Cyclists' choice of lateral position and feeling of safety between tram tracks, sharrows and parked cars

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1 INTRODUCTION

Cycling is good for the environment, healthy and affordable [1]. However, these benefits are offset by the risk of being involved in traffic crashes [1], with infrastructure characteristics like tram tracks or parked cars increasing aforementioned risk [2, 3]. Bicycle crashes with tram tracks can occur when cyclists turn onto streets with tram tracks or cross them for other reasons, such as avoiding parked cars on the side (oftentimes related to sudden maneuvers to avoid collisions with the door of a parked car being opened) [4]. Such collisions, referred to as *dooring crashes*, account for a significant proportion of bicycle crashes [3]. Nevertheless, the majority of cyclists ride in the so-called dooring zone, which is the area next to parked cars where dooring crashes can occur. If the cyclists' lateral distance to parked cars is large enough, the risk of being involved in a dooring crash can be eliminated [2]. Cyclists' position on the road can be influenced by descriptive norms which reflect a typical or normal behavior: If many other cyclists ride within the dooring zone, then the descriptive norm in this situation is to ride in the dooring zone [5]. People may also ride in the dooring zone because they are convinced that important people around them would approve of this behavior (injunctive norm), e.g. because it is communicated verbally. Apart from influencing cyclists' choice of position through norms, installing bicycle lanes with buffer zones to keep cyclists out of the dooring zone would be a solution. However, particularly in urban areas, a lack of space can make this impossible. Additionally, if tram tracks run on the road, it is not always practical to mark bicycle lanes or protective lanes, especially when there is little space to the right of the outer tram track. In connection with frequent bicycle crashes roads with tram tracks, it is discussed whether cyclists might particularly often ride within the dooring zone there as not to have to cross the tracks [3, 6]. In those cases where marking of bicycle lanes or protective lanes is not feasible due to width or tram track constraints, bicycle pictograms, so-called sharrows, can be marked in the middle of the lane as a measure aimed at encouraging cyclists to choose a position outside of the dooring zone and to increase their perceived safety, another factor influencing the positional choice [2]. To date, a joint experimental variation of the presence of tram tracks, parked cars, and sharrows with the aim of investigating cyclists' position on the road and their feeling of safety has not yet taken place. Two online studies were carried out to address this research gap, with cyclists being asked to indicate their perceived safety and their preferred position on the road based on images of a traffic situation in which the presence of tram tracks, parked cars and sharrows was varied.

2 METHODS

In both studies, convenience samples were recruited, with around two thirds of respondents being male and most cycling at least 4 times a week. In the first study, 1 862 individuals were presented with 20 images (cf. figure 1, left-hand side). Three independent categorical variables were varied as within factors: the type of pictogram (none, simple pictogram, pictogram with arrow above, pictogram with two chevrons above, pictogram with one chevron above and one below), parking (no parking, parking) and the position of the person cycling ahead in the images (0.8 m from the edge, 1.2 m from the edge; referred to as descriptive norm).

Participants were asked to indicate where they would ride by selecting one of 21 yellow lines and to indicate on a 5-point Likert scale how safe they would feel *in the position of the cyclist in front of them*.
In the second study, tram tracks as well as injunctive norms were added as further factors and the number of presented lines was reduced. 3 200 individuals were presented with 8 images (c.f. figure 1, right-hand side). Three independent categorial variables were varied as within factors: tram tracks (no tram tracks, tram tracks), parking (no parking, parking) and sharrows (none, pictogram with two chevrons above). Two independent categorial variables were varied as between-factors: the position of the person cycling ahead in the images (0.6 m from the edge, 1.8 m from the edge; referred to as descriptive norm) and an injunctive norm, communicated by a text (text that stated that cyclists should ride close to the edge; text that stated that cyclists should ride far from the edge). Participants were asked to indicate where they would cycle by selecting one of 8 lines and to indicate on a 5-point Likert scale how safe they would feel were they to cycle *in the depicted traffic situation*. The second study was preregistered (https://doi.org/10.17605/OSF.IO/S7PE6).

Figure 1. Left: Example of one of the trial images used in study 1 (condition pictogram without chevrons, with parking, person cycling ahead in 0.8 m distance from parked cars). Distance between the lines 0.04 m. Right: Example of one of the trial images used in study 2 (condition sharrows, with parking, with tram tracks, person cycling ahead in 0.6 m distance from parked car). Distance between the lines 0.03 m.

3 RESULTS

3.1 Which position did the respondents choose on the road?

As expected, in both studies participants chose a more central position for situations with sharrows than for situations without sharrows. Furthermore, participants chose more central positions in the presence of sharrows compared to no sharrows in both studies. Respondents in both studies were found to choose more central positions when parked cars were present. If the cyclist ahead was depicted in a more central position, respondents in both studies also chose a more central position compared to when the cyclist riding ahead drove further to the right, showing an effect of the descriptive norm. Participants in study 2 who read a text that communicated the injunctive norm that cyclists should ride close to the edge chose a position closer to the edge than those who read a text that communicated the injunctive norm that cyclists should ride in the center of the lane. Unexpectedly, in study 2 the chosen position was significantly farther from the edge for situations with tram tracks than for situations without tram tracks.

3.2 How safe did the respondents say they felt…

… **in the position of the person cycling ahead?**

In study 1, respondents reported feeling safer were they in the position of the person cycling ahead when there were no cars parked compared to when there were parked cars. In situations with parked cars, women reported feeling safer if they were to cycle in the position of the person cycling ahead than men, whereas for situations without parked cars, the difference between men and women was smaller. Respondents indicated feeling safer in the position of the person cycling ahead when the person was depicted in a more central position rather than closer to edge as well as when pictograms were present compared to no pictograms being present, regardless of the type of pictogram used.

… in the depicted traffic situation? (explorative)

While in the first study, we wanted to know how safe the respondents rated the positional choice another person, namely the depicted person cycling ahead, made, in study 2, we asked about the respondents' feelings

of safety for the depicted situation. In situations with tram tracks, participants reported feeling less safe than in situations without tram tracks. The perceived safety was similar for situations with sharrows and for situations without sharrows. For situations with parallel parked cars, the perceived safety was lower than for situations without parallel parked cars. The perceived safety was similar for situations with a cyclist cycling ahead far from the edge and for situations with a cyclist cycling ahead close to the edge.

4 DISCUSSION

The more central positions in the presence of parked cars as well as in the presence of pictograms on the road found in both online studies were confirmed in other field studies as well [8, 9]. Prior to our studies, there had been no research on cyclists' positional choices and perceived safety in traffic situations with tram tracks and sharrows. The fact that cyclists chose more central positions in situations with tram tracks is surprising, as that would mean cycling within the track axis and would require crossing the tracks, which is associated with an increased crash risk [4]. As in other studies, cyclists rated situations without parked cars as safer in the two samples studied compared to situations with parked cars [10]. Our online studies show that in situations with sharrows, cyclists felt safer than in situations without this feature. In field studies, cyclists also rated routes with sharrows as safer [8]. The generalizability of the findings is limited not only by the lack of representativeness of the samples, but also by limitations in the study design. The transferability of findings from online studies to the field (ecological validity) is limited. In surveys, only the intention to perform a certain behavior (in the present case: choosing a certain position when cycling) is measured, but not the actual behavior [11]. It is well established in the literature that an intention does not necessarily lead to the intended behavior [12]. In the future, a repetition of the studies with a more representative sample and as before-and-after studies in the field would be desirable to be able to make statements not only about intentions, but also about actually chosen positions and to be able to test the findings on the feeling of safety in a real traffic context.

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