

Interactions among cyclists riding the wrong way on the bicycle path

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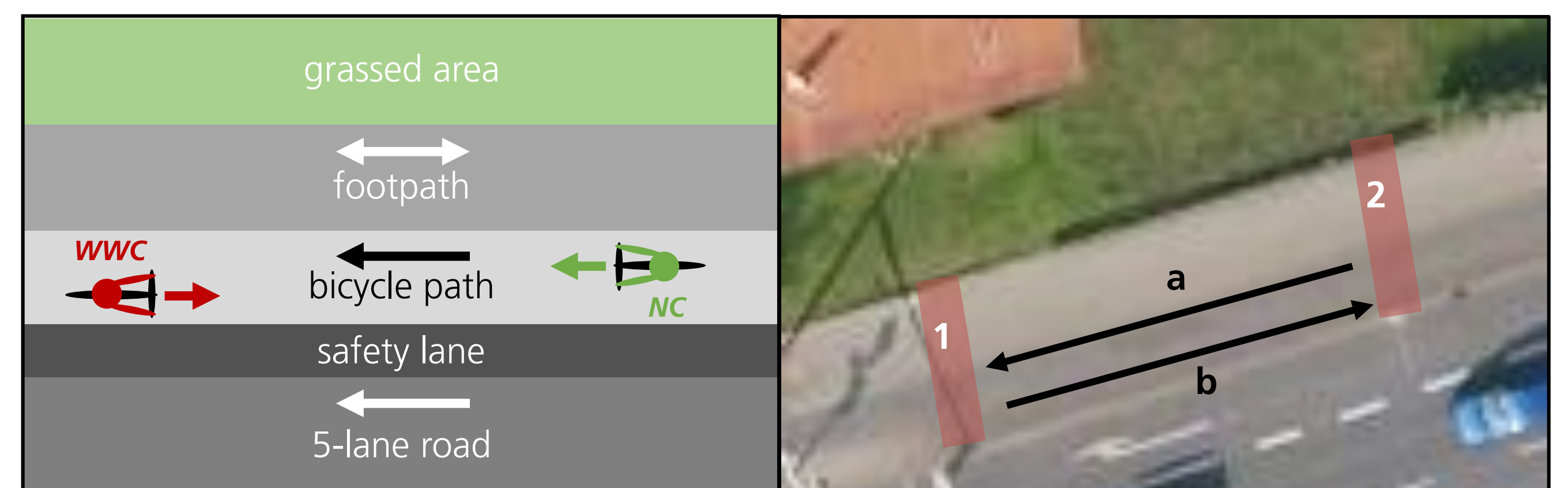
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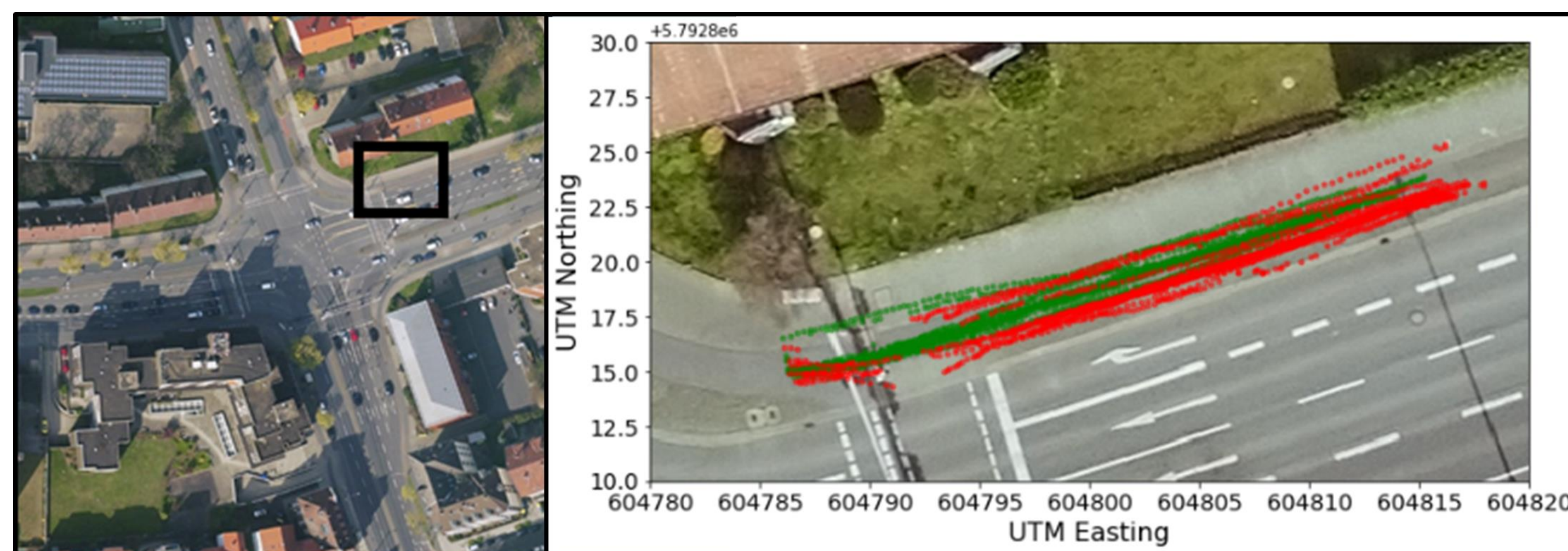
INTRODUCTION

- Riding on the bicycle path in the opposite direction (wrong-way-cycling, *WWC*) can be a criminal offence in Germany and often leads to critical encounter situations or crashes.
- In Brunswick, Germany, *WWC* is the second leading cause in 13% of accidents involving cyclists [1].
- Among the causes of road accidents with injuries caused by cyclists, *WWC* accounts for 9%.
- Accidents involving left-side cycling ranged between 12% and 18% [2].
- No official statistics available in Germany
- Only a few observation studies shed some light on such situations.

To understand how bicyclists interact with each other is very important to improve traffic safety and conduct realistic simulation studies between normal cyclists (*NC*) and wrong-way-cyclists (*WWC*).



Left: Sketch of the study area with abbreviations (*WWC*: Wrong-Way-Cyclist, *NC*: Normal Cyclist); right: Satellite image of AIM Research Intersection (red: regions of the selected polygons, black: pair of cyclists routes (sketch)).



Left: Satellite image of AIM Research Intersection (black: area of interest for this analysis); right: *NC* and *WWC* on bicycle path ($n = 20$) in UTM (red: *WWC*; green: *NC*).

METHOD

- Camera-based traffic observation at a signalised intersection
- 256 hours of analysed trajectory and video data (20 fps)
- Measurements: February 2022, October 2022, March 2023
- Intersection has a separate footpath and bicycle path
- Study area is approx. 25m long, straight and the bicycle path is around 1.50m wide

<i>NC</i>	<i>WWC</i>	Type	No. of cases	d_{mean} d_{min} [m]	$ v $ [m/s]
bicycle path	footpath	straight	110 (65.1%)	2.29 ± 0.04 1.42	5.12 ± 0.13 ^{NC} 4.39 ± 0.11 ^{WWC}
		crossing	24 (14.2%)	2.14 ± 0.07 1.50	5.21 ± 0.24 ^{NC} 4.76 ± 0.19 ^{WWC}
bicycle path	bicycle path	straight	20 (11.8%)	2.38 ± 0.49 0.68	4.98 ± 0.25 ^{NC} 4.63 ± 0.16 ^{WWC}
		crossing	7 (4.1%)	1.65 ± 0.09 1.48	5.44 ± 0.27 ^{NC} 5.00 ± 0.30 ^{WWC}
footpath	bicycle path	straight	4 (2.4%)	2.50 ± 0.17 2.16	6.21 ± 0.59 ^{NC} 4.93 ± 0.39 ^{WWC}
		crossing	3 (1.8%)	1.43 ± 0.39 0.68	4.56 ± 0.45 ^{NC} 4.90 ± 0.34 ^{WWC}

Scenarios of 169 interacting cyclist pairs with speed: $|v|$ for normal cyclists (*NC*) and wrong-way cyclists (*WWC*), and mean of minimum distance between the cyclists during interaction: d_{mean} , the minimum distance between the cyclists during the interaction of all cyclists: d_{min} and type "straight" for keeping their lane during they passed or type "crossing" for first changed lanes.

RESULTS

- 169 interacting couples were identified and analysed
- 12% *WWC* ($n_{total} \approx 19.000$)
- *NC* rode most frequently on the bicycle path while the *WWC* already were on the footpath (about 65%, *straight*).
- In 14%, the *WWC* first rode on the bicycle path and changed to the footpath before they passed each other (*crossing*).
- *WWCs* switched from the bicycle path to the footpath approximately $17.49m \pm 3.75m$ before the interaction.
- *WWC* have lower speeds than *NC*.
- 27% of *NC* wore a helmet, compared to only 7% (12%) of male *WWC* (of female *WWC*) for 130 interaction pairs.



Sample video images: left: *WWC* on footpath and *NC* on bicycle path, middle: *WWC* on bicycle path and *NC* on footpath, right: *WWC* and *NC* on bicycle path.

CONCLUSION AND FUTURE WORK

- Interaction of oncoming cyclists differed from each other and could be clustered.
- Further analyses could provide information about when cyclists avoid or keep their path and, if necessary, at what distance a speed is maintained or adjusted to determine behavioural and kinematic patterns of interacting cyclists for safety simulation purposes.

[1] Polizeiinspektion Braunschweig, *Polizeiliche Verkehrsunfallstatistik 2021*. 18.04.2023. <https://cache.pressmailing.net/content/e9c85f39-e7ae-4701-a269-fc9cb131e6f6/VU-Statistik2021.pdf>
 [2] Handlungsleitfaden GEISTERRADELN -Grundlagen und Empfehlungen zur Vermeidung von Konflikten durch Radfahren entgegen der vorgeschriebenen Fahrtrichtung. Endbericht des NRVP2020-Forschungsvorhabens `Geisterradeln - Ursachen der Radwegbenutzung entgegen der vorgeschriebenen Fahrtrichtung und Strategien der Unfallvermeidung` 30. November 2021. <https://www.geisterradeln.de/wp-content/uploads/2022/07/Handlungsleitfaden-Geisterradeln-2021.pdf>