Does experience affect perceived risk of cycling hazards?

Emma Bill (University of Strathclyde)
David Rowe (Physical Activity for Health)
Neil Ferguson (University of Strathclyde, Civil and Environmental Engineering)

Contact e-mail of main author: emma.bill@strath.ac.uk

ABSTRACT

A significant barrier to mainstreaming cycling is that it is perceived as a risky activity. An online survey was circulated during October 2014 to commuter cyclists and individuals who were considering cycling to work. Respondents (n=213) included 42% of females and 30% of novice and intermediate cyclists. Question one investigated the likelihood of encountering thirteen cycling hazards; on the basis of having encountered each hazard, question two considered the likelihood of being involved in an accident; finally, having been involved in an accident, question three considered the anticipated severity of injury associated with each hazard. Hazards included interactions with motorised vehicles, active users, and hazards relating to the state and quality of the road environment. Based on initial analysis of Likert scale responses (1 – 7), hazards perceived to be encountered more often were not the same hazards as those perceived as more likely to result in an accident. Respondents perceived interactions with large vehicles to result in the most severe injuries. Interactions with other motorised vehicles, including cars, were also perceived to result in severe injuries. Mean scores for females, novice and intermediate cyclists, were generally higher. Ordered logit modelling was undertaken to investigate perceived risk of cycling among two groups: experienced cyclists and a combined group of novice and intermediate cyclists. When controlling for age and gender, statistically significant differences were found for one hazard in question one, and three hazards in question two. Gender was found to be statistically significant for two hazards in question one, five hazards in question two, and one hazard in question three. Cycling hazards carry different levels of perceived risk. Perceived risk of cycling hazards is likely to be effected by individual factors, such as, age, gender, and cycling experience. Interventions to improve safety perceptions of cycling should consider specific hazards with respect to these factors.

1. INTRODUCTION

Promoting cycling has social, economic, and environmental benefits. First, regular active travel provides an opportunity to tackle current health challenges facing society (obesity, coronary heart disease, stroke, type-2 diabetes, depression, and some cancers). Recommended levels of physical activity (i.e. 150 minutes a week) could be achieved through regular walking and cycling (Department of Health, 2011). Second, the costs associated with congestion and road traffic accidents can be minimized following increased walking and cycling. Third, travelling to work by foot or by bicycle may lead to reductions in transport-related carbon emissions and other harmful pollutants (Maibach et al. 2009). Despite these multiple benefits, a significant barrier to mainstreaming cycling is that it is perceived as a risky activity (National Institute for Health and Care Excellence, 2012). At a national level, cycling has remained at 2% of all journeys for a number of years (Department for Transport, 2013). Though, over the past fifteen years some UK local areas have seen increases in cycling (Aldred, 2015).

Perceived risk of cycling has received intermittent attention from researchers during the previous two decades. Authors have considered network-specific variables including the presence and quality of cycling infrastructure (e.g. segregated and on-road cycling facilities), road geometry (e.g. lane width), and the operation and regulation of the road environment (e.g. traffic speed, traffic volume) (See Lawson et al. (2013) for a review of studies). Cycling facilities are expected to modify perceptions of the safety of the environment (Winters et al., 2012). However, traffic remains a key concern for cyclists and potential cyclists (Sanders, 2015), and a lack of dedicated cycle infrastructure is a significant deterrent to mass cycle use (Pooley et al., 2011). In addition to network-specific variables (Parkin and Meyers, 2010), research has shown that driver overtaking behaviour may also be dependent on the image and perception of the cyclist. Ultimately, these studies bring into question the role of some cycling facilities, such as on-road cycle lanes, in making cycling [feel] safer.

Parkin et al. (2007) confirmed the significance of perceived risk in relation to cycling behaviour. In this paper, risk is viewed as being subjectively biased, which is consistent with the psychometric paradigm. One of the most important assumptions within the psychometric approach is that risk is inherently subjective; to paraphrase Slovic (1992), risk is not independent of our minds and cultures. The examination of diverse groups has demonstrated that psychometric scaling can identify and quantify similarities and differences in risk perceptions and attitudes among groups (Slovic et al., 1985). The downside of this measurement is that it does not reveal why and how individuals differ in their risk perception (van Winsen et al., 2011).

The road environment for cyclists can involve many potentially hazardous situations. Beyond the general finding that many people fear bicycling next to motorized traffic there is little understanding about perceived traffic risk (Sanders, 2015). Moreover, few studies on perceived risk of cycling have considered the effect of road user-specific variables (e.g. age, gender, level of experience) (Lawson et al., 2013). In this research, individual situations were presented to online survey respondents, who were asked to rate thirteen cycling hazards in terms of three dimensions: (i) the likelihood of encountering the hazard; (ii) having encountered the hazard, the likelihood of being involved in an accident; (iii) having been involved in an accident, the perceived severity of injury related to the hazard. This paper focuses on the effect of level of experience of cycling on the perceived risk of cycling hazards.

2. LITERATURE REVIEW

During the previous two decades there have been several key studies on perceived risk of cycling (e.g. Landis et al., 1997; Møller and Hels, 2008; Parkin et al., 2007; Sorton and Walsh, 1994). However, despite a wider acknowledgement that it is a significant barrier to mainstreaming cycling in the UK (National Institute for Health and Care Excellence, 2012), perceived risk of cycling is currently under researched.

A study by Møller and Hels (2008) in Denmark concluded that roundabouts with a cycle facility generally were perceived as safer than roundabouts without a cycle facility. The authors speculated that this finding is due to a sense of control and predictability created by the clear segregation of cyclists from other road users. Although counterintuitive, Parkin et al. (2007) found the presence of facilities on roundabouts to increase the perceived risk of cycling. They also found that the presence of facilities along motor trafficked routes and at junctions generally did not have a significant effect on perceived risk. Perceived risk was lowest in traffic free conditions. It was noted in this latter study that participants may have considered the presence of facilities to imply the presence of a hazardous situation, deterring potential users. While it may be possible to conclude that these studies contradict one another, it should be noted that contrasting methodologies are used. While Møller and Hels employed a user intercept survey (i.e. interview), the latter study required cyclist and non-cyclist participants to rate combinations of routes and junctions which mimicked real potential journeys (Parkin et al. 2007). Moreover and previously considered by Reynolds et al. (2009) the terminology used for different cycling infrastructure, and what is considered typical infrastructure, may very across countries, influencing the extent to which direct comparisons can be made.

Research has compared the objective risk of cycle facilities with subjective assessments of the infrastructure. Based on 690 injured adult cyclists who visited emergency departments in Toronto and Vancouver, Winters et al. (2012) concluded that most route types that were perceived as higher risk were found to be so objectively (major streets with shared lanes or without any bicycle infrastructure). Similarly, most route types perceived as safer were also found to be so (residential streets, designated as bike routes or not, with or without traffic calming), major streets with bike lanes (with or without parking) and off-street paths for bikes only. Discrepancies were observed for cycle tracks (perceived as less safe than observed) and for multi-use paths (perceived as safer than observed). Perceived risk was calculated as the mean response of study participants to the question: “How safe do you think this site was for cyclists on that trip?” with a 5-point response scale (very safe to very dangerous). Study limitations included the fact that injured individuals may have had heightened perceptions of risk at any site (injury or control) following an injury event. Also, less severe injuries and potential crashes that do not require hospital admission were not considered. Recently, Sanders (2015) has drawn attention to a lack of empirical knowledge about how certain aspects of traffic risk rank against others, and has provided evidence to support the impact of near misses on perceived risk of cycling.

3. METHODS

Thirteen cycling hazards were identified through a literature review of key references in the field. Additionally, the main author viewed video footage shot from a cyclist’s perspective[1] to identify typical hazards encountered when cycling on the road. The results are summarised in Table 1. Road safety statistics at the national and local level, as well as existing research, confirm that road user (predominantly driver) behaviour is the greatest contributor to crashes (Department for Transport, 2014; Shaw et al. 2012). Therefore, these hazards were considered to be important when researching perceived risk of cycling. Eight of the hazards listed in Table 1 relate to driver behaviour, three hazards relate to pedestrian and cyclist behaviour, and two hazards focus on the environment.

Members of the University of Strathclyde’s Bicycle Users Group assisted in the survey design during a small pilot exercise prior to wider circulation. The structure of the first three questions included elements of a standard risk assessment protocol (University of Strathclyde, 2010). Question one investigated the likelihood of encountering each of the thirteen cycling hazards; on the basis of having encountered each hazard, question two considered the likelihood of being involved in an accident; finally, having been involved in an accident, question three considered the anticipated severity of injury associated with each hazard. Finally, respondents were asked to specify their age, gender and self-reported level of cycling experience. Two questions assessed respondents’ level of experience of cycling. In this research, the self-reported level of experience of cycling was considered to be the optimum classification criteria, explained below.

[1] First, video footage, recorded on behalf of Glasgow City Council Future Cities, was viewed. These videos showed seven cycle routes in Glasgow, recorded from the cyclist’s perspective. Interactions between users were noted. Second, using a GoPro camera additional footage was recorded at on-road sections on three of these routes where cyclists were required to interact with motorised traffic and other active users.

Table 1: Sources used to identify cycling hazards

Hazard	Source
1. Bus moving into cyclist's path	Joshi & Smith (1992) Frings et al. (2014) Authors' video footage
2. Car door opening in cyclist's path	Wood et al. (2009) Pucher et al. (1999)
3. Car overtaking too closely	Joshi & Smith (1992) Connor and Brown (2010) Parkin and Meyers, (2010) Walker (2007) Authors' video footage
4. Large vehicle (e.g. lorry, bus, van) overtaking too closely	Frings et al. (2014) Authors' video footage
5. Other cyclist overtaking too closely	Aldred (2013)
6. Overtaking another cyclist who is cycling too slowly	GCC video footage
7. Overtaking parked vehicles	Joshi & Smith (1992)
8. Pedestrian crossing into cyclists' path	GCC video footage
9. Road works	GCC video footage
10. Uneven road surfaces (e.g. potholes)	Joshi & Smith (1992) Scottish Household Survey (2013) GCC footage Authors' video footage
11. Vehicles emerging from junction into cyclists' path	Joshi & Smith (1992) Wood et al. (2009) Chaurand and Delhomme (2013)
12. Vehicles positioned in advanced stop box (ASB) waiting at traffic lights	Johnson et al. (2014)
13. Verbal abuse from drivers	O'Connor and Brown (2010)

In this survey, two seven item scales were adapted from Noland and Kunreuther (1995), who were investigating policies to discourage car use and promote active transport. Noland and Kunreuther (1995) sought to understand (i) the likelihood of being in an accident according to the selected mode of transport, and (ii) anticipated injury severity following an accident if using said mode of transport. In contrast, the focus of the present study was to understand the perceived risk of specific *hazards* encountered by cyclists using the road network. First, respondents were required to rate individual cycling hazards, as opposed to the risks associated with cycling in general. Second, this survey included three, as opposed to, two questions. In addition to asking respondents to rate the likelihood of an accident associated with each hazard and the anticipated severity of injury following such an accident, an additional question required an assessment of the likelihood of encountering each hazard. Sanders (2015) has suggested that cyclists' near misses may be particularly important to understand because they psychologically and physically resemble crashes, differing only in the avoidance of a collision at the last moment, and they are likely to occur more frequently than crashes. Table 2 shows the adapted scale (item 4, question 1). The seven item scale in question 3 was unchanged.

Table 2: Seven item scales used in survey

<table>
<tr><th>Likelihood of encountering hazards</th><th>Having encountered hazard, likelihood of being involved in an accident</th><th>Having been involved in an accident, anticipated injury severity associated with each hazard</th></tr>
<tr><td colspan="2">1 = Almost certain not to happen</td><td>1 = No injuries whatsoever</td></tr>
<tr><td colspan="2">2 = Very unlikely</td><td>2 = Minor scrapes and bruises</td></tr>
<tr><td colspan="2">3 = Somewhat unlikely</td><td>3 = injuries requiring medical attention but no hospital stay</td></tr>
<tr><td>4 = 50% chance of encountering hazard</td><td>4 = 50% chance of an accident resulting from the hazard</td><td>4 = Injuries requiring short hospital stay of a few days</td></tr>
<tr><td colspan="2">5 = Somewhat likely</td><td>5 = Injuries requiring lengthy hospital stay of several months with full recovery</td></tr>
<tr><td colspan="2">6 = Very likely</td><td>6 = Permanently disabling injuries</td></tr>
<tr><td colspan="2">7 = Almost certain to happen</td><td>7 = Fatal injuries</td></tr>
</table>

An online survey of cyclists and individuals who were considering cycling to their current workplace in Scotland and the rest of the UK was circulated on 15th October 2014 and closed on 28th October 2014. Initially, the survey targeted the Scottish-based cycle campaign group 'Pedal on Parliament' and a cycle group for women living in or around Glasgow 'Belles on Bikes'. An advertisement was also placed on the University of Strathclyde online learning system. It is likely that the majority of self-selecting respondents were based in Scottish cities, predominantly, Glasgow and Edinburgh. However, given that the survey was not addressed to individuals and included instructions to share the survey with other cyclists and individuals who were considering cycling to work, a number of respondents were expected to come from other parts of the UK. Though it would not be impossible for respondents to be based outside of the UK, it is unlikely given that information on the nature of potential respondents (i.e. inclusion criteria) was circulated together with the survey link. Also, the survey was open for a limited time and peaks in responses were noted following circulation to different groups during that period.

Two-hundred and thirteen people completed the survey in full. Additionally, sixty two people started the survey and did not complete it. Of the latter group, no responses were included the analysis. It is assumed that these respondents subsequently withdrew their consent (i.e. they did not give permission to use their responses), they became bored or uninterested or ran out of time.

4. RESULTS I: DESCRIPTIVE STATISTICS

Tables 3 and 4 include respondents' demographics and self-reported level of experience of cycling. The largest age group comprised those aged 25 to 34. Half of respondents who regarded themselves as experienced cyclists were male, while 20 per cent of respondents who identified with this group were female. Twenty-two per cent of respondents who regarded themselves as novice and intermediate cyclists were female, while 8 per cent of respondents who identified with this group were male. Aldred (2015) confirms that in low-cycling countries cycling is not evenly distributed across genders and age groups, and in the UK, men are twice as likely as women to cycle to work and cycling tends to be dominated by younger adults.

Table 3: Age and level of experience of cycling

Age	Level of experience of cycling		Total
	Novice and intermediate	Experienced	
18 – 24	10	6	16
25 – 34	24	78	102
35 – 44	16	40	56
45 – 54	10	17	27
55 – 64	3	8	11
Total	63	149	212*

*One respondent could not be classified as they did not complete all of the relevant questions

Table 4: Gender and level of experience of cycling

		Level of experience of cycling		Total
		Novice and intermediate	Experienced	
Gender	Female	46	43	89
	Male	17	105	122
Total		63	148	211*

*Two respondents could not be classified as they did not complete all of the relevant questions

Table 5, below, highlights the complexity in grouping respondents in terms of their level of experience of cycling, and demonstrates that cycling experience is not necessarily indicative of cycling frequency. Individuals' responses to different questions appear conflicting, and may not reveal the complete picture. However, as individuals' perceptions of their cycling skills are associated with assessments of perceived risk of cycling hazards, and ultimately the way they might behave in certain [traffic] situations (Dixit et al. 2013), in this research, self-reported level of experience of cycling was considered an optimum criterion.

Table 5: Cycling status vs. level of cycling experience of cycling

		Level of experience of cycling			Total
		Novice	Intermediate	Experienced	
Cycling status	You have never used a bike to travel to work but have considered using one.	1	3	2	6
	You rarely or sometimes use a bike for travel and have considered using one.	2	13	10	25
	You often use a bike for travel to work.	2	31	55	88
	You always use a bike for travel to work.	1	10	81	92
Total		6	57	148	211*

*Two respondents could not be classified as they did not complete all of the relevant questions

Table 6, below, shows respondents' mean scores for the three questions overall and disaggregated by cycling experience. The three highest scoring hazards for each question are highlighted in bold. Generally, mean scores for novice and intermediate cyclists were higher than mean scores for experienced cyclists.

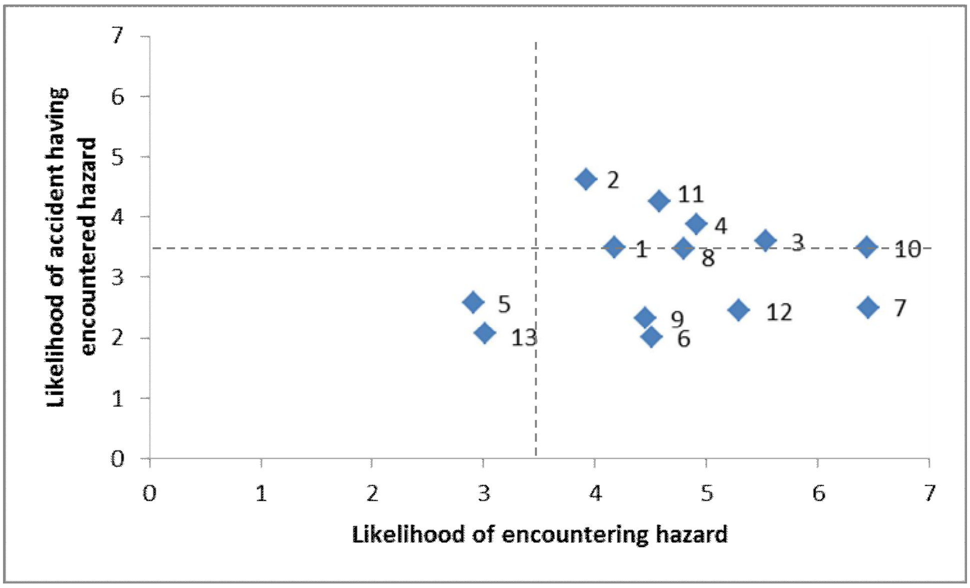
With reference to Question 1, relative to experienced cyclists, novice and intermediate cyclists considered it more likely that they would encounter twelve of the thirteen hazards. The exception to this trend for question 1 was for the hazard 'overtaking slower moving cyclist'.

Hazards perceived to be encountered more often (overtaking parked vehicles; uneven road surfaces; car overtaking too closely) were not the same hazards as those perceived as more likely to result in an accident (car door opening in cyclists' path; vehicle emerging from junction into cyclists' path; large vehicle overtaking too closely). Respondents perceived interactions with large vehicles to result in the most severe injuries. To a lesser extent, interactions with other motorised vehicles, including cars, were also perceived to result in severe injuries.

Table 6: Overall mean scores and mean scores of experienced and novice/intermediate cyclists for the three risk perception questions. The three hazards that received the highest mean scores are highlighted in bold. Brackets indicate first, second, and third highest mean scores.

Question	Likelihood of encountering hazard			Likelihood of being in an accident			Anticipated severity of injury		
Hazard	Overall encounter	Experienced encounter	Intermediate/ novice encounter	Overall accident	Experienced accident	Intermediate/ novice accident	Overall severity	Experienced severity	Intermediate/ novice severity
1. Bus moving into cyclists' path	4.18	4.07	4.46	3.50	3.27	4.03	**4.85 (2)**	**4.76 (2)**	**5.07 (2)**
2. Car door opening in cyclists' path	3.93	3.76	4.35	**4.63 (1)**	**4.49 (1)**	**4.98 (1)**	4.09	4.06	4.17
3. Car overtaking too closely	**5.54 (3)**	**5.50 (3)**	**5.65 (3)**	3.61	3.44	4.02	4.44	4.44	4.45
4. Large vehicle overtaking too closely	4.92	4.81	5.18	**3.87 (3)**	**3.71 (3)**	**4.24 (3)**	**5.43 (1)**	**4.76 (1)**	**5.42(1)**
5. Other cyclist overtaking too closely	2.91	2.81	3.16	2.59	2.52	2.76	2.34	2.33	2.37
6. Overtaking another cyclist who is cycling too slowly	4.51	4.77	3.90	2.02	1.92	2.26	2.15	2.11	2.24
7. Overtaking parked vehicles	**6.46 (1)**	**6.46 (1)**	**6.48 (2)**	2.51	2.33	2.95	2.62	2.56	2.75
8. Pedestrian crossing into cyclists' path	4.80	4.64	5.18	3.47	3.39	3.66	2.71	2.74	2.63
9. Road works	4.46	4.39	4.62	2.33	2.18	2.68	2.52	2.47	2.61
10. Uneven road surfaces	**6.45 (2)**	**6.42 (2)**	**6.52 (1)**	3.50	3.34	3.89	2.92	2.83	3.14
11. Vehicles emerging from junction into cyclists' path	4.58	4.45	4.90	**4.27 (2)**	**4.12 (2)**	**4.60 (2)**	**4.66 (3)**	**4.55 (3)**	**4.93 (3)**
12. Vehicles positioned in ASB waiting at traffic lights	5.30	5.32	5.25	2.45	2.37	2.65	2.33	2.30	2.39
13. Verbal abuse from drivers	3.02	2.88	3.35	2.08	2.03	2.19	1.58	1.56	1.61

Figure 1: Overall mean scores for likelihood of encountering hazard (Question 1) vs. having encountered the hazard, likelihood of accident (Question 2)



The mean scores of the perceived likelihood of encountering each hazard were plotted against perceived likelihood of the hazard resulting in an accident (Figure 1). The top right hand quadrant is most important as it signifies combined higher likelihood of encountering hazard and higher likelihood of accident given that hazard has been encountered. Six hazards can be found in this 'high risk' quadrant (2 = car door opening in cyclist's path; 11 = vehicles emerging from junction into cyclist's path; 4 = large vehicle overtaking to closely; 3 = car overtaking too closely; 10 = uneven road surfaces; 1 = bus moving into cyclist's path). For these hazards overall mean scores for questions one and two were equal to or greater than 3.5.

Figure 2: Mean scores for experienced (group 1) novice and intermediate (group 2) cyclists likelihood of encountering hazard (Question 1) vs. having encountered the hazard, likelihood of accident (Question 2)

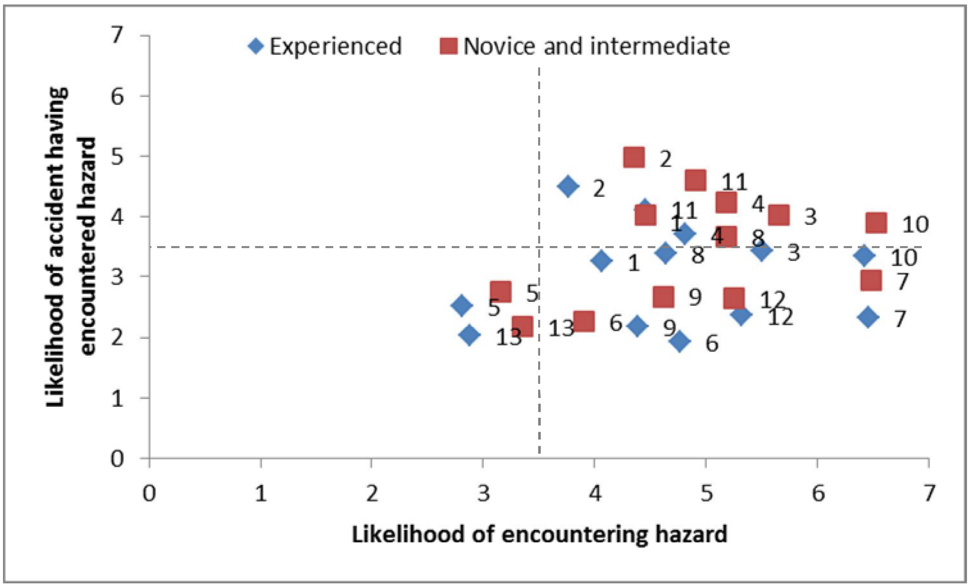


Figure 2 shows that three hazards remained in the 'high risk' quadrant for both experienced, novice and intermediate cyclists (2 = car door opening in cyclist's path; 11 = vehicles emerging from junction into cyclist's path; 4 = large vehicle overtaking too closely). For these three hazards mean scores for questions one and two, disaggregated by experience, were greater than 3.5.

5. RESULTS II: ORDINAL LOGISTIC REGRESSION

Ordinal logistic regression models were developed for each hazard for the three questions without controlling for age and gender. Though these initial models are not reported in this paper, statistically significant differences were found between experienced and novice and intermediate cyclists for seven hazards in question one, (car door opening in cyclist's path; other cyclist overtaking too closely; overtaking another cyclist who is cycling too slowly; pedestrian crossing road into cyclist's path; vehicles emerging from junction into cyclist's path; vehicles positioned in advanced stop box waiting at traffic lights; verbal abuse from drivers), nine hazards in question two, (bus moving into cyclist's path; car door opening in cyclist's path; car overtaking too closely; large vehicle overtaking too closely; overtaking another cyclist who is cycling too slowly; overtaking parked vehicles; road works; uneven road surfaces; vehicles emerging from junction into cyclist's path), and one hazard in question three (vehicles emerging from junction into cyclist's path). Following the inclusion of age and gender in the models, the significance of cycling experience remained for one hazard in question one (table 7) and three hazards in question 2 (tables 8 - 10). Gender was shown to be significant for two hazards in question one (pedestrian crossing road into cyclist's path; verbal abuse from drivers), five hazards in question two (bus moving into cyclist's path; car overtaking too closely; large vehicle overtaking too closely; uneven road surfaces; vehicles emerging from junction into cyclist's path), and one hazard in question three (vehicles emerging from junction into cyclist's path). Age was shown to be significant for one hazard in question two (car overtaking too closely).

Table 7: Ordinal logistic regression (age, experience, gender) perceived likelihood of encountering another cyclist who is cycling too slowly (Question 1)

Variable		**Coefficient**	**Standard Error**	***p*-value**
Experience	Novice and intermediate Experienced	-0.748 -	0.302 -	0.013 -
Gender	Female Male	-0.439 -	0.274 -	0.109 -
Age	18 – 24 25 – 34 35 – 44 45 – 54 55 – 64	0.535 0.971 0.229 -0.399 -	0.701 0.567 0.586 0.633 -	0.445 0.163 0.696 0.528 -
Summary Statistics Intercept 269.050 Final 243.778 Chi-Square 25.272 Sig. 0.000 Cox ad Snell 0.113 Nagelkerke 0.116 McFadden 0.033				

The model presented in Table 7 indicates a good overall fit. The coefficient for novice and intermediate shows that experienced cyclists were more likely to perceive more frequent encounters with 'another cyclist who is cycling too slowly', compared to the former group. This is unsurprising given that experienced cyclists may cycle at higher speeds relative to novice and intermediate cyclists.

It is speculated that this may also be related to infrastructure preferences for the most direct routes by experienced cyclists, likely to involve main roads. Mean responses to this hazard in question one support this (table 6) (overall mean = 4.51; experience mean = 4.77; novice and intermediate mean = 3.90).

Table 8: Ordinal logistic regression (age, experience, gender) perceived likelihood of being involved in an accident, following encountering a bus moving into cyclist's path (Question 2)

Variable		**Coefficient**	**Standard Error**	***p-value***
Experience	Novice and intermediate Experienced	0.639 -	0.308 -	0.038 -
Gender	Female Male	0.835 -	0.285 -	0.003 -
Age	18 – 24 25 – 34 35 – 44 45 – 54 55 – 64	-0.310 -0.550 -4.29 -0.316 -	0.709 0.576 0.597 0.643 -	0.965 0.340 0.472 0.623 -
Summary Statistics Intercept 248.427 Final 223.482 Chi-Square 24.946 Sig. 0.000 Cox & Snell 0.113 Nagelkerke 0.117 McFadden 0.036				

The model presented in Table 8 indicates a good overall fit. The coefficient for level of experience shows that the subjective assessment of the likelihood of an accident in a situation where a bus has moved into a cyclist's path was significantly higher for novice/intermediate cyclists than experienced cyclists. In terms of anticipated severity of injury (question 3), interactions with large vehicles were perceived to result in the most severe injuries. Novice and intermediate cyclists were expected to be less confident in dealing with large vehicles, particularly as they may have little to no experience on busy roads when travelling by bike. Experienced cyclists are more likely than novice and intermediate cyclists to have developed the hazard perception skills that enable them to better understand how drivers of large specific vehicles are likely to act, and thus respond accordingly. Mean scores in table 6 support this (overall mean = 3.50; experienced mean = 3.27; novice and intermediate mean = 4.03). The latter novice and intermediate score meets the 3.50 threshold illustrated in figures 1 and 2.

Table 9: Ordinal logistic regression (age, experience, gender) perceived likelihood of being involved in an accident, following encountering overtaking parked vehicles (Question 2)

Variable		Coefficient	Standard Error	*p-value*
Experience	Novice and intermediate Experienced	0.747 -	0.314 -	0.017 -
Gender	Female Male	0.428 -	0.283 -	0.131 -
Age	18 – 24 25 – 34 35 – 44 45 – 54 55 – 64	-0.185 -0.152 -0.153 -0.193 -	0.718 0.580 0.613 0.653 -	0.797 0.794 0.799 0.768 -
Summary statistics Intercept 190.028 Final 176.571 Chi-Square 13.457 Sig. 0.036 Cox & Snell 0.033 Nagelkerke 0.066 McFadden 0.022				

Table 10: Ordinal logistic regression (age, experience, gender) perceived likelihood of being involved in an accident, following encountering road works (Question 2)

Variable		Coefficient	Standard Error	*p-value*
Experience	Novice and intermediate Experienced	0.716 -	0.316 -	0.023 -
Gender	Female Male	0.443 -	0.286 -	0.121 -
Age	18 – 24 25 – 34 35 – 44 45 – 54 55 – 64	0.804 -0.804 -1.108 -0.502 -	0.724 0.588 0.607 0.655 -	0.267 0.059 0.408 0.229 -
Summary statistics Intercept 176.560 Final 157.551 Chi-Square 19.048 Sig. 0.004 Cox & Snell 0.087 Nagelkerke 0.093 McFadden 0.033				

While there were significant differences between experienced and novice and intermediate cyclists' for the hazards in Tables 8 and 9, mean scores indicate that these hazards, relative to other hazards listed, were less likely to be perceived (i) as a frequent encounter and (ii) to result in an accident. Therefore, statistically significant differences here have less importance with regards to reducing perceived risk of cycling hazards, and therefore encouraging cycling.

6. CONCLUSION

This paper has reported on survey results concerning commonly-encountered cycling hazards. Generally, novice/intermediate cyclists had higher mean scores than experienced cyclists and demonstrated heightened risk perceptions of hazards faced by cyclists using the road network. Study findings suggest that cyclists perceived interactions with large vehicles as risky, particularly with regard to severity of injury sustained following an accident. Previous research has also indicated that large vehicles increase perceived risk of cycling (Frings et al. 2014). Particularly for novice and intermediate cyclists, perceived risk of hazards involving interactions with motorised vehicles may lead them to avoid using routes where they are likely to encounter large vehicles (i.e. usually the most direct routes), cycle less frequently, or make the decision to not cycle at all. Statistically significant differences were found between perceived risk of cycling hazards among experienced and novice/intermediate cyclists with regards to two components: (i) the likelihood of encountering a hazard; (ii) having encountered the hazard, the likelihood of being involved in an accident. However, gender may be a better predictor of perceived risk of cycling hazards.

Though these results indicate that perceived risk of cycling hazards may be dependent on cyclist-specific variables (age, experience, gender), the results do not shed light on the reasons behind these differences. To address further limitations of survey data, and associated subjective estimates of perceived risk, some have considered the use of physiological measures of perceived risk to obtain a less bias measure of risk perception (Chaurand and Delhomme, 2013). The following stage of this research study has involved monitoring cyclists' and potential cyclists' physiological responses (heart rate, skin conductance) to videos showing different cycling environments, and several traffic scenarios encountered when cycling on the roads. Physiological and qualitative data is currently being analysed. In providing support to Sanders (2015) conclusions that near misses are more strongly associated than collisions with perceived traffic risk, interviews have drawn attention to the period immediately after encountering a hazard, and suggest how a near miss situation may lead to some moments of disorientation/stress whereby cyclists are more vulnerable should a situation arise then.

Further research on perceived risk of cycling could be extended by investigating behavioural responses to discrete traffic scenarios and the risks (perceived and actual) associated with them. Methods including video analysis as well as monitoring behaviour in highly controlled simulated environments enable perceived risk of cycling research to expand on what is currently known about important factors such as the infrastructure, operation and regulation of the road environment. While perceived risk of cycling may be modified by improvements to the infrastructure, common interactions encountered by cyclists' on the road, and perceptions of other road users' behaviour, act as a barrier to mainstreaming cycling and should be considered by researchers, policy-makers and transport planning professionals.

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