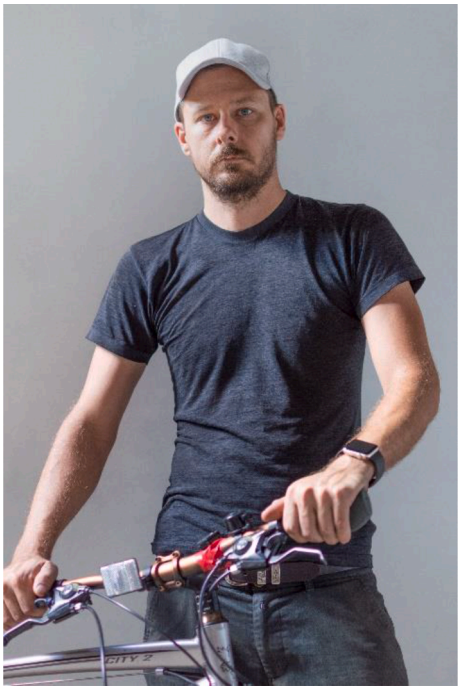
Appendix 1. Survey images

FemBare



MaleBare

FemCap



MaleCap

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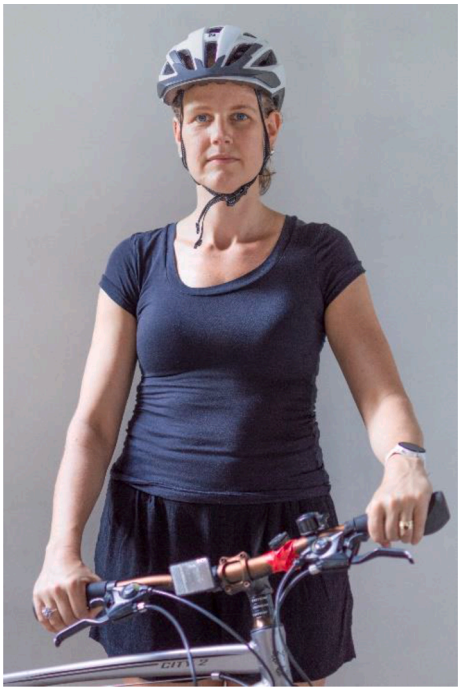
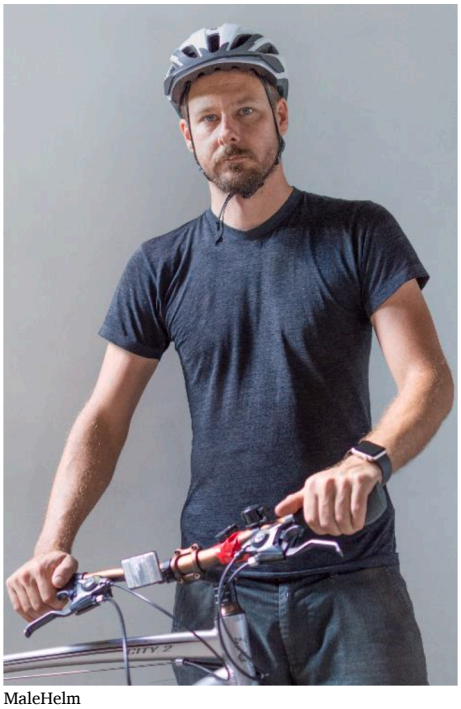
(*continued*)



FemHelm



MaleHelm

FemVest

MaleVest

(*continued on next page*)

(*continued*)

LycraBlue

LycraGray

Appendix 2. Additional results

Table 6
Coefficients from the Bradley Terry model.

	Estimate	Std. Error	z value	Pr(>|z|)
MaleBare	0.085	0.046	1.851	0.064
MaleCap	0.595	0.045	13.183	0.000
MaleHelm	1.021	0.046	22.339	0.000
FemCap	0.481	0.045	10.668	0.000
FemHelm	0.967	0.046	21.208	0.000
FemVest	1.319	0.047	28.246	0.000
MaleVest	1.448	0.047	30.609	0.000
LycraBlue	1.884	0.103	18.302	0.000
LycraGray	1.952	0.105	18.570	0.000

Null deviance: 2317.1 on 30 degrees of freedom
Residual deviance: 101.6 on 21 degrees of freedom
AIC: 318.75

Table 7
Coefficients from the Bradley Terry model including a "worst-case" choice of respondents who did not complete the survey.

	Estimate	Std. Error	z value	Pr(>|z|)
MaleBare	0.052	0.036	1.453	0.146
MaleCap	0.377	0.036	10.589	0.000
MaleHelm	0.654	0.036	18.259	0.000
FemCap	0.304	0.036	8.526	0.000
FemHelm	0.619	0.036	17.299	0.000
FemVest	0.844	0.036	23.332	0.000
MaleVest	0.924	0.036	25.394	0.000
LycraBlue	1.217	0.080	15.139	0.000
LycraGray	1.255	0.081	15.483	0.000

(*continued on next page*)

Table 7 (*continued*)

	Estimate	Std. Error	z value	Pr(>|z|)
Null deviance: 1531.4 on 30 degrees of freedom Residual deviance: 73.2 on 21 degrees of freedom AIC: 304.65				

Table 8
Worth parameters from Bradley Terry model with the influence of gender.

	Female-Bare	Male-Bare	Female-Cap	Male-Cap	Female-Helmet	Male-Helmet	Female-Vest	Male-Vest
Node 2 (Women/non binary)	0.043	0.068	0.085	0.109	0.144	0.186	0.155	0.210
Node 3 (Men/not stated)	0.058	0.052	0.085	0.089	0.135	0.128	0.223	0.231

Table 9
Negative binomial regression model results following Delbosc et. al. (2019).

Variable	β	Std. Error	z value	Exp(β)	95 % Lower CI	95 % Upper CI	Pr(>|z|)
Intercept	1.41	0.07	21.5	4.11	3.61	4.67	0
Dehumanisation scale:							
89 % or less	0.03	0.06	0.56	1.03	0.92	1.16	0.57
90 % or more*							
Gender:							
Male	0.02	0.05	0.4	1.02	0.93	1.12	0.69
Female*							
Frequency of cycling							
Less than weekly cyclist	−0.02	0.08	−0.25	0.98	0.84	1.15	0.8
Weekly Cyclist	−0.03	0.07	−0.45	0.97	0.85	1.11	0.65
Non-cyclist*							

* Reference category.

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