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Predictors of the frequency and subjective experience of cycling near misses: findings from the first two years of the UK Near Miss Project

Rachel Aldred and Anna Goodman

1. Background

Successfully promoting cycling would bring considerable benefits for population health, greenhouse gas emissions, urban air pollution and congestion (Cabinet Office 2009, Maizlish et al 2013, Woodcock et al 2013, Woodcock 2014). Cycling participation remains low, however, in the UK and many other high-income countries relative to its potential (Lovelace et al 2016; TfL 2010). Although multiple factors may act as barriers to cycling, the most common reason that people give for not cycling is perceived risk (Lawson et al 2013, Horton 2007, Thornton et al 2010). These concerns may partly reflect media over-reporting of road traffic crashes involving cyclists relative to users of other modes (MacMillan 2016), but may also reflect the impact of seeing or experiencing a cycling road injury or 'near miss'.

The latter has traditionally received little research or policy attention, but this has begun to change. Sanders (2015) showed that because of the high frequency of near misses, they have stronger impact on cycling experiences, and potentially withdrawal from cycling, than do injury incidents. New mapping tools such as Collideoscope or bikemaps.org, alongside existing reporting systems run directly by police or transport authorities, have allowed people to report such incidents in real time. There is a growing recognition that non-injury incidents may form a missing link between the relatively low 'objectively measured' injury rate (even in low-cycling contexts) and the high levels of 'fear of cycling' (Aldred 2016).

In the UK, near misses have started to become incorporated within policing and planning policy. For example, in October 2016 West Midlands Police began a work stream focusing on close passes, using an undercover officer to catch and educate drivers who give cyclists little room. This is justified on grounds both of safety and perceived safety. The scheme aims to educate drivers about safe passing distances and create a belief that any cyclist might be an undercover police officer. At the time of writing, 15 other UK police services are planning to introduce such a scheme; while others are introducing or stepping up recording of near miss or dangerous driving incidents (e.g. RoadSafe London[1]).

Within this growing field methods vary, and different methods lend themselves to different types of analysis. One methodological consideration is the duration of time during which participant cyclists are asked to record near misses. Real-time reporting systems recruit cyclists to report near misses for weeks or months at a time which, given the high rate of minor incidents, is likely to be onerous even for self-selecting, committed respondents[2]. Such systems may therefore only capture a minority of near-misses, perhaps the most serious incidents. This may still be useful in recording incidents of greatest

[1] http://content.met.police.uk/Site/roadsafelondon

[2] There is also an issue of self-selection which affects much of this research; in very low-cycling contexts this problem cannot easily be avoided, although it can perhaps be minimised.

concern for policy, but for assessing rates of all types of incident it may be necessary to conduct studies that use a much shorter time period such as a single day.

Definitions of 'near misses' also vary, with some highly subjective and others more objective. As with any research there is a trade-off between capturing individual experience and creating a generalizable measure of that experience. An 'objective' definition of near misses is attractive as in theory it can be independently verified. Much 'near miss' research has hence focused on close passes as these can, with on-bike equipment, be measured (e.g. Walker et al 2014, Walker 2007). Another definition is based on an approach often taken for studying near misses between motorised vehicles, and relates to the taking of evasive action. For example, Matsui et al (2015) state:

> 'A near-miss incident is a situation that a car accident involving a cyclist is avoided by the attention and braking of a driver.'

Similarly, Girotto et al (2016) defined a 'near-miss accident as the performance of an evasive manoeuver **by the driver** [our emphasis] to avoid a vehicle accident'.

By contrast, in many Near Miss Project incidents, cyclists said that they had prevented incidents by modifying their *own* behaviour. More broadly, definitions that rely on evasive action being taken (by any party: driver, pedestrian or cyclist) will not capture incidents such as close passes where neither party in fact swerved, but the experience might still have been unpleasant and intimidating.

However, a subjective definition of near misses raises the question as to whether these experiences can be generalised and reliably counted. Subjectively reported rates may differ sharply depending on how and in what order questions are asked, and how long a recall period the question covered. Sanders (2015) left the time period entirely open, Girotto et al (2016) used a twelve-month period, while Fyhri et al (2016) asked about a specific trip. Different survey methods might imply that a near-miss is a collision only just avoided, or that a near-miss covers a wide range of incident categories. Again, survey design should take account of this depending upon what the research seeks to capture.

One way of assessing the reliability of subjective reporting is to compare rates obtained through objective and subjective measurements, although this may only be possible for some types of near miss, and will depend on the definitions used. For example, Joshi et al (2001) wanted to capture all incidents that caused fear or annoyance to respondents and it is hard to see how this could be directly verified by independent observation. By contrast, verifying rates of close passes is feasible, and this was done in Aldred (2016) which found rates of subjective and objective reporting roughly comparable in the UK context for that specific 'near-miss' incident type.

St-Aubin et al (2015) used automation to identify and analyse near-miss events at a roundabout, identifying evasive action taken and how soon this happened before a collision would have occurred ('time-to-event'). While a highly promising approach this currently would not capture many categories of cyclist-defined incident. Rapid development of such techniques will make it easier to objectively measure some types of non-injury incident, but we should remember that subjectively defined incidents may be important, and measurable, even if they will not easily map to something that can be (at present) objectively measured.

However, clearly it is important to ensure that where experiences are being subjectively measured, these do have some consistency and validity. Using 2014 and 2015 data from the UK Near Miss Project, this paper therefore aims to examine the consistency of incident rates for cycling near misses across these two years. It further examines the consistency of the individual-level predictors of experiencing a near miss, including what influences the scariness of an incident. This builds upon our previous work that only analysed data from the first, 2014, period of data collection (Aldred 2016, Aldred and Crosweller 2015).

In addition, in 2015 the Near Miss Project asked for the first time about cycling experience. This additional question was included because in 2014 we had found that incident rates declined weakly with age (Aldred 2016, Aldred and Crosweller 2015), a finding that might be explained by age acting as a proxy for cycling experience. Our second aim here is therefore to examine whether the incident rate is associated with how much cycling experience participant has, with a particular focus on new cyclists.

Finally, the 2015 Near Miss Project also asked participants for the first time whether they would self-define a non-injury incident as a 'near miss'. We used this to address our third aim, which was to examine what individual and incident characteristics predict perceptions of whether an incident is deliberate, whether it is a near miss, and whether it is very scary.

2. Methods

2.1 Participants

In 2014 and then again in 2015, the Near Miss project recruited a convenience sample of people who cycle. Channels for recruitment included organisational mailing lists, cycling organisations, leafleting (in the first year), traditional and social media dissemination, and re-contacting previous survey participants. Participants were informed that the study focused on cycling near misses and that it should take around 15-20 minutes to complete. Ethical approval for the study was granted by Westminster University.

The recruitment method could introduce bias, if people more prone to near misses sign up. However, given only 2% of trips are by cycle, using more traditional methods to recruit a national sample of cyclists would be difficult and expensive. The study sought to ensure different types of cyclist were represented by using a range of recruitment channels and messages.

Out of an initial sample of 2,668 completed diaries, we removed 66 reporting many incidents (>10) as (i) detailed information was only asked about the first 10 incidents experienced and (ii) people reporting more than 10 incidents could be seen as potential outliers, with unusually high rates of/awareness of non-injury incidents. We further excluded 16 diaries because the same individual had completed two diaries in the same year; in this case we only used the first diary that they completed in that year. This left a final sample of 2586 diaries, 1525 completed in 2014 and 1061 in 2015. 398 participants completed diaries in both 2014 and 2015.

In addition to describing their incidents, participants provided us with some information on individual characteristics. This included their gender, their age, and (in 2015 only) responses to the question "Please tell us how long you have been cycling for, in years". Participants also told us their home postcode, which we used to assign the prevalence of commuter cycling in the participant's local authority, using data from the 2011 Census. We have previously shown that this measure of commuter cycling in the Census is highly correlated, at the population level, with the total amount of cycling in an area (Goodman 2013).

2.2 Data collection on near misses

Participants were asked to nominate in advance one day over a two-week period on which they would record cycle trips and any near miss incidents. On the nominated day, each participant completed an online one-day diary that asked participants to report all cycle trip stages, without exact location details: for example 'Home to Work' or 'Work to Meeting'. Participants were asked for timings of each trip stage and whether any non-injury incidents occurred. If any incidents did occur, participants were asked to locate the incident on a Google map. To allow calculation of a daily incident rate, participants were also asked to estimate the total distance they had cycled across the day and their confidence in this estimate. Many were reporting a repeated journey (typically, commute) while others used apps such as Strava, so confidence was generally high.

The definition of 'incident' was left open, with participants directed to record all events they found 'frightening' and/or 'annoying'. They were asked to separately rate how scary or annoying incidents were; where on each scale 0 represented 'not at all scary' or 'not at all annoying' and 3 'very scary' or 'very annoying'. In the 2015 questionnaire, participants were also asked if they thought an incident was deliberate, and if they would consider it a 'near miss'. Answers to these questions could be 'yes', 'no' and 'unsure'[3]. We asked these two questions because we thought it interesting and important to explore the extent to which a just-avoided collision, and/or overt aggression by another road user, might affect the level of fear generated by an incident.

Participants described each incident separately in a free text field. In 2014 the open descriptions of incidents were coded to create seven incident types accounting for 97.3% of all reported incidents (Aldred and Crosweller 2015). An iterative and inductive approach was employed, with two coders classifying incidents using NVivo qualitative software, combining incident types that then seemed to share important similarities (e.g. near left-hooks and near right-hooks).

In 2015, we again asked for an open description of the incident, but afterwards additionally asked the respondent to place the incident in one of eight categories, if appropriate (one of our original seven incident types, covering near misses caused by an obstruction, was split in two depending on whether a pedestrian or something else was blocking the cyclist's way). Once the data had been collected, we went

[3] These questions were not included in the 2014 questionnaire, although we had provisionally coded incidents we thought might have been deliberate based on a description that included overt hostility (e.g. beeping or verbal abuse).

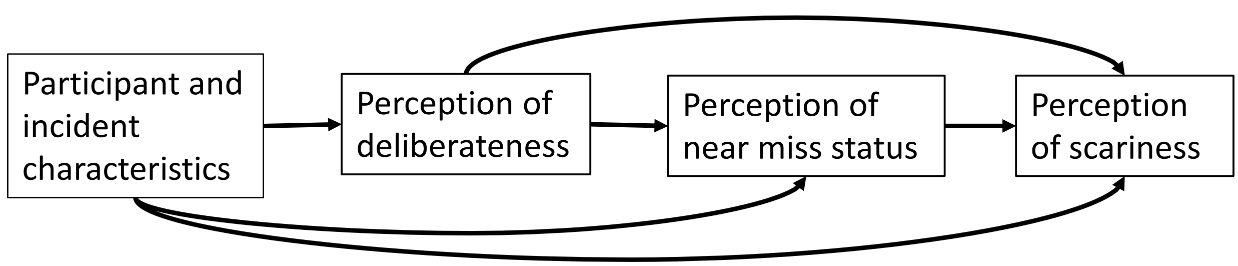
through every incident recoding where necessary (the main change being that some incidents categorised as 'other' by a respondent did fit into a category, on reading the incident description).

2.3 Data analysis

In addressing our first and second aims, we used Poisson regression with individuals as the unit of analysis. Our outcome was the number of incidents that a person experienced on their diary day. We fit these regression models in 3 stages. First, we fit unadjusted models; second we fit models adjusting for other participant and incident characteristics (gender, age, day of week and local cycling prevalence); and finally we additionally adjusted for total distance travelled across the day. We included this third stage of additionally adjusted for total distance travelled in order to examine how far any differences in the daily incident rate could be explained by differences in the amount of cycling done. In those analyses that pooled together 2014 and 2015 data, we used multilevel analysis (diaries nested within individuals) to account for the fact that 398 participants completed diaries in both years.

In addressing our third aim, we used logistic regression with incidents as the unit of analysis. Our three outcomes were the participant's perception of whether the incident was a) deliberate, b) a near miss, and c) very scary. We fit three sets of regression models, one for each outcome, guided by the conceptual model shown in Figure 1. As this figure shows, we hypothesised that individual and incident-level characteristics might independently predict all three outcomes. We further hypothesised that perceptions of deliberateness might independently predict whether an incident was seen as a near miss; and that perceptions of both deliberateness and near miss status might independently predict how scary an incident was. We used multilevel analysis (incidents nested within diaries) to account for the fact that many diaries included multiple incidents. These analyses were restricted to the 2015 data, meaning that there was only one diary completed per participant.

Figure 1: Conceptual model guiding analysis of incident perceptions



The proportion of missing data for the individual and incident-level characteristics examined ranged from 0% to 3%. We imputed this missing data using multiple imputation by chained equations (5 imputations), under an assumption of missing at random. All findings were very similar when we instead restricted our analyses to individuals with complete data.

3. Results

3.1 Comparison of incident rate and incident patterning between 2014 and 2015

Table 1 shows the characteristics of our participants in 2014 and 2015. As the table shows, participants were disproportionately male in both surveys, with a relatively wide age distribution. Levels of cycling experience were high, with only 4% of participants having cycled less than 2 years and with 64% having cycled for 11 years or more. The large majority of participants completed diaries on a weekday and a substantial minority lived in London.

Table 1: Participant characteristics in the 2014 and 2015 samples

		No. (%) 2014	No. (%) 2015
Full sample		1525 (100%)	1061 (100%)
Gender	Male	1096 (72%)	770 (73%)
	Female	423 (28%)	282 (27%)
Age	20-29	261 (17%)	129 (12%)
	30-39	482 (32%)	295 (28%)
	40-49	455 (30%)	339 (32%)
	50-59	224 (15%)	203 (19%)
	60+	84 (6%)	91 (9%)
Cycling experience	11+ years	-	656 (64%)
	5-10.9 years	-	216 (21%)
	2-4.9 years	-	111 (11%)
	<2 years	-	42 (4%)
Day of the week	Weekday	1407 (92%)	977 (92%)
	Weekend	118 (8%)	84 (8%)
Local cycling prevalence	0-1.9%	414 (28%)	306 (29%)
	2-3.9%	361 (24%)	291 (28%)
	4-5.9%	255 (17%)	192 (18%)
	6-9.9%	341 (23%)	186 (18%)
	10%+	131 (9%)	78 (7%)

Note that the number of participants adds to less than 100% for some variables because of missing data. This missing data was imputed using multiple imputation, allowing all participants to be included in the regression analyses shown in subsequent tables.

Between 2014 and 2015 there was a significant decrease in the overall incident rate, with the total number of incidents per person per day falling by almost a third from 2.6 in 2014 to 1.8 in 2015 ($p<0.001$ for difference). This fall in the average number of incidents per day does not seem to reflect a decrease in the amount of cycling done by the 2015 sample, with the average daily distance cycled and time spent cycling remaining similar (15.2 miles in 2014, 15.5 miles in 2015; 86 minutes in both years). The result is that corresponding declines were also observed between 2014 and 2015 in the average number of incidents that each participant experienced per mile (from 0.29 incidents to 0.17 incidents), and per hour (from 2.4 incidents to 1.6 incidents). This decline in the overall number of incidents between 2014 and 2015 was mirrored by a decline in the average number of very scary incidents that each participant experienced (0.37 to 0.23 per day; 0.035 to 0.020 per mile; 0.31 to 0.20 per hour).

The reason for this decrease in incident rate between 2014 and 2015 is uncertain. There was evidence of a somewhat larger decline observed among people who participated in both 2014 and 2015 (from

0.31 incidents/mile to 0.15 incidents/mile, a 52% decline) than among people who participated in only one year (from 0.29 incidents per mile to 0.18 incidents per mile, a 37% decline; $p<0.001$ for interaction). In addition, in terms of changes in the rate of specific categories of incident, the largest decreases were observed for the least scary categories of incidents (e.g. having to swerve to avoid an obstruction; see Appendix Figure A1). Taken together, this suggests that the decline may reflect changes in how people responded to the survey: people in the second survey may have had, on average, a higher threshold for reporting "borderline" incidents, particularly if they had participated in the survey previously. It is possible that there may be some element of "real" decline, however, as police-recorded cycling injuries in Britain fell by 11% between 2014 and 2015 (5% for fatalities and serious injuries, 13% for slight injuries).

The decline in the incident rate between 2014 and 2015 was observed to a very similar degree irrespective of gender, age, day of the week or the local prevalence of cycling (all $p\geq0.3$ for interaction, see Appendix Table A1). In other words, although the absolute number of incidents was lower in 2015 than 2014, the patterning of those incidents with respect to the participant's characteristics was very similar. As shown in Table 2, which pools data from 2014 and 2015 to increase statistical power, the number of incidents reported per person per day was higher for women and for younger adults. For example, the average number of incidents per day was 2.44 in women and 2.21 in men, corresponding to a crude incident rate of 2.42/2.21=1.10, i.e. an estimate that the rate was 10% higher in women than men. After additionally adjusting for participant characteristics and for total distance travelled (adjusted model 2), the daily incident rate was 12% higher in women than men.

The average number of incidents per day was slightly lower on weekend days than on weekdays, and this effect became even more pronounced after adjusting for the fact that, on average, participants travelled further on weekend days (30 miles versus 14 miles on weekdays). There was no evidence that the incident rate was associated with local prevalence of cycling; this remained the case when treating local prevalence of cycling as a categorical variable (e.g. the average daily incident rate was 2.26 in areas with less than 2% prevalence of cycling to work; 2.24 in areas with a 2-5.9% prevalence of cycling to work; 2.24 in areas with a 6-9.9% prevalence; and 2.50 in areas with a 10%+prevalence).

Table 2: Individual-level predictors of incident rate, 2014 and 2015 samples combined

		No. Incidents per day	Crude (unadjusted) rate ratio (95% CI)	Adjusted rate ratio, model 1 (95% CI)	Adjusted rate ratio, model 2 (95% CI)
Gender	Male	2.21	1*	1	1*
	Female	2.42	1.10 (1.01, 1.19)	1.07 (0.98, 1.16)	1.12 (1.03, 1.21)
Age	20-29	2.47	1***	1*	1**
	30-39	2.38	0.97 (0.87, 1.08)	1.00 (0.90, 1.12)	0.99 (0.88, 1.10)
	40-49	2.29	0.93 (0.83, 1.04)	0.99 (0.88, 1.11)	0.97 (0.86, 1.08)
	50-59	2.00	0.80 (0.71, 0.91)	0.88 (0.77, 1.00)	0.85 (0.75, 0.97)
	60+	1.85	0.73 (0.61, 0.87)	0.82 (0.69, 0.98)	0.78 (0.65, 0.93)
Day of the week	Weekday	2.28	1†	1	1**
	Weekend	2.08	0.89 (0.78, 1.01)	0.92 (0.81, 1.05)	0.81 (0.71, 0.94)
Local cycling prevalence	Change per 10 percentage-point increase	-	1.07 (1.00, 1.16)†	1.02 (0.95, 1.10)	1.06 (0.99, 1.15)

†p<0.10, *p<0.05, ** p<0.01, ***p<0.001. CI = confidence interval. Rate ratios calculated using Poisson regression. Adjusted model one adjusts for all variables shown in the column, plus year of data collection. Adjusted model 2 additionally adjusts for total daily cycling distance, entered as a linear plus quadratic term. Results in adjusted model 2 were almost identical when adjusting for total cycling duration, as opposed to total cycling distance. After adjusting for total daily cycling distance (i.e. in adjusted model 2), mean cycling speed was not significantly associated with the daily number of incidents and adjusting for speed had little impact on the other regression coefficients presented.

3.2 Impact of cycling experience on incident rate

As already shown in Table 1, levels of cycling experience were high among the 1061 participants in the 2015 survey: the average reported duration of cycling experience was 23 years (median 22 years). Table 3 shows the association between cycling experience and the daily incident rate, both in relation to all incidents and very scary incidents. As the table shows, there was evidence that the daily incident rate was higher among newer cyclists, who had been cycling for less than 2 years, than among cyclists with longer cycling experience. After adjusting for the participants' characteristics and cycling distance (adjusted model 2), newer cyclists with less than 2 years of cycling experience reported almost 40% more incidents per day than cyclists with more than 2 years of experience (p= 0.005). The difference was even larger with respect to very scary incidents, with new cyclists reporting twice the daily incidents of cyclists with more than 2 years of experience (p= 0.003).

By contrast, there was little or no evidence of any association between cycling experience and incident rate among cyclists with 2 or more years of cycling experience. Given this, and given our *a priori* decision to focus on the experiences of new cyclists, we entered cycling experience as a binary variable in all subsequent analyses.

Table 3: Cycling experience and incident rate, 2015 sample (N=1061)

		All incidents				Very scary incidents			
		No. Incidents per day	**Unadjusted rate ratio (95% CI)**	**Adjusted rate ratio, model 1 (95% CI)**	**Adjusted rate ratio, model 2 (95% CI)**	**No. Incidents per day**	**Unadjusted rate ratio (95% CI)**	**Adjusted rate ratio, model 1 (95% CI)**	**Adjusted rate ratio, model 2 (95% CI)**
Cycling experience, categorised	11+ years	1.73	1*	1*	1*	0.22	1*	1*	1*
	5-10.9 years	1.71	0.99 (0.88, 1.11)	0.93 (0.82, 1.06)	0.91 (0.80, 1.03)	0.18	0.81 (0.57, 1.15)	0.78 (0.53, 1.16)	0.76 (0.52, 1.12)
	2-4.9 years	1.81	1.04 (0.90, 1.21)	0.98 (0.84, 1.15)	0.95 (0.81, 1.11)	0.27	1.21 (0.80, 1.82)	1.18 (0.76, 1.85)	1.12 (0.72, 1.74)
	<2 years	2.44	1.41 (1.13, 1.75)	1.33 (1.05, 1.67)	1.33 (1.05, 1.67)	0.45	2.02 (1.25, 3.25)	1.99 (1.18, 3.34)	1.97 (1.17, 3.33)
Cycling experience, binary	≥ 2 years	1.74	1**	1**	1**	0.22	1**	1**	1**
	<2 years	2.44	1.40 (1.13, 1.74)	1.36 (1.09, 1.70)	1.38 (1.11, 1.72)	0.45	2.05 (1.29, 3.27)	2.06 (1.26, 3.36)	2.09 (1.28, 3.41)

*p<0.05, ** p<0.01, ***p<0.001, from tests for heterogeneity. CI = confidence interval. Rate ratios calculated using Poisson regression. Adjusted model one adjusts for all participant and incident characteristics shown in Table 2, plus year of data collection. Adjusted model 2 additionally adjusts for total daily cycling distance, entered as a linear plus quadratic term. Results in adjusted model 2 were almost identical when adjusting for total cycling duration, as opposed to total cycling distance, or when additionally adjusting for cycling speed.

3.3 Individual and incident-level predictors of incident perceptions

As shown in Table 4, by far the most common types of incidents were close passes and someone pulling in or out across the path of the cyclist. Almost all these incidents involved motor vehicles, as did the large majority of incidents involving a left or right hook, tailgating, a near-dooring, or, to a lesser extent, someone approaching head on. Motor vehicle involvement was also common in incidents involving swerving around an obstruction and in "other" incidents, but very rare in incidents involving a pedestrian stepping out.

Incidents involving pedestrians stepping out were far less likely to be judged deliberate than most other incident categories, and the proportion of incidents judged deliberate was also somewhat lower in the two types of incidents most likely to involve parked motor vehicles (swerving around an obstruction and near-doorings). Potentially, this suggests that walking, parking, or exiting a car in a cycle-unfriendly way is judged less likely to be deliberate than cycle-unfriendly driving.

This inference is further supported by examining an incident is perceived as deliberate in relation to the type of other road user defined by the participants as the 'primary cause'. It can be seen in Figure 2 that pedestrians are indeed seen most positively, in this regard, followed by other cyclists and then bus drivers. Perceptions of different groups of drivers also varied, with only 30% of incidents caused by bus or coach drivers judged deliberate, compared to 41% of incidents caused by van or lorry drivers, and 48% of incidents caused by taxi drivers. The proportion of respondents saying that they did not know whether the incident was deliberate was also higher for motorised modes than for pedestrians and other cyclists.

Note that some 'swerve around an obstruction' incidents are judged deliberate. Many of these did involve other vehicles, most obviously where the obstruction was a parked or loading car, but also where the obstructions exist on busy roads necessitating interactions with other vehicles that may be driven in inconsiderate ways. (For incidents not involving any other person or vehicle, participants were not asked whether the incident was deliberate).

Table 4: Incident characteristics in the 2015 sample

	No. (%)	% involving a motor vehicle	% judged deliberate	% judged a near miss	% judged very scary
A close pass	699 (37%)	98%	46%	74%	16%
Someone pulling in or out	403 (21%)	96%	30%	73%	14%
A near left or right hook	149 (8%)	99%	36%	87%	15%
Someone approaching head on	128 (7%)	87%	42%	74%	17%
Tailgating	81 (4%)	98%	43%	56%	15%
A near-dooring	11 (1%)	100%	27%	91%	27%
Swerve around an obstruction	132 (7%)	79%	27%	38%	5%
Pedestrian steps out	133 (7%)	5%	14%	67%	5%
Other	139 (7%)	59%	19%	41%	6%
All incidents	1875 (100%)	86%	36%	69%	13%

Figure 2: Proportion of incident seen as deliberate, according to the type of other road user involved

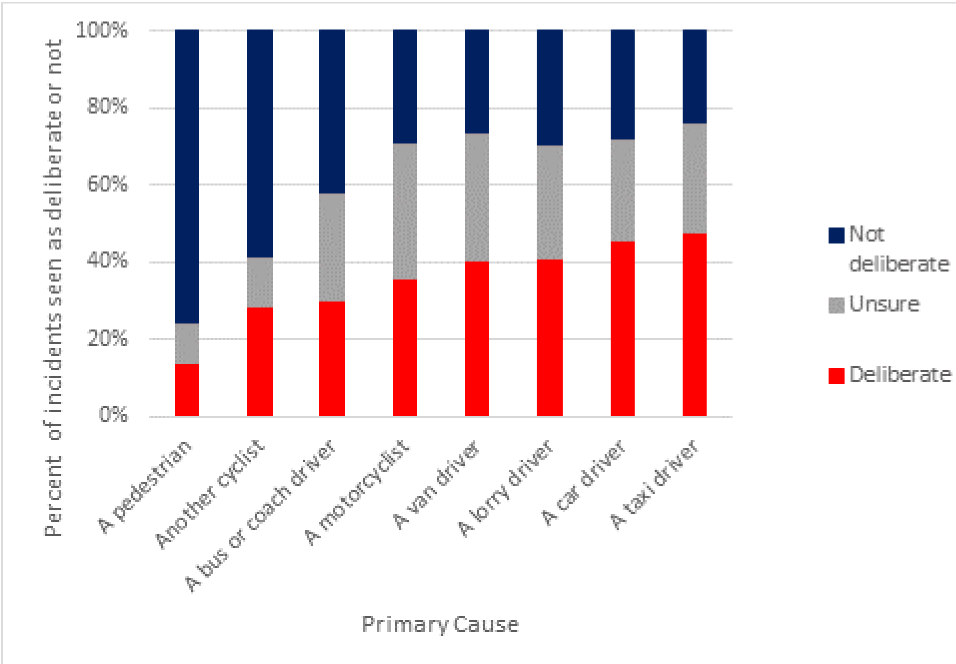
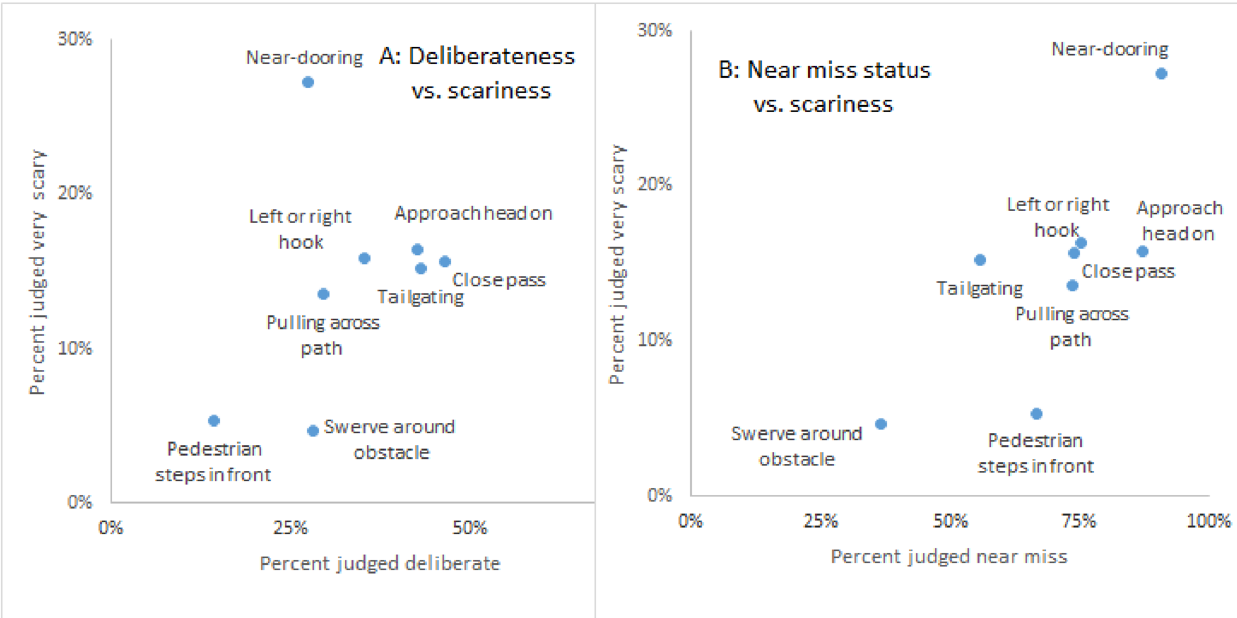


Table 4 also shows that different types of incidents have a different profile in terms of perceptions as to whether they were deliberate, whether they were a near miss, and whether they were very scary. In particular, as shown in Figure 3A, types of incidents that were judged to be deliberate tended also to be more likely to be judged very scary. Near-doorings, however, stand out as a type of instance that is relatively unlikely to be judged deliberate but is often judged very scary. Similarly, types of incidents judged more likely to be near misses were generally also more likely to be judged very scary (Figure 3B). Tailgating, however, appears to be unusual in being judged more scary than one would expect given the proportion of incidents judged to be near misses.

Figure 3: Correlation between perceptions of incident deliberateness and near miss status, and incident scariness, stratified by incident type



Predictors of perceptions of deliberateness

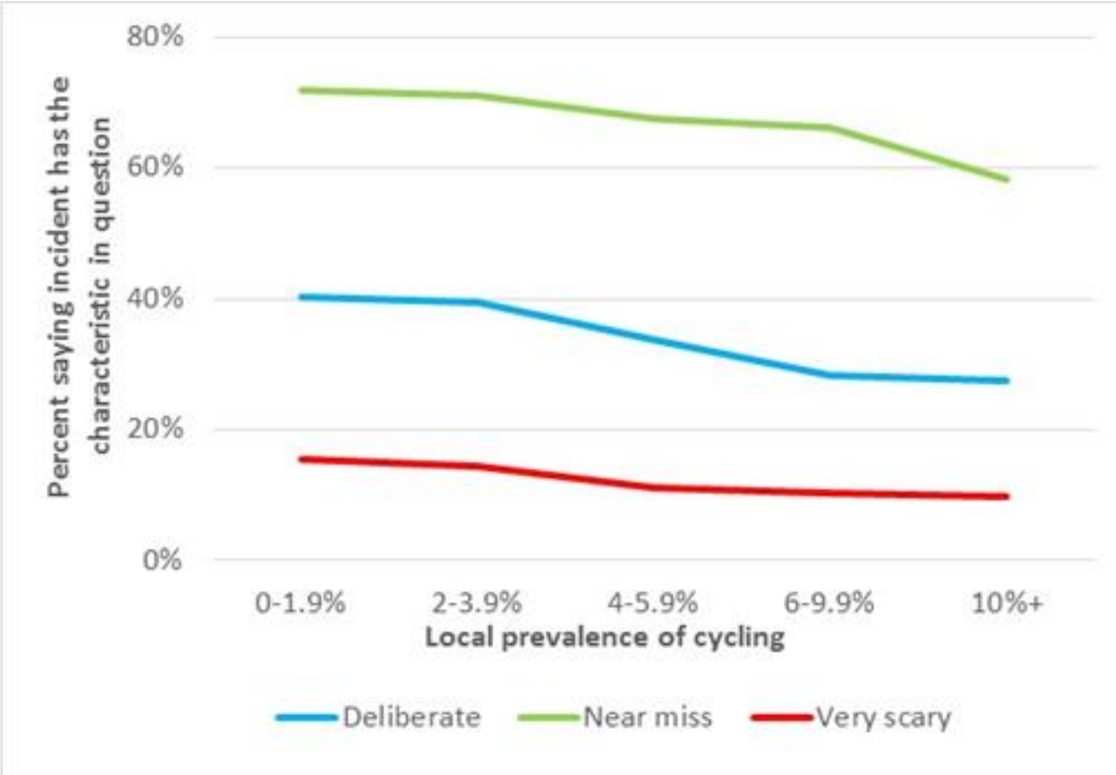
Table 5 examines the individual and incident-level characteristics that predict whether an incident is seen as deliberate. This table does not include "any motor vehicle involved" as a predictor variable because this is so highly correlated with incident type (see Table 4), so instead it uses "any large motor vehicle involved" as a predictor variable. As Table 5 shows, close passes and tailgating were particularly likely to be judged deliberate, and pedestrians stepping out were particularly unlikely to be judged deliberate. There was also some evidence that incidents were less likely to be judged deliberate in areas with a higher prevalence of cycling (see also Figure 4). Otherwise none of the individual- or incident-level characteristics were significant predictors of reporting an incident is deliberate, although there were non-significant trends towards a higher proportion of deliberate incidents among individuals in their 40s and 50s and at the weekend.

Table 5: Predictors of which incidents are seen as deliberate, 2015 sample (1875 incidents)

		No. Incidents	% deli-berate	Adjusted odds ratio, model 1 (95% CI)	Adjusted odds ratio, model 2 (95% CI)
Gender	Male	1346	36%	1	1
	Female	516	35%	0.95 (0.62, 1.45)	1.09 (0.70, 1.70)
Age	20-29	241	29%	1	1
	30-39	553	31%	1.08 (0.57, 2.07)	1.13 (0.57, 2.24)
	40-49	620	40%	1.63 (0.85, 3.13)	1.81 (0.92, 3.59)
	50-59	329	43%	1.73 (0.85, 3.54)	1.90 (0.90, 4.02)
	60+	126	31%	0.79 (0.32, 1.98)	0.90 (0.35, 2.36)
Day of the Week	Weekday	1744	35%	1	1
	Weekend	131	46%	1.81 (0.90, 3.67)	1.62 (0.77, 3.41)
Local cycling prevalence	Change per 10 percentage-point increase	-	-	0.56 (0.35, 0.90)*	0.61 (0.37, 0.99)*
Cycling Experience	≥ 2 years	1721	36%	1	1
	< 2 years	102	31%	0.96 (0.40, 2.30)	0.97 (0.39, 2.44)
Incident Type	A close pass	699	46%		1***
	Someone pulling in or out	81	30%		0.41 (0.28, 0.60)
	A near left or right hook	149	36%		0.54 (0.32, 0.92)
	Someone approaching head on	128	42%		0.70 (0.41, 1.22)
	Tailgating	403	43%		1.33 (0.66, 2.65)
	A near-dooring	11	27%		0.33 (0.04, 2.39)
	Swerve around an obstruction	133	27%		0.35 (0.19, 0.64)
	Pedestrian steps out	132	14%		0.09 (0.04, 0.19)
	Other	139	19%		0.18 (0.10, 0.33)
Involving a bus/ coach/HGV	No	1655	36%		1
	Yes	210	33%		0.94 (0.60, 1.47)

†p<0.10, *p<0.05, ** p<0.01, ***p<0.001, from tests for heterogeneity except in the case of local cycling prevalence rate where it is a test for linear trend. CI = confidence interval. Note that the number of incidents sometimes adds to less than 1875 in the first column, due to missing data for some predictor variables. Multiple imputation for missing data is used to include all 1875 incidents in the subsequent columns. Logistic regression was used and the regression models adjust for all variables shown in the column.

Figure 4: Perceptions of incidents, according to the local prevalence of cycling (N=1875 incidents)



Predictors of perceptions of near miss status

As shown in Table 6, there were very large differences in the proportion of incidents seen as near misses by incident type, and these differences largely persisted after adjusting for whether the incident was judged to be deliberate. In line with the prediction of our conceptual model, Figure 1, there was also strong evidence that participants were more likely to see deliberate incidents as being near misses. In addition, there was some evidence that the proportion of incidents judged to be near misses were somewhat higher among participants living in areas with a lower cycling prevalence (see also Figure 4).

Table 6: Predictors of which incidents are seen as near misses, 2015 sample (1875 incidents)

		No. Incidents	% Near miss	Adjusted odds ratio, model 1 (95% CI)	Adjusted odds ratio, model 2 (95% CI)	Adjusted odds ratio, model 3 (95% CI)
Gender	Male	1346	71%	1*	1	1
	Female	516	62%	0.66 (0.45, 0.97)	0.75 (0.50, 1.11)	0.75 (0.52, 1.09)
Age	20-29	241	66%	1	1	1
	30-39	553	68%	0.87 (0.49, 1.54)	0.97 (0.54, 1.76)	0.95 (0.54, 1.66)
	40-49	620	70%	0.93 (0.52, 1.65)	0.94 (0.52, 1.71)	0.88 (0.50, 1.55)
	50-59	329	69%	0.87 (0.46, 1.64)	0.87 (0.45, 1.69)	0.82 (0.44, 1.53)
	60+	126	71%	1.00 (0.44, 2.24)	1.17 (0.50, 2.74)	1.17 (0.53, 2.59)
Day of the week	Weekday	1744	69%	1	1	1
	Weekend	131	73%	1.25 (0.65, 2.40)	1.24 (0.63, 2.43)	1.18 (0.62, 2.23)
Local cycling prevalence	Change per 10 percentage-point increase	-	-	0.64 (0.44, 0.93)*	0.68 (0.46, 1.00)†	0.71 (0.49, 1.04)†
Cycling experience	≥ 2 years	1721	69%	1	1	1
	< 2 years	102	60%	0.59 (0.28, 1.26)	0.68 (0.31, 1.50)	0.69 (0.33, 1.46)
Incident type	A close pass	699	74%		1***	1***
	Someone pulling in or out	81	73%		0.94 (0.65, 1.36)	1.04 (0.73, 1.50)
	A near left or right hook	149	87%		2.84 (1.50, 5.37)	3.02 (1.62, 5.63)
	Someone approach-ing head on	128	74%		1.08 (0.61, 1.89)	1.11 (0.64, 1.93)
	Tailgating	403	56%		0.37 (0.20, 0.70)	0.37 (0.20, 0.69)
	A near-dooring	11	91%		3.87 (0.35, 43.48)	4.38 (0.40, 47.40)
	Swerve around an obstruction	133	38%		0.12 (0.07, 0.21)	0.14 (0.08, 0.25)
	Pedestrian steps out	132	67%		0.74 (0.43, 1.26)	0.90 (0.53, 1.53)
	Other	139	41%		0.16 (0.09, 0.27)	0.20 (0.12, 0.33)
Involving a bus/ coach/HGV	No	1655	70%		1	1
	Yes	210	62%		0.79 (0.52, 1.19)	0.78 (0.52, 1.18)
Incident deliberate	No	1202	62%			1***
	Yes	673	80%			2.08 (1.53, 2.83)

†p<0.10, *p<0.05, ** p<0.01, ***p<0.001, from tests for heterogeneity except in the case of local cycling prevalence rate where it is a test for linear trend. CI = confidence interval. Note that the number of incidents sometimes adds to less than 1875 in the first column, due to missing data for some predictor variables. Multiple imputation for missing data is used to include all 1875

incidents in the subsequent columns. Logistic regression was used and the regression models adjust for all variables shown in the column.

Predictors of perceptions of incident scariness

As shown in Table 7, near miss incidents were much more likely to be experienced as very scary (18% very scary versus 2% of incidents that were not near misses). There was a strong effect of incident deliberateness (odds ratio 2.60 in adjusted model 3), only partially attenuated after adjusting for near miss status (odds ratio 2.26 in adjusted model 4). This suggests that the effect of perceptions of deliberateness upon perceptions of scariness is partly mediated through perceptions of near miss status (i.e. deliberate incidents are judged somewhat more likely to be near misses, and that makes them more scary), but is largely direct (i.e. deliberate incidents are judged scary even if they did not result in a near miss). However, there was no independent effect of incident type upon perceptions of scariness after adjusting for perceptions of deliberateness and near miss status, suggesting that these two perception variables account for much of the reported differences in scariness between different incident types.

As for the other individual-level predictors of scariness, there was some evidence that people are more likely to report that an incident was very scary on the weekend or in areas with a lower prevalence of cycling (see also Figure 4). There was a non-significant trend for newer cyclists to report incidents as being very scary (19% versus 13%) - a trend that explains why, as reported in Table 3, the daily rate ratio for scary incidents was even stronger new cyclists than the daily rate ratio for all incidents. Interestingly, this trend was not attenuated after adjusting for perceptions as to whether the incident was deliberate or near miss, suggesting that these two variables do not explain why newer cyclists appear to be particularly likely to report a given incident as scary.

Table 7: Predictors of which incidents are seen as very scary, 2015 sample (1875 incidents)

		No. Incidents	% Near miss	Adjusted odds ratio, model 1 (95% CI)	Adjusted odds ratio, model 2 (95% CI)	Adjusted odds ratio, model 3 (95% CI)	Adjusted odds ratio, model 4 (95% CI)
Gender	Male	1346	13%	1	1	1	1
	Female	516	13%	1.09 (0.69, 1.72)	1.21 (0.76, 1.91)	1.19 (0.76, 1.86)	1.35 (0.85, 2.15)
Age	20-29	241	14%	1	1	1	1
	30-39	553	12%	0.77 (0.39, 1.51)	0.80 (0.40, 1.58)	0.79 (0.41, 1.54)	0.81 (0.41, 1.60)
	40-49	620	12%	0.79 (0.40, 1.56)	0.82 (0.42, 1.62)	0.76 (0.39, 1.47)	0.78 (0.39, 1.54)
	50-59	329	17%	1.26 (0.61, 2.61)	1.32 (0.64, 2.73)	1.19 (0.58, 2.43)	1.34 (0.64, 2.79)
	60+	126	12%	0.65 (0.24, 1.77)	0.71 (0.26, 1.93)	0.72 (0.27, 1.92)	0.73 (0.27, 1.99)
Day of the Week	Weekday	1744	12%	1*	1†	1	1
	Weekend	131	21%	2.04 (1.01, 4.11)	1.94 (0.96, 3.93)	1.78 (0.89, 3.56)	1.73 (0.85, 3.50)
Local cycling prevalence	Change per 10 percentage-point increase	-	-	0.58 (0.34, 0.98)*	0.60 (0.35, 1.01)†	0.65 (0.39, 1.10)	0.68 (0.40, 1.16)
Cycling experience	≥ 2 years	1721	13%	1	1	1	1†
	< 2 years	102	19%	1.85 (0.80, 4.28)	1.91 (0.82, 4.45)	1.91 (0.84, 4.34)	2.31 (0.99, 5.36)
Incident Type	A close pass	699	16%		1**	1*	1
	Someone pulling in or out	81	14%		0.94 (0.61, 1.45)	1.06 (0.68, 1.63)	1.05 (0.67, 1.65)
	A near left or right hook	149	15%		1.12 (0.62, 2.05)	1.25 (0.69, 2.28)	1.03 (0.56, 1.90)
	Someone approaching head on	128	16%		1.06 (0.57, 1.97)	1.13 (0.61, 2.11)	1.14 (0.60, 2.16)
	Tailgating	403	15%		0.97 (0.44, 2.16)	0.98 (0.45, 2.16)	1.40 (0.61, 3.24)
	A near-dooring	11	27%		1.85 (0.32, 10.66)	2.19 (0.37, 13.04)	1.77 (0.30, 10.53)
	Swerve around an obstruction	133	5%		0.26 (0.10, 0.68)	0.31 (0.12, 0.80)	0.58 (0.21, 1.60)
	Pedestrian steps out	132	5%		0.27 (0.11, 0.68)	0.39 (0.16, 0.96)	0.37 (0.15, 0.94)
	Other	139	6%		0.28 (0.12, 0.67)	0.37 (0.16, 0.88)	0.61 (0.24, 1.55)
Involving a bus/ coach/HGV	No	1655	13%		1	1	1
	Yes	210	15%		1.25 (0.75, 2.08)	1.26 (0.76, 2.09)	1.39 (0.81, 2.37)
Incident deliberate	No	1202	9%			1***	1***
	Yes	673	21%			2.60 (1.81, 3.73)	2.26 (1.55, 3.29)

Incident a near miss	No Yes	585 1290	2% 18%				1*** 14.4 (6.97, 29.6)

†p<0.10, *p<0.05, ** p<0.01, ***p<0.001, from tests for heterogeneity except in the case of local cycling prevalence rate where it is a test for linear trend. CI = confidence interval. Note that the number of incidents sometimes adds to less than 1875 in the first column, due to missing data for some predictor variables. Multiple imputation for missing data is used to include all 1875 incidents in the subsequent columns. Logistic regression was used and the regression models adjust for all variables shown in the column.

4. Discussion

4.1 Incident rates

We found an unexplained decline in incident rates between 2014 and 2015. We consider it unlikely that this represents a 'real' decline, i.e. it likely rather demonstrates the impact of subjectivity in reporting. Attempts to estimate injury rates may share these issues – we know, for example, that slight injuries are substantially under-reported in police and hospital statistics, but self-report surveys introduce an element of subjectivity in terms of definitions of 'injury' (which is not necessarily self-evident).

Despite the decline between 2014 and 2015, the rates are still of the same order of magnitude, i.e. many thousands of times more common than injuries. Hence while the results caution against placing much emphasis on the precise incidence rate estimates, they do confirm that near misses and non-injury incidents are very common and of concern to people cycling. This is supported by the persistence of the pattern associations observed in Aldred (2016); the most frightening types of incident in 2014 were also found to be particularly frightening in 2015.

4.2 Cycling experience

It was concerning that cyclists with under two years' cycling experience reported substantially more incidents that more experienced cyclists – including twice the daily number of 'very scary incidents' compared with cyclists with over two years' experience. It is likely that newer cyclists are more sensitive to such incidents as are many of the very experienced, longer-term cyclists in our sample. This finding could be interpreted in different ways. Perhaps, as cyclists become more skilled, their ability to avoid near misses grows – although near miss numbers do remain high among more experienced cyclists. Alternatively or additionally, near misses might deter those beginner cyclists who are most sensitive to them. Given differential attitudes to risk by gender (for instance: Aldred et al 2016) this might be one reason for under-representation of women cycling in contexts where scary near misses are common.

4.3 Deliberate, scary and near-miss incidents

Perhaps not surprisingly, incidents that participants thought were deliberate, or felt were near-misses (i.e. likely to have resulted in an actual collision), were more likely to frighten them. Insofar as a high proportion of incidents were judged to be deliberate (36%) or near misses (69%), it seems likely that these two perceptions play an important role in contributing to the potential experience of cycling as a risky mode.

The high proportion of incidents judge deliberate is also related to a broader road culture in which cyclists feel that they are effectively second-class citizens (Christmas et al 2009). This data sheds more light on this perception. If cyclists experience on a daily basis incidents in which they feel other road users are actively disregarding their safety, this may form the basis for that wider sense of marginalisation, rather than it solely being due to, for example, negative media coverage. In support of this interpretation, participants living in high-cycling areas (in which cyclists might be expected to feel less marginalised) did judge a smaller proportion of incidents to be deliberate.

In general, the problem road users – judged to be deliberately putting cyclists at risk – were motorists. In pedestrian-stepping-out incidents, only 14% were judged deliberate. By contrast, for incidents caused by motorists (except bus and coach drivers or motorcyclists), 40% or more were judged deliberate. This proportion is substantially higher than the value of 4.8% assessed in the first, 2014 survey, in which deliberateness was assigned by the researchers to those incidents in which the free text description includes the description of hostile behaviour, such as beeping or verbal abuse (Aldred and Crosweller 2015). Perceived deliberateness runs deeper than this, and might include for instance a close pass being judged deliberate because of the cyclist's assumption that the driver knew that s/he was passing close, rather than because of the pass being accompanied by overt aggression. It is also interesting to note that participants were much more likely to say that they did not know whether an incident was deliberate or not when it concerned a motorist, reflecting the difficulty of reading a person's intention when they are physically separated from you by being in a motor vehicle.

While there were close associations between perceptions of near misses, and perceived scariness, the results suggest caution against always restricting study of incidents to only self-defined 'near misses'. In particular, tailgating incidents were judged more frightening than might be expected, given the proportion of that category incidents that were judged 'near misses'. Tailgating without a collision is also unlikely to rank as a near miss in terms of definitions that rely on evasive action being taken, yet (a) may result in a collision, in a minority of cases and (b) may be paradigmatic of an attitude to driving where cyclists are seen as obstructions on the road. Even where aggressive driving is not associated with a near-collision, this may still create intimidation and deter people from continuing to cycle. This may particularly affect newer and more sensitive cyclists, and the majority who do not feel themselves to be 'strong and fearless' (Dill and McNeil 2014).

4.4 Near Miss Rates and Cycling Prevalence

Finally, near miss rates in relation to cycling prevalence is worth some comment. In earlier work, we found that near miss rates were not lower at peak times when there are more cyclists on the road, nor did they seem lower in places with higher rates of cycling. This paper examines the latter issue in more detail, exploring the perceptions of incidents as deliberate, near misses, or very scary. While again we did not find a lower rate of reporting incidents in local authority areas with a higher cycling prevalence, we did find some evidence that those incidents reported were less likely to be perceived as deliberate, near misses, or very scary (independent of the types of incident).

This finding was interesting, because these effects are independent of the impact of different incident types. Perhaps there is no behavioural improvement among other road users, but cyclists feel less disregarded or less under threat in a context where cycling feels more 'normal'. Or perhaps incidents in higher-cycling areas differ in a way that we have not captured here; being somehow experienced as less severe although categorised under the same headings. Further research could helpfully explore the extent to which perceptions of cyclists and cycling incidents might differ depending on the broader local prevalence of cycling.

4.5 Cycling infrastructure and road environment: a potential direction for future research

One limitation of the current research it does not include any characteristics related to the road environment, including cycling infrastructure. Examining the effect of the road environment on the experience of near misses would pose some challenges, as it is not enough to know the road environment characteristics of the places where incidents took place (the numerator). Instead one also needs to know how much cycling occurs in different types of road environments (the denominator). One promising possibility would be to adapt an approach successfully used in relation to cycling injuries (Teschke et al 2012) and collect information on participant's cycling *routes* as well as the location of their near misses. This would allow each near miss location to be matched to a randomly-selected control location elsewhere on their route, in other words each cyclist would act as their own control. We hope that future research may include such approaches, and thereby contribute to evidence regarding subjective experience of cycling risk in different types of road environment.

5. Conclusion

This paper has compared two years of the UK Near Miss Project, including new analysis focused on perceptions of incidents, and the impact of cycling experience. Incident rates per person per day have remained at the same order of magnitude, albeit declining by around a third for unknown reasons (we think probably due to changes in reporting). Thus we would caution against placing too much weight on the precise magnitude of incidents rates or on year-on-year changes in subjectively reported near misses and other non-injury collisions. However, near misses clearly are very commonly experienced by UK cyclists, and appear stable in terms of the types of incidents experienced and the patterning of these incidents across different groups of cyclists.

The paper has also explored how subjective feelings about non-injury incidents (whether they are near misses, and whether they are deliberate) shape incident perceptions. Where incidents are perceived to be deliberate, and/or near misses, they are more likely to be perceived as very scary. New cyclists stand out as being more likely to see incidents as being near misses, deliberate or scary, also reporting significantly higher non-injury incident rates than more experienced cyclists. It is important that these voices be heard in policy and planning. This research was skewed towards very experienced cyclists who may have grown able to cope with such incidents, but newer cyclists seem to have more negative experiences and to be more intimidated by them.

More research is needed to understand the experiences of newer cyclists, and the extent to which near misses might contribute to discouraging new cyclists from continuing. It would be useful for future studies to collect data on cycling exposure at route-level, in order to include infrastructural correlates of near miss risk in future analysis. In these ways, we can continue to develop our understanding of the subjective experience of cycling risk, seeking to create cycling conditions that both *are* safer and *feel* safer.

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A1 Appendix: supplementary analyses

Figure A1 shows the correlation between the mean scariness of different types of incidents in 2014, and the change in the rate of that incident type in 2015 relative 2014. Incident type is classified according to the primary incident descriptor. As Figure A1 shows, incidents involving having to swerve around an obstruction, or having a pedestrian step out in front, were both judged considerably less scary on average, and also showed a markedly larger decline in 2015 relative to 2014.

Figure A1: Correlation between mean scariness and change in incident rate, stratified by incident type

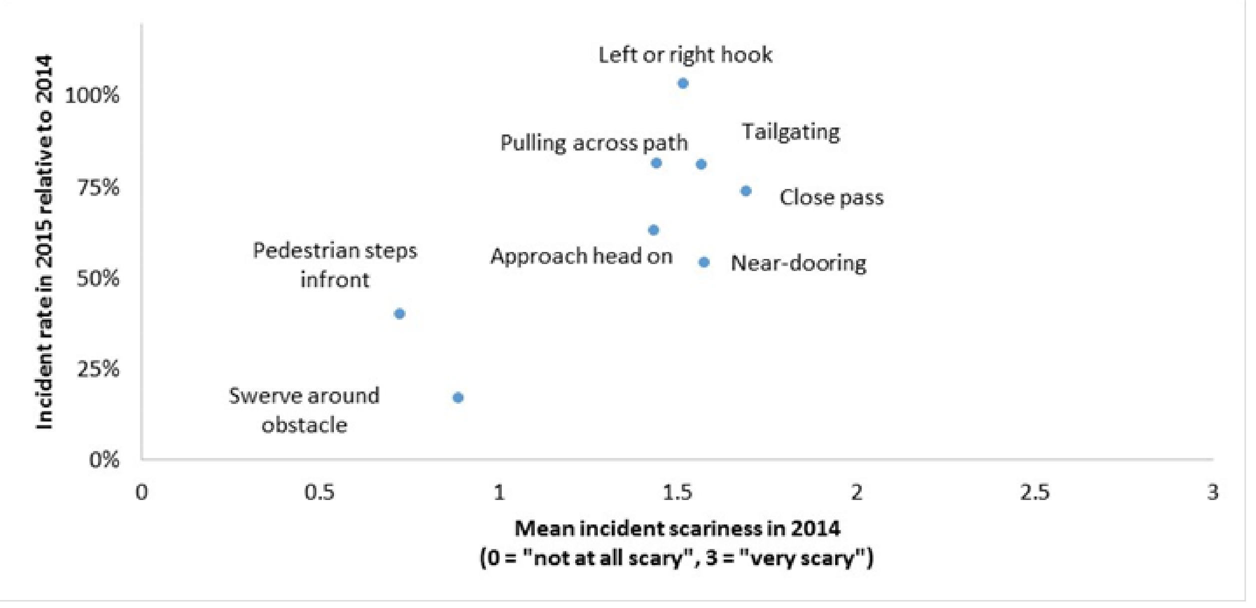

Table A1 compares the number of incidents and the incident rate per mile between 2014 and 2015 after stratifying by gender, age, region, day of the week. As it shows, the decrease in incident rate was observed across all types of participant, with no evidence of larger decreases in some groups compared to others (all p>0.2 for interaction). The results were very similar after restricting the 2015 sample to people who had not previously completed a diary in 2014 (all p>0.4 for interaction). The results were also very similar when using scary incidents as the outcome (all p>0.5 for interaction).

Table A1: Comparison over time of number of incidents, stratified by participant characteristics (2586 diary days)

		No. incidents/ day, 2014	No. incidents/ day, 2015	p-value for interaction in unadjusted model	p-value for interaction after adjusting for trip distance
Full sample		2.6	1.8	-	-
Gender	Male	2.5	1.7	0.38	0.28
	Female	2.8	1.8		
Age	20-29	2.8	1.9	0.73	0.68
	30-39	2.7	1.9		
	40-49	2.6	1.8		
	50-59	2.3	1.6		
	60+	2.4	1.4		
Day of the week	Weekday	2.6	1.8	0.56	0.61
	Weekend	2.4	1.6		
Local cycling prevalence	Change per 10 percentage-point increase	-	-	0.50	0.50

*p-value for interaction calculated in a Poisson model, with number of incidents as the outcome and including an interaction term between year and the covariate in question (e.g. between year and gender in the first row). In the final column, the model adjusted for distance as an additional covariate.

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