

CAR DRIVER ATTITUDES TOWARDS CYCLISTS

1 **The factors shaping car drivers' attitudes towards cyclist and their impact on behaviour**

2 **Abstract**

3 Cycling for transportation has multiple benefits to both individuals and societies. However, in
4 many countries, cycling rates are very low. One major deterrent is hostile or aggressive behaviours
5 directed towards cyclists. Past research has established that negative attitudes towards cyclist are a
6 major driver of aggressive behaviour. However, the attitudinal roots that motivate these negative
7 attitudes are currently not well understood. This study investigates to what extent negative attitudes
8 towards cyclists are rooted in a sense of attachment to cars and environmental attitudes.
9 Furthermore, the study examines whether the distinctiveness of group-membership of cyclists, as
10 signalled by cycling attire, influences the link between attitudes and aggressive behaviours directed
11 at cyclists. An online survey of 308 car drivers measured automobility and environmental attitudes,
12 attitudes towards cyclist, and aggressive behaviour addressed at two groups of cyclists (lycra-clad or
13 casually dressed cyclists). Hierarchical regression analyses showed that automobility, but not
14 environmental attitudes, were associated with negative car driver attitudes towards cyclists. A
15 significant link between negative attitudes towards cyclists and aggressive behaviour addressed at
16 cyclists was not moderated by the type of cyclist shown. These findings provide a more refined
17 understanding of the basis in which negative attitudes towards cyclists are rooted and how they
18 affect driver behaviour. This research may inform campaigns and initiatives aimed at changing
19 attitudes towards cyclists.

20 **Keywords**

21 Automobility; environment; cycling; attitudes; aggressive behaviour; cyclist-driver interactions

22

23 **The factors shaping car drivers' attitudes towards cyclist and their impact on behaviour**

24 Cycling for transportation has a number of economic, environmental and societal benefits. It is
25 a sustainable means of transport that reduces congestion and pollution in cities, it has relatively low
26 costs of infrastructure, and is associated with improvements in physical and mental health among
27 the public. (e.g. Celis-Morales, Lyall, Welsh et al, 2017; de Hartog, Boogaard, Nijland & Hoek, 2010;
28 Oja, Titze, Bauman, de Geus, et al 2011). Yet, in many countries, cycling rates are low (Horton, Cox &
29 Rosen, 2007). For instance, only 8% of EU citizens reported cycling as their most common mode of
30 daily transport (European Commission, 2013). In North America, only around 1% of all trips are made
31 using a bike (Pucher, Buehler, & Seinen, 2011). Similarly, in Australia, where this study is based,
32 15.5% of the population report cycling in a typical week, a number that has significantly decreased
33 since 2011 (Austroads, 2017).

34 Cycling as a low-emission transportation option (Oja et al, 2011; Mulley, Tyson, McCue, et al,
35 2013) is a real alternative to other forms of transport, particularly in urban areas, and can help
36 address some of the issues that have emerged as a result of increased traffic density and pollution
37 (e.g. pollution, congestion; Cohen, Anderson, Ostro et al, 2005; Kunzli, Kaiser, Medina, & Studnicka,
38 2000). In fact, the impact of traffic related air pollution has been linked with mortality (Hoek,
39 Brunekreef, Goldbohm, Fischer, & van den Brandt, 2002). Therefore, increasing cycling rates should
40 be a priority, and understanding the barriers to cycling is an essential first step.

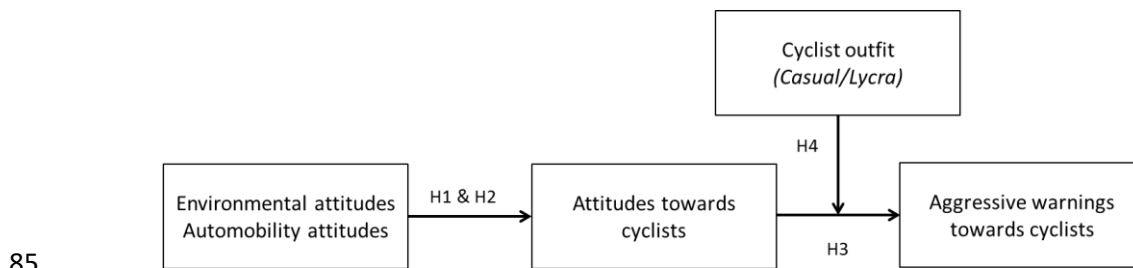
41 Low rates of cycling have been attributed to the risks associated with using bicycles on the
42 roads. Indeed, in Australia, cyclists comprise 3% of all road fatalities and 15% of road-user
43 hospitalisations. Notably, around 85% of the cyclist casualty crashes reported by the Australian
44 Government Department of Infrastructure and Regional Development (2015) involved another
45 vehicle (mostly cars). Moreover, near miss research examining incidents that resulted in no injuries
46 illustrates that cyclists often experience dangerous passes, or being blocked by motorists (Aldred,
47 2016). Next to the actual risks associated with cycling, subjectively perceived risk, derived from

48 accidents and near misses, is also an important factor that contributes to reluctance to use bicycles
49 as a mode of transport (Chataway, Kaplan, Nielsen, & Prato, 2014; Garrard, Greaves, Ellison, 2010;
50 Gatersleben & Appleton, 2007; Horton, 2007; Joshi, Senior & Smith, 2001; Sanders, 2015). That is,
51 simply the fear of sharing the roads with motorists prevents a large number of people from cycling
52 (RAC, 2015). Many people cite traffic and safety concerns as major barriers to cycling. Furthermore,
53 hostile motorist behaviour in the form of harassment or aggressive treatment of cyclists can also
54 contribute to perceived risks and reluctance to cycle. For example, in a survey of Australian cyclists,
55 most of the respondents reported that they had experienced harassment of some form from drivers
56 (Heesch, Sahlqvist & Garrard, 2011).

57 A growing body of research has examined the attitudes that drivers hold towards cyclists and
58 whether these attitudes influence their behaviour towards cyclists. Studies have shown that a
59 significant number of car drivers hold negative attitudes towards cyclists (Basford, Reid, Lester, et
60 al., 2002; Johnson, Oxley, Newstead, & Charlton, 2014; Thørrisen, 2013). Specifically, they consider
61 themselves to be distinct and different from cyclists (Gatersleben & Haddad, 2010), perceive cyclists
62 as a minority, or outgroup (Horton, 2007; Basford et al, 2002). Further a significant proportion of
63 drivers do not believe that cyclists should be on the roads at all, and driver knowledge has been
64 shown to be linked to such attitudes (Rissel, Campbell, Ashley & Jackson, 2002). Importantly, this
65 line of research has established that car drivers' negative attitudes towards cyclists are associated
66 with aggressive behaviour directed at cyclists (Fruhen & Flin, 2015; Thørrisen, 2013). While this
67 research is an important first step in understanding the nature of hostile behaviour directed at
68 cyclists, it is critical to also examine the more distal causes of these attitudes and behaviours, in
69 order to know how to effectively shift car driver attitudes and aggressive behaviour towards cyclists.

70 Accordingly, this study investigates the attitudinal antecedents of negative car driver attitudes
71 towards cyclists and generates more detailed insights into the link between negative driver attitudes
72 towards cyclists and aggressive behaviour directed at cyclists. It is also the first to examine this link

73 in an Australian setting. Specifically, the aims of this study are threefold. First, we investigate the
 74 extent to which attitudes towards cyclists are associated with beliefs about the role of cars in
 75 societies (i.e. pro-automobility attitudes) and endorsement of an environmental worldview (i.e.
 76 attitudes towards the environment). Second, as a point of replication, we test the link between
 77 negative attitudes towards cyclists and (self-reported) aggressive behaviours that car drivers show
 78 towards cyclists. This relationship has been demonstrated by previous studies that were conducted
 79 in Europe (Fruhen & Flin, 2015; Thørrisen, 2013); however, our study tests this relationship in the
 80 Australian context. Doing so allows insight into the robustness of this effect and its generalisability
 81 across different national contexts. Third, this study extends previous research showing a link
 82 between car driver attitudes and aggressive behaviour by considering the extent to which the
 83 influence of attitudes towards cyclists on driver behaviour is affected by the attire that cyclists wear
 84 (casual or lycra). The links tested in this study are summarised in Figure 1.



85
86 **Figure 1**

87 *Model of attitudes and driver behaviour towards cyclists*

88 **1.1 Antecedents of attitudes towards cyclists**

89 In this paper, we draw on the theory of planned behaviour proposed by Ajzen and Fishbein
 90 (1980) which posits that attitudes, social norms and perceived behavioural control influence
 91 behaviour. We focus specifically on the attitudes that may drive behaviour towards cyclists.
 92 Attitudes describe a “relatively enduring tendency to respond to someone or something in a way
 93 that reflects a positive or negative evaluation of that person or thing” (Manstead, 1996, p. 3). Within

94 the theory of planned behaviour, it is suggested that the more specific attitudes are to a given
95 behaviour or a target, the more likely they are to affect that behaviour. Thus, more general
96 worldviews that are not necessarily directly relevant to cycling are not very likely to inform
97 behaviours towards cyclists directly. However, they can indirectly affect behaviours via attitudes that
98 are more specific to the targeted behaviour, which will then in turn influence the behaviour. That is,
99 in order for those distal attitudes to affect the specific attitude they need to be distinct, yet related
100 to the specific attitude. We focus on automobility attitudes and environmental attitudes as
101 antecedents of negative attitudes towards cyclists. We argue that these attitudes are not specific to
102 cycling per se, but may represent important belief systems that potentially motivate negative
103 attitudes towards cyclists that sit within the domains of cyclists and car drivers. . We also
104 acknowledge that there are other attitudes that may be relevant to the issues addressed in this
105 paper (e.g. physical exercise; Aldred, 2013), which were beyond the scope of this paper. While the
106 link between views on cycling and these two groups of attitudes has been discussed and speculated
107 about in other research, this association has so far not been tested empirically (Skinner & Rosen,
108 2007).

109 As suggested above, we propose that one group of attitudes that may be distinct, yet related
110 to attitudes towards cyclists is people's views about the role of cars in our society. Research in this
111 area has conceptualised automobility attitudes as the personal importance that individuals place on
112 their ability to travel with cars and the social relations that people have with cars that move beyond
113 the traditional factors considered in travel analysis (Polk, 2003). These attitudes tap into what the
114 car means symbolically and socially to individuals. These views may be common because modern
115 societies have thrived on automobility, are built around it and have accepted automobility as a
116 necessity (Wells & Beynon, 2011). Beyond the practicalities of the car's ability to mobilise people, it
117 has also been described as a culturally charged symbol (Canzler & Knie, 2016), about which
118 individuals hold powerful emotive views (Sheller, 2004). The car confers social meaning, and is seen
119 as a manifestation of individual freedom (Wells & Beynon, 2011). In fact, research shows that even

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120 children as young as 9-11 years of age form cultural associations about cars and can become 'car
121 cultured' in their perceptions and attitudes (Baslington, 2009).

122 The extent to which drivers hold positive views towards automobility is likely to inform their
123 attitudes towards cyclists. Those holding more positive views towards automobility, including its part
124 in society, the benefits of car use, as well as low perceptions of negative aspects related to
125 automobility, may perceive cyclists as a distinct group that is a threat to car users. Car drivers have
126 been found to perceive cyclists as getting in the way of cars when on the roads (Basford et al, 2002).
127 The link between automobility attitudes and negative attitudes towards cyclist may be based on
128 increased perceptions of cyclists as infringing into a space that should be reserved for cars (i.e. the
129 roads). More generally, those who are more attached to the car as a principle may have stronger
130 perceptions of an "us vs them" divide between car drivers and cyclists, which could reinforce
131 negative attitudes towards cyclists. Thus, we hypothesise:

132 **H1:** Automobility attitudes are positively linked with negative attitudes towards cyclists

133 Environmental beliefs are another major group of attitudes that we propose may be related
134 to, yet distinct from, car driver attitudes towards cyclists. Environmental attitudes have been
135 defined by Hawcroft and Milfont (2010) as "a psychological tendency expressed by evaluating the
136 natural environment with some degree of favour or disfavour" (p. 143). Research shows that cyclists
137 in Australia themselves construe cycling to be a "green" activity (Daley & Rissel, 2011). Furthermore,
138 increasing cycling rates is often framed as an environmental initiative. Indeed, a literature review by
139 Yang, Sahlqvist, McMinn, Griffin and Ogilvie (2010) showed that interventions designed to promote
140 cycling could be predominantly classified as emphasising cycling as environmentally friendly. In
141 many ways, cycling is the poster-child of sustainable transport as it is often identified and promoted
142 as beneficial for the environment by governments, environmentalists and cycling advocates (Cupples
143 & Ridley, 2008; Parkin, Ryley & Jones, 2007). Based on the premise that cycling is an environmentally
144 friendly activity, it is likely that an association between environmental attitudes and positive

145 attitudes toward cyclists exists. Because cycling may be construed as an environmentally motivated
146 behaviour, car drivers with more favourable attitudes towards the environment are less likely to also
147 hold negative views towards cyclists. Accordingly, we hypothesise:

148 **H2:** Environmental attitudes are negatively linked with negative attitudes towards cyclists

149 **1.2 Attitudes towards cyclists and aggressive behaviour towards cyclists in car drivers**

150 The theory of planned behaviour stipulates that attitudes affect behaviour (Fishbein & Ajzen,
151 1980) and previous research typically shows this link be of medium effect size (as shown in a meta-
152 analysis by Cooke and Sheeran, 2004). More specifically, previous research also reports a link
153 between car driver attitudes and behaviour towards cyclists. For example, Johnson et al. (2014)
154 demonstrated that more positive attitudes towards cyclists are related to safe driving when turning
155 left and crossing the path of a cyclist (based on self-reports). They also observed that car drivers
156 experienced frustration with repeatedly having to overtake cyclists on the roads in Australia.
157 Further, De Angelis, Puchades, Fraboni et al. (2017) reported that drivers with more positive
158 attitudes towards cyclists show higher levels of acceptance of an in-car cyclist detection system. In
159 this study, we seek to replicate the link between car driver attitudes and aggressive driving
160 behaviour towards cyclists.

161 Previous research into car drivers' aggressive behaviour towards cyclists has identified that
162 this behaviour towards cyclists is best represented and captured via aggressive warning (i.e. minor
163 aggressive behaviour, such as honking horn, hand gestures, cutting up), rather than hostile
164 aggression (i.e. ramming, physically attacking; Fruhen & Flin, 2015, based on Özkan & Lajunen,
165 2005). Accordingly, our study focuses on aggressive warnings towards cyclists and tests this
166 association in the Australian context. Testing the link between attitudes towards cyclists and
167 aggressive behaviour towards cyclists in this study represents a replication of previous research
168 conducted in the European context. The context in which cycling occurs has been described as

169 determined by history, culture, topography and climate, as well as government policies, including
170 transport policies, land-use policies, urban development policies, housing policies, environmental
171 policies, taxation policies and parking policies (Pucher & Buehler, 2008). Australia is generally classed
172 as a country of low cycling frequency (Pucher & Buehler, 2008), and will have its own context in
173 which cycling occurs. The current study, therefore, identifies whether the link between driver
174 attitudes towards cyclists and their behaviour towards cyclists is consistent across different national
175 contexts, which can illustrate the robustness of this effect.

176 **H3:** Negative attitudes towards cyclists are related to more aggressive driving behaviour
177 towards cyclists

178 **1.3 The role of cyclists' attire in the link between negative attitudes and aggressive behaviour**
179 **towards cyclists**

180 Previous research into the interaction of car drivers and cyclists on the roads suggest that the
181 type of attire that cyclists wear may be a factor that shapes these interactions. For example, studies
182 have shown that drivers exhibit different behaviours towards cyclists who wear helmets compared
183 to those who do not wear helmets (Basford et al, 2002; Walker, 2007). Aside from helmets, which
184 are mandatory in Australia where the current study is set, there are other distinguishing features
185 that set different types of cyclists apart, namely the attire that they wear. In particular, there are
186 two groups of cyclists that can be distinguished based on their type of outfit: whether they wear a
187 full cyclist outfit, often referred as a lycra outfit, or casual clothes that they would wear in any other
188 context (see Gatersleben and Haddad (2010) for commonly held stereotypes around cyclists outfits).
189 A study conducted by Walker, Garrard and Jowitt (2014) found no difference in overtaking behaviour
190 by drivers who encounter cyclists wearing these two types of outfits. As noted by Walker et al (2014)
191 their study only considered overtaking behaviour, however effects on other types of behaviour may
192 still occur. In our study, our aim is not to explore the main effect of cyclist outfit on the driver
193 behaviour per se, but rather to examine whether the type of outfit that a cyclist wears affects the

194 extent to which attitudes towards cyclists are associated with aggressive driving behaviour. We base
195 this proposition on stereotype activation theories (Dijksterhuis, 2001). Stereotype activation is
196 thought to be based on the “increased accessibility of the constellation of attributes that are
197 believed to characterise members of a given social class” (p. 797; Wheeler & Petty, 2001).

198 Lepore and Brown (1997) suggest that people with different attitudes would respond
199 differently to the same stereotype activator. Following their argument we propose that the
200 activation of a stereotype, depending on the type of cyclists that drivers encounter, will influence
201 the extent to which driver attitudes affect their behaviour. Basford et al (2002) found that cyclists
202 are perceived as a distinctive social group by car drivers. Further, Aldred (2013) reports that the type
203 of attire, in particular lycra, is referred to by cyclists when constructing their own identities and that
204 it has an identity signalling function. In line with Aldred’s findings around stigma, both types of
205 outfits may represent varying degrees of sportiness as well as competence in cyclists, thus
206 contributing to different reactions by car drivers based on their attitudes towards cyclists. Further,
207 Daley and Rissel (2011) have found that cyclists themselves see lycra as both indicating positive and
208 negative attributes of cyclists (e.g. competence vs “bike nut” status).

209 Given that cyclists themselves see a distinction between lycra and casually dressed cyclists, it
210 is likely that a similar effect occurs in car drivers. In particular, cyclists who wear different types of
211 outfit are likely to more or less clearly indicate group belongingness to “the cyclists”, thereby
212 activating varying levels of stereotypes. A cyclist wearing a professional cycling outfit (i.e. lycra) is
213 likely to be a stronger representation of “the cyclists”, compared to someone who cycles while
214 wearing an outfit that could be worn in a range of other contexts (i.e. casual). Drivers who hold
215 strong negative attitudes towards cyclists may be more inclined to act aggressively towards cyclists
216 wearing a lycra outfit than a casual outfit, as this will be a stronger trigger for the stereotype.
217 Accordingly, we hypothesise:

218 **H4:** The link between cycling attitudes and aggressive behaviour towards cyclists is moderated by
219 the attire worn by cyclists such that negative cycling attitudes will have a stronger link with
220 aggressive warnings for cyclists wearing lycra, compared to casual clothes.

221 **2. Method**

222 **2.1 Sample**

223 Participants completed a survey that was hosted on a university server and website. The study
224 was advertised in a newspaper article published in a state-wide media outlet and accessed via a
225 Western Australian university website ([http://crowdresearch.uwa.edu.au/project/evaluating-
226 drivers-attitudes-towards-cyclists-wa/](http://crowdresearch.uwa.edu.au/project/evaluating-drivers-attitudes-towards-cyclists-wa/)). A total of 403 individuals responded to the survey, however
227 only 308 actually completed it. Men ($n=154$) and women ($n=148$) were equally represented in the
228 sample (6 participants preferred not to indicate their gender). Participant's age ranged from 18 years
229 to 89 years ($M = 44.33$; $sd = 14.01$). All but five participants indicated that they live in Australia, and
230 the analysis only included those living in Australia. Further, all but one participant indicated they
231 hold a driving license and this participant was excluded from the analysis as our study investigates
232 attitudes in car drivers and not the general population (resulting in a final $n = 302$). Length of license
233 held ranged from 1 year to 66 years, with a mean length of 25.71 years ($sd = 13.92$). The majority of
234 participants reported they have regularly ridden a bicycle on the road since the age of 12 ($n=217$;
235 70.5%), however only a quarter ($n = 79$; 25.6%) indicated they had done so in the past 12 months. It
236 should be noted that the cycling frequency of our sample was lower than the frequency identified in
237 the 2011 Australian national cycling participation survey in which 39.6% reported to have cycled in
238 the last 12 months (Austroads, 2011). It is possible that this difference occurred because our sample
239 was limited to car drivers.

240 **2.2 Measures**

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241 **Attitudes towards cyclists** were measured using the attitudes towards cyclists scale developed
242 by Rissel et al. (2002). The scale consists of ten items (example item: It is very frustrating sharing the
243 road with cyclists). The Likert scale ranged from 1 = strongly disagree to 5 = strongly agree, so that a
244 higher score represented more negative attitudes towards cyclists. Cronbach's alpha for this scale
245 was $\alpha = .87$ and a sum score across all items was computed.

246 **Attitudes towards automobility** were measured via a scale by Polk (2003). Participants
247 responded to the eight items on a Likert scale ranging from 1 = strongly disagree to 7 = strongly
248 agree (higher scores indicating more positive attitudes towards auto-mobility). An example item is:
249 to have a car is a right. Cronbach's alpha for this scale was $\alpha = .77$ and a mean score across all items
250 was computed.

251 **Environmental attitudes** were assessed using the environmental actions and attitudes scale
252 developed by Hawcroft and Milfont (2010; example item: humans are severely abusing the
253 environment). The scale consists of 15 items to which participants responded using a Likert scale
254 ranging from 1 = strongly disagree to 7 = strongly agree. This scale's Cronbach's alpha was $\alpha = .88$
255 and a mean score across all items was calculated.

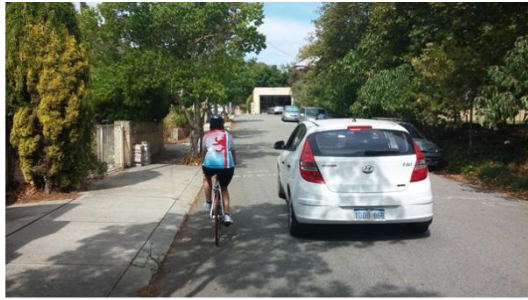
256 **Aggressive driving behaviour towards cyclists** was measured with a modified version of the
257 aggressive warnings subscale of the DAIS (Driver Anger Indicator Scale; Ozkan & Lajunen, 2005) that
258 had previously been used and refined to measure behaviour towards cyclists by Fruhen and Flin
259 (2015). The scale contained six items to which participants responded on a scale from 1 to 5 (ranging
260 from never to very often; example item: swore/verbally abused). Cronbach's alpha for this scale was
261 $\alpha = .72$.

262 **Prompting of cyclists' outfit** was elicited by instructing participants to report their aggressive
263 driving behaviour in reference to a picture that was included in the survey and showed cyclists with
264 two types of outfit (see Figure 2 below; between subject design). The pictures either showed a

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265 casually dressed cyclists, or a cyclist dressed in lycra (for both conditions pictures of men and women
266 were included). The type of cyclist that participants were shown was assigned at random ($n = 156$
267 were in the casual cyclist condition; $n = 151$ were in the lycra cyclist condition). To test whether the
268 different cyclists in the pictures were accurately perceived by participants, a manipulation check was
269 conducted. A sample of participants ($n = 9$, who were not part of the final sample in the study,
270 viewed the pictures showing the four types of cyclists and were instructed to identify whether the
271 cyclists they were shown were male, female, wearing lycra, or a casual outfit. Results showed that
272 the pictures could clearly be identified as showing the cyclists as intended. All participants'
273 responses were aligned with the type of cyclist that was shown (i.e. none of the participants
274 indicated the cyclists wearing lycra were to be casually dressed cyclists and vice versa (independent
275 of gender); the male cyclists were never perceived to be female and vice versa (independent of
276 outfit)), giving strong support to the effectiveness of the prompting. Although the manipulation
277 check indicated that the cyclists could clearly be distinguished, it should be noted that the data
278 collected in the main study indicated no difference in the level of aggressive behaviour depending on
279 the gender ($M_{\text{male}} = 1.09$; $sd = .26$; $M_{\text{female}} = 1.09$; $sd = .20$; $t(305) = .22$; $p = .82$), or outfit ($M_{\text{lycra}} =$
280 1.09 ; $sd = .18$; $M_{\text{casual}} = 1.08$; $sd = .27$; $t(305) = -.07$; $p = .95$) of the cyclists that were shown.

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Female Lycra



Male Casual



Male Lycra



Female Casual

281

282 **Figure 2**

283 *Pictures of cyclists – Lycra vs Casual*

284 **Demographic information** was also collected from the participants including age, gender and
285 their own cycling frequency during the past 12 months (ranging from 6 = every day to 1 = never;
286 Rissel et al, 2002).

287 **2.3 Analysis**

288 The Kolmogorov–Smirnov test indicated that only the responses to the attitudes towards
289 auto-mobility were normally distributed ($D(302) = 0.05; p > .05$). It should also be noted that the
290 residuals of our outcome measures (attitudes towards cyclists ($D(307) = .06; p < .05$; aggressive
291 driving towards cyclists $D(307) = .31; p < .001$) were also not normally distributed. Accordingly, the
292 data were analysed using non-parametric statistics, namely Kendall's tau to compute the
293 correlations and bootstrapped hierarchical regression analysis to test the hypotheses.

294 **3. Results**

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295 Correlation results shown in Table 1 indicated a link between aggressive driving behaviours
 296 and negative attitudes towards cyclists ($r = .22; p < .01$). Aggressive driving behaviours were also
 297 associated with automobility attitudes ($r = .09; p < .05$), but not environmental attitudes ($r = -.06; p >$
 298 $.05$). Further, attitudes towards cyclists were negatively linked with environmental attitudes ($r = -.13$
 299 $p < .01$), and positively linked with automobility attitudes ($r = .37; p < .01$). The cyclist outfit did
 300 not correlate with the level of aggressive warnings reported by car drivers ($r = -.03; p > .05$).

301 **Table 1**

302 *Correlations*

Variable	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
1. Age (in years)	44.43	14.04							
2. Gender	1.52	0.54	-.10*						
3. Cycling frequency	3.09	1.66	.01	-.21**					
4. Environmental attitudes	5.20	0.96	.01	.16**	.06				
5. Automobility attitudes	3.82	1.02	.15**	-.04	-.23**	-.31**			
6. <i>Negative</i> attitudes towards cyclists	35.13	10.78	.09*	.07	-.41**	-.13**	.37**		
7. Aggressive warnings	1.09	0.23	-.04	-.09	-.12*	-.06	.09*	.22**	
8. Cyclist outfit	0.49	0.50	.06	.05	.03	.02	.00	-.03	-.08

303 Note: ** $p < .01$; * $p < .05$; Cyclist outfit: 0 = causal; 1 = lycra

304 Next, regression analysis was carried out. To test the association of attitudes towards cyclists
 305 with automobility and environmental attitudes (hypotheses 1 and 2), we first entered the controls,
 306 namely age, gender and cycle frequency of the drivers. The controls explained 31% of the variance in
 307 attitudes towards cyclists, with cycling frequency having a significant link with attitudes towards
 308 cyclists ($\beta = -.55; p < .001$), indicating that those who cycle more frequently also have more positive
 309 attitudes towards cyclists.

310 **Table 2**

311 *Bootstrapped regression analysis of aggressive warnings towards cyclists on attitudes*

Variable	<i>B</i>	<i>SE B</i>	β	<i>R</i> ²	<i>CI</i> _{LL 95%}	<i>CI</i> _{UL 95%}
Hypothesis 1 & 2 (Outcome: Attitudes towards cyclists)						
Step 1						
Age	0.10	.04	.13		0.02	0.18
Gender	-1.29	1.01	-.06		-3.33	0.68
Cycling frequency	3.56	.32	-.55**	.312	2.87	4.24
Step 2						

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Age	.028	.04	.04		-0.05	0.11
Gender	-0.85	.94	-.04		-2.64	.902
Cycling frequency	2.75	.31	-.43**		2.13	3.40
Automobility attitudes	4.48	.56	.43**		3.18	5.63
Environmental attitudes	0.77	.56	.07	.435	-0.46	2.04
Hypothesis 3 (Outcome: Aggressive warnings towards cyclists)						
Step 1						
Age	0.00	.00	-.03		0.00	0.00
Gender	-0.08	.03	-.18		-0.14	-0.03
Cycling frequency	0.02	.01	-.16	.033	0.01	0.04
Step 2						
Age	0.00	.00	-.08		0.00	0.00
Gender	-0.07	.03	-.15		-0.12	-0.02
Cycling frequency	-0.01	.01	-.06		-0.03	.011
Attitudes towards cyclists	0.01	.00	.39**	.136	0.00	.014

312 Note: ** $p \leq .001$, gender is coded so that 1 = female, 2 = male, $F_{H1 \& H2} (5, 291) = 46.66, p < .001$; $F_{H3} (4, 292)$
 313 = 12.67, $p < .001$ (F is reported for Step 2 only), number of bootstrapped samples is 5000
 314

315 The addition of the automobility and environmental attitudes explained a further 12.3% of
 316 variance in the outcome. The results indicate that automobility attitudes ($\beta = .43; p < .001$), but not
 317 environmental attitudes ($\beta = .07; p > .05$) were significantly linked with attitudes towards cyclists.
 318 Accordingly, hypothesis 1 was supported, but hypothesis 2 was not confirmed.

319 Hypothesis 3 stated that negative attitudes towards cyclists relate to the tendency to show
 320 aggressive warnings towards cyclists. The regression analysis showed that after controlling for age,
 321 gender, as well as the drivers' cycling frequency in Step 1, negative attitudes towards cyclists were
 322 positively linked with the aggressive warnings ($\beta = .39, p < .001$). Accordingly, hypothesis 3 was
 323 supported.

324 Finally, to test the extent to which the association of attitudes towards cyclists with
 325 behaviours towards cyclists is affected by the type of outfit a cyclist wears, we conducted a
 326 moderation analysis (following Baron & Kenny, 1986).

327 **Table 3**
 328 *Bootstrapped regression analysis of the interaction of attitudes towards cyclists with cyclist outfit*

Variable	B	SE B	β	R^2	CI _{LL} 95%	CI _{UL} 95%
Hypothesis 4 (Outcome: Attitudes towards cyclists)						

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Step 1

Age	-.01	.01	-.03		-.03	.02
Gender	-.04	.01	-.18		-.07	-.02
Cycling frequency	.04	.01	-.16*	.033	-.06	-.01

Step 2

Age	-.02	.01	-.08		-.05	.01
Gender	-.04	.01	-.15*		-.06	-.01
Cycling frequency	.01	.02	.05		-.02	.04
Attitudes towards cyclists	.07	.02	.31**		.04	.11
Cyclist outfit	.01	.03	.02		-.04	.06
Attitudes towards cyclists *cyclist outfit	.03	.03	.10	.135	-.04	.11

329 Note: ** $p \leq .001$; * $p \leq .01$; Cyclist outfit: 0 = causal; 1 = lycra; $F_{H4}(6, 290) = 8.69$, $p < .001$; (F is reported
 330 for Step 2 only), number of bootstrapped samples is 5000; cyclist outfit: 0 = causal; 1 = lycra
 331

332 The results shown in Table 3 indicate that the link between attitudes towards cyclists and
 333 aggressive behaviour towards cyclists was not moderated by the type of outfit that the cyclists were
 334 wearing ($\beta = .10$, $p > .05$). Accordingly, hypothesis 4 was not supported. Overall, the findings suggest
 335 that negative attitudes towards cyclists are consistently related to car driver behaviour towards
 336 cyclists, independent of the type of cyclist that drivers encounter.

337 4. Discussion

338 This study investigated the link between automobility and environmental attitudes and car
 339 driver attitudes towards cyclists. It further tested the association between car driver attitudes
 340 towards cyclists and aggressive behaviour towards cyclists and whether this relationship would differ
 341 depending on the type of cyclist that car drivers encounter. The results indicated that positive
 342 attitudes towards automobility, but not pro-environmental attitudes were related to negative
 343 attitudes towards cyclists, thereby confirming hypothesis 1 but not hypothesis 2. This finding
 344 suggests that the importance and social value that drivers assign to the car (Polk, 2003) may
 345 enhance their tendency to see cyclists more negatively. Previous research indicates that drivers tend
 346 to generally perceive cyclist as an outgroup (Horton, 2007; Basford et al, 2002) and our findings
 347 illustrates that this tendency may be reinforced by a stronger attachment to the car. Aldred (2013)

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348 noted that cycling is viewed in comparison and competition of other motorised modes of transport,
349 and it appears that this competition is enhanced by higher levels of attachment to the car in drivers.

350 Environmental attitudes were not linked with attitudes towards cyclists. This finding
351 indicates that the environmentally friendly nature of cycling (Cupples & Ridley, 2008; Parkin, Ryley &
352 Jones, 2007), may not affect car driver attitudes towards cyclists on the road. It needs to be
353 considered that previous research supports a link between environmental attitudes with people's
354 own, and more general pro-environmental behaviours (including cycling, e.g. Bamberg & Moeser,
355 2007). Cyclists themselves most commonly report choosing to cycle because of enjoyment, fitness,
356 low cost and a range of other benefits, other than it being an environmental friendly activity
357 (Gattersleben & Appleton, 2007). Our results show that environmental attitudes are also not
358 associated with specific attitudes towards others that engage in environmentally friendly behaviour.
359 It needs to be considered that car drivers may not take into account that cycling is an environmental
360 friendly activity when thinking about cyclists on the roads and forming attitudes towards them. It is
361 possible that they do so as they are more likely to see cyclists more immediately in the context of
362 traffic and their interaction with them, rather than their wider implications for society and the
363 environment.

364 Further, our results showed an association between negative attitudes towards cyclist and
365 aggressive behaviour towards cyclists (in support of hypothesis 3). In doing so, the results replicate
366 previous findings obtained in the European context (Fruhen & Flin, 2015; Thørrisen, 2013) and
367 extend them to the Australian context. Considered in the context of previous research showing that
368 a large number of car drivers hold negative attitudes towards cyclists (Basford et al., 2002; Johnson,
369 et al, 2014; Thørrisen, 2013), this finding further illustrates the role of these attitudes in informing
370 behaviour.

371 Finally, our results indicated that the link between car driver attitudes towards cyclists with
372 aggressive behaviour towards cyclists was consistent for different cyclists that car drivers encounter

373 (counter hypothesis 4). Based on the different identities that cyclists themselves attach to cyclists
374 wearing the two types of outfit referenced in this study (Aldred, 2013), and rooted in stereotype
375 activation theory (Dijksterhuis, 2001), we had expected a variation in the strength of association
376 between attitudes and behaviours towards casual and lycra wearing cyclists. Further, we did not
377 detect difference in aggressive behaviour towards these two groups of cyclists. Our findings are in
378 line with previous research showing no difference in overtaking distances given to casual and lycra
379 clad cyclists (Walker et al 2014). However is not aligned with research showing that cycle gear, in
380 particular helmets, may encourage certain types of negative behaviours towards cyclists (Basford et
381 al, 2002; Walker, 2007). Thus, it is possible that these previous studies' findings are specific to
382 helmet use. Further, these other studies considered close overtaking of cyclists, which was not
383 measured as aggressive behavior in our study and is conceptually different to aggressive behaviour.
384 However, it may in some cases be an expression of aggression towards cyclists. Further, our study
385 relied on self-report. It is possible that some differences are masked in self-report due to social
386 desirability effects (Marlowe & Crowne, 1961) and that drivers may, knowingly or unknowingly, not
387 accurately describe their behaviours towards different types of cyclists. Overall, our findings suggest
388 that car drivers' attitudes are the overriding factor when it comes to shaping their behaviour,
389 independent of the type of cyclist they encounter. Thus it appears that the outfit displayed in this
390 study may signal different cycle identities, however these identities do not differ in their effect on
391 how car driver attitudes shape car driver aggressive behaviour.

392 **4.1 Limitations and future research**

393 Future research in this area can extend our research and address some of its limitations in the
394 following ways. First, our manipulation check showed that the types of cyclists were clearly
395 distinguishable based on their outfit, however we did not find differences in aggressive behaviour
396 towards the depicted cyclists. Going forward, it will be of interest to explore whether other types of
397 behaviour towards these types of cyclists differ, including overtaking behaviour, or even positive

398 behaviour such as careful driving around cyclists. Second, we proposed stereotype activation as the
399 mechanism through which the link between attitudes and aggressive behaviour towards cyclists
400 would be shaped; however, we did not explicitly test whether different levels of stereotype
401 activation had occurred and what specifically these stereotypes are. Because it has been shown that
402 cyclists attach certain identities to different types of cyclists (Aldred, 2013), future research can
403 identify what stereotypes, or identities car drivers recognise for different types of cyclists. Moreover,
404 such research can study which specific features trigger these stereotypes, and can work towards
405 understanding the impact of these stereotypes on car driver behaviour in more detail. Third, our
406 research relied on self-reported behaviour thus may not reflect actual behaviours on the roads.
407 Further, the association of attitudes with behaviours may be overestimated as someone willing to
408 admit they dislike cyclists may also more readily admit to showing aggressive behaviour towards
409 them. It should however be noted that research into the utility of self-reporting in traffic behaviour
410 studies shows that effects of social desirability are generally small, and that these can be reduced by
411 collecting information in a private setting (Lajunen & Summala, 2003). The participants in our study
412 responded anonymously, so self-reporting and impression management effects were likely
413 minimised. Nonetheless, it is important to research the associations tested here in a simulator, or
414 field-based setting, to identify the extent to which the link between attitudes and aggressive
415 behaviour reported by the car drivers hold up and to what extent self-reported and actual behaviour
416 regarding these issues actually differ.

417 Fourth, this study considered environmental and automobility attitudes in car drivers in
418 relation to attitudes towards cyclists, given their relevance to both driving and cycling. Future
419 research may gain further insights into the roots of car driver attitudes towards cyclists by
420 considering their relationship with other types of attitudes, such as attitudes towards health,
421 attitudes towards aggression, or attitudes towards cheap travel.

422 Fifth, the participants included in this study were a self-selected convenience sample.
423 Therefore, their responses may not represent the overall population. It should be noted that a total
424 of 18.8 million vehicles are registered in Australia and the number of driving licences may be similar
425 to this statistic (Australian Bureau of Statistics, 2017; note that statistics about driver's licenses are
426 not available for all of Australia). For our sample to be representative, a total of 384 participants
427 (confidence level at 95%; confidence interval at 5%) would have been required. Our initial sampling
428 generated 387 responses, however only 302 were useable, so that the final sample falls slightly short
429 of being representative.

430 Finally, our findings were obtained in Australia, which given it is the first study to do so,
431 represents a strength of the study. Having said this, while aligned to research conducted in other
432 contexts (e.g. UK, Norway, Fruhen & Flin, 2015; Thorrisen 2013), the findings are potentially limited
433 to this nation's cycling context of overall low and falling cycling numbers (Austroads, 2017). Research
434 has shown that cycling numbers in countries can affect safety of cyclists on the roads (i.e. the safety
435 in numbers effect, Jacobsen, 2003). Further, cycling culture has been identified as a factor shaping
436 views on cycling and differs in contexts with high vs low cycling rates (Aldred & Jungnickel, 2014).
437 Accordingly, it will be relevant to explore whether the identified links would be similar in a context
438 that is more cycling friendly. Moreover, in coming years, research will need to take account of new
439 technologies, such as e-bikes, which may not only increase overall cycling numbers and change
440 perceptions of cycling, but will also potentially change the demographic makeup of if cyclists, making
441 it more accessible to older cyclists (Johnson & Rose, 2015). Accordingly, considering the role of e-
442 bikes, as well as perceived age of cyclists in shaping drivers' and cyclists' interactions may be useful
443 extensions of the work presented here. Finally, considering other attributes of cyclists such as age,
444 and whether they cycle with children, may generate further valuable insights into the factors that
445 shape car driver interactions with cyclists.

446 **4.2 Conclusion and practical implications**

447 Policy-makers and green transport activists in many western countries have been increasingly
448 active in promoting cycling, usually via interventions, or cycling infrastructure. Yet, cycling numbers
449 continue to fall in Australia (Austroads, 2017). Our research suggests that attitude change towards
450 cyclists should be considered as an important component of efforts aimed at improving car driver
451 and cyclists' interactions on the roads (Joshi et al., 2001; Gatersleben & Appleton, 2007; Gatersleben
452 & Uzzell, 2007). Specifically, our findings suggest that an important avenue for changing car driver
453 attitudes towards cyclists is to take account of their attitudes towards automobility. It may be that
454 campaigns designed to promote the benefits of cycling are inadvertently threatening people's
455 attachment to cars, thereby increasing hostility towards cyclists . Therefore, future interventions
456 may benefit from associating negative attitudes towards cyclists with being a bad driver, thus trying
457 to get those who see themselves as 'good drivers' on side. Such understandings may help shape car
458 driver attitudes in a way that leads to fewer negative interactions of car drivers and cyclists on the
459 roads. Another line of research suggests that because attitudes can be difficult to shift, it may be
460 best to bypass attitudes altogether and instead focus on emphasising social norms in order to
461 change behaviour. Research across a variety of behavioural domains has indicated that framing a
462 given behaviour as common and socially approved of can lead a shift in behaviour without
463 necessarily shifting people's beliefs (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius , 2007; Schultz,
464 Nolan, Cialdini, Goldstein, & Griskevicius, 2018). Therefore, social marketing campaigns that frame
465 non-aggressive behaviours, and at least one metre overtaking distance, as normative, may be one
466 effective approach. Of course, these suggestions are only theoretical speculations and would need to
467 be tested empirically. Finally, our results suggest that attire of cyclists does not alter the impact of
468 attitudes on driver behaviour. Accordingly, campaigns may not need to consider these different
469 groups of cyclists separately.

470 **Author notes**

471 Please note that information regarding survey items can be obtained by e-mailing the
 472 corresponding author.

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