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Thinking aloud on the road: Thematic differences in the experiences of drivers, cyclists, and motorcyclists

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ABSTRACT

This study takes a qualitative approach to exploring the experiences (and differences therein) of individuals using either their car, bicycle, or motorcycle to navigate a ~10.5 km urban route in a provincial UK city, with the aim of contributing to our understanding of the needs and requirements of different road users. Forty-six individuals provided concurrent verbal reports, using the 'think aloud' method, whilst using their vehicle to navigate the test route, the transcripts of which were subjected to a theory-agnostic, inductive, thematic analysis. A number of group differences were observed, revealing (among other factors) the importance of road surface quality to cyclists, the focus on vigilant observation in motorcyclists, and the heightened emotionality experienced by both two-wheeled groups, particularly those on bicycles. This affective component has, as yet, been under-explored in the academic domain and under-utilised in road transport policy and strategy; this is discussed, with attention drawn to the cyclists' greater tendency to make negatively valenced value judgements. Results are also discussed in terms of the potential to improve road users' experiences, foster inter-group empathy and understanding, and encourage a shift in mobility towards more sustainable modes.

1. Introduction

The experiences of different types of road users interacting with the same road system certainly differ; what can these differences tell us about the needs of current and potential car, motorcycle, and bicycle users? This article aims to address this question through the qualitative analysis of the verbal reports of road users interacting with the UK road system in an urban, provincial city, setting.

Safety and sustainability remain significant challenges in the road transport domain; currently in the UK, users of bicycles and motorcycles represent the most vulnerable of road users in terms of fatalities per vehicle mile (DfT, 2019), yet it is use of these modes, in particular the bicycle, that will be most required (in the UK and globally) if we are to reduce on-road congestion and emissions and mitigate the myriad knock-on effects these have on human health and well-being. Our road system has been designed primarily with the car in mind, and the very large majority of road investment is still geared towards supporting the use of that mode (e.g., DfT, 2020). Although some current trends in policy and research focus on the ways we can encourage active transport (e.g., Hirst, 2020), the solutions proposed (if indeed they are proposed) are often not immediately (or even in the medium-term) practicable. Moreover, the human experience aspect is often left out in the enthusiasm for engineering and technology, despite this user perspective being critical to system success (e.g., Lyons, Hammond, & Mackay, 2020).

The mode of transport a person uses to interact with the road system will have a large impact upon their experience. Research has

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explored how drivers, motorcyclists, and cyclists interpret road situations differently, and the information those user groups use (e.g., Walker, Stanton, & Salmon, 2011; Salmon, Young, & Cornelissen, 2013); however, this has typically been couched in terms of existing theory (e.g., situation awareness theory, e.g., Salmon, Stanton, Walker, & Jenkins, 2009). Although such theory driven research is extremely valuable, it can suffer from a narrowing of focus. There is a place for exploratory research in the field of road user experience that is complementary to the top-down research more commonly conducted. The current research contributes to the literature by offering this, through the bottom-up analysis of verbal reports provided by cyclists, motorcyclists, and drivers, in a naturalistic setting.

1.1. Verbal protocol analysis

Recording one's eye movements, or observing one's physical behaviours, gestures, and interactions with task artefacts both offer data sets that can be interpreted in terms of cognition and experience (e.g., Rayner, 1998; Underwood et al., 2002). Nevertheless, to collect these forms of data whilst an individual is engaged in certain tasks can be costly, distract from the task at hand, provide data sets that are difficult to interpret, and is sometimes impossible. One such method that attempts to circumvent these issues is verbal protocol analysis, or the 'think aloud' technique (Ericsson & Simon, 1980, 1993).

The technique has two primary variants; concurrent think-aloud and retrospective think-aloud. Concurrent think-aloud requires an individual to verbalise their thoughts concurrently with task performance; in retrospective think-aloud the participant provides verbal reports after the task has finished. Each has its advantages and disadvantages, and each may be more suited to certain environments or domains (e.g. Banks, Stanton, & Harvey, 2014; Russo, Johnson, & Stephens, 1989; Van Den Haak, De Jong, & Jan Schellens, 2003). It has been argued that retrospective reporting suffers from problems of non-veridicality, i.e., the lack of correspondence between verbal reports and cognitive processes, particularly in tasks of long durations (e.g. Van Gog, Kester, Nievelstein, Giesbers, & Paas, 2009); hence, the greater popularity of concurrent verbal reporting in naturalistic road user studies.

The concurrent think-aloud procedure has been popular in the driving domain for some time (e.g., Hughes and Cole, 1986), with examples including Young and colleagues' investigation of distraction-induced driver error (Young et al., 2013) and attention at railroad crossings (Young et al., 2015); Kircher and Ahlstrom's (2018) evaluation of methods for assessing attention while driving; Revell et al. (2020) investigation of the relationship between drivers and semi-autonomous vehicles; and Walker, Salmon, and colleagues' studies on road user situation awareness (Walker et al., 2007; Walker et al., 2011; Salmon et al., 2013; see also Salmon, Lenne, Walker, Stanton, & Filtness, 2014). Regarding the latter, notwithstanding the insights garnered in that research, there has been a suggestion that caution should be taken when using verbal reports to measure situation awareness (Rose, Bearman, Naweed, & Dorrian, 2019). Paired with appropriate analysis methods, however, they can provide a wealth of information well-suited to exploratory research (see, e.g., Johnsen, Slettebø, and Fossum (2016) and Welsh, Dewhurst, and Perry (2018) for examples in nursing and professional snooker, respectively).

1.2. Thematic analysis

Several methods exist to interpret or analyse verbal report data, some of which assist in developing theory (e.g., Lopez & Willis, 2004; Glaser & Strauss, 2017), others in meaningfully describing the content of the data (e.g., Mayring, 2004; Braun & Clarke, 2006). In most cases, any given method can be applied deductively or inductively; the former being relevant when one has a pre-existing theory to test or refine, the latter when existing knowledge or theory is limited, or not relevant to the research questions (Elo & Kyngäs, 2008). The purpose of the current research was to shed light on road user experiences (not develop theory), hence inductive thematic analysis was considered appropriate. This approach been oft applied in the road transport domain. For example, Hafner, Walker, and Verplanken (2017) used the approach in their investigation of the factors influencing vehicle purchasing decisions, Nikitas, Wang, and Knamiller (2019) in their study of parental perceptions of school travel, and Plyushteva and Boussauw (2020) in their study of night-time mobility is Sofia. These studies used interview or focus group data; however, thematic analysis has also been applied to think aloud protocols, for example Revell et al. (2020) and Ekman, Johansson, Bligård, Karlsson, and Strömberg (2019) in their explorations of driver behaviour and cognition in automated driving, and Whitehead et al. (2019) in a study of cognition in competitive cyclists (though they used a deductive, rather than inductive, approach; Whitehead et al., 2019).

There is currently a lack of similar research that also considers motorcyclists, or that looks at multiple road user types. It makes intuitive sense that cyclists, motorcyclists, and car drivers will differ in the thematic content of their verbal reports, at least in terms of the extent to which certain themes are discussed. The above-cited literature on road user situation awareness (e.g., Salmon et al., 2009; Salmon et al., 2013) went some way to provide evidence for this; however, there is significant scope to expand upon this. The current research does so, contributing to our understanding of the qualitative experience, and therefore the needs (perceived or real), of cyclists, motorcyclists, and car drivers on the UK roads.

2. Method

This was a semi-naturalistic, on-road study in which participants drove or rode around a pre-defined urban route, using their own car, motorcycle, or human-powered bicycle (we did not include e-bikes of any category). All users provided concurrent verbal reports; audio was recorded along with video of the scene ahead.

2.1. Study route

The route was approximately 6.5 miles (10.5 km) long and included a busy commercial section (approximately 0.8 miles / 1.36 km long), several residential streets, and an urban commuter route (see Fig. 1). The route contained two lengths of on-road, painted cycle lanes, totalling approximately one kilometre; there was no segregated cycling infrastructure. Three roundabouts were also included in the route, two of which were negotiated twice (from different directions). All roads and streets had a 30 miles per hour speed limit (~48 km/h). The route was identified using road traffic collision statistics for the years 2012 to 2017, in collaboration with a subject matter expert at the Hampshire Constabulary and Thames Valley Police Joint Operations Unit. It was identified as containing three collision 'hotspots' (relatively speaking, give the rarity of serious collisions in the city), as containing a number of distinct road environments (i.e., university area, commercial street, a well-known complex roundabout junction, an east–west commuter corridor, and a number of residential streets), and as being within the practical constraints of length, location, and suitability for all three transport modes.

2.2. Participant recruitment, training, and data inclusion

To recruit participants, posters advertising the study were placed around the University of Southampton's main campuses, study adverts placed in relevant social media user groups, and emails sent to local bicycle and motorcycle clubs (identified through local knowledge and internet searches). Those responding to the adverts were asked to pass on information to friends, family, and/or colleagues (where willing, able, and appropriate).

For reasons of brevity, we hereafter use the terms 'driver', 'motorcyclist', and 'cyclist' to refer to members of the three participant groups. This should not be taken as endorsement of the wider use of these terms to describe road users; most people regularly use more than one type of transport, and people should not be defined by the transport mode they use in any given moment. Referring to people in such ways can have negative consequences (e.g., Delbosc, Naznin, Haslam, & Haworth, 2019). We use the terms simply as indicators

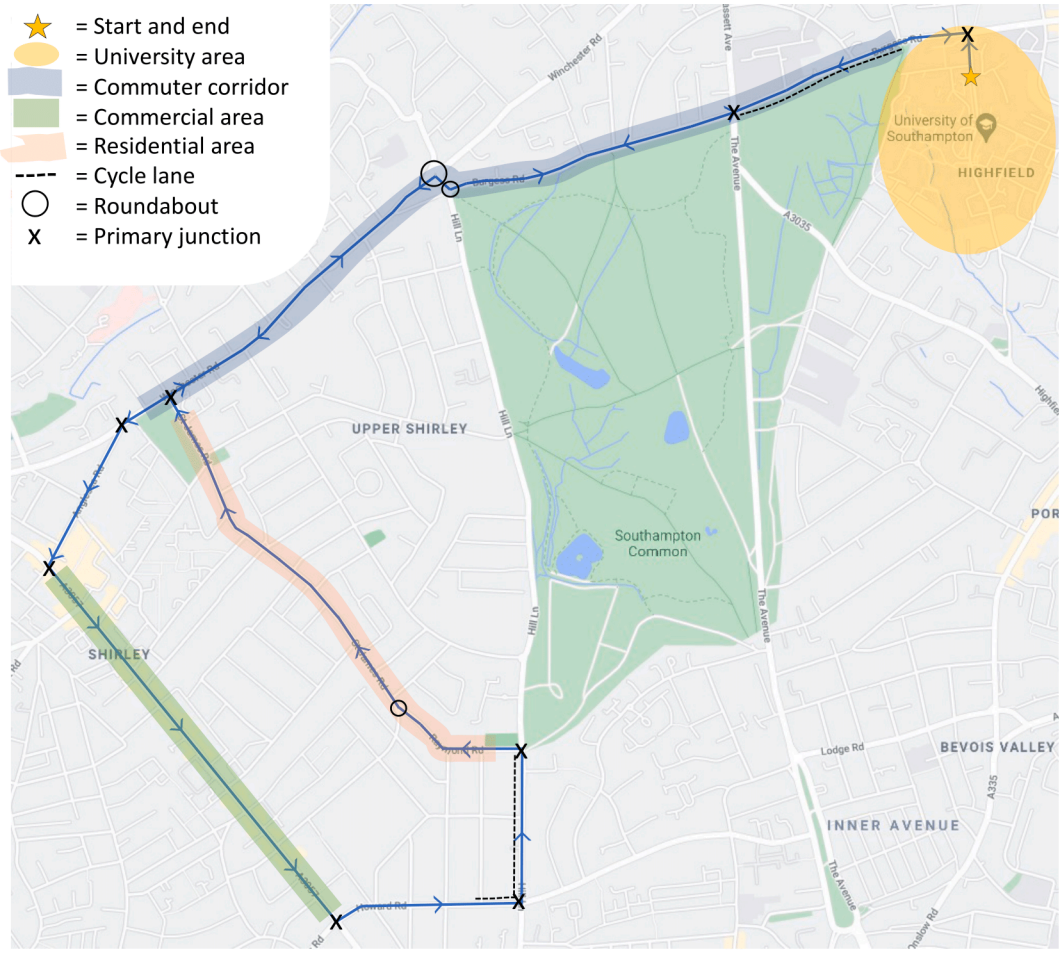

Fig. 1. Annotated map of the experimental route (adapted from Google Maps). Cycle lanes indicated are on-road, white-line separated sections of the road.

of the participants' membership to one of the three groups included in this investigation.

In total, 60 individuals were recruited and completed the study route, all of whom provided fully informed consent (ethical approval provided by the University of Southampton Ethics Committee, ID 30964). All were provided with a £5 food and drink voucher to compensate them for their time. A small number of the motorcyclists and cyclists took wrong turns during their journeys; some were able to quickly return to the study route whereas others took larger detours. If the participant travelled away from the study route for more than two minutes before returning, their data were not included in the final analysis.

Of the 20 cyclists who completed the journey, five made such detours, hence were excluded from subsequent analyses. An additional cyclist was excluded due to language issues; judging by the lack of fluidity of the verbal reports provided (i.e., speaking in a non-native language was clearly a barrier to expression of thought), a decision was made (collectively among the current authors) to exclude that participant's data. As such, data for 14 cyclists were ultimately analysed. In total, 23 motorcyclists completed the route; of those, six made sufficiently large detours to merit exclusion. Data for 17 motorcyclists were therefore included for analysis. A total of 17 drivers completed the study route; data for two of these participants were excluded, one due to the excessively conversational nature of their verbal reports (despite explicit instructions to the contrary), and one due to a recording failure. Data for 15 were therefore included in the analysis. Of the 46 participants whose data were included in the analysis, one (a driver) did not complete the demographics questionnaire. Age and gender information concerning the remaining 45 are presented in Table 1.

At the time of participation, drivers had held their licenses for an average of 31.7 years (min = 10, max = 55, SD = 15.1). Motorcyclists had held their motorcycle licenses for an average of 23.1 years (min = 4, max = 51, SD = 17.2). Cyclists reported an average of 23.2 years' experience cycling on the roads (min = 4, max = 52, SD = 15.2). All but one motorcyclist also held a driver's license, having done so for an average of 31.9 years (min = 10, max = 50, SD = 13.5). Eleven of the 14 bicycle riders also held a driver's license, having done so for an average of 21.5 years (min = 0, max = 42, SD = 12.3). The regularity with which each group reported using their own form of transport is displayed in Table 2.

2.3. Materials

Demographics questionnaires were completed either on pen and paper, or on a laptop computer. Video and audio were recorded using GoPro HERO5 cameras, with external microphones for those using bicycles and motorcycles (the camera's built-in microphone was sufficient for car drivers). For all motorcycle and bicycle participants, the camera was mounted on the participants' helmet. For car drivers, the camera was mounted on the inside of the windscreen of the vehicle, with care taken not to obscure the forward view. All participants used their own vehicle to complete the study route. Think aloud training was conducted using a laptop computer. All participants were introduced to the route via a printed map and a number of accompanying photos of landmarks along the route. Bicycle and motorcycle participants were provided with the map to take with them on their journey. Additionally, a laminated notice stating "Remember to think aloud" in large, bold, capital letters was attached to the handlebars of the cyclists' vehicles, and to the handlebars or petrol tank of the motorcyclists' vehicles.

2.4. Procedure

Participants were first required to read an information sheet and sign a consent form. They then completed a demographics questionnaire. The think aloud method was then explained to them, and a two-minute video of someone performing the method in a driving context (in a different road environment to that of the study) shown to them. They were invited to ask questions about the method, with any queries or uncertainties discussed, following which they practiced the method using the laptop computer. Training lasted approximately 15 minutes. The study route was then introduced; they were shown the route on the map and shown photos of landmarks along the route. Once satisfied with the route, bicycle and motorcycle users were informed that they could take the map if necessary. Car drivers were instructed that they would be accompanied in their vehicle (with the investigator in the passenger seat) and that they could ask for directions, but that the investigator would not otherwise speak, and that conversation was to be avoided. To control for traffic conditions, all trials took place between 10:00 and 14:00 on a working day (i.e., Monday to Friday). Bicycle and motorcycle trials were only conducted if the weather was agreeable (i.e., no trials took place in heavy rain or high winds).

Table 1
Participant age and gender splits.

		Age						
		18–25	26–35	35–45	46–55	56–65	Over 65	**Total**
Car	Male	0	0	2	2	0	4	**8**
(n = 15)	Female	0	3	0	0	3	0	**6**
Motorbike	Male	1	3	1	3	4	3	**15**
(n = 17)	Female	0	0	0	1	1	0	**2**
Bicycle	Male	3	4	1	2	1	0	**11**
(n = 14)	Female	1	0	1	1	0	0	**3**

Note: *n* in the first column refers to total number of participants included in the analyses, including the one car driver who did not provide demographics information

Table 2
Frequency of responses to the question "How often do you drive / cycle / use your motorcycle?".

	<1 day per week	1–3 days per week	>3 days per week	Most days	**Total**
Drivers	0	2	2	11	**15**
Motorcyclists	0	4	5	8	**17**
Cyclists	2	2	2	8	**14**

2.5. Transcription, segmentation, and coding

Recordings were transcribed verbatim then each transcript segmented into short phrases. Segmentation was done according to identifiable units of speech, each representing (as closely as is possible) an individual thought or idea. For consistency, and to support immersion in the data, the lead author transcribed and segmented all 46 transcripts. As discussed in the introduction, verbal coding took a thematic analysis approach; this proceeded in an iterative fashion. Video and audio were recorded together; as such, the video stream was used to aid coding development and application. Care was taken not to go through the transcripts of all participants of one road user group before moving to the next, rather transcripts from the three user groups were analysed in a pseudo-random fashion, with analysis of a transcript from one user group followed by analysis of a transcript from a different group. Three full iterations were required to reach the final coding scheme (i.e., each transcript was analysed three times until the coding scheme was deemed suitable). All segments of all transcripts were assigned a code, and all coding was performed by the lead author. Three transcripts, one from each road user group, were also coded by two additional individuals (external to this research). Both individuals had previous experience of thematic analysis. Inter-rater reliability was calculated in SPSS v.26 using percentage agreement and Cohen's kappa (Cohen, 1960). The full process, from transcription to final coding, was based on that described by Braun and Clarke (2006).

3. Results and analysis

The time taken to complete the study route, the number of words spoken, and the number of words spoken per minute are presented in Table 3. Although large individual differences were seen (as would be expected), three separate Analysis of Variance (ANOVA) tests showed no significant group differences in trip time, words spoken, or words spoken per minute. The process of segmentation resulted in the transcripts being broken down into an average of 578.9 (sd = 191.5) segments for car drivers, 668.2 (sd = 153.5) for motorcycle riders, and 690.4 (sd = 233.5) for bicycle riders. Across all three road user groups, a total of 29,709 segments of speech were categorised, with average segment length at 6.1 words (sd = 0.7).

The main coding scheme, with short descriptions of each code, is presented in Table 4. The amount each parent theme was present in the transcripts, in terms of proportions across the three road user groups (i.e., the percentage of segments in a single transcript assigned each code), is presented in Fig. 2. The presence of each sub-theme (again as proportions of the total number of segments within an individual's transcript), for each road user group (i.e., averaged across group members), are presented in Figs. 3–11; in all Figures, bar charts show the mean percentage of segments assigned to each sub-theme. 95% percent confidence intervals are displayed to give an indication of data spread; they are not intended to be taken as indicators of statistical significance. Inter-rater reliability between the main analyst and the first additional coder was calculated as $\kappa = 0.675$ ($p < .001$; indicating good agreement; Altman, 1991), and percentage agreement was 70.5%. Between the main analyst and the second additional coder, reliability was calculated as $\kappa = 0.681$ ($p < .001$; also indicating good agreement; Altman, 1991), and percentage agreement was 71.0%.

Quotes presented in the following discussions are denoted by the number assigned to the participant who provided them (assigned upon an individual's first response to the invitation to participate) and the mode of transport they used for the study.

3.1. Own actions and position

This parent theme was prominent across the three groups; all participants readily spoke about what they were currently doing. Group differences could be discerned in some of the sub-themes (see Fig. 3), in particular 'Procedures' sub-theme (e.g., "*I will drop down a gear*" Ppt 15, car) and 'Danger avoidance' (e.g., "*Keeping a wide berth away from these vehicles*" Ppt 8, bicycle), and the two sub-themes related to road positioning, i.e., 'General positioning' (e.g., "*so I'm going to just stay a little bit away from the kerb*" Ppt 75, motorcycle) and 'Dominant, claiming' (e.g., "*going to take my lane because I am going straight on*" Ppt 5, bicycle).

The 'Polite, Deferential' theme (e.g., "*So we just let it through*" Ppt 35, car) was expressed to a similar extent across groups; however, there were qualitative difference within this sub-theme. The term 'deferential' was included in the theme name due to the sentiment

Table 3
Time taken to complete the study route, number of words spoken, and words spoken per minute, for each of the three road user groups.

	Trip time (mm:ss)		Words spoken		Words spoken per minute	
	Range	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)
Car	30:13 – 46:22	35:06 (04:43)	1446–6275	3526 (1319)	44.4 – 147.6	100.0 (32.0)
Motorcycle	23:11 – 44:56	32:38 (05:13)	2083–5572	3959 (1070)	61.0 – 177.2	121.7 (28.9)
Bicycle	28:45 – 76:41	41:29 (11:48)	1568 – 7146	4465 (1609)	46.9 – 175.8	108.9 (34.9)

Table 4
Primary coding scheme with descriptions of each sub-theme.

Theme	Sub-theme	Description
Own actions and current position	Navigation	Directions or names of places and roads along the route in relation to necessary actions
	Procedures	Actions performed by the participant, including turning, waiting, speeding up, changing gear, etc.
	Danger avoidance	Actions specifically made to avoid a current, potential, or perceived danger
	Polite, deferential	Allowing other road users to act, e.g., giving space, allowing through, waving on,
	General positioning	Actions to change or maintain road position, including lane choice and in relation to others
	Dominant, claiming	Asserting one's position in the road, taking the lane, being bold, for safety or otherwise
Checking and looking around	General	Looking ahead, around, to the sides, etc.
	Behind	Looking behind, whether over the shoulder or via mirrors
	Directed	Checking or looking to a specific location, e.g., a junction, or watching a particular road user
Local situation	Descriptive	Verbalising the presence or absence of an object, or its state or current action
	Quality judgement	Judging the quality of something in the environment, including its safety, cleanliness, or suitability
	Gap, space, and time	Referring to space in which to move, for self or for others
	Uncertainty	Being confused, or questioning something in the environment and/or its actions or state
	Projection	Referring to a future state of the environment, whether known, assumed, or hypothetical
Other road users	Descriptive	Verbalising the presence or absence of another road user, or its state or current action
	Quality judgement	Judging the quality of another road user's behaviour or attitude, real, perceived, or projected
	Uncertainty	Being confused, or questioning something about another road user and/or their actions or state
	Projection	Referring to a future state of another road user, whether known, assumed, or hypothetical
Communication	Informing	Telling other road users of own intention, through signals, gestures, movement, or position
	Thanking	Thanking other road users when, for example, being allowed to pass or enter a junction
	Being seen	Reference to making eye contact with another road user, being seen, or ensuring own visibility
Own vehicle	Status	Comment describing the state of own vehicle, including speed, current gear, equipment, etc.
	Biophysical	Reference to own physical abilities, including muscle strength, tiredness, shortness of breath, etc.
Emotion	Fear and intimidation	Expression of being afraid or feeling intimidated by other road users or the environment
	Relief	Expression of being worry free, feeling safe, being relieved, or there being no problems
	Anger and frustration	Expression of anger or frustration directed towards other road users or the environment
Weather and temperature		Comments related to weather conditions
Other	Not task related	Conversational or comments irrelevant to the task or environment
	Incomplete / inaudible	Comments made in which not all words could be discerned, or were not complete

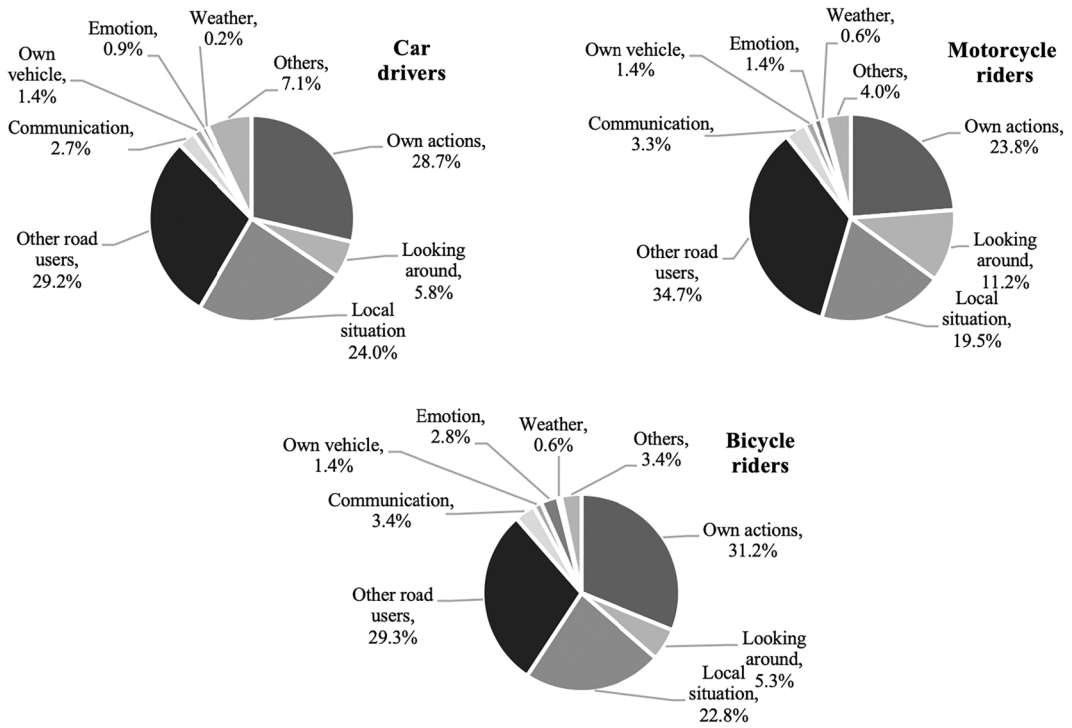

Fig. 2. Percentage of segments assigned to each parent theme, averaged across participants in each road user group.

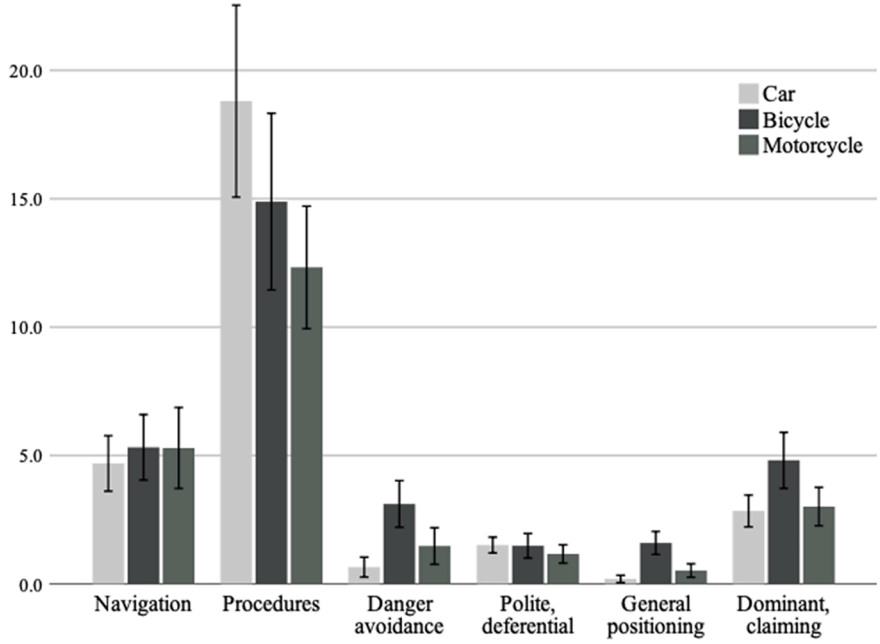

Fig. 3. Percentage of segments assigned to each 'Own actions and current position' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

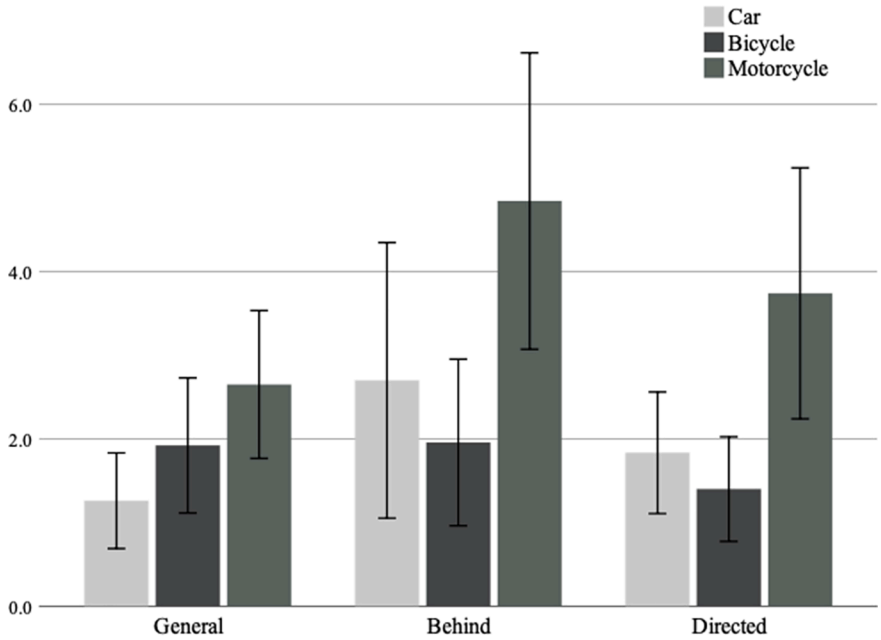

Fig. 4. Percentage of segments assigned to each 'Checking and looking around' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

coming through in the cyclists' verbal reports, with that user group not only acting out of politeness, but also wanting to "*keep up relations between road users*" (Ppt 1, bicycle) and not wanting to impact upon the journeys of others (e.g., "*I'm going to stick to the left-hand side as much as possible, to let as many of them go past me*" Ppt 9, bicycle; "*And secondly even though it's a 30 limit it's quite a fast road want to give the cars as much room as I possibly can no reason to hinder them*" Ppt 22, bicycle). This was even to the point of sounding apologetic for being on the road ("*probably seem like a right douchebag to the driver behind me, cos I'm taking the middle of the road*" Ppt 9, bicycle). This contrasts to comments coded under the 'Dominant, claiming' sub-theme, e.g., "*take up the space I've got as much right*" (Ppt

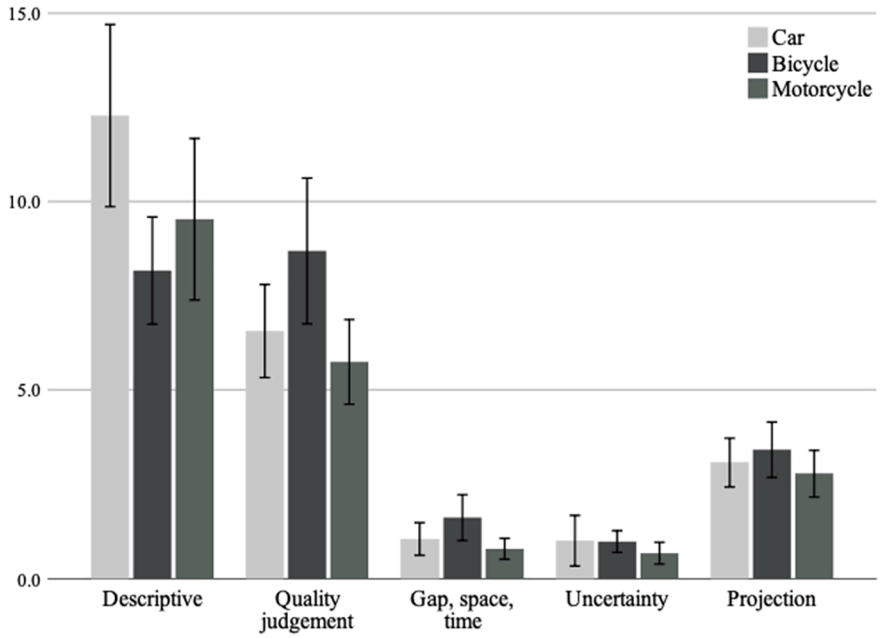

Fig. 5. Percentage of segments assigned to each 'Local situation' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

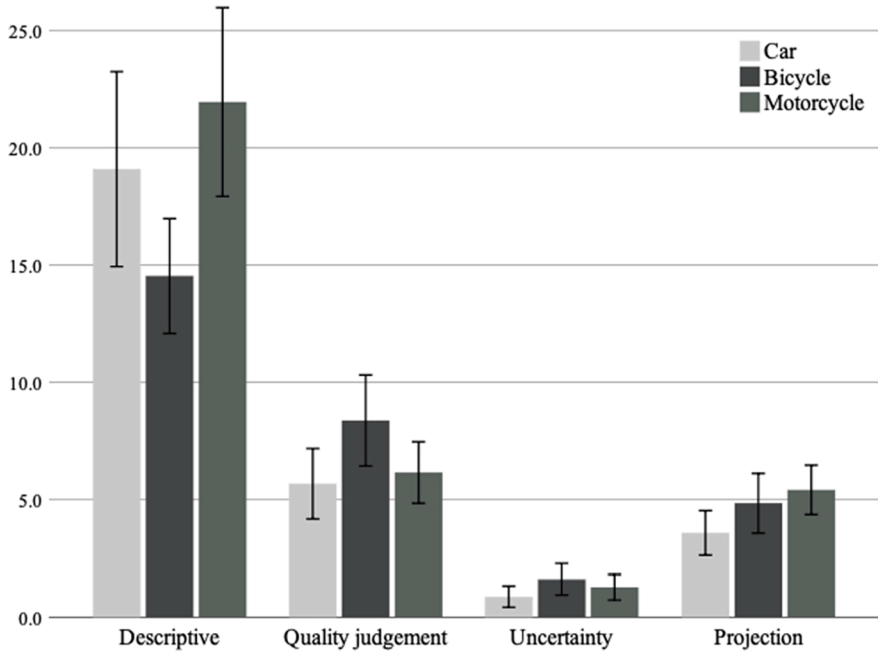

Fig. 6. Percentage of segments assigned to each 'Other road users' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

29, bicycle).

3.2. Checking and looking around

Clear group differences were seen in this theme (see Fig. 4), with a noticeably larger proportion motorcyclists' comments describing acts of looking at or for someone or something compared to cyclists or drivers (who did not differ from each other). The theme's pattern

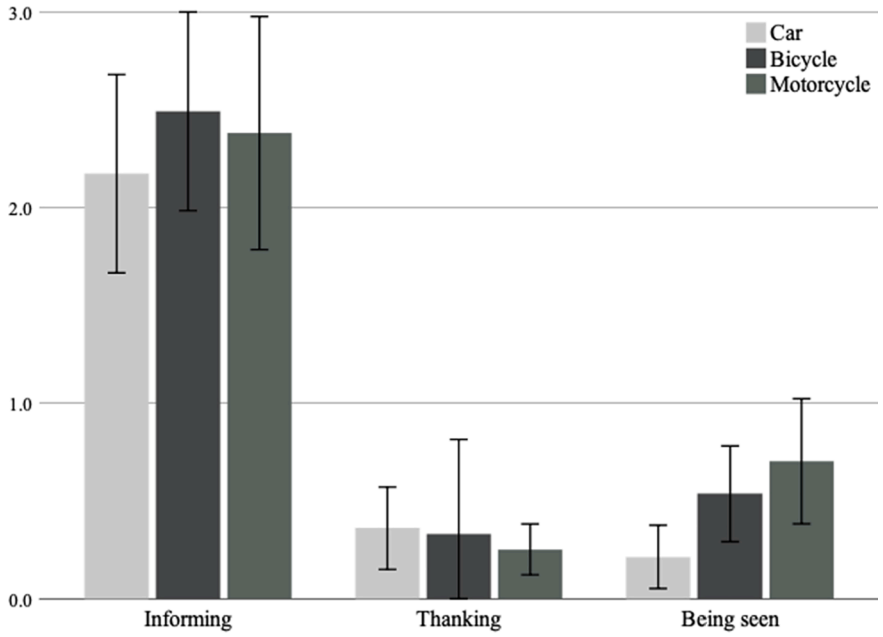

Fig. 7. Percentage of segments assigned to each 'Communication' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

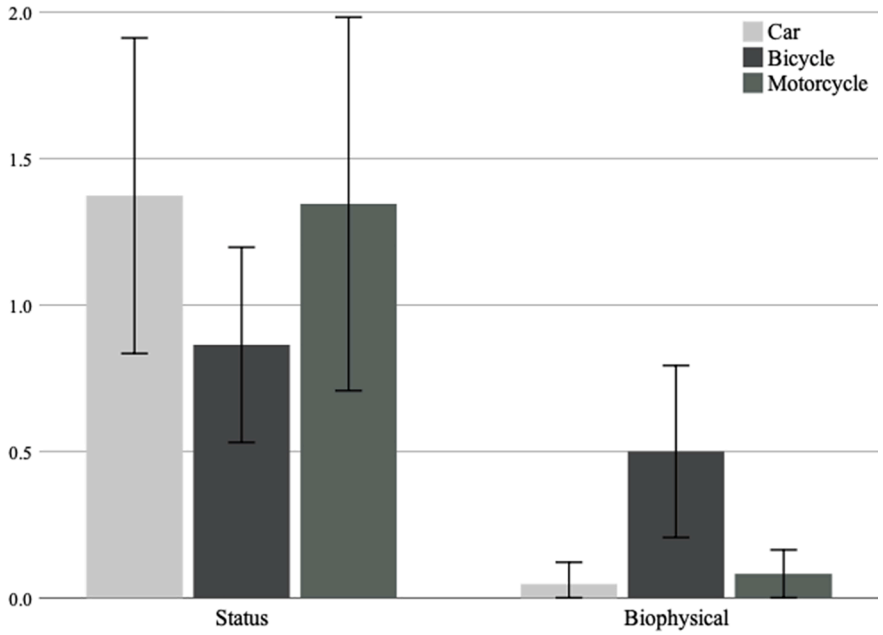

Fig. 8. Percentage of segments assigned to each 'Own vehicle' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

was repeated in its sub-themes of 'General' (e.g., "*checking left and right*" Ppt 3, bicycle), 'Behind' (e.g., "*just checking behind me*" Ppt 18, car), and 'Directed' (e.g., "*and I'm keeping an eye on these cars*" Ppt 62, motorcycle). The shoulder check (coded in 'Behind') was explicitly referred to as the 'lifesaver' check by two of the motorcyclists, a term used by the UK organisation responsible for vehicle licensing and used in motorcycle training (e.g., DVSA, 2013).

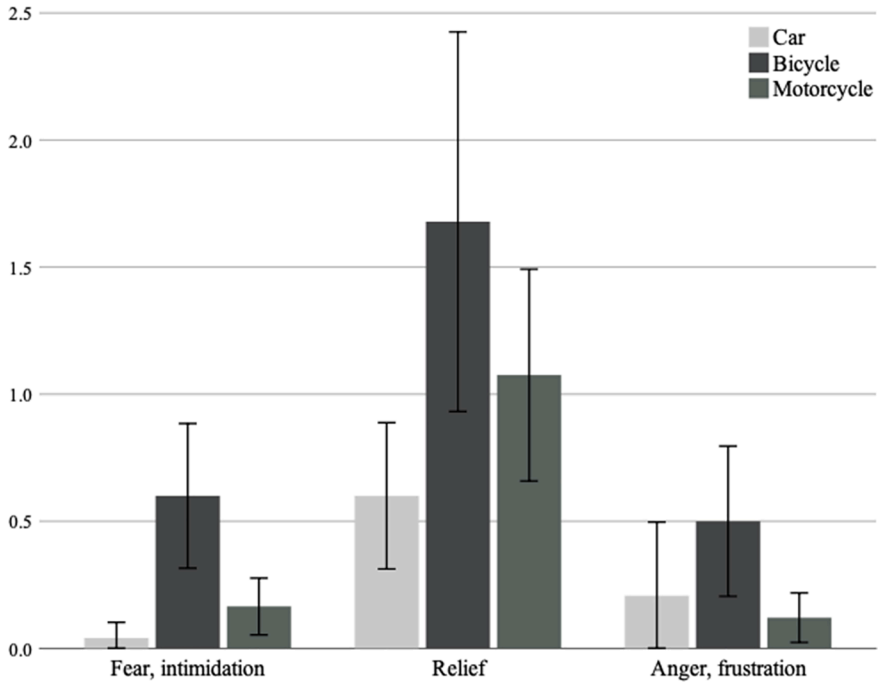

Fig. 9. Percentage of segments assigned to each 'Emotion' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

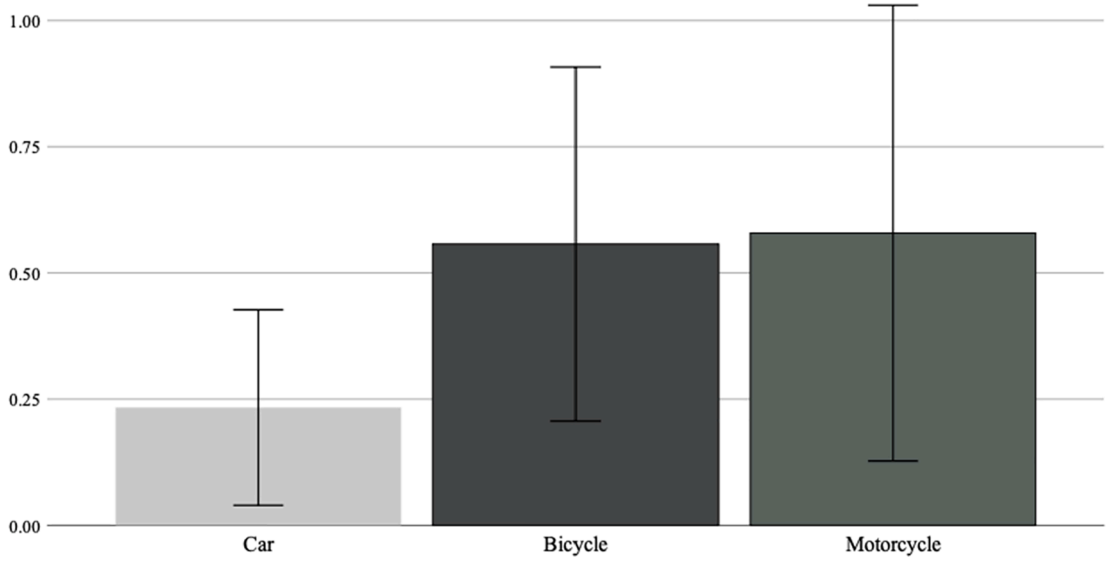

Fig. 10. Percentage of segments assigned to the 'Weather' theme, averaged across participants in each road user group, with 95% confidence intervals.

3.3. Local situation

This theme was also prominent across the three groups, with group differences seen in sub-themes (see Fig. 5). Car drivers made more 'Descriptive' comments (e.g., "*Bend to the right*" Ppt 103, car; "*Lights are going green*" Ppt19, car) whereas Cyclists made more 'Quality judgement' comments, often manifesting as comments on the quality of the road infrastructure (e.g., describing a cycle lane as "*pitifully short*" Ppt 1, bicycle), the state of the road surface (e.g., "*okay, the road surface here isn't great*" Ppt 4, bicycle), or the general state or characteristics of the road environment (e.g., "*the road's quiet*" Ppt 9, bicycle; "*quite a narrow, windy section of road, this*" Ppt 20, bicycle). Drivers and motorcyclists made broadly similar proportions of comments referring generally to the amount of space available

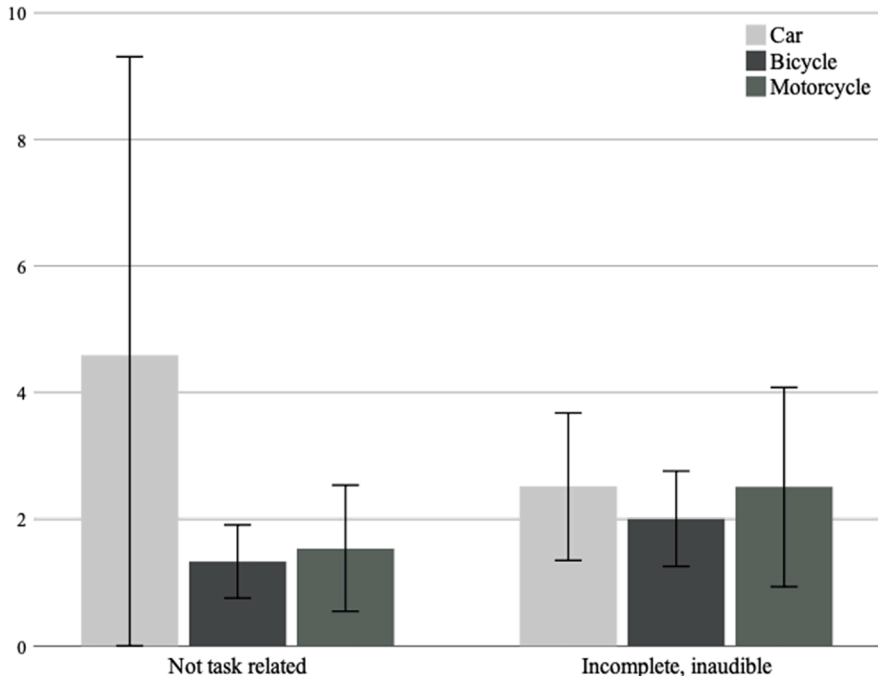

Fig. 11. Percentage of segments assigned to each 'Other' sub-theme, averaged across participants in each road user group, with 95% confidence intervals.

('Gap, space, and time'; e.g., "*plenty of space*" Ppt 62, motorcycle), while cyclists made relatively more of these comments. 'Uncertainty' (e.g., "*Which I don't really know which cycles should use it*" Ppt 7, bicycle; "*might be a pedestrian crossing*" Ppt 75, motorcycle) and 'Projection' (e.g., "*so we might be moving in a second*", Ppt 19, car; "*I'll expect that to change at some point*" Ppt 49, motorcycle) were similar across groups.

3.4. Other road users

This theme was most prominent in the motorcyclists' transcripts (see Fig. 6), with the 'Descriptive' sub-theme representing the largest proportion for all participants; all readily described another road user's presence (or absence) or state (e.g., "*Bus on the right*" Ppt 44, motorcycle; "*another cyclist up ahead*" Ppt74, motorcycle), though some group differences were observed (Fig. 6). As with the 'Local situation' theme (above), cyclists had a greater propensity towards making quality judgements (e.g., "*that was a good overtake from him*", "*quite a fast-moving vehicle behind*" both Ppt 8, bicycle) than motorcyclists or drivers. The 'Uncertainty' (e.g., "*not too sure where those cars are going*" Ppt 104, car) and 'Projection' (e.g., "*this silver car's probably going to want out of here in a wee second*" Ppt 49, motorcycle) sub-themes were both more commonly expressed by motorcyclists and cyclists than by car drivers.

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3.5. Communication

The first two sub-codes of 'Communication', namely 'Informing' (e.g., "*we're indicating left*" Ppt 69, motorcycle) and 'Thanking' (e.g., "*acknowledge thank you*" Ppt 24, car) showed similar patterns across groups (Fig. 7). The sub-theme 'Being seen' (e.g., "*That woman has seen me, good*" Ppt 9, bicycle) was less prominent in the drivers' transcripts than in the motorcyclists' or cyclists' transcripts. For the vulnerable road users, ensuring their own visibility (e.g., "*trying to make sure that they see me in my nice bright yellow jacket*" Ppt 7, bicycle) and making eye contact with other (most commonly large) vehicle drivers (e.g., "*It's always good to try and make eye contact*" Ppt 57, motorcycle) was more important.

3.6. Own vehicle

The 'Own vehicle' category was equally prominent across groups (Fig. 8), though cyclists differed from car drivers and motor cyclists insofar as they produced a lower proportion of verbalisations under the 'Status' sub-theme, and a higher proportion under the 'Biophysical' sub-theme. This is unsurprising; in addition to comments regarding current gear selection of mechanical state (relevant to all three groups), 'Status' also included comments pertaining to current vehicle speed (e.g., "*So we're doing 26, 27*" Ppt 74, motorcycle), something far more relevant to motorists, who have speedometers and a need to restrict their speed to the limit of the road (neither of which is relevant for most urban cyclists). Although some motorcyclists made reference to putting their vehicle into neutral in order to avoiding tiredness in the hand due to holding the clutch while at a standstill (e.g., "*there's no point tiring out my clutch hand*" Ppt 49, motorcycle), this was a far more common topic among cyclists, for whom their 'motor' is their own body (e.g., "*getting my leg exercise for the day*" Ppt 1, bicycle). Only two car drivers made a comments about tiredness; one was regarding moving toes while at a standstill ("*So trying to wriggle me toes*" Ppt 103, car), the other about general tiredness, not caused by the driving task (i.e., "*I'm pretty zonked after four hard days' work*" Ppt 33, car).

3.7. Emotion

In the 'Emotion' theme, clear group differences were observed (Fig. 9), with cyclists making a higher proportion of these statements than the other two groups. This was true for all three sub-themes. The 'Fear and intimidation' code was present in eight of the 17 motorcycle transcripts (e.g., "*Putting myself in peril from the cars coming the other way*" Ppt 85, motorcycle); 12 of the 14 cyclists made such comments (e.g., "*Ooh bloody hell that guy was a bit close*" Ppt 1, Bicycle). In contrast, only two car drivers made such comments; one, for fear of hitting a cyclist (i.e., not for own safety; "*I always have this fear of cyclists sweeping up on the side*" Ppt 6, car), one in terms of social pressure for being in a poor position at a junction ("*So I feel a bit like a sitting duck*" Ppt 18, car). 'Anger and frustration' were expressed by participants in all three groups but was also more common among cyclists compared to drivers and motorcyclists. In that group, such comments were typically in relation to the behaviour of others (e.g., close passes; "*Ok fine, fine! Do that you f**king moron!*" Ppt 9, bicycle) or the state of the road surface (e.g., "*God, this road's awful!*" Ppt 5, bicycle). When in relation to others, it was usually in response to the behaviour of a car driver; however, there was also frustration expressed at the behaviours of other cyclists, in terms of the effect that would have on their reputation as a group, e.g., "*Oh there's a cyclist on the pavement breaking the law and pulling out in front of moving vehicles, excellent, really doing a lot for our reputation*" (Ppt 11, bicycle).

The only positive emotion expressed was that of 'Relief', most often in relation to the avoidance of a danger or a potential danger that did not ultimately manifest (e.g., "*luckily the driver stayed where he was*" Ppt 88, motorcycle), or a general comment about being happy about the situation (e.g., "*Somebody behind us, but in no great hurry thankfully*" Ppt 20, bicycle). Again, cyclists produced the largest proportion of such statements, with many in reference to another road user's behaviour (e.g., "*Please, please don't overtake, good, thank you, thank you*" Ppt 9, bicycle; "*thankfully they are not pulling out that's good*" Ppt 14, bicycle) or in the relief of encountering some cycling infrastructure (e.g., "*Now I'm liking the fact that I've got a bit of a cycle lane here*" Ppt 14, bicycle; "*It's nice to have a cycle lane that's wide enough*" Ppt 5, bicycle).

3.8. Weather and temperature

Weather (e.g., "*wind back up again*" Ppt 4, bicycle; "*Oh it's hot*" Ppt 6, car) was more often referenced by those on two wheels than by those in the car (Fig. 10). For cyclists, this was often related to heating up from the physical exertion, and the need to remove layers (e.g., "*It's getting a bit hot now, I should take my jacket off*" Ppt3, bicycle), while among motorcyclists this more commonly manifested as references to road surface conditions (e.g., "*we're alright today, it's nice and dry*" Ppt 49, motorcycle) and visibility (e.g., "*suddenly get a full glare, glare of sun in your eyes*" Ppt 57, motorcycle).

3.9. Other

Drivers stood out as making more comments under this theme (Fig. 11). On average, drivers had a greater tendency to make conversational remarks, or remarks unrelated to the driving task or environment (e.g., "*My brother lives round here*", Ppt 24, car; "*I need to go shopping later on*" Ppt 50, motorcycle) than motorcyclists or cyclists.

3.10. Additional topics

During the main coding process, it became clear that cyclists and (to a slightly lesser extent) motorcyclists differed from car drivers in a number of ways not fully captured by the primary coding scheme. In particular, there were marked group differences in participants' references to the following four topics;

- *Road surface quality*: Reference to potholes, drain covers, road markings, etc., and to the presence of rubbish in the roadway, in terms of their effect on travel
- *Room to move*: Comment referring to the participant having room around them, in a positive, thankful way
- *Being doored*: A description or recognition of the potential to have a door opened in one's path
- *Fatalism*: Reference to being squashed, flattened, killed, crashed into, etc.

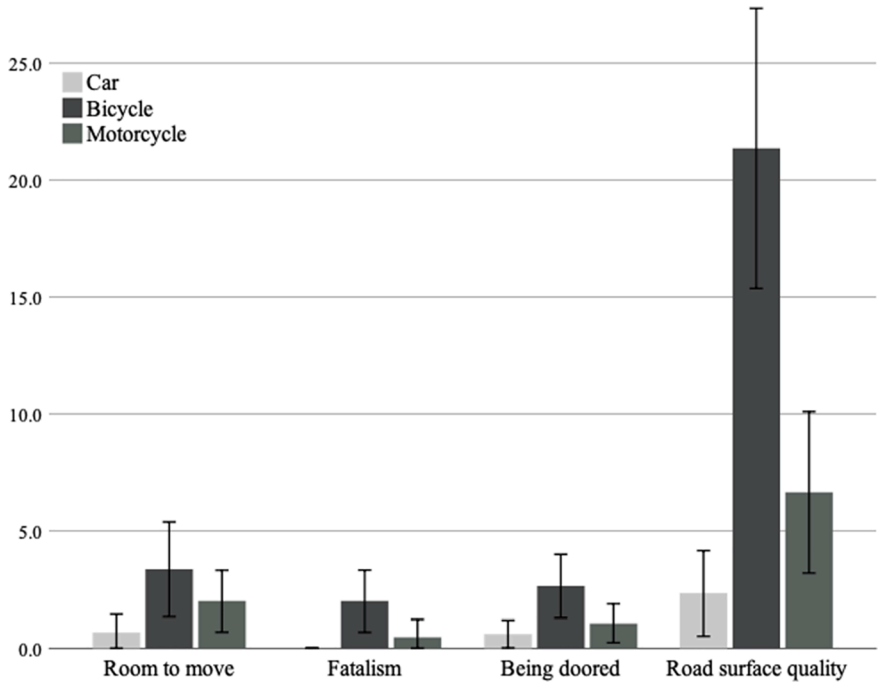

Fig. 12. Average number of times each supplementary theme appears in the transcripts, by road user group, with 95% confidence intervals.

In order to highlight these group differences, the extent to which these four supplementary topics were present across all transcripts was explored. These topics were additional to the codes applied above (i.e., all segments had already been coded using the scheme in Table 3), hence this stage represented a second pass or layer of analysis. All 29,709 segments across all transcripts were considered in terms of these four topics, but only 638 were identified as being relevant to this supplementary analysis. The extent to which the themes were present in the three groups' transcripts is presented in Fig. 12. As not all segments were coded, Fig. 12 presents average number of occurrences (rather than proportions).

'Road surface quality' (e.g., "*Road full of potholes*" Ppt 19, car) was referenced by cyclists to a far greater extent than it was by motorcyclists or car drivers. Every cyclist made multiple references to potholes, drainage covers, and other such indentations, lumps, or cracks in the road, largely referring to the need to avoid them, or to slow down or stand up on the bicycle in order to safely go over them (e.g., "*Big pothole here, brace myself for it*" Ppt 8, bicycle). In some instances, cyclists referred to the compound danger presented by the need to avoid the hazard (e.g., "*A massive pothole, better check behind me and swerve around it*" Ppt 26, bicycle) and the presence of traffic (e.g., "*Oh, look at that pothole, dammit! Oh, I would have gone out to the right, but I could hear a car behind me*" Ppt 29, bicycle), referring to the need to balance priorities (e.g., "*one* [car] *on my tail, I ended up staying slightly more in the gutter, riding the pothole, than I would have preferred. But then again it wasn't safe enough to change my position*" Ppt 105, bicycle). There were also references to the impossibility of giving attention to both the road surface and the traffic conditions; e.g., "*I am mainly watching the road, the surface, rather than the traffic*" (Ppt 26, bicycle); "*can make it tricky when you're trying to look over your shoulder and you might then hit something*" (Ppt 105, bicycle).

Also included in 'Road surface quality' were references to road markings affecting behaviour; e.g., "*I don't want to go onto the double yellow lines, especially don't want to get caught on them, and especially, it's not raining, but if it was raining it can get quite slick*" (Ppt 29, bicycle); "*because the double yellows are thick and lumpy and slippy*" (Ppt 105, bicycle). This was only mentioned by cyclists. Motorcyclists also had concerns over the slip qualities of the road surface, though primarily in relation to drainage covers (e.g., "*Nice big wet manhole cover there*" Ppt 47, motorcycle). This is likely due to the locations of said drainage covers, being more in their path of travel (i.e., typically nearer the middle of the lane) than in cyclists' path (i.e., typically near the side of the lane).

All of the cyclists made comments that were considered to be related to road surface quality, whereas 14 of the 17 motorcyclists made such comments. Although also a concern for the car drivers, it was to an even lesser extent; 9 of the 15 drivers made such comments. For drivers, when comments were made, it was almost exclusively referring to potholes, with very few references to drainage covers, and no mention of road markings. In addition to cracks, potholes, etc., five cyclists commented on the presence of rubbish in the roadway (e.g., broken glass, plastic bags, etc.), e.g., "*Plastic milk bottle, we've moved to glass*" (Ppt 3, bicycle). This was exclusively referring to detritus along the sides of the road, where the cyclist usually travels. None of the car drivers or motorcyclists made any such comments.

'Room to move' (e.g., "*Truck behind me is giving me a wide berth, which is comforting*" Ppt 58, motorcycle) related to a participant feeling comfortable about the room given to them by other road users, usually either whilst being overtaken or when stopped at junctions or traffic lights (e.g., "*That car's given me a nice bit of space*" Ppt 29, bicycle). Again, cyclists made more such comments than

did motorcyclists or car drivers. Eleven of the 15 cyclists verbalised such thoughts, while 10 of the 17 motorcyclists did so. As with road surface quality, although also relevant to a number of car drivers, it was verbalised far fewer times; only four (out of 15 drivers) made reference to being given room.

In terms of the potential for parked vehicles to open their doors into the path of the participant ('Being doored'; e.g., "*I don't want to get clobbered if somebody opens their door*" Ppt 14, bicycle), the verbal reports collected suggest this to be more a concern for cyclists than for motorcyclists or car drivers. Twelve of the 14 cyclists commented on the potential for being 'doored' or of being in 'the door zone' (e.g., "*keeping out of the door zone just in case*" Ppt 20, bicycle). In the motorcyclist group, the concern was also verbalised, though by a smaller proportion of the participants; eight of the 17 motorcyclists made comments to this effect (e.g., "*Staying out of the car door zone here*" Ppt 49, motorcycle). Finally, five of the 15 drivers verbalised a concern for, or a recognition of, the potential for a door to be opened from a car parked along the side of the road on which they were travelling (e.g., "*in case the driver suddenly decides to open his car door*" Ppt 15, car).

The 'Fatalism' theme (e.g., "*in case there's anybody trying to create a sandwich out of me and the car in front*" Ppt 44, motorcycle) revealed the differences felt by the road users in terms of their vulnerability, at least in terms of their own perceptions of that vulnerability. Three of the 17 motorcyclists made comments referring to being 'squeezed' or 'sandwiched (e.g., "*if anything of any size came up in the other direction, I could get sandwiched*" Ppt 58, motorcycle). In the cyclist group, this sentiment was more commonly expressed; eight of the fourteen participants made fatalistic comments (e.g., "*I also want them to turn and not kill me*" Ppt 8, bicycle). No fatalistic comments were made by any car driver.

4. Discussion

This investigation took a semi-naturalistic approach to investigating the experiences, and differences therein, of 46 individuals using three different transport modes (i.e., car, motorcycle, and bicycle) to navigate the same urban route. Participants were required to 'think aloud' during their journey, the transcripts of which were subjected to inductive thematic analysis. The themes and sub-themes identified were compared in terms of their presence in the three groups' verbalisations. Similarities were found in the extent to which participants verbalised their own actions and the things they saw in the environment (as would be expected); regardless of the activity they are undertaking, people readily verbalise what they can see and what they are doing (e.g., Plant & Stanton, 2015).

More interesting, however, were the differences between groups. For the cyclists, the need for active avoidance of danger was prominent. Motorcyclists stood out in observation and the need to be seen. Car drivers referred more to the procedural actions required to operate the vehicle. More so than for drivers, road positioning was a concern for both cyclists and motorcyclists, an effect that was especially pronounced for cyclists, where a conflict between being assertive and submissive came through in the transcripts. Those on two wheels also expressed a greater amount of emotion and made more value judgements of the things they saw around them; again, cyclists in particular stood out in this regard. Finally, car drivers differed in making a notably greater proportion of non-task related statements. With the protection afforded by the vehicle and the infrastructure primarily designed to support them, those participants had a greater opportunity (compared to cyclists and motorcyclists) to allow their mind to wander (though note there were large individual differences therein). Supplementary topics additional to the themes identified in the primary thematic analysis further highlighted how the three user groups' experiences differed. There exists evidence that a greater uptake of two-wheeled transport, whether motorised or not, would offer significant benefits to transport systems (and societies) not already dominated by such modes (e.g., Cox & Mutel, 2018; Götshci et al. 2016; Neun & Haubold, 2016). As such, implications are discussed below in terms of their impact on current and potential motorcycle and bicycle users (with a stronger focus on the bicycle user, given the further benefits of that mode on personal and environmental health).

4.1. The case of motorcycle users

For those on two wheels, observation of the environment and of other road users was a major part of their on-road experience (see also Salmon et al., 2014). This was especially true for motorcyclists; it was in these regards that the motorcyclist participants of our research stood out most clearly from the other two groups. This is perhaps unsurprising; motorcyclists are generally less visible than larger vehicles and are more likely to suffer severe or fatal injuries if involved in a collision (due to their speed compared to cyclists and their lack of protection compared to car drivers). There exists a perception that they must therefore protect themselves through the vigilant observation of other (usually larger) road users' actions. This is also borne out in the literature; the effect of inattention of others on collisions (e.g., Mannering & Grodsky, 1995), and the violation (by drivers) of the motorcyclist's right of way (e.g., Clarke, Ward, Bartle, & Truman, 2007; Crundall, Crundall, Clarke, & Shahar, 2012) is well documented, and has influenced motorcyclist training (e.g., with inclusion of the 'lifesaver' shoulder check; DVSA, 2013).

The motorcyclist participants also made more emotional comments and fatalistic remarks than the drivers as well as more comments revealing a sense of fear or intimidation and anger or frustration. Our results therefore support those reported by Samuel et al. (2019), who provided an analysis of motorcycle riders' emotional state changes at intersections. Those authors found motorcyclists' journeys to be characterised by high emotional dynamism (Samuel et al., 2019); our results are highly comparable in this regard. Interestingly, Samuel et al.'s work also used verbal protocol analysis; however, their analysis approach was driven by existing theory, with a specific model of affect serving to structure their analyses. Our approach differed insofar as analysis was wholly deductive. We have also made comparisons between road user groups, something not done by Samuel et al. (2019). Indeed, as will be discussed in more detail below, the heightened emotionality aspect was yet more pronounced for cyclists, with journeys characterised by an even

greater sense of emotion.

Motorcyclists in our research could be differentiated from car drivers in their reference to road surface quality, particularly with regards to potholes and other deformations, as well as to manhole or drainage covers. The former was of even greater concern for cyclists (discussed below); the latter unique to the motorcyclist group. The slipperiness of a drainage cover is of little consequence for a car driver, yet their effect on motorcyclists is known (e.g., Chang, 2014; Elliott, Baughan, & Sexton, 2007). Moreover, they are often directly in motorcyclists' paths given their placement in the middle of the lane, commonly at junctions with residential side roads (with junctions representing additional risk for motorcyclists, whether they are turning or not; Brown, 2002; Clarke et al., 2007). Although we do not suggest the wholescale movement of manhole covers (a task that would be highly disruptive and unreasonably costly), when existing works are being undertaken, or where new developments are planned, further consideration should be paid to the effects of infrastructure on motorcyclists.

4.2. The case of bicycle users

Where motorcyclists made more comments on road surface quality than drivers, the cyclist participants stood out even more; for those on bicycles, the quality of the road surface had a major influence on experience (reflecting findings reported elsewhere, e.g., Habib, Mann, Mahmoud, & Weiss, 2014). This concern extended to reference to rubbish (or litter) in the roadway, something that did not arise in the motorcyclist or car driver transcripts. In addition to being at risk of being more seriously affected by such factors, cyclists are exposed to them to a greater extent due to the perceived need to position themselves towards the edge of the roadway. This positioning is also relevant to being doored (i.e., having a car door suddenly open in one's path of travel), a well-known issue for cyclists (e.g., Johnson, Newstead, Oxley, & Charlton, 2013; Lawrence, Oxley, Logan, & Stevenson, 2018) that came through in the verbal reports of our participants (although also potentially catastrophic for motorcyclists, those users usually take the centre of the lane, hence it presents less of a concern; this was reflected in the lesser extent to which it was referenced by that group).

References to road position highlighted an additional area in which cyclists stood out. Our study route contained no fully segregated cycle lanes, with the only cycling infrastructure on the ~10.5 km route being two sections of painted, on-road cycle lanes (one of approximately 500 m length, the second of approximately 400 m). As such, cyclists had to assert their own space. The expression of submission and deference to others, in terms of feeling the need to stop and pull in to let cars past and being apologetic for taking up space and holding up traffic, contrasted with the assertiveness (of positioning) required to complete their journey safely and in a reasonable time. This conflict likely contributed to the large group differences observed in the verbalisation of emotion, be it fear, relief, or anger. Cyclists made more of these types of comments than motorcyclists (who in turn made more than drivers, as discussed above). As discussed above, our results therefore add to Samuel et al.'s (2019) work on the emotional dynamism of motorcycling, extending it to demonstrate the additional level of emotionality in cycling. As described in the introduction, this result was found through taking an inductive, theory-agnostic approach, in contrast to Samuel et al., who specifically focussed on emotional experience by framing their work using Russel's circumplex model of affect (Russell, 1980).

One manifestation of cyclist emotionality was the relief verbalised by cyclists upon finding suitable cycling infrastructure and the frustration at encountering unsuitable infrastructure. This result, and the prominence of road positioning in the cyclist transcripts, is likely to be highly dependent on the nature of our study route, i.e., there was no segregated cycling infrastructure at all, with the small sections of dedicated cycle lanes that were present only being so in the form of painted lines on the road surface (without any road widening activity having previously taken place). Infrastructure has a major influence on road user experience, and the benefits of dedicated cycling infrastructure are now well documented (e.g., Aldred, Croft, & Goodman, 2019). This point also arose in the driver transcripts, with the implication that car drivers would benefit from improved cycling infrastructure through removal of the fear or confusion that arises from close interaction with the low-speed, vulnerable group ("*Cyclists concern me, I never really know how much space to give them*" Ppt 35, car). Nevertheless, the construction or alteration of infrastructure is, for a variety of reasons, not always immediately practicable. Given the importance of road surface quality to cyclists, and its potential for high impact (on road user experience) at a relatively low cost (e.g., Munster, Koorey, & Walton, 2001), it would be highly beneficial for its improvement to be made a priority.

To return to the emotional experience, riding a bicycle has the potential to bring about feelings of relief and happiness, something that came through in our participants' verbalisations. Indeed, Zhu and Fan (2018) found cycling to be the 'happiest' of transport modes; although many of the positive remarks made by our participants were about finding infrastructure, or being relieved at the safe action of another (and the avoidance of danger), there were also comments about the ability to pass cars in a queue, being able to enjoy the sunshine, and feeling like one is getting the benefit of exercise.

The benefits notwithstanding, for someone on a bicycle the road environment is one that is often characterised by fear and intimidation (see also Pánek & Benediktsson, 2017). This is likely to have influenced the way participants spoke of the things around them; where motorised vehicle users made more comments simply describing the environment and other road users (i.e., their presence or absence), cyclists made a larger proportion of statements assigning some quality judgement (e.g., perception of size or speed, a user's driving style or skill level, the quality or suitability of infrastructure). Research has demonstrated that a heightened sense of emotional arousal (like that experienced by our cyclist participants) leads to judgements that are more pronounced than they would be given a relaxed state (see attribution explanations of arousal and judgement; e.g., Schachter & Singer, 1962; Zillmann, 1978). This would explain why our drivers did not exhibit the same tendency to make such value judgements (i.e., their driving experience was not as emotionally charged).

This tendency to make value judgements may well contribute to the 'us and them' mentality spoken of in both the academic and wider literature (e.g., Brown, 2018; Hoekstra, Twisk, & Hagenzieker, 2018). Although our drivers did not judge cyclists to the same

extent (partly because there were far fewer car-bicycle interactions in the drivers' transcripts than in the cyclists'), this tendency to judge others in emotional situations is almost certainly compounded by a lack of empathy and understanding between road user groups. This is relevant for both groups; just as an individual who wants to use a bicycle has no requirement to first understand the rules governing the vehicles with whom they will share the road environment, many drivers will have had little experience of what it is like to cycle on the UK's roads; wide-scale, readily accessible bicycle training, for all ages, still does not exist in the UK (e.g., Goodman, van Sluijs, & Ogilvie, 2015). Training such inter-group understanding (and, therefore, empathy) could therefore provide a fruitful avenue for future study.

4.3. Study limitations

This research has a number of limitations that must be noted. Although rarely a goal of qualitative research, we feel it necessary to point out that the sample is not representative of the wider road user population. First, the gender balance was not equal in the sample. Although our sample does, to a certain extent, reflect on-road reality (in the UK), to encourage greater gender equity in transport (something currently lacking, e.g., Mejia-Dorantes, 2018; Ravensbergen, Buliung, & Sersli, 2020), academics should also strive for gender equality in their research. Second, none of our cyclists was over 65, and none of our drivers was under 25. This is indicative of the fact that different people will be attracted to different modes of transport. As such, the exploration of the impact of age and gender on road user experience represents another potentially interesting avenue for further study.

Secondly, we have not investigated the influence of experience with a given transport mode (in terms of number of years of use, or regularity of use) on participants' verbal reports. There is a wealth of research on the effect of experience and exposure on driving, riding, and cycling performance, and although not within the scope of the current investigation, its importance is clear. For example, it is those who use bicycles least that must be best supported by any system hoping to increase active transport levels. Relatedly, we did not ask participants specifically about their familiarity with the study route. Although all participants were residents of the city (hence would have very likely been familiar with at least parts of the route), differing levels of familiarity would likely have an impact on a person's experience navigating a given route. To explore these issues, e.g., by studying the effect of route familiarity or mode experience on the affective experience of a journey, would present yet another interesting avenue for deeper investigation.

Finally, analyst bias is an inherent part of qualitative thematic analysis; the analyst is intimately involved in the production of the research. The lead author, who performed all analyses, is primarily a bicycle user (using the bicycle most days to travel to work) but also a driver (using the car around once a week). This author also maintains the strongly held belief that for a transport system to function to the benefit of society (in terms of health, well-being, and sustainability) active transport must represent a much larger proportion of journeys (and the private car a much lower proportion) than is currently the case. This will have affected his interpretation of the transcripts, and therefore the development and application of the coding scheme. Had a different individual performed the analyses, a different coding scheme would likely have resulted; however, just as with different methods of studying thinking, results from different analysts would simply be different, they would not necessarily be better or worse, or more or less accurate (e.g., Eccles & Arsal, 2017). We would therefore argue that the insights revealed by the analysis presented above remain valid, useful, and relevant to the transport research, practice, and policy community.

5. Conclusions

This study has used a qualitative approach to investigate the subjective experiences of cyclists, drivers, and motorcyclists using the UK road system, contributing to our knowledge of road user requirements and to our understanding of the differences between different road user groups in cognition and emotion. It was clear from the verbalisations made by participants that each of the groups included had differing concerns and needs, with cyclists referring more to road surface quality and road positioning, motorcyclists concerned more with vigilant observation, and car drivers primarily focussed on the physical task of controlling their vehicle. Differences in the participants' affective experience also came through strongly; building Samuel et al.'s (2019) work with motorcyclists, our results highlighted the heightened emotionality associated with use of two-wheelers, particularly the bicycle.

This has important ramifications for policy and practice. If we are to build a more sustainable road transport system we will need to see more users of two-wheeled vehicles. To encourage such modal shift, not only does safety need to improve, but people's perception of safety, something that is especially important for those considering a shift in mobility practices. If we are to achieve the proposed benefits of greater motorcycle and bicycle uptake (e.g., Cox & Mutel, 2018; Gössling, Choi, Dekker, & Metzler, 2019; Götschi, Garrard, & Giles-Corti, 2016; Hatfield & Boufous, 2016; Singleton, 2019) we must make it safer and more enjoyable for those already using those modes, as well as more appealing to those that currently are not.

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.

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