2023 TRANSW Symposium

Movement Patterns of Pedestrians and Cyclists at Signalized Segregated Crosswalks

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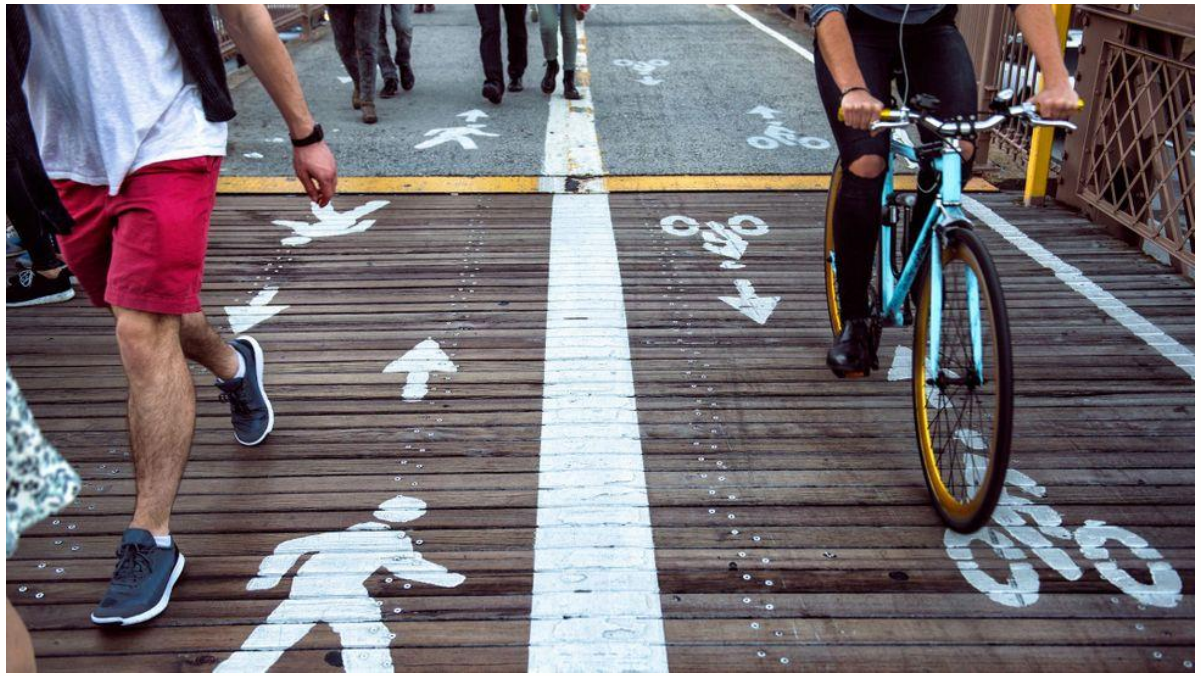


https://www.bbc.com/travel/article/20220912-four-health-conscious-cities-putting-pedestrians-first

https://www.tmr.qld.gov.au/travel-and-transport/cycling/infrastructure-projects/bicentennial-bikeway

- One measure is to introduce road centerline or segregation to allocate road space separately (for different road users or different movement directions);
- The majority of pedestrians and cyclists prefer the segregated road types, however, they usually feel uncomfortable if they find their counterparts frequently moving into the wrong side of the road;
- Very few studies focused on crossing and space sharing behaviors of pedestrians and cyclists at segregated crosswalks.

Field observation & Data collection

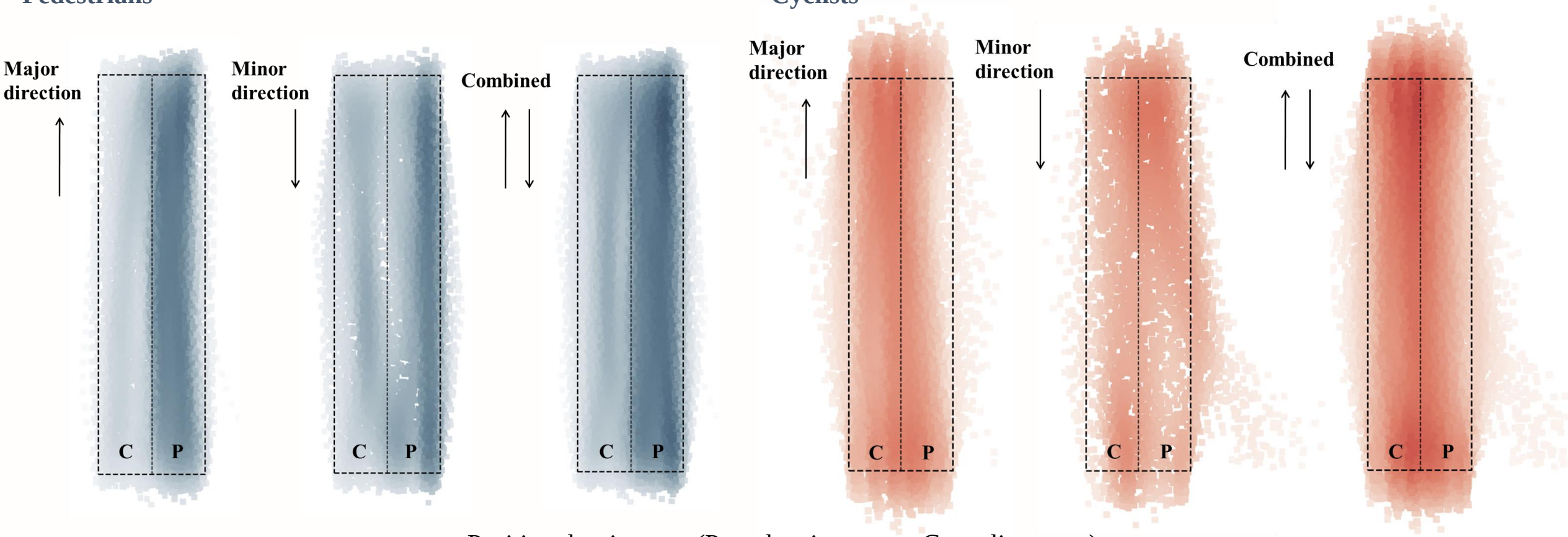
Shuanglong – Tianyuan Zhong Intersection in Nanjing, China

- The width of 8.0m is equally divided into two segments for walking and cycling, respectively;
- Unobtrusive field observations were conducted by video recording from 5th to 9th September 2022 during peak hours on working days;
- The video recordings were captured by a camera installed on a nearby building to get a complete view of the crosswalks and trajectories of pedestrians and cyclists;
- In total, 659 pedestrians and 1,212 (e-)cyclists are observed, and 34,067 position samples are extracted;
- Three types of influencing factors are collected: (1) Road user characteristics; (2) Traffic features; (3) Traffic signal timing.

Results - Route choice

Pedestrians

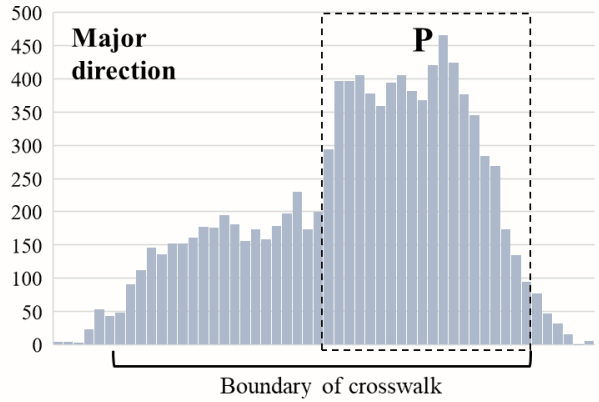
Cyclists

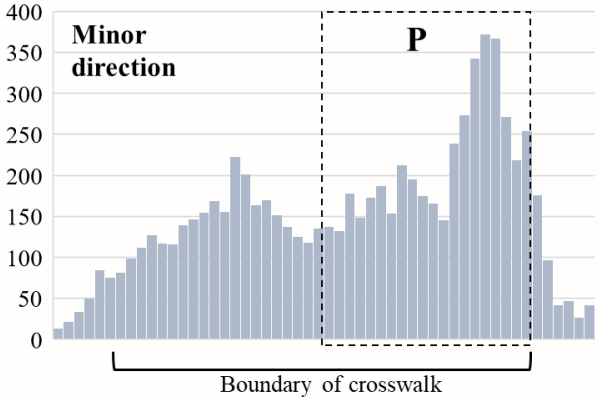


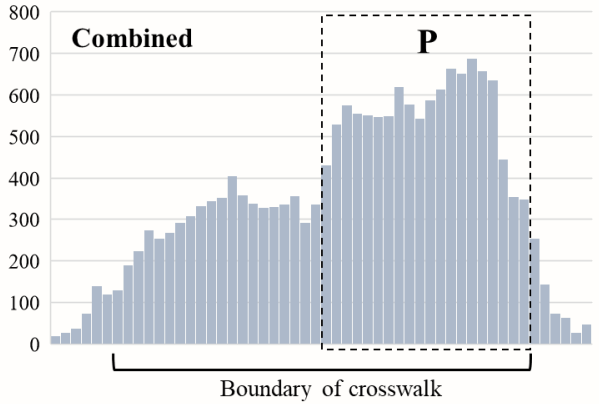
Position density map (P: pedestrian space; C: cyclist space)

- Pedestrians in both major and minor directions primarily choose the rightful crosswalk space;
- The majority of cyclists in the major direction choose the rightful crosswalk space;
- Cyclists in the minor direction are the main type of road users violating the segregation rule.

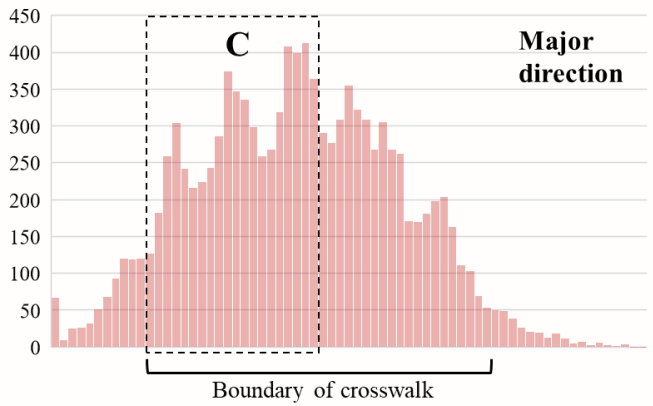
Results - Route choice

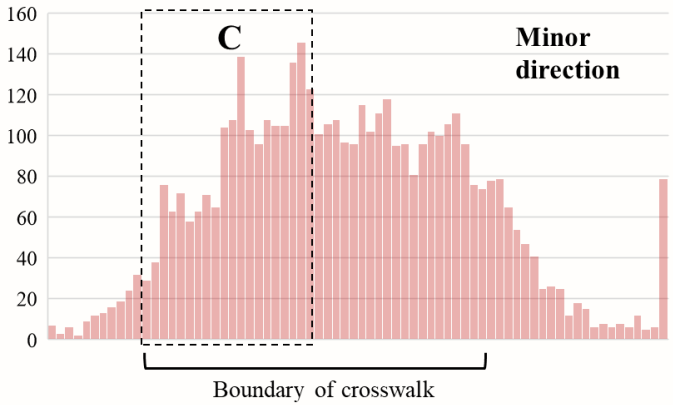


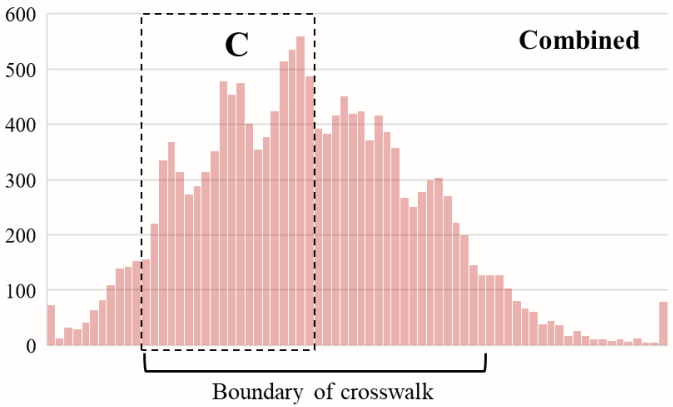




Pedestrians







Cyclists

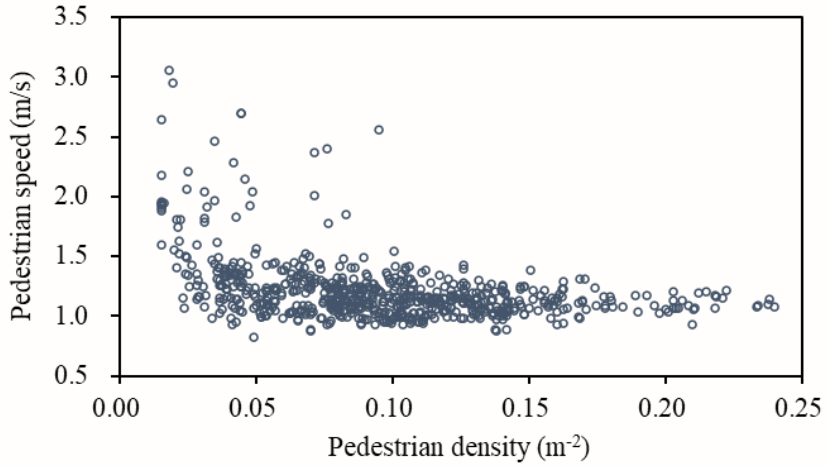
- Most pedestrian positions locate inside the boundary of crosswalk, while a large proportion of cyclist positions locate outside the boundary of crosswalk;
- Pedestrians and cyclists in the minor direction violate the segregation rule more frequently;
- Several peaks and valleys can be observed for cyclists due to the presence of steel pipes at the entering and exiting position of crosswalk.

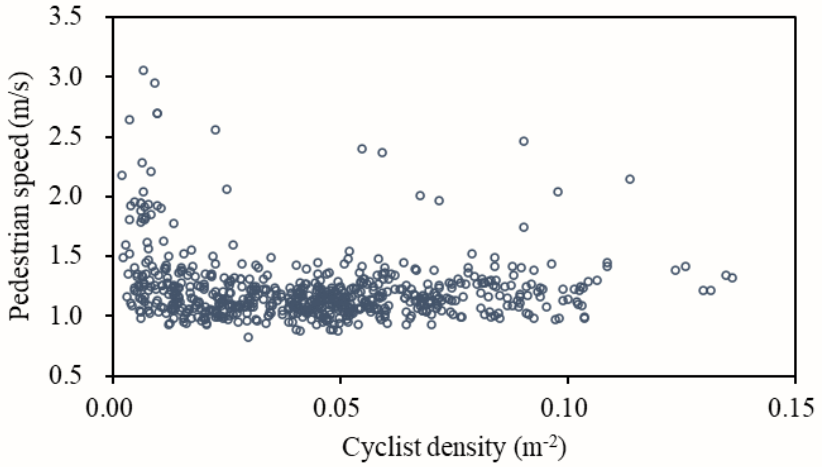
Results - Route choice

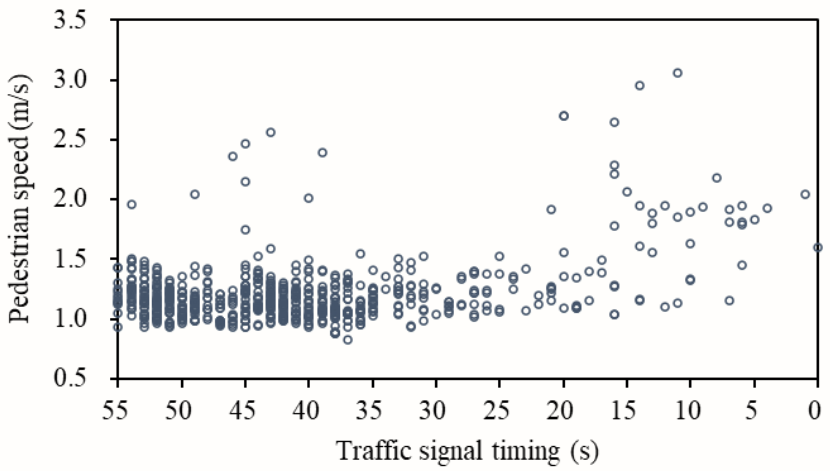
	Pedestrians					Cyclists				
	'Not follow' ⟶ 'Follow'					'Not follow' ⟶ 'Follow'				
Category	I	II	III	IV	Total	I	II	III	IV	Total
Road user direction										
Major direction	25.4%	6.7%	6.4%	61.5%	374	29.8%	8.1%	11.3%	50.9%	879
Minor direction	32.6%	5.3%	4.9%	57.2%	285	48.3%	9.6%	7.2%	34.8%	333
Entering position										
Entering rightful	1.9%	2.4%	4.1%	91.5%	413	4.7%	5.2%	5.9%	84.2%	614
Entering wrongful	73.2%	12.2%	8.5%	6.1%	246	65.9%	11.9%	14.5%	7.7%	598
Exiting position										
Exiting rightful	9.6%	5.6%	4.7%	80.1%	448	4.1%	7.5%	12.5%	75.9%	681
Exiting wrongful	68.7%	7.1%	8.1%	16.1%	211	74.4%	9.8%	7.2%	8.7%	531
Ratio of road users										
Smaller than 0.5	22.8%	5.9%	6.4%	64.9%	202	35.7%	7.0%	10.6%	46.6%	554
Greater than 0.5	31.1%	6.1%	5.5%	57.3%	457	34.2%	9.7%	9.7%	46.4%	658
Ratio of directions										
Smaller than 2.0	31.5%	6.9%	4.9%	56.7%	305	35.8%	9.3%	9.0%	45.9%	536
Greater than 2.0	26.0%	5.4%	6.5%	62.1%	354	34.2%	7.8%	11.1%	46.9%	676
Traffic signal timing										
Greater than 30s	30.8%	6.2%	5.8%	57.2%	565	33.9%	8.5%	8.7%	49.0%	992
Smaller than 30s	14.9%	5.3%	5.3%	74.5%	94	39.5%	8.6%	16.8%	35.0%	220
Total	**188**	**40**	**38**	**393**	**659**	**423**	**103**	**123**	**563**	**1212**

Results - Crossing speed

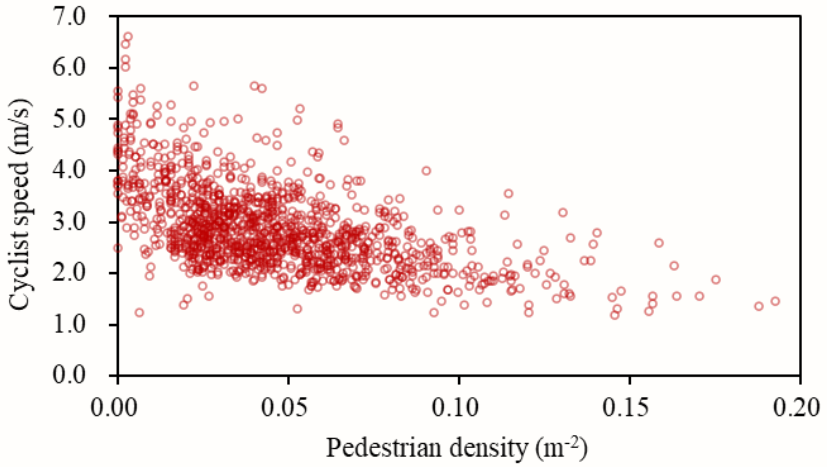
Pedestrians

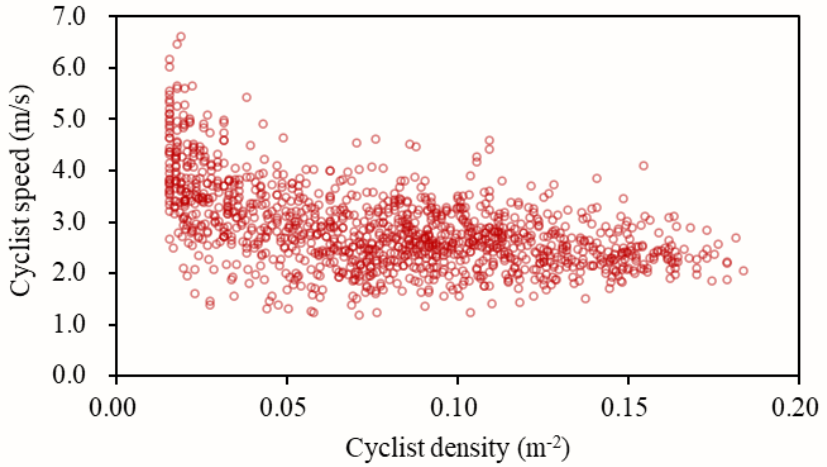


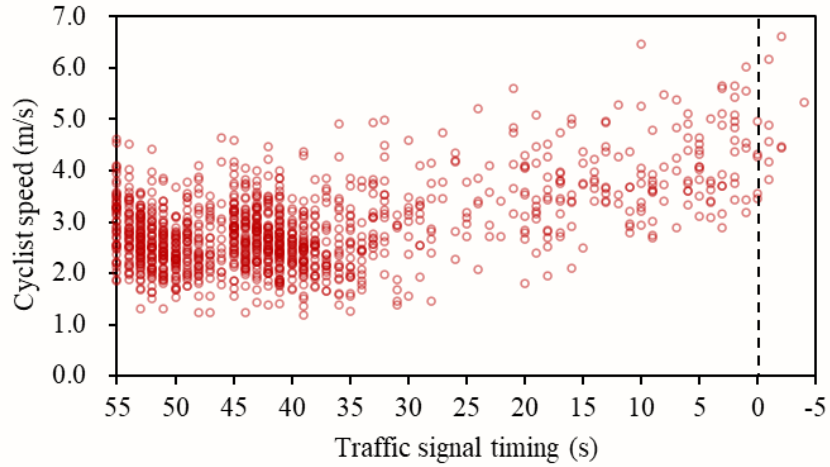




Cyclists



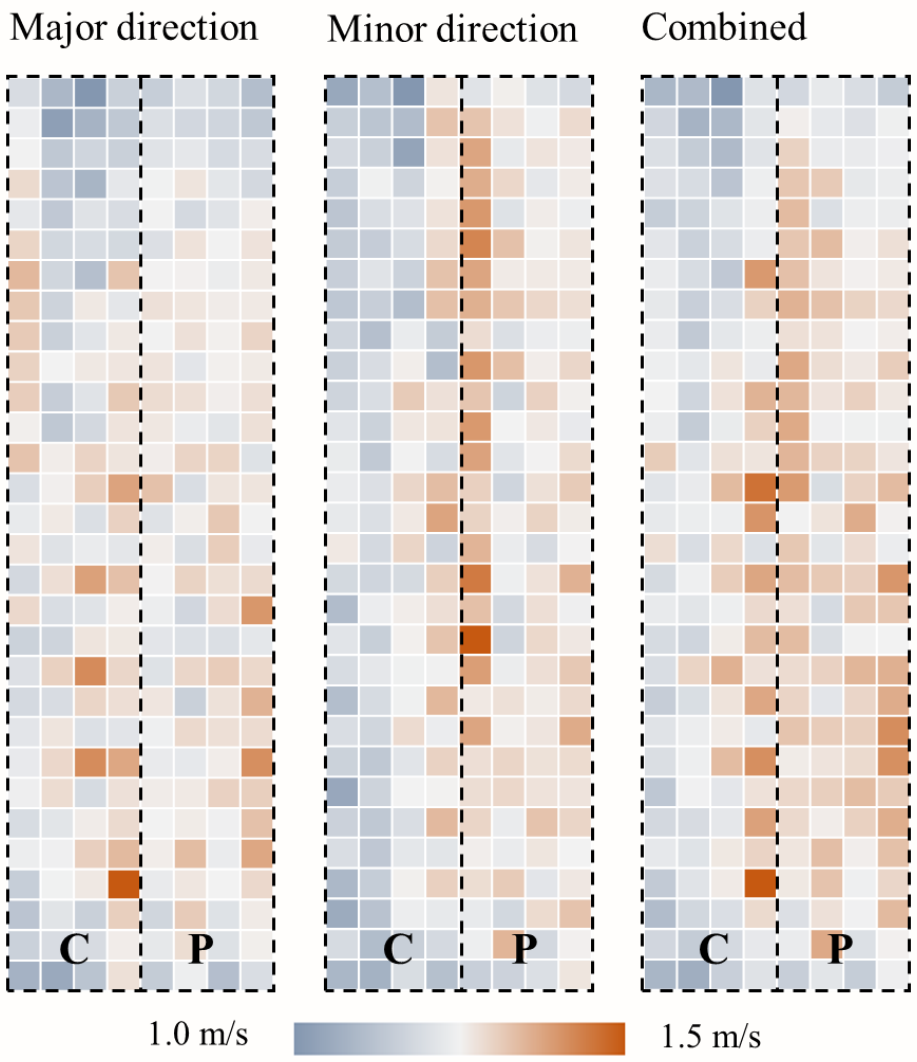




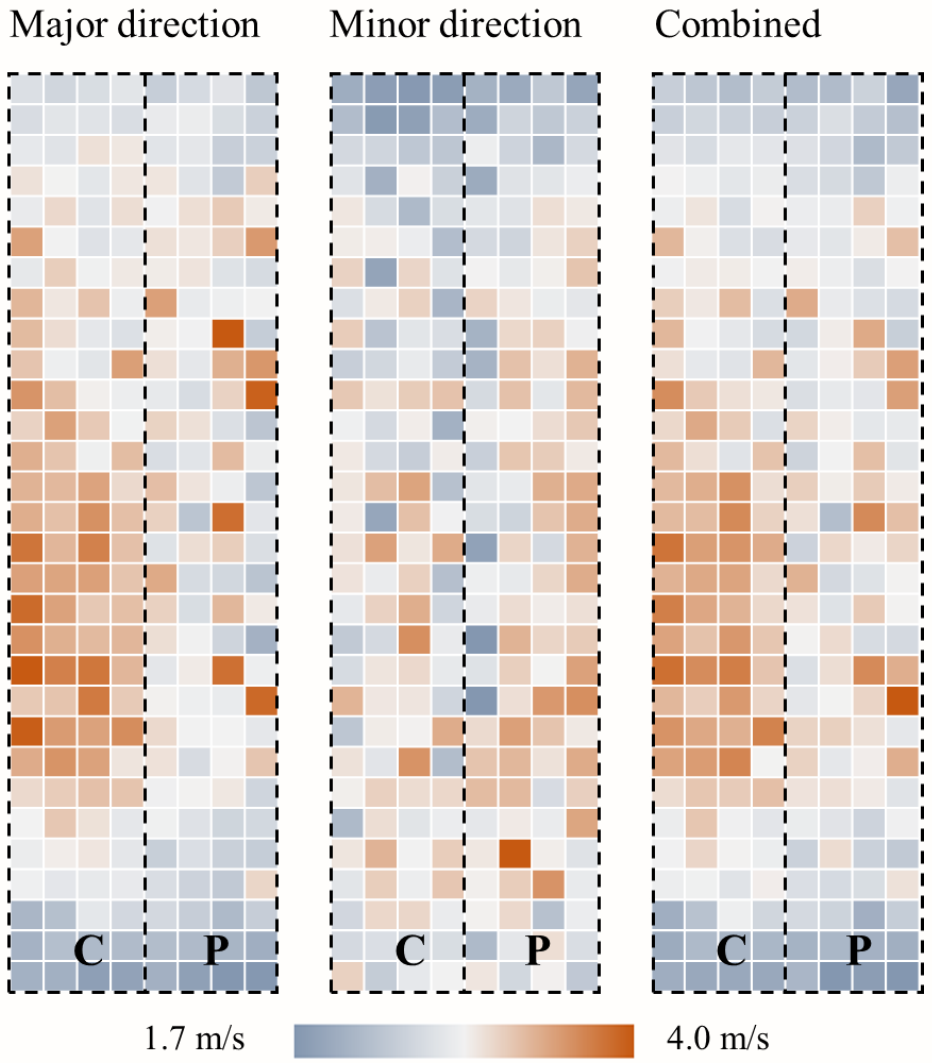
Influence of various influencing factors on crossing speeds

Results - Crossing speed

Pedestrians



Cyclists



Spatial distributions of pedestrians' and cyclists' speeds (P: pedestrian space; C: cyclist space)

Main conclusions:

- Most pedestrians prefer to walk on the right side and cyclists tend to ride on the left side, which follow the habit of ‘overtaking from the left’ in China;
- Highlighting the segregation rule is crucial to reduce the violation rate of both pedestrians and cyclists;
- The effectiveness of the segregated crosswalk for bidirectional pedestrian-cyclist flow, especially when the minor direction has large volume, is still problematic.

Recommendations:

- It is recommended to adopt the segregated crosswalks mainly for unidirectional pedestrian and cyclist flow;
- It is necessary to paint different colors and draw pedestrian/bicycle icon for walking/cycling space, and install clear marks at the entering position of the crosswalks.

Limitations:

- Further investigation on different layout design of crosswalks or intersections in various cities or countries is needed;
- Comparative study should be conducted for traditional and e-bicycle riders to analyze their behaviors and collision risks at crosswalks.

Thank you!

Reference:

Cheng Zhang, Bo Du, Jun Shen. Movement Patterns of Pedestrians and Cyclists at Signalized Segregated Crosswalks: A Case Study in Nanjing, China. *IEEE 26th International Conference on Intelligent Transportation Systems (ITSC)*, Bilbao, Spain, 2023 (Accepted).