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The effects of cycle lanes, vehicle to kerb distance and vehicle type on cyclists' attention allocation during junction negotiation.

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Word Count: 8,781

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Abstract

Increased frequency of cycle journeys has led to an escalation in collisions between cyclists and vehicles, particularly at shared junctions. Risks associated with passing decisions have been shown to influence cyclists' behavioural intentions. The current study extended this research by linking not only risk perception but also attention allocation (via tracking the eye movements of twenty cyclists viewing junction approaches presented on video) to behavioural intentions. These constructs were measured in a variety of contexts: junctions featuring cycle lanes, large vs. small vehicles and differing kerb to vehicle distances). Overall, cyclists devoted the majority of their attention to the nearside (side closest to kerb) of vehicles, and perceived near and offside (side furthest from kerb) passing as most risky. Waiting behind was the most frequent behavioural intention, followed by nearside and then offside passing. While cycle lane presence did not affect behaviour, it did lead to nearside passing being perceived as less risky, and to less attention being devoted to the offside. Large vehicles led to increased risk perceived with passing, and more attention directed towards the rear of vehicles, with reduced offside passing and increased intentions to remain behind the vehicle. Whether the vehicle was large or small, nearside passing was preferred around 30% of the time. Wide kerb distances increased nearside passing intentions and lower associated perceptions of risk. Additionally, relationships between attention and both risk evaluations and behaviours were observed. These results are discussed in relation to the cyclists' situational awareness and biases that various contextual factors can introduce. From these, recommendations for road safety and training are suggested.

Keywords:

Cycling, attention, risk, behaviour, passing, eye tracking, collision

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attention allocation during junction negotiation.**

1. Introduction

Cycling is becoming a common mode of commuting, particularly in towns and cities where there has been concerted investment in cycling infrastructure, for example in London in the United Kingdom (UK) and the eighteen English Cycling Cities and Towns. For instance, TfL (2010) reported 500,000 journey stages by bicycle in Greater London on an average day in 2009 and it was estimated that this had grown by 61% since 2001. This increase in cycling has also resulted in increased sharing of road space between cycles and other vehicles, such as heavy goods vehicles (HGVs) – particularly in urban areas. Sharing of road space raises concerns about safety, particularly for cyclists. According to TfL (2010), overall in London there were 3,202 collisions involving cyclists and resulting in casualties in 2008. Of the eight fatalities in London reported by TfL (2010), seven were due to cyclists not being allowed sufficient road space by the HGV, in particular when turning left at junctions or changing to the left lane. Vehicles (of any type) being in close proximity with cyclists was implicated in 37% of serious injuries. ‘Close proximity’ incidents included vehicle and cycle alongside, and the vehicle turning left (in left side of road driving countries) or changing lane to the left into the path of the cyclist. When attempting to understand why these collisions occur (and how to reduce their frequency) one area of interest is the way cyclists perceive their environment in terms of risk, and how this influences both how they attend to it, and how they intend to behave.

Frings, Rose and Ridley (2012) investigated the perception of risk associated with certain cycling manoeuvres when approaching HGVs at signal controlled junctions. These included

nearside passing manoeuvres (passing on the side opposite that of the driver, i.e. the left in the UK) and *offside passing* manoeuvres (passing on the driver's side, i.e. the right in the UK). The preferred choice of action relating to the same manoeuvres was also assessed. Using a web based survey which recruited 4,593 cyclists it was found that, overall, participants' assessment of risk predicted both the reported likelihood they would engage in risky manoeuvres and collision prevalence. Advanced cycling training increased the perceived risk associated with passing on the nearside. In summary, this initial self-report research indicates an association between the assessment of risk and cyclists' decisions about passing stationary HGVs at junctions.

Physical factors which may influence collision rates and severity are wide ranging and may include the following: mix of vehicle types; overall road widths; manner of carriageway division into lanes and their widths; presence of parking; type of parking (turnover); junction spacing; junction type; number and type of pedestrian crossings; number of bus stops; volume of pedestrian activity (on footway and crossings). Collisions result when vehicles become too close, and hence the issue of available space is a dominating factor. The factors that directly influence space available are: size of vehicle (categorised by type); whether or not specific space is provided to cycle traffic (in the form of cycle lane) and the positioning of vehicles within the space available.

What is not yet known is whether there are differences in attention or other cognitive processes (e.g. what information cyclists and goods vehicle drivers seek out) that may underpin the tendency to prefer nearside passing, nor how such contextual factors may interact with them. To address this, one possibility is to examine the attention allocation of cyclists to examine how they process information available and how this links to risk assessment and

behavioural choice. In research designed to model cycling route choice, studies have involved respondents watching video clips of approaches to various junctions and indicating the level of perceived risk involved. For instance, Parkin, Wardman and Page (2007) used responses to video scenarios at junctions and along roads to develop risk models to quantify the acceptability of routes for whole cycling journeys. The need to undertake manoeuvres at junctions added to the quantum of perceived risk, with signal controlled junctions being viewed as less adverse than roundabouts.

Drawing on the above areas of research, the goal of the current research is to test the relationships between risk perception and passing choice, and also link these to how cyclists allocate their attention in the moments preceding such decisions. This is achieved by measuring attention allocation by tracking the eye movements of participants while they watch videos taken from the point of view of a cyclist on approach to junctions.

2 Literature review

2.1 Attention allocation

Eye direction during effortful tasks is thought to reflect attention processes under most circumstances (see, for example, Findlay & Gilchrist, 2003; Hoffman & Subramaniam, 1995; Deubel & Schneider, 1996). Attention allocation data of this type includes two factors as follows: the number of times attention falls on any given place within a particular area of the visual field; and the dwell time (the total length of time of those fixations). A greater number of fixations in a given time period typically reflects more active search strategies, and longer dwell times typically reflect more attention being directed at a particular place. Eye movements (saccades) have also been linked to changes in direction amongst pedestrians (e.g. Holland, Patla & Vickers, 2002). Eye movement data have been used in traffic research quite

extensively, but have yet to be applied to understanding how cyclists negotiate junctions. For instance, Underwood, Chapman, Bowden and Crundall (2002) showed that experienced car drivers scan demanding sections of motorways more thoroughly than do novices. Nunes and Recarte (2002) found that having a telephone conversation during driving focuses attention towards the roadway, at the expense of dashboard instrumentation, while Schweigert & Bubb (2001) showed drivers allocated less attention to mirrors as demands linked to driving increased.

Attention allocation has also been linked to risk perception and vice-versa. Amongst anxious individuals, threatening / dangerous stimuli attract more attention than safer ones, (e.g. a vigilance-avoidant pattern, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van IJzendoorn, 2007). However, after threatening stimuli has been noticed, other evidence (e.g. Hermans, Vansteenwegen & Eelen, 1999; Rohner (2002) and Mogg, Bradley Miles and Dixon, 2004) suggests that whilst attention is initially drawn towards threatening stimuli, it is sometimes subsequently directed away from threatening (and towards less/ none threatening) stimuli. Some research also broadly suggests that perceptions of risk can also influence attentional allocation. For instance, priming participants to feel motivationally threatened (a state which can involve a desire to avoid losses) has been shown to lead to greater allocation of visual attention to areas of their visual field associated with avoiding losses rather than those associated with achieving gains (Frings, Rycroft, Allen & Fenn, 2014). Similarly, participants with a prevention orientation (who aim to reach goals through avoiding errors) can also show a general attentional bias towards stimuli related with loss avoidance (e.g. Higgins, 1997, Sassenberg, Sassenrath & Fetterman, 2014). Taken together, these indicate that in many situations people attend to 'safer' options when there is a choice available. For cyclists, decision making about routes and choices within the network are likely to be motivated by a

range of factors including time, effort and risk (Parkin, Wardman. & Page, 2007). Thinking particularly about risk, macro level decisions about route choice are likely to be influenced by threats at the micro level, i.e. staying on the nearside to avoiding being hit by oncoming traffic, and also gains (i.e. looking for extra space on the offside of vehicles, a gain).

The more general study of attention allocation has direct relevance for cyclists. Although the majority of attention is likely to be focussed on the nearside of vehicles ahead (as this is the usual route of cyclists in traffic streams) it is important that cyclists also attend to offside areas. Failure to do so may lead to opportunities for potentially safer offside passing being missed, and for potentially dangerous actions by other vehicles or developing situations on the oncoming roadway to be noticed too late. Thus, examining how cyclists divide their attention and how this interacts with the effects of contextual factors on attention allocation tells us how such factors affect cyclists' overall situational awareness and, in particular, their awareness of offside passing opportunities. Recent research using eye tracking methodology suggests that in the absence of junctions or other traffic, cyclists divide their attention between the goal (a visible end point to their journey) and the path they are travelling on, with little attention directed outside these areas (Vansteenkiste, Cardon, D'Hondt, Philippaerts, & Lenoir, 2013). Combining this finding with research into the relationship between risk and attention, it is predicted that cyclists should attend more to areas of the visual field where they intend to pass if they are seen as less risky (for instance, cyclists who perceive offside passing as more risky will attend more to the nearside). This would be reflected by a positive correlation between nearside risk and attendance to the offside, and/or a positive correlation between offside risk and attendance to the nearside.

The research presented in the present paper draws on and extends the work of Frings et al. (2012), Parkin et al. (2007) and Vansteenkiste et al., (2013) by using video clips to evaluate how cyclists perceive their environment in complex junction negotiation situations. It also extends prior research by measuring eye movements during such tasks. Three contextual factors; cycle lanes passing distance and vehicle type were examined.

2.2 Cycle lanes, passing space (including kerb distance) and vehicle type

Cycle lanes to help provide space for cycle traffic within the carriageway have become an increasingly common method of providing some sort of facility to promote cycling. They have advantages such as allowing cycle users legally to undertake queuing traffic on the approach to junctions, but they may have disadvantages particularly if they are of insufficient width (i.e., do not allow for the cyclist to have both space on their nearside to escape whilst also providing passing distance between themselves and other vehicles). Research has shown that with a cycle lane it is also the case that motor traffic may pass closer to a cycle user than they would if the cycle user and the motor vehicle driver were sharing the same lane (Parkin and Meyers, 2010). No evidence has shown directly that cycle lane presence reduces the perceived risk of cycling. However, Noland and Kunreuther (1995) argued that cycle lane presence should increase cycle use, and the perception that a route contains cycle routes increases the likelihood that it will be chosen (Hoehner, Ramirez, Elliott, Handy & Brownson, 2005).

The space between a vehicle and the kerb (*distance to kerb*) is one factor which defines the space between vehicles and cyclists. With the exception of heavy goods vehicles and buses on roads with a posted speed limit of 50mph, vehicles tend to give up to 180mm additional space between themselves and cyclists (such space typically ranging from 1.0 metres to 1.5

metres). Despite the different widths of vehicles (broadly grouped as cars; vans; and heavy goods vehicles and buses) which range from a median of 1.8 metres to 2.5 metres, larger vehicles did not tend to give either consistently more or consistently less passing distance (although other research suggests larger vehicles give less distance, see Walker, 2007). No conclusive results were obtained for 30mph roads and this is the subject of further investigation. The reason is likely to be because of the different manoeuvres that vehicles perform within urban areas, such as slowing, merging, diverging, and turning. All of these acts of driving tend to require lateral changes in road position with the presence or otherwise of cycle traffic perhaps being of secondary importance so far as drivers are concerned. Lower levels of space are objectively more likely to lead to collision, as margins of error are lower, and smaller deviations by either party become more significant. In terms of distance to kerb, a narrow distance may be perceived as more risky as it reduces the possible passing space, and may be more cognitively demanding (leading to more attention being directed towards it).

The current research tests firstly how cyclists allocate their attention during cycling in using a novel and relatively ecologically valid laboratory based methodology. In addition, it tests the effects of cycle lane presence, vehicle type and kerb distance on risk perception and behavioural decision making (replicating and extending previous research). Given the existing research on risk perception and decision making, it is predicted that cyclists will intend to engage in manoeuvres they perceive as high risk less often than those perceived as low risk ones. In terms of attention allocation, existing evidence leads to a hypotheses that when a manoeuvre is perceived as higher risk, participants will spend less time attending to areas of the visual field it involves (for instance, for offside passing, offside areas of the visual field). As little or no data exist for the relationship between contextual variables and attention / risk is

available, no directional hypothesis can be made around the relationships between these variables (i.e. the study is exploratory in these respects).

3 Method

3.1 Participants

Ethical approval for the study was obtained from the London South Bank University Research Ethics Committee. Twenty cyclists (11 male, 9 female) were recruited via email distribution lists and forum postings on cyclist websites. The mean age of the sample was 44.70 years (SD = 14.35). Three participants had Bikeability Level 3 training¹, eight had received cycle proficiency training², and eight had received no training. One had received non-specified training. Sixteen participants reported cycling more than three times per week, one reported cycling 2-3 times per week. One reported cycling less than once a month. Twelve of the participants reported collisions or near misses while cycling in the last three years.

3.2 Materials

Video trial generation. Fifty-seven short videos representing over an hour of data capture were taken on 26th to 28th March 2012 on a variety of busy roads in central London from the point of view of a cycle user while riding a bicycle. The data were captured using a Gopro HD Hero video camera set to its widest HD Video 16:9 aspect ratio, and video frames were taken at the rate of thirty per second with a resolution of 1280 x 720. The video clips were collected in various road contexts, in particular at junctions with and without the presence of a cycle lane, where queuing vehicles left a narrow (approximately up to 1 metre) or wide

¹ Level 1 is skills based, Level 2 demands skill in moving traffic on quiet roads and Level 3 provides additional training for movement on busy roads.

² Cycle proficiency training was the long-running forerunner of Bikeability training.

(approximately greater than 1 metre) distance from the nearside kerb³. Finally, the vehicle at the end of the queue was either a small vehicle (car or van) or a large vehicle (rigid goods vehicle, bus, coach, or ‘articulated goods vehicle’).

Observations from the real world include extraneous circumstantial information that may or may not be confounders to behaviour and attitude. The alternative to real world observation is visualisation, but that has the disadvantage of lacking realism. Of the fifty-seven clips, twenty-six were selected to minimise uncontrolled for factors. They are shown in Table 1 and were selected on the basis that the contextual variables were consistent and minimal, there was an obvious vehicle about which a decision would have to be made by the approaching cyclist, and that levels of lighting and other factors were such that sufficient detail could be made out. Large vehicles comprised of heavy goods vehicles (rigid and articulated), and buses and coaches. The clips were taken in central and west London on busy major roads. The junctions were all signal controlled, and typically the cyclist was approaching a queue that was between one and three or four vehicles long, which meant that the cyclists could see that they were approaching a signal junction. Extensive signal control means that traffic progresses in platoons. No vehicle was shown overtaking the cyclist as he approached the end of the queue, and in this sense the volume of traffic at the moment of the decision is indefinable. Clip duration varied from 1000 to 12000 milliseconds (as the distinct ‘approach’ to a junction varied in length according to traffic conditions, cyclist speed etc.).

*****TABLE 1 ABOUT HERE*****

³ Note that during the initial stages of the study, consideration was given to conceiving of the experiment as a laboratory experiment, with the width to the kerb being precisely defined and adhered to by trained drivers. Complexities of funding and managing this approach led to the ‘natural experimental’ approach of obtaining source data from real world cycling on roads in London.

Attention allocation. Eye movement data was recorded on an EyeLink 1000 Desktop (S-R Research Ltd, Canada) eye tracker. We are grateful for the positive collaboration we have had with the manufacturers as we developed schemes for flagging ‘areas of interest’ within the video image which the eye tracker will automatically record (hits and dwell times). This has been complex because the areas of interest ‘move’ across the image area as the moving bicycle approaches the rear of the queue. The resolution of the issue is based on changed sizes of areas of interest at different periods within the video (see below). The sampling rate of this equipment (2000hz) is such that meaningful data can be drawn from clips as short as 1000ms.

The experiment consisted of twenty six trials. Participants viewed each trial on a 19 inch (480mm) TFT monitor, from a seated position 600mm distant. For each trial, a video clip was shown (720 pixels high, by 576 pixels wide). The first frame of the clip was shown as a still for 2000 milliseconds before each trial, to allow participants to orientate themselves to the screen and the circumstance being displayed. Three interest areas were defined for each clip, as shown in Figure 1.

******Figure 1 about here******

The edges of each area were defined vertically by the top and bottom of the clip, the horizontally by the position of the target vehicle. The first (left area) ranged from the edge of the clip to the left hand edge of the vehicle. The second area (left centre) ranged from the left edge of the vehicle to the centre of the vehicle. The third (right centre) ranged from the centre of the vehicle to its right hand edge. The fourth (right area) began at the vehicle right hand edge and ended at the edge of the clip.

To account for changes in the location of these edges (due to the vehicle looming visually as it becomes closer) these edges were re-calculated one third and two thirds of the way through the clip's duration. For each trial, the number of fixations and total dwell time were recorded. As the duration of each clip varied, fixations and dwell time in each trial were converted into a proportion of fixations and dwell times in all areas on a participant by participant, trial by trial basis.

Two measures we have categorised (attention 'areas of interest', and distance from kerb) could have been measured as continuous variables. So far as the attention areas are concerned, we would expect variability of precise attention location within the different areas of interest based on the different spatial orientations of the object relative to the subject (camera) location. Hence, the adoption of a categorical approach will enhance rather than reduce the power of analysis in the results. It would have been a complex process to measure the precise distance to the kerb from the videos of the vehicle at the end of the queue. Were it to have been possible, it would have added power to our analysis.

Risk Perception. Subsequent to viewing each trial, participants were asked to indicate on a 4-point Likert scale (anchored at 1, *Very Low*, 2, *Low*, 3, *High* and 4, *Very High*) 'the risk associated with passing the vehicle on the nearside [offside]'.

Behavioural Choice. After assessing the risk associated with each manoeuvre, participants indicated what they would plan to do in this situation (choosing between options to overtake on nearside, offside or wait behind).

3.3 Procedure

After giving informed consent, participants viewed one clip per trial. Before watching each clip, participants were asked to orientate their attention to the centre of the screen. Clips faded up from black and began with a 2000ms still of the first frame to allow participants to orientate themselves to the scene. While watching the clip, participants' eye movement data were collected. Clips were ordered randomly at the start of the study, and were subsequently presented to all participants in the same order. After each clip, participants rated the risk of nearside and offside passing, and also their behavioural choice. Upon completion of the study, participants were debriefed, thanked and paid a nominal sum (in the form of a voucher) for their participation.

4. Results

4.1 Overview

We present the results of responses made by the participants in terms of three factors collected as follows: Behavioural Choice (passing on the offside, pass on the nearside, or wait behind); Risk Perception score (for passing either on the nearside or the offside); and Attention Allocation (of both fixation and dwell time in four different areas). These results are presented initially as means and standard deviations. We then present analyses of variance (within-subject ANOVAs⁴) to test the significance of differences in the three difference contexts: Cycle

⁴ The use of percentages in ANOVA can lead to violation of the assumption of sphericity, leading to an increase in the chance of a Type I error. A recognised response to this is to apply a correction to the degrees of freedom when calculating main effects and interactions. In the current study, completing the reported analysis using both Greenhouse-Geisser and Huynh-Feldt corrections led to no differences in patterns of significance. In the interests of readability (and as no differences were observed) standard, unadjusted tests are reported.

Lane (present vs. absent), Vehicle Size (large vs. small) and Kerb Distance (distance between target vehicle and kerb: narrow [< 1 metre], wide [> 1 metre]) for the three dependent variables. Tables 2 and 3 present the means and standard deviations of behavioural choice and risk perception respectively. These data are presented as overall means, and are broken down by context: Cycle Lane, Vehicle Size and Kerb Distance

*****TABLE 2 ABOUT HERE*****

*****TABLE 3 ABOUT HERE*****

Table 4 and Figure 2 presents mean proportions of fixations and dwell times by interest area, as defined in Figure 1. The proportions of dwell time and number of fixations were calculated including only trials in which the relevant contextual factor was either present or absent. The majority of fixations and dwell times are on the centre left area (which is the left hand side of the vehicle).

*****TABLE 4 ABOUT HERE*****

Table 5 presents results from analyses of variance (ANOVA) which were undertaken separately for both the overall data and each contextual variable *and* for each dependent variable (fixations and dwell times, behavioural choice and risk perception). Description and analysis of interactions (simple effects) is contained in the narrative that follows Table 5.

*******TABLE 5 ABOUT HERE*****

4.2 Overall risk perception, behaviour and attention

To test the relationships between risk perception and behavioural choice, both ANOVA and correlations (see 4.4, below) were undertaken. ANOVA indicate the differences in mean proportion of choices to wait behind, pass to the nearside and pass to the offside were significant. Simple effects revealed that offside overtaking was less frequently chosen than passing to the nearside ($p = .045$) and waiting behind ($p = .002$). Nearside overtaking was chosen less frequently than waiting behind with marginal significance ($p = .057$). Cyclists did not see nearside passing as more or less risky than offside passing, $t(19) = .01, p = .99$.

To explore how cyclists allocated attention, ANOVA was conducted on both fixations and dwell time, with area as the independent variable. Number of fixations and dwell time both varied by area. Overall, respondents had more fixations within the centre left area than in all other areas, $ps < .026$. There was also a significant difference between fixations on both the centre right and right areas, $p < 0.001$, and marginally from those in the left area, $p = 0.072$. In terms of the proportion of dwell times, the centre left area had significantly greater dwell times than all other areas, p 's < 0.01 . The proportion of dwell time directed towards the right area was lower than that directed toward all other areas, $ps < .05$.

In summary, although cyclists did not see offside passing as either more or less risky than nearside passing, they intended to do it less frequently. Analysis of attention allocation suggests that cyclists, on average, allocate substantially more attention to the left side of the vehicle (centre left area) ahead of them than any other area of interest.

4.3. Contextual analyses

To explore how contextual variables affected risk perception, behavioural choice and risk perception, a number of within subjects ANOVAs were undertaken.

4.3.1. Cycle lanes

The lack of an interaction between cycle lane and behavioural choice suggests that the presence or absence of lanes did not affect participants' behavioural choices. Passing on the near or offside was perceived as equally risky in both cycle lane and no lane conditions. However, passing vehicles when a cycle lane was present was perceived as less risky than where no lane was present. There were no significant interactions.

As revealed by significant interactions between cycle lane presence or absence and fixation area, cycle lane presence or absence had a significant effect on the mean proportion of fixations in the four areas of interest. The presence of cycle lanes was associated with a greater proportion of fixations to the centre left ($p = .004$) area and, marginally, the left area ($p = .065$). Cycle lane presence was also associated with a lower proportion of fixations in the right ($p = .003$) and centre right ($p = .006$) areas. When a cycle lane was present, the proportion of fixations in each area differed from other areas significantly ($ps < .05$) with the exception of left and centre right areas which did not, $p = 0.87$. When cycle lanes were absent, the proportion of fixations directed between areas differed ($ps < .05$) except for between the left and both centre right area and right area, which did not, $ps > .19$.

As far as proportion of dwell time is concerned, again, cycle lane presence or absence had a significant effect qualified by an interaction. Cycle lanes marginally increased the proportion of dwell time in the centre left area ($p = 0.095$) and reduced the proportion of dwell

time in the right hand area ($p = .016$) and the centre right area ($p = .025$). Cycle lane presence did not affect dwell time in the left hand area ($p = .13$). When a cycle lane was present, proportion of dwell time in each area differed from one another ($ps < .05$) with the exception of the left and centre right areas which did not differ. When a lane was absent, proportion of dwell time differed significantly between all areas ($ps < .05$) with the exception of the left and centre right areas which did not ($p = .20$).

In summary, cycle lanes did not affect behavioural intentions, but did appear to influence perceptions of risk (making passing in general appear lower risk) and attention allocation. In particular, when a cycle lane was present, fixations in the two left areas were more frequent and fixations to the right hand areas were less frequent. When there was no cycle lane fixations were longer in the centre left area than all other areas. This different pattern, as a function of cycle lane presence, indicates a slightly increased focus on the target vehicle rather than the presumably 'safe' area of the cycle lane itself. Cycle lane presence also increased dwell time in the left hand areas of the visual field. Taken together, these results suggest that participants in general attend mostly to the centre left area. However, when a cycle lane is present, reduced fixations and decreased dwell time in the right hand areas suggest they attend even less to the offside passing areas, but that this does not affect behaviour.

4.3.2 Vehicle Size

There was a significant interaction between vehicle size and behavioural choice. Simple effects analysis reveals that a larger vehicle significantly increases the proportion of trials in which participants intended to wait behind the vehicle ($p = .025$) and significantly reduces the proportion of trials in which participants intended to pass on the offside, $p = .017$. When a small vehicle was present, participants choose waiting behind more often than offside passing

($p = .019$) but not more often than nearside passing ($p = .21$). They also choose offside passing less than nearside passing with marginal significance ($p = .075$). When a large vehicle was present, all proportions for each behaviour differed from one another, $ps < .05$, with waiting behind as the most frequent option followed by nearside and finally offside passing.

The risk associated in passing was higher when a large vehicle was present than when a small vehicle was. Passing on the nearside and offside was seen as equally risky, and this factor did not interact with vehicle size.

For proportion of fixations, there was a significant interaction between vehicle size and area. Simple effects revealed that when compared to smaller vehicles, larger vehicles resulted in a greater proportion of fixations being allocated to the centre left area ($p = .026$) and also the centre right area, $p = .015$. In the right area, the proportion of fixations within the area decreased when the vehicle was larger, $p = .005$. In the left hand area there was a marginal ($p = .11$) decrease in the proportion of fixations allocated when the vehicle was larger. When a smaller vehicle was present, the proportion of fixations in each area differed from other areas, $ps < .05$ with the exception of between the left and both the right ($p = .16$) and centre right areas which did not differ, $p > .72$. When a larger vehicle was present, proportions between areas differed ($ps < .05$) except between the left and centre right areas which did not, $p = .42$.

For dwell time, an interaction between behaviour and vehicle size was also present. Simple effects analysis revealed that when compared to small vehicles, dwell times were longer for large vehicles in the left area ($p = 0.024$) and shorter in the centre left area ($p = .045$). Vehicle size did not affect dwell time in the right or centre right areas. When a smaller vehicle was present, the proportion of dwell time differed between all areas with the exception of the

left and both the centre right areas ($ps > .18$). When the vehicle was larger, dwell time between areas differed, $ps < .05$, with the exception of between the left and centre right areas ($p = .30$).

In summary, when a large vehicle is present, cyclists are more likely to wait behind and less likely to pass on the offside compared to when a small vehicle is present. In general, higher levels of risk were perceived when a large vehicle was present. In terms of attention allocation, whilst attention was generally directed to the centre areas, when compared to a small vehicle, the presence of a large vehicle increased fixations to an even greater extent in the centre left and right areas, and reduced fixations to the right area. When compared to small vehicles, the presence of large vehicles resulted in a shift in dwell time to the far left and away from the centre left. Taken together with the fixation data this suggests that large vehicles are associated in greater monitoring of the left hand area (an increase in dwell time spread across fewer fixations) and away from the rear of the vehicle (decreased dwell time). As there is an increased tendency to wait behind larger vehicles, this shift of dwell time to the left side may indicate that this is accompanied by looking for a nearside passing opportunity.

4.3.3 Kerb Distance

For behavioural choice, there was an interaction between distance to kerb and area of interest. A choice to pass on the offside or wait behind was more frequent when the distance was narrow than when it was wide, $p = .004$ and $p = .019$ respectively. Choices to pass on the nearside were less frequent when the distance was narrow, $p < .001$. When the distance was narrow, the proportion of choices to wait behind were significantly more frequent from other choices ($ps < .01$). Proportion of choices to pass on the offside and nearside did not differ, $p = .80$. When the distance was wide, the proportion of offside passing choices was significantly

less frequent than nearside and waiting behind choices, $ps < .01$ but nearside and waiting behind did not differ, $p = .18$.

For risk, there was an interaction between perception and kerb distance. Simple effects revealed that perception of nearside passing risk was affected by distance to kerb, with narrow distance leading to perception of greater risk ($p < 0.001$). Offside risk was not affected by kerb distance, $p = .12$. When the gap was narrow, the risk of nearside and offside passing differed marginally, $p = .099$. When the gap was wide, these risks did not differ, $p = .43$.

For fixations, there was an interaction between area of interest and kerb distance. Simple effects analysis showed that there were marginally fewer fixations in the left area when the distance was narrow than when it was wide, $p = .06$. There was a significantly lower proportion of fixations in the far right hand area when the gap was wider relative to when it was narrow, $p = .004$. Distance did not affect the proportion of fixations in either the centre left ($p = .41$) and centre right ($p = .19$) areas. When the distance was narrow the proportion of fixations differed between areas ($ps < .05$) with the exception of the left area and both the centre right area and the right area which did not ($ps > .44$). When the distance was wide, proportions differed between all areas, $ps < .05$, with the exception of the left and centre right which did not ($p = .70$). For dwell time, there was no interaction between kerb distance and area, indicating that kerb distance did not affect how dwell time was allocated.

In summary, narrow distances led to decreased choices to pass nearside when compared to wide distances, and increased waiting behind and offside passing. Narrow kerb distance lead to a higher general risk of passing, with this effect apparently driven by nearside passing being considered more risky than offside passing when the space was narrow. In both distance conditions more fixations were focussed on the centre left area than any other area. However,

when compared to wide kerb distance, narrow kerb distance resulted in fewer fixations to the left and more fixations to the right areas of interest. Taken together, these attention data suggest that narrow gaps lead to more active searching (indicated by a combination of more fixations within the same dwell time duration) towards the offside of vehicles.

4.4. Correlations

Correlations were calculated to test the hypothesised relationships between risk perception and behavioural choice, and also between Risk Perception and Attention Allocation (see Table 6).

*****Table 6 about here*****

Higher levels of perceived risk for passing on the nearside / offside were negatively correlated with choices to engage in passing on the respective side, and positively correlated with choice to wait behind. Participants who perceived offside passing as more risky also demonstrated shorter dwell times on the right hand side of the vehicle ahead of them, and also, marginally, shorter dwell times to the left hand side. In addition, they demonstrated longer dwell times on the left of the vehicle itself. No other dwell times were significantly correlated with either nearside passing or offside passing. There were no significant correlations between number of fixations and the perception of risk of nearside or offside passing.

To examine the relationship between attention allocation and behavioural choice, zero order correlations were calculated between the number of fixations and dwell time in each area, and the proportion of each behavioural choice. For both fixations and dwell time, no correlations were observed between the proportion of frequency / duration in any area and behavioural choice ($ps > .34$).

5. Discussion

Nearside passing is a high risk cyclist activity which is linked to numerous cycling fatalities each year. Although previous research has observed that cyclists' perception of risk is linked to behavioural choice, little is known about the attentional processes that precede risk judgements, or the effects of various contextual factors on such allocation. The current experiment addressed this gap by showing video clips from the cyclist's point of view of the approach to queuing traffic at junctions. For each clip, measures of risk, behavioural choice and attention allocation were taken by tracking eye movements. In addition, and to test their effects, the experiment manipulated the presence or absence of cycle lanes, the distance between the kerb and vehicle to be overtaken, and the size of the vehicle.

5.1. Risk, attention and behavioural choice.

The aim of the study was to provide an empirical description of how cyclists allocate their attention when negotiating junctions with other road users, and how this links to their perceived risk. It was hypothesised that intentions to engage in behaviours perceived as high risk would be lower than low risk behaviours, and that areas of the visual field associated with high risk manoeuvres would receive less attention than those associated with lower risk ones. It was also expected this allocation would be related to lowered intentions to engage in such behaviours. In addition, exploratory analyses of the effects of various contextual variables were undertaken to add insight into their effects on cyclists cognitions, attention and behaviours.

In line with previous research (e.g. Frings et al., 2012), cyclists perceived nearside and offside passing as risky. The current study replicates this finding and extends it by showing that cyclists allocate around 60% of their attention to the nearside of vehicles (of which approximately two thirds is to the centre left) and 40% to the offside. As the nearside

represents the usual path of a cyclist route, this is unsurprising. However, and more importantly, there was a clear relationship between the perceived risk of passing on the near and offside and the amount of attention allocated to the respective areas. Cyclists who perceived offside passing as more risky allocated less attention to the areas to the right of the vehicle they were to pass. This suggests that cyclists who perceive that offside passing is sometimes safer also monitor the relevant area of their visual field to a greater extent. One possible benefit of this is that opportunities for offside passing are likely to be identified more frequently. In support of this, cyclists who perceived offside passing as less risky did intend to engage in offside passing more frequently.

A second aim of the study was to investigate the relationship between attention and behavioural choice. No direct links between attention allocation and behavioural choices were observed. This suggests that the relationship between attention and behaviour occurs through the relationship between attention and risk rather than independently. Other mediating factors not measured in the current study may also be relevant to this relationship – for instance levels of cycling experience, prior training (See Frings et al, 2012) and, possibly, familiarity with the stretch of road. These could be investigated in future research.

One empirical question which cannot be answered by this research is the direction of causation in the observed relationships. It is possible that attention influences risk perception which influences behavioural choice. This model is based on a well-established assumption that risk perception guides subsequent behaviour (see Frings, 2012, for an example). Alternatively, behavioural choices may direct risk perception, with attention directed to low risk areas. Research suggesting that we actively seek and consider important information that confirms our beliefs to a greater extent than information which disconfirms them supports this possibility (*confirmation bias*, see Nickerson, 1998). A final option is that the two processes

are reciprocal, with attention guiding behaviour through risk perception, which informs subsequent attention allocation. Future research could test these options by creating a paradigm in which cyclists' attention is directed to offside areas (either through training or through salient stimuli) and its effects on risk perception and subsequent behaviour measured.

Regardless of which causal relationship is operating, these findings present two possibilities for harm reduction through training when taken together. Firstly, as argued in Frings et al., (2012), trainers should account for the level of continual risk assessment being undertaken by cyclists and direct their teaching accordingly. This may include a discussion of the importance (and risks) of offside passing and the importance of maintaining an awareness of the whole traffic situation, rather than focussing exclusively on what is happening along the cyclist's intended route. The current research provides further evidence for this, suggesting it may be important not just for identifying offside passing opportunities, but also more generally. As well as identifying passing opportunities, cyclists who monitor the offside of their visual fields may also have higher levels of situational awareness about developing traffic situations. This may allow the early detection and avoidance of risky situations. Further research should be undertaken to explore these possibilities.

In addition to providing a novel and innovative description of how cyclists' allocate their attention during junction negotiation, the study also experimentally tested the effects of three contextual factors, the presence of cycle lanes, the size of the vehicle being approached and the distance between the kerb and the vehicle.

Cycle lanes provide a priority lane for cyclists and a motor traffic free area for them to travel through, but do not provide exclusive right of way to cyclists in all circumstances. Other vehicles often encroach legitimately into cycle lanes as a result of road geometry or in order to navigate a passage based on the presence of other traffic. Additionally, at junctions, a cycle

lane does not negate the fact that cyclists are often in drivers' blind spots. Thus, maintaining an awareness of passing opportunities on the nearside and offside of vehicles remains important. This research suggests, for the first time, that the presence of cycle lanes is linked with reduced perceived risk of passing vehicles in general (i.e. of both near and offside passing). Attentional processes were also affected in that there were both fewer fixations and less dwell time directed towards the offside of the approached vehicle when cycle lanes were present. More attention (higher proportion of fixations, and marginally more dwell time) was directed to the nearside (left and centre left). This suggests that when cycle lanes are present, cyclists in the current study neglected to monitor the offside to the same extent as when they are absent. One result of this is that they may miss opportunities for safer offside passing, and may not observe developing traffic situations. Although behavioural choice was unaffected directly by the presence of cycle lanes it did have associations with attention allocation and risk perception. The changes in attention allocation were in turn related to behavioural choice. Specifically, cycle lanes led to less attention being allocated to the right hand side of the visual field. This inattention was linked to lower choices to pass on this side.

When considering the practical implications of these findings, it is important to balance the risk of poor situational awareness and missed offside passing opportunities against the increased awareness that other vehicle users may have of cyclists operating in a cycle lane, and, importantly, the decreased awareness other road users may have towards cyclists who stray from them. It is also important to note that field research is needed to confirm the generalisability of the findings of this laboratory study before strong conclusions about cyclists routes in cycle lanes can be drawn. If they appear to generalise, this current finding begins to suggest that those delivering cycle training could consider communicating clearly to trainees

the danger of becoming complacent whilst using cycle lanes, and failing to attend to traffic movements to the same extent that they would otherwise.

The results for cycle lanes also highlight an inconsistency not observed in other analysis. Namely, the change in context (between a cycle lane being present and absent) affected attention allocation and perception of risk, but did not affect behaviour in any way. This may be in part because cycle lanes are very noticeable and as they may also provide a more directive meaning (i.e. cyclist are generally in the lane, while vehicles are generally not) than the other contextual variables (there are no 'rules' associated with kerb distance, and differences may not be as salient). In other words, cycle lanes may provide such a salient cue that the influence of other factors on behavioural intentions become less pronounced. This supposition (which requires further testing) would suggest a boundary condition (salience) for the purported links between attention, risk and behaviour.

Larger vehicles present an increased risk when nearside passing, as cyclists are in such vehicles' blind spots for a greater length of time, so offside passing may be. The risk of nearside passing has been highlighted in a number of recent high profile public safety campaigns in London. In the current study, cyclists perceived all passing options as more risky when they shared a junction with a larger vehicle. The current research suggests that when confronted with a larger vehicle, the cyclists in this study directed their attention less upon the left side (lower dwell time). They also directed a lower proportion of fixations to the offside. A decrease in the number of fixations but no change in dwell time can indicate a more methodological search pattern as it comprises fewer fixations of longer duration.

These findings indicate that the cyclists sampled recognise the risks involved in passing larger vehicles on the nearside and may have been looking for alternative passing opportunities when presented with larger vehicles. However, this did not translate into changes in increased

offside passing intentions. When large vehicles were presented, choices to pass offside decreased and choices to wait behind increased relative to small vehicles. However, vehicle size did not affect nearside passing intention frequency. Looking within the large vehicle condition, nearside passing was *intended* less frequently than waiting behind, but importantly, was still selected in around one third of trials.

Risk to cycle users associated with large vehicles has been the focus of national media coverage (e.g. The Times, 2013) for some time. Although cyclists appear to be searching for offside passing opportunities, many are still prepared to pass on the nearside: The rate of nearside passing was as high when large as opposed to small vehicles were present (neither was it affected by the presence or absence of cycle lanes). This does not imply that training to date has been ineffective however, as no baseline data can be used as a comparison and significant improvements may have been made. It does however, suggest that need for cyclists' education still exists. When small vehicles were present, nearside passing was as frequently selected as waiting behind. Small vehicles therefore also seem to encourage offside passing. In this sense, they encourage riskier behaviour. Although this may often be a relatively safe manoeuvre, training should still encourage a complete evaluation to ensure that the risks of passing of small vehicles on either side are not underestimated. In contrast, offside passing frequency decreased significantly when large vehicles were present, so training could also encourage monitoring for safe opportunities to engage in this manoeuvre.

The final contextual factor tested was the distance between the vehicle to be passed and the kerb. Narrow kerb distance led to a pattern of attention linked with more systematic searches on the offside (fewer fixations of longer duration). Narrow kerbs spaces lead to nearside passing being perceived as more risky than offside passing. These effects were mirrored by changes in behavioural choice – narrow kerb space led to fewer choices to pass on

the nearside, and more frequent choices to wait behind the vehicle, or to pass on the offside. When wide kerb distances were present, participants were just as likely to pass on the nearside as wait behind. Again, this pattern of results suggests that when presented with narrow spaces, cyclists search the areas to the right for opportunities to pass offside. When these are absent, they may become less likely to nearside pass, and more likely to wait behind. Nearside passes in these situations may be problematic when negotiating a junction, as kerb space can increase or decrease dynamically according to the shape of the junction and the path of the vehicle. Training should highlight that wide spaces can rapidly become narrow or vanish.

There are a number of limitations to the current experiment which suggest avenues for future research. The research presents correlational data between risk, attention and behavioural choices. As such, mediational processes cannot be presumed to be causal. Moreover, although other research (e.g. Frings et al., 2012) suggests risk perception may be linked to collision involvement, it would be presumptive to assume that risk perception and, in particular, attentional allocation is a causal factor in collision occurrence. The current research considered three key contextual variables, but it is likely that other factors may affect attentional allocation and behaviour. These might include, for example, different levels of traffic intensity, different weather conditions, varying lighting levels (day or night), different numbers of traffic lanes on the approach, unpredictable periods of time before the vehicle ahead might once again start to move at speed, and so on. Another set of factors which may alter attention allocation are related to cyclists themselves. Frings et al., (2012) showed that gender, level of training and experience and is linked to differential risk perception. Although insufficient statistical power was obtained to investigate these factors, they may also affect attention allocation. Thus, future research should systematically manipulate or vary these factors to test how they interact with those measured in the current study.

A further limitation of the research is that the trials were recorded by a cyclist who was himself ensuring junctions were negotiated safely. Thus, the positioning of the viewpoint may have been influenced by the cyclist's own risk perception and behavioural choices. To attempt to mitigate this, the clips were selected with this consideration in mind, and clips ended at a point where it was judged a decision had been made. In addition, multiple trials were used to increase variability of the viewpoint as much as possible. Different viewpoints during approach may influence both judgements and behaviour and these in turn may influence where the cyclist positions themselves – moving the viewpoint. Future research could address this by using computer generated simulations of traffic situations which would increase experimental control. Such an approach would however, lack the ecological validity of the current study, but is in line with naturalistic driving studies (e.g. Wong and Huang, 2013).

5.2. Conclusion

The study presented in this paper has found that cyclists allocate around 60% of their attention to the nearside of vehicles they are approaching, and 40% to the offside. Cyclists who perceive offside passing as less risky monitor the area to the right of a vehicle they are approaching to a greater extent than other cyclists, and they intended to engage in offside passing more often. It would appear that the relationship between attention allocation and behavioural choice occurs through the relationship between attention allocation and risk, rather than independently.

While the processes observed may conform to the well-established assumption that risk perception guides behaviour, it could be that behavioural choices direct risk perception, or that the two processes are reciprocal with attention guiding behaviour through risk perception, which informs subsequent attention allocation. Our findings so far as cycle training is

concerned are that such training could consider emphasising how cyclists should direct their attention, stressing the need to maintain awareness of the whole traffic situation, rather than just the intended route. It also provides some initial evidence that cycle lanes reduce both the perceived risk of nearside and offside passing vehicles and the number of fixations and dwell time directed to the offside, which links with lower choices to pass on this side. If these findings generalise beyond the laboratory, cyclists' training programmes may consider highlighting the need to continue to attend to all traffic movements in the presence of cycle lanes.

When presented with large vehicles, the cyclists in this study adopted a methodological approach to searching by adopting fewer fixations with longer durations. It would appear that cyclists search for offside passing more when approaching large vehicles than when approaching small vehicles, but overall they are more likely to wait behind. When the distance from the kerb to a vehicle was narrow, cyclists searched the areas to the right hand side for opportunities to pass offside and in the absence of these opportunities, they were less likely to pass on the nearside and more likely to wait behind. In both these instances, training should encourage situational awareness across the whole visual field.

6. Acknowledgements.

This research was supported by the Chartered Institute of Logistics and Transport (grant number RC6417). The authors would like to thank Sean Rooney for technical assistance and Lee Henry-Johnson for assistance with data collection.

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Table 1: Summary of content of videos recorded

Distance to kerb	Without cycle lane		With Cycle Lane		Total
	Car or van	Large vehicles	Car or van	Large vehicles	
Narrow	3	3	3	4	13
Wide	2	5	3	3	13
Total	5	8	6	7	26
Overall Total	13		13		

Table 2: Means of Behavioural Choice proportions

Context	Contextual condition	Behavioural Choice		
		Wait behind	Nearside pass	Offside pass
Overall		0.51 (0.27)	0.30 (0.20)	0.19 (0.18)
Cycle Lane	Present	0.47 (0.34)	0.34 (0.29)	0.19 (0.21)
	Absent	0.54 (0.23)	0.30 (0.13)	0.16 (0.17)
Vehicle size	Small	0.46 (0.29)	0.32 (0.22)	0.21 (0.18)
	Large	0.55 (0.26)	0.31 (0.20)	0.14 (0.19)
Kerb distance	Narrow	0.53 (0.27)	0.24 (0.19)	0.22 (0.19)
	Wide	0.48 (0.28)	0.34 (0.20)	0.18 (0.17)

Note: The first row presents the overall means, with subsequent rows providing data split down by context. Standard deviations in parentheses.

Table 3: Mean Risk Perception scores.

Context	Contextual condition	Risk		
		Nearside	Offside	Total
Overall		3.02 (0.58)	3.02 (0.57)	3.02 (0.58)
Cycle Lanes	Present	2.95 (0.69)	2.92 (0.57)	2.94 (0.63)
	Absent	3.09 (0.45)	3.13 (0.62)	3.11 (0.54)
Vehicle size	Small	2.94 (0.63)	2.96 (0.57)	2.95 (0.60)
	Large	3.10 (0.53)	3.09 (0.61)	3.10 (0.57)
Kerb distance	Narrow	3.22 (0.57)	2.96 (0.64)	3.09 (0.61)
	Wide	2.91 (0.57)	3.03 (0.55)	2.97 (0.56)

Note: The first row presents the overall means, with subsequent rows providing data split down by context. Standard deviations in parenthesis.

Table 4: Proportion of fixations and dwell times directed to the four areas of interest

Mean proportion of	Contextual factor	Interest area			
		Left	Centre left	Centre right	Right
		Mean (S.D.)	Mean (S.D.)	Mean (S.D.)	Mean (S.D.)
Fixation	Overall	0.22 (0.16)	0.41 (0.17)	0.23 (0.09)	0.14 (0.03)
	Cycle Lane: present	0.22 (0.17)	0.44 (0.19)	0.21 (0.10)	0.13 (0.32)
	Cycle Lane: absent	0.19 (0.16)	0.37 (0.16)	0.26 (0.09)	0.16 (0.03)
	Vehicle Size: small	0.23 (0.16)	0.39 (0.16)	0.22 (0.09)	0.17 (0.05)
	Vehicle Size: large	0.21 (0.17)	0.43 (0.19)	0.25 (0.10)	0.12 (0.04)
	Kerb Distance: narrow	0.19 (0.16)	0.40 (0.18)	0.22 (0.09)	0.16 (0.04)
	Kerb Distance: wide	0.22 (0.16)	0.41 (0.17)	0.24 (0.09)	0.12 (0.03)
	Dwell time	Overall	0.18 (0.15)	0.45 (0.20)	0.26 (0.11)
	Cycle Lane: present	0.19 (0.17)	0.47 (0.21)	0.24 (0.13)	0.10 (0.05)
	Cycle Lane: absent	0.22 (0.13)	0.44 (0.19)	0.27 (0.10)	0.13 (0.03)
	Vehicle Size: small	0.17 (0.17)	0.47 (0.21)	0.26 (0.11)	0.11 (0.05)
	Vehicle Size: large	0.20 (0.13)	0.44 (0.19)	0.25 (0.11)	0.12 (0.04)
	Kerb Distance: narrow	0.21 (0.15)	0.47 (0.21)	0.26 (0.12)	0.11 (0.05)
	Kerb Distance: wide	0.19 (0.16)	0.43 (0.19)	0.27 (0.11)	0.12 (0.04)

Table 5: ANOVA of proportion of fixations and dwell time in each interest area. ME = main effect; I = interaction.

Context	Dependent variable	ME/I	F	Df	p	partial η^2	
Overall	Behavioural Choice	ME (Choice)	7.39	2, 38	0.002	0.28	
	Mean proportion of fixation	ME (Area)	9.91	3, 48	< 0.001	0.38	
	Mean proportion dwell time	ME (Area)	15.58	3, 51	< 0.001	0.48	
Cycle Lane	Behavioural Choice	ME (Choice)	7.64	2, 38	.002	0.28	
		I (Choice X Context)	1.44	2, 38	0.25	0.10	
	Risk Perception	ME (Context)	12.01	1, 19	0.003	0.39	
		ME (Behaviour)	< .001	1, 19	.99	< .001	
		I (Context X Behaviour)	0.79	1, 19	0.39	0.04	
	Mean proportion of fixation	ME (Area)	10.24	3, 48	< 0.001	0.39	
		I (Area X Context)	9.08	3, 48	< 0.001	0.36	
	Mean proportion dwell time	ME (Area)	15.01	3, 51	< 0.001	0.47	
		I (Area X Context)	3.45	3, 51	0.023	0.17	
Vehicle size	Behavioural Choice	ME (Choice)	7.64	2, 38	0.002	0.29	
		I (Choice X Context)	4.83	2, 38	0.014	0.20	
	Risk perception	ME (Context)	8.51	1, 19	0.009	0.31	
		ME (Behaviour)	< 0.01	1, 19	0.99	< 0.01	
		I (Context X Behaviour)	0.16	1, 19	0.70	0.008	
	Mean proportion of fixations	ME (Area)	9.91	3, 48	< 0.001	0.38	
		I (Area X Context)	6.47	3, 48	< 0.001	0.29	
	Mean proportion dwell time	ME (Area)	15.58	3, 51	0.001	0.48	
		I (Area X Context)	3.77	3, 51	0.016	0.18	
	Kerb distance	Behavioural choice	ME (Choice)	7.00	2, 38	0.003	0.27
			I (Choice X Context)	14.51	2, 38	< 0.001	0.43
		Risk perception	ME (Context)	13.42	1, 19	0.002	0.41
ME (Behaviour)			0.25	1, 19	0.63	0.01	
I(Context X Behaviour)			51.80	1, 19	0.001	0.73	
Mean proportion of fixations		ME (Area)	10.24	3, 48	< 0.001	0.40	
		I (Area X Context)	3.34	3, 48	0.027	0.17	
Mean proportion dwell time		ME (Area)	15.02	3, 51	< 0.001	0.47	
		I (Area X Context)	1.62	3, 51	0.195	0.09	

Notes

1 Behavioural Choice is one of three passing decisions: pass to left, pass to right, stay behind. For risk perception, behaviour is considered as within subjects variable.

2 Fixations and dwell times is to one of four areas of interest: left, centre left, centre right, right (see Figure 1).

3 Risk Perception score is for either passing to the right or passing to the left

4 Context factors are all binary: presence/absence of cycle lane; large/small vehicle; and wide/narrow distance to kerb.

Where a proportion was calculated (for dwell time and fixations, behavioural choice) the main effect of contextual variables was not calculated because the total proportions across all options must always equal 1.

Table 6: Correlations of Behavioural Choice and Dwell Time with Risk Perception

	Risk perception	
	Nearside passing r (d.f)	Offside passing r (d.f)
Behavioural Choice		
Proportion nearside passing	-0.94 (18)***	-0.21 (18)
Proportion waiting behind	0.75 (18)***	0.56 (18)**
Proportion offside passing	-0.12 (18)	-0.65 (18)**
Dwell time		
Proportion left area	-0.02 (18)	-0.39 (18)**
Proportion centre left area	0.12 (17)	0.45 (17)**
Proportion centre right area	-0.68 (17)	-0.09 (17)
Proportion right area	-.12 (.16)	-0.52 (16)*

*Note: Pearsons rs zero order correlations are reported. Co-efficients marked with asterix(es) indicate statistical significance at the following levels; * = $p < .05$, ** = $p < .01$, ***, $p < .001$.*

Figure 1: Image showing single video frame, with areas of interest marked and labelled.

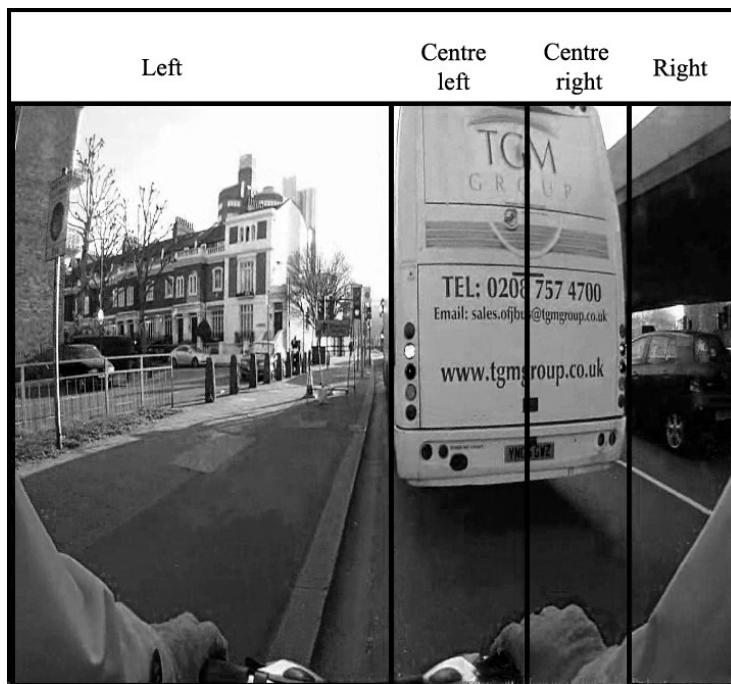


Figure 2: Mean proportion of dwell time and fixations directed at each interest area.

