15th Urban Mobility India Conference & Expo2022

Urban Mobility India Research Symposium 2022

An experimental study on the behavior of social groups in pedestrian bidirectional flow

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Presented by:

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भारतीय विज्ञान संस्थान

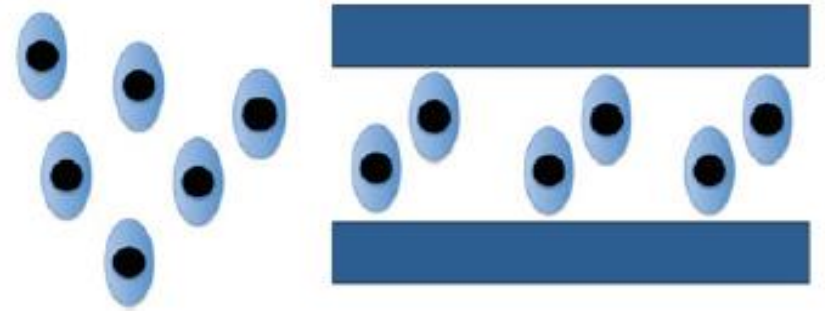
Contents

Pedestrians

- Why study pedestrians ?
  - encroachment of pedestrian infrastructure
  - lack of proper street design
  - highest share of traffic accident
  - people's perception – affordability

Pedestrians in crowd

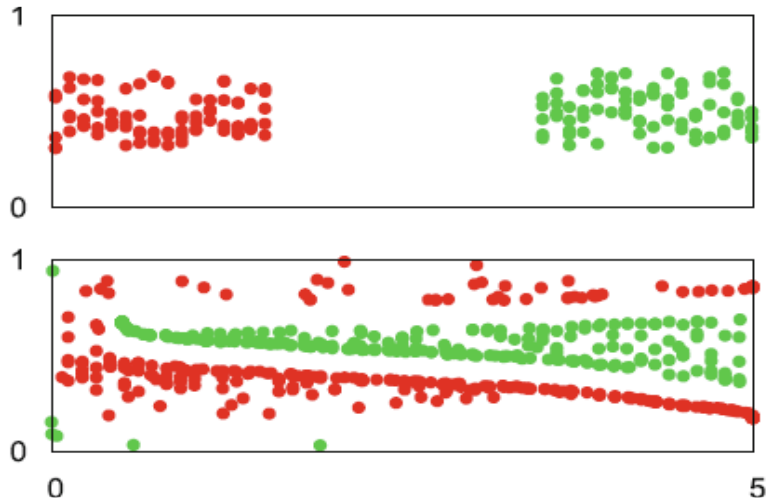
Clogging & arching at exits



Staggered walking at bottlenecks

V-shape walking pattern

Social groups

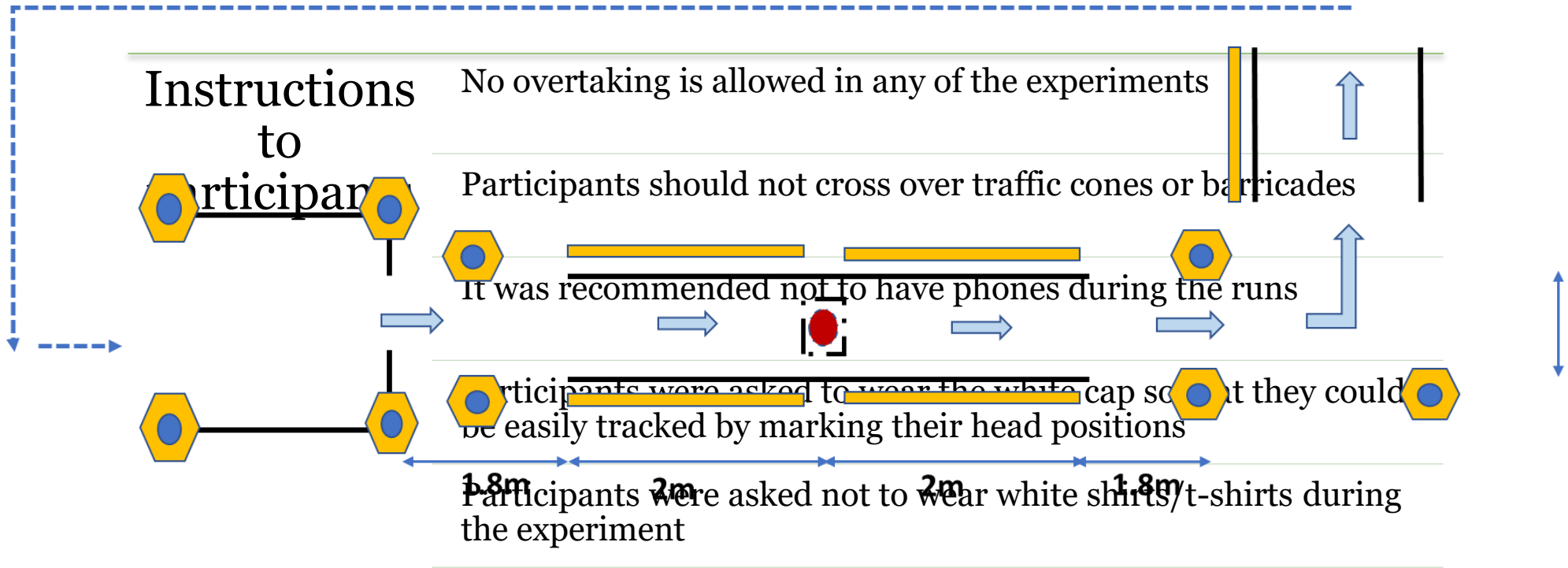


Lane formation

Objectives

- To understand the effect of social groups on pedestrian walking speed
- To understand pedestrian group patterns/formations such as line-abreast, V-like, and Inverted-V and to assess the most predominant formations
- To quantify the change in spatial formation over time in a bidirectional flow
- To understand the deviation from desired trajectories and velocities for predicted time to collision

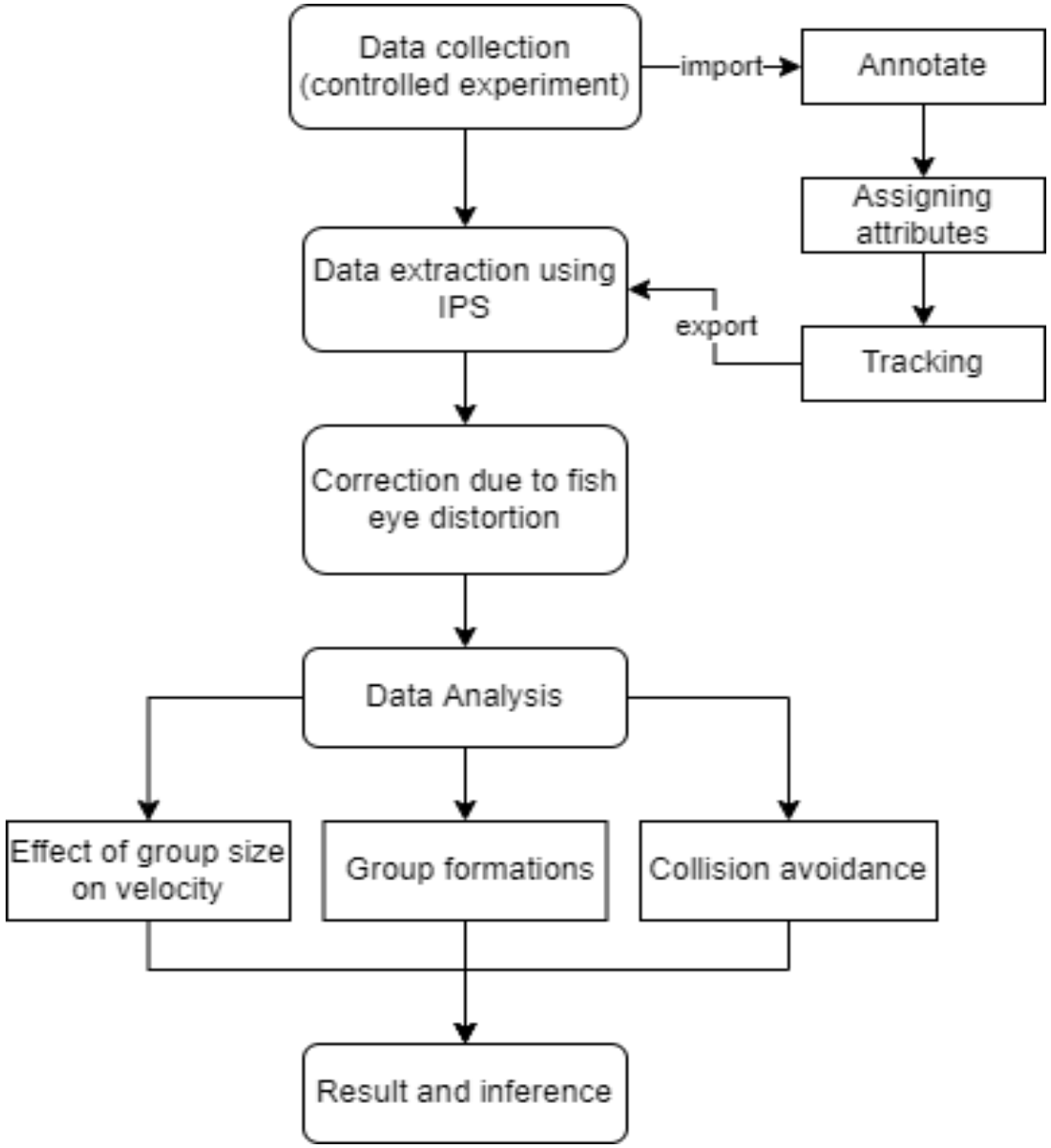
Controlled Experiment



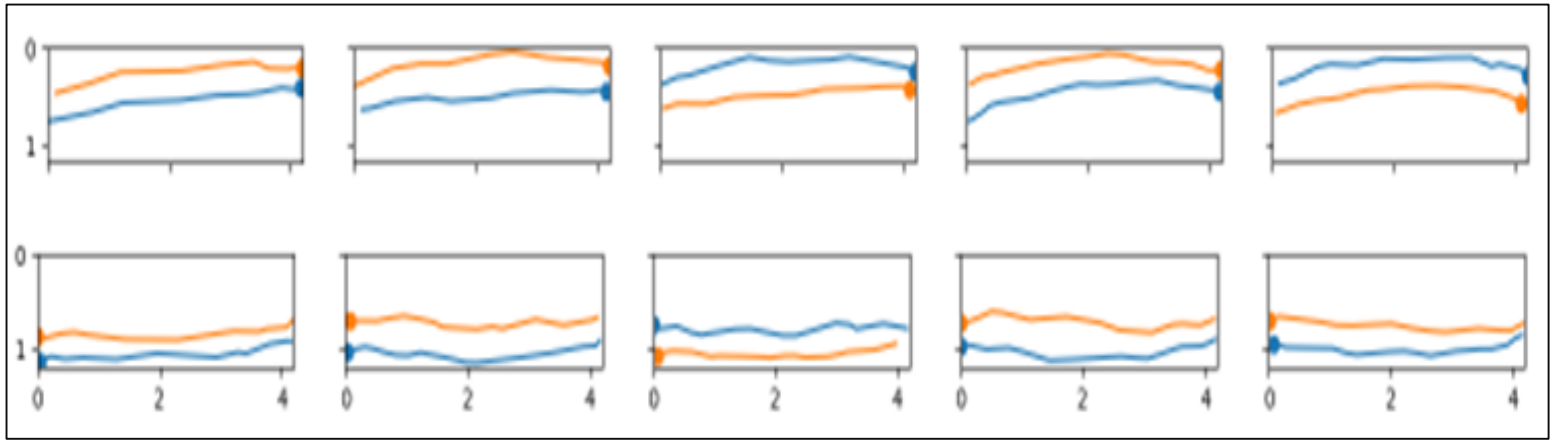
Details of Experiment runs

Experiment	Width (m)	Runs	#participants/ run
Bidirectional flow (w/o social groups)	1.2	8	20,30
Bidirectional flow (w/ social groups)	1.2	8	20,30

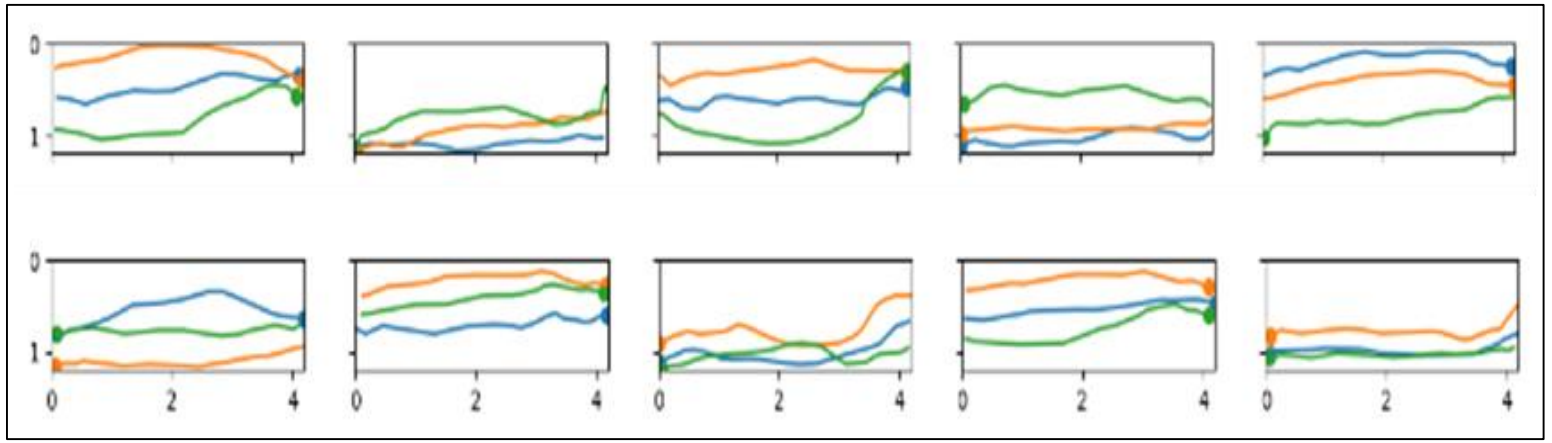
Methodology



Trajectories of pedestrians in groups

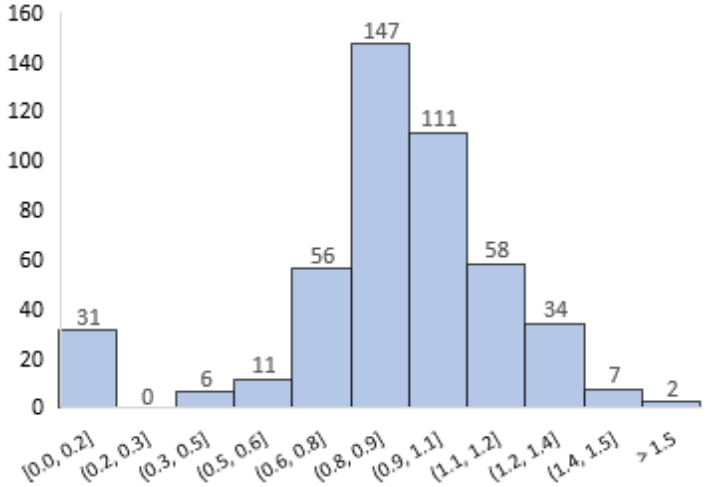


Group size 2 run 1 real-world coordinate

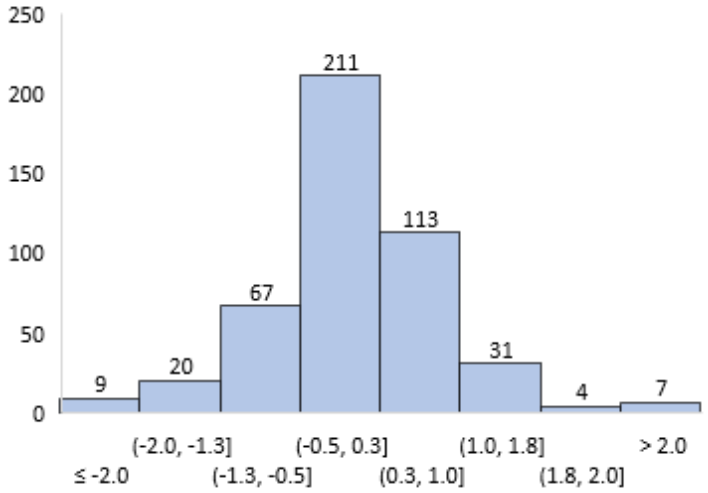


Group size 3 run 1 real-world coordinate

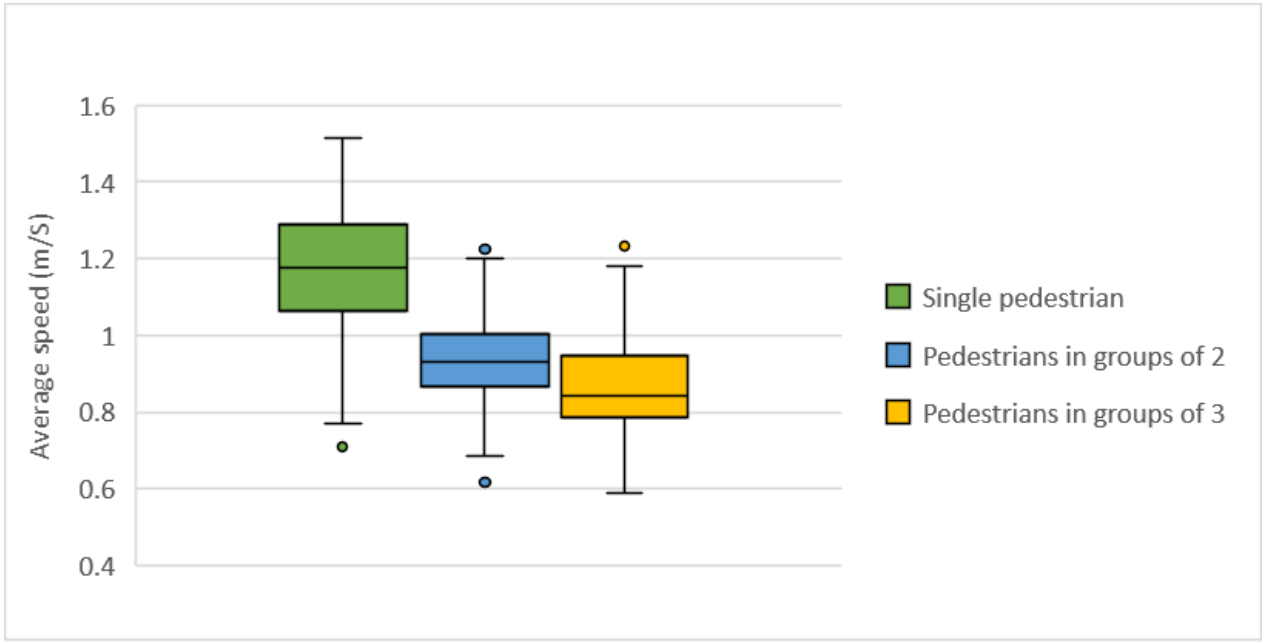
Results



Velocity(m/s) distribution for group size 2



Acceleration(m/s^2) distribution for group size 2

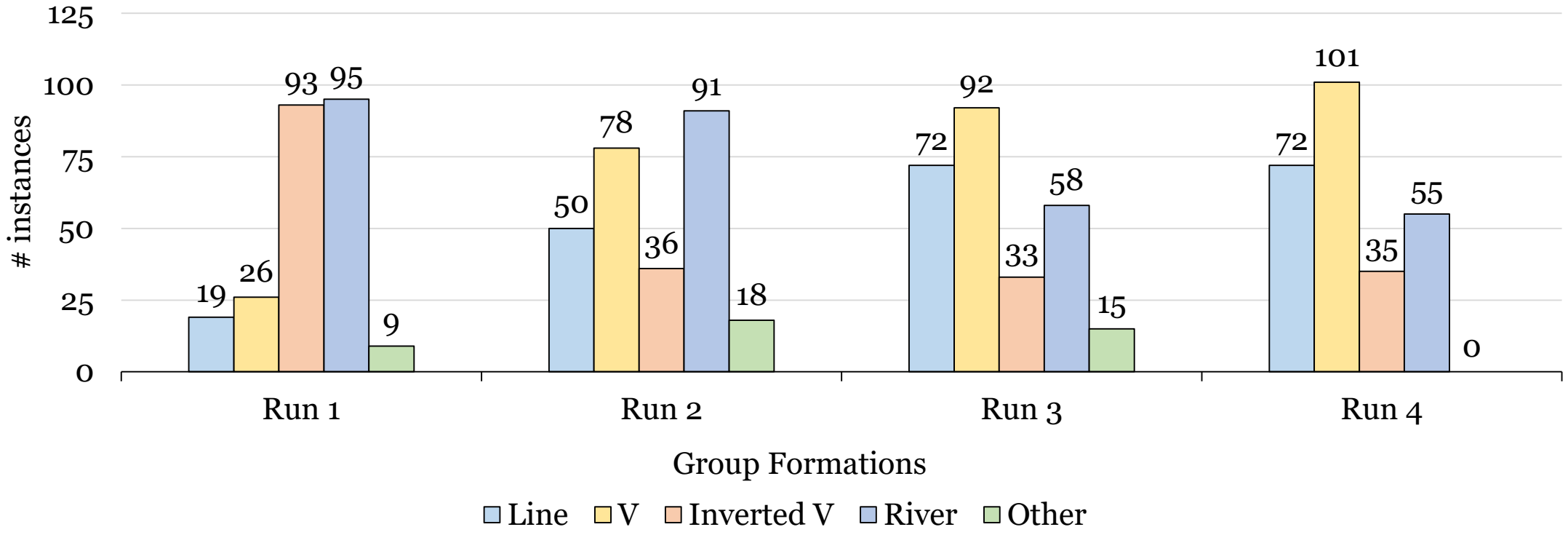


Comparison of the average velocity of pedestrians across group size

Group formation/ pattern

Formations- line, V, inverted V, river

Group formations in bidirectional flow



Group formations in bidirectional flow

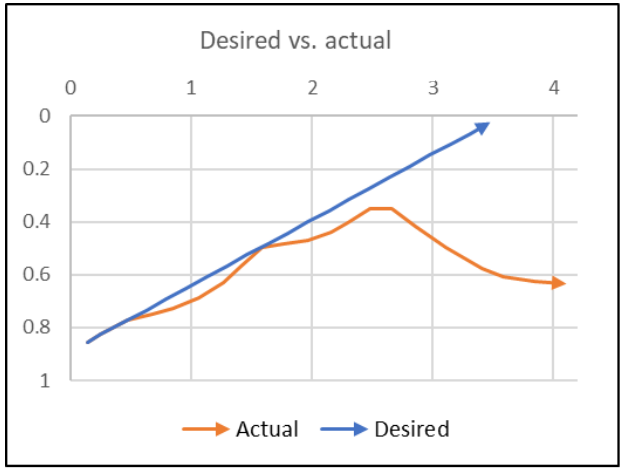
Change in Group formations	Average time (frames)
V+IV	22.33
R	23.38
L+IV+R	23.67
V+IV+U	24.67
L+IV	24.67
R+U	25
IV	25.67
V	26.08
L+R	26.44
V+R	27.17
L	28

L- Line, V-V shape. IV- Inverted V, R - River

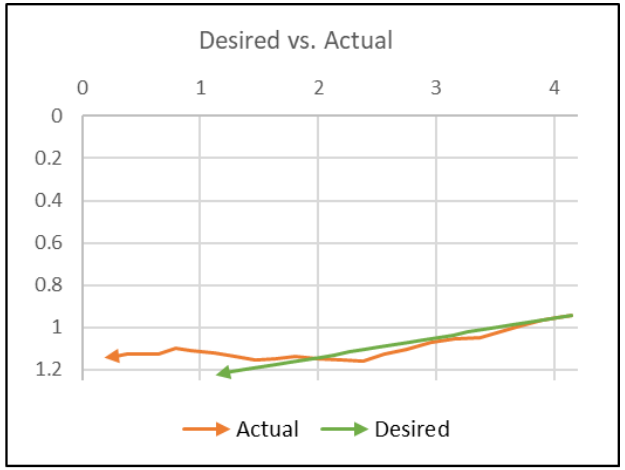
- Formations and the changes in the spatial formations over time also indicate the degree of group cohesiveness
- Formation adopted by groups is mostly line-abreast, followed by river formations while avoiding a collision

Collision avoidance behaviour

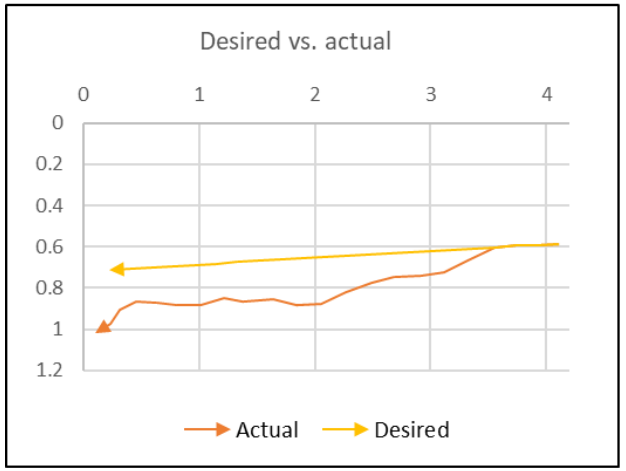
Desired vs actual trajectories for sample pedestrians



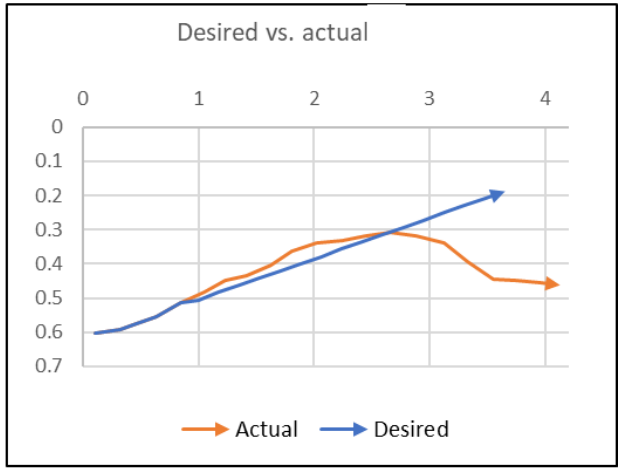
(a)



(b)



(c)



(d)

Inferences

- Across the runs, the adoption of line-abreast and V formations has increased
- Time to cross the section is the least when the river and inverted V are the dominant formations adopted
- Participants initially begin with a line-abreast pattern , but most groups shift to Inverted V or river pattern
- With an increase in predicted time to collision, the deviation from desired trajectory decreases
  - Other factors - change in speed, the opposite pedestrian walk dynamics, and spacing between opposite group members

Conclusions

- The study investigated how social groups affect pedestrians' walking dynamics in linear corridors
  - social groups vs. isolated pedestrians
  - scenarios artificially simulated using laboratory experiments
  - limited to small social groups of 2 and 3 members
- Decrease in the walking speed in the presence of an additional group member
- Different group formations - group interactions vs collision avoidance
- Most three-member groups adopt an inverted V-shape or river pattern
- Deviation from desire trajectories and velocities are inversely proportional to the predicted time to collision
- Limitations
  - Difficult to instill the feeling of togetherness or watchfulness for the fellow group members
  - Reluctance to trust or acknowledge an individual from the group as a leader

Thank you