

Movement strategies when people encounter each other at a bottleneck

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Key points

- 1 The presence of other pedestrians alters the use of space through adjustments in speed, walkway, and shoulder rotation.
- 2 Movement of first person passing a bottleneck in an encounter is comparable to individually moving persons.
- 3 The presence of other pedestrians leads to higher peak shoulder rotation amplitudes as well as an overall increase of rotation.

Experimental design

Two sets of experiments:

- Participants encounter each other at a bottleneck, and
- Participants pass the bottleneck individually (reference data).

Variations:

- No. of participants involved in encounter
 - Approaching angles of participants
 - Normal and hurried motivation
- ~25 repetitions per setup

All participants were equipped with full-body 3D motion capturing suits.

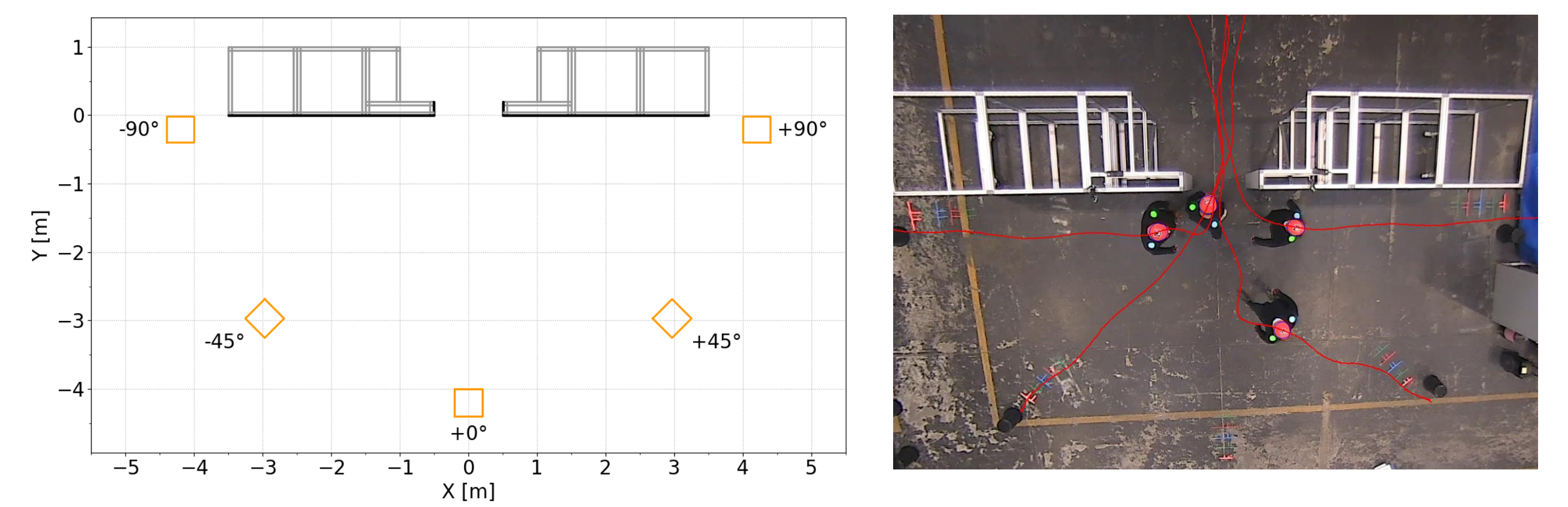
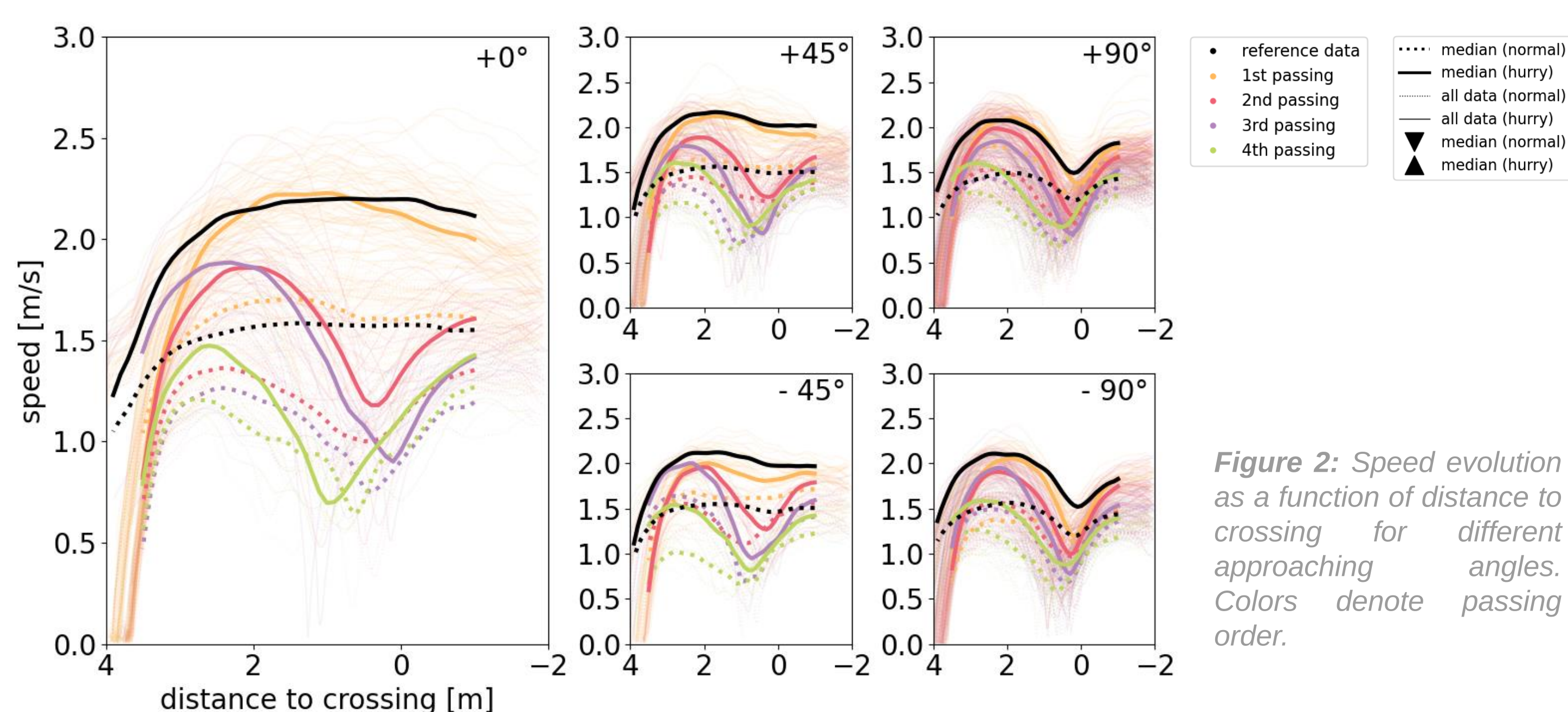


Figure 1: (left) Sketch of experimental setup, coordinate system and position of origin. (right) Snapshot of four person encounter from starting positions at +90°, +45°, -45° and -90°. Head trajectories for each person displayed as red lines.

Speed evolution



- Speed curve and distance to crossing at the start of deceleration show a dependence on
 - placement in the order of passing,
 - approaching angle,
 - motivation.

- Speed curve and start of deceleration of the person passing 1st are comparable to the ones of individually moving pedestrians.

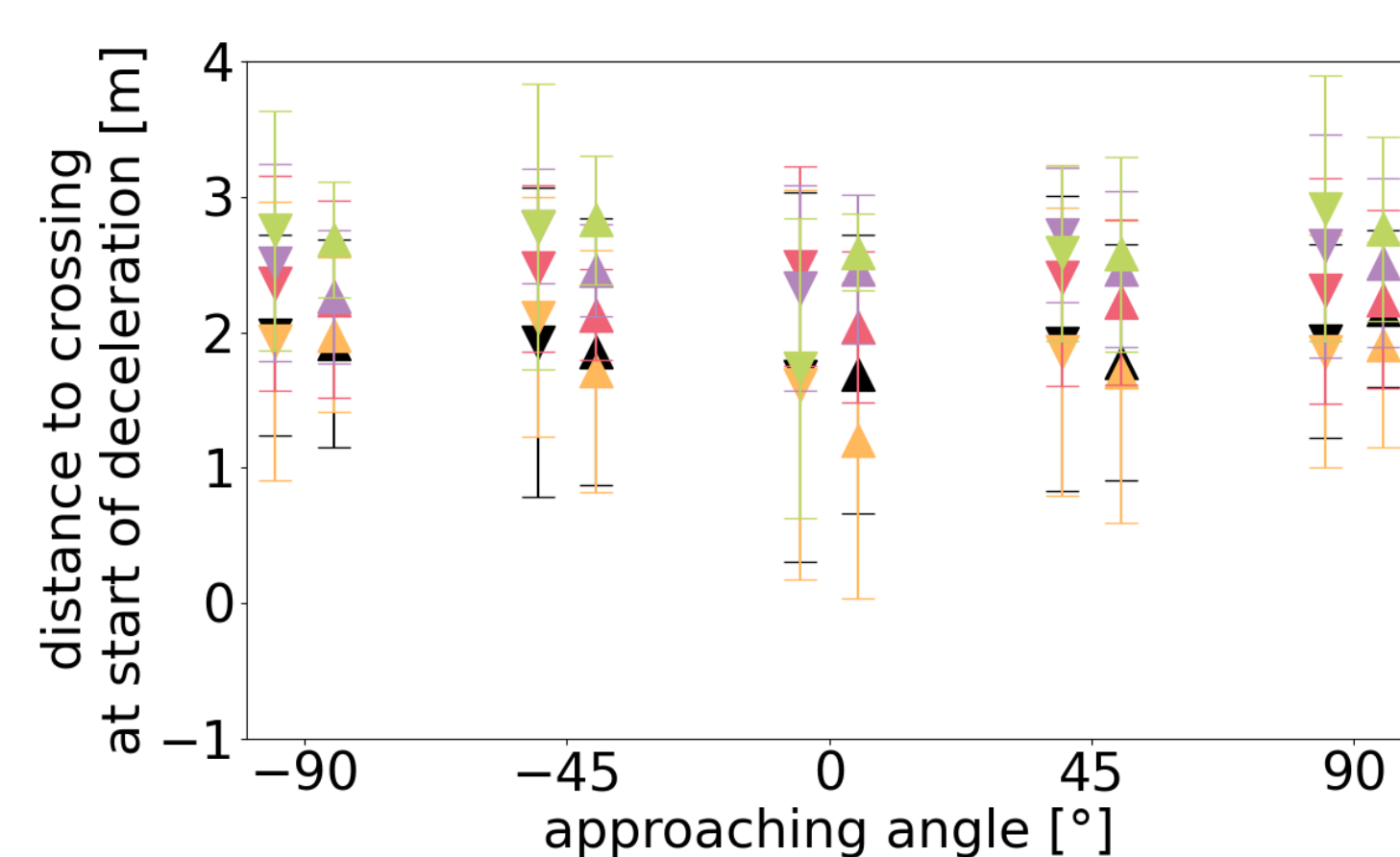


Figure 3: Distance to crossing at start of deceleration for different approaching angles. Colors denote passing order.

Walkway displacement

- Larger variability of walkway
 - when people encounter each other compared to reference data,
 - for people passing 1st compared to 2nd to 4th.
- Greater distance from the wall is maintained during encounter experiments.

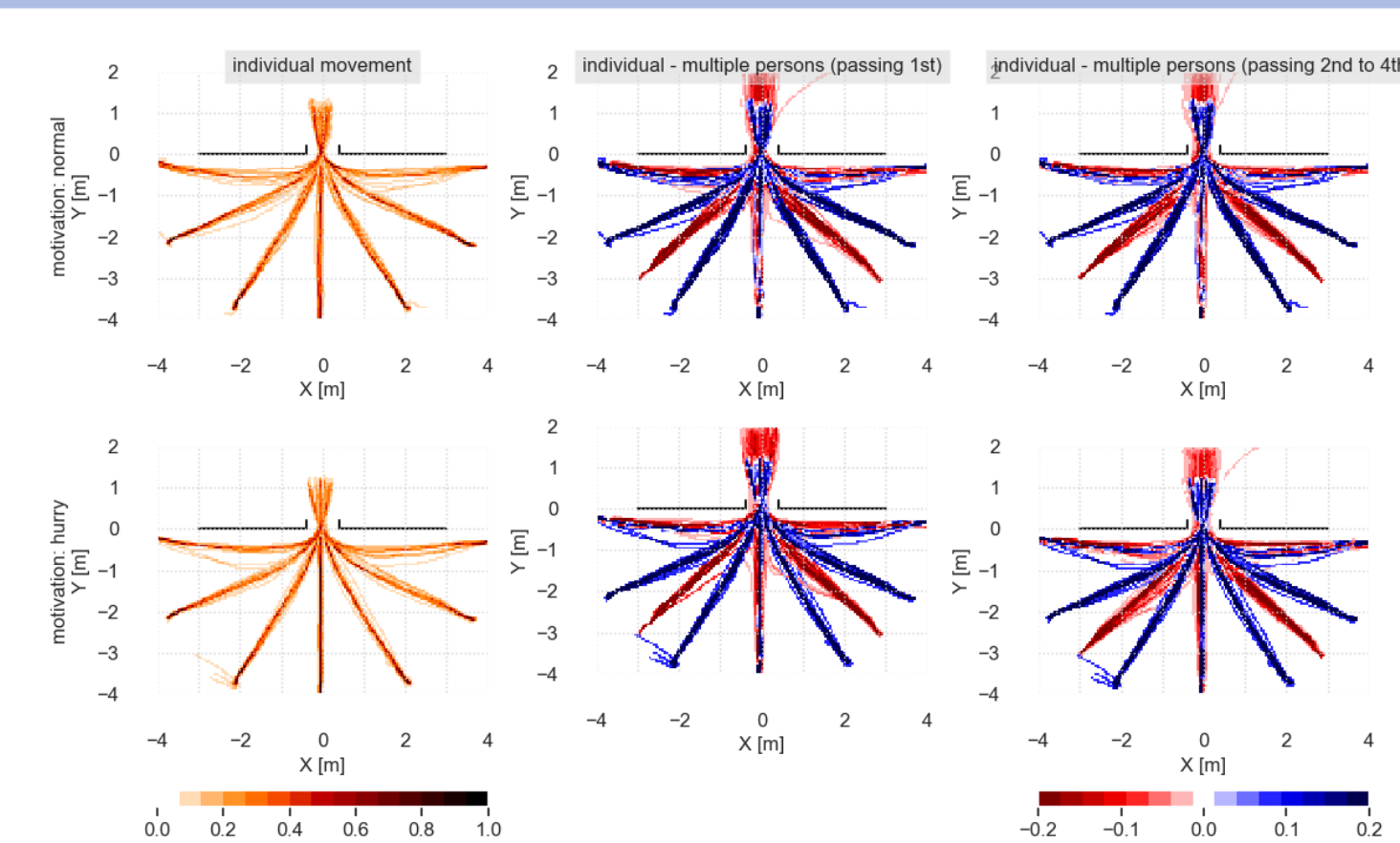
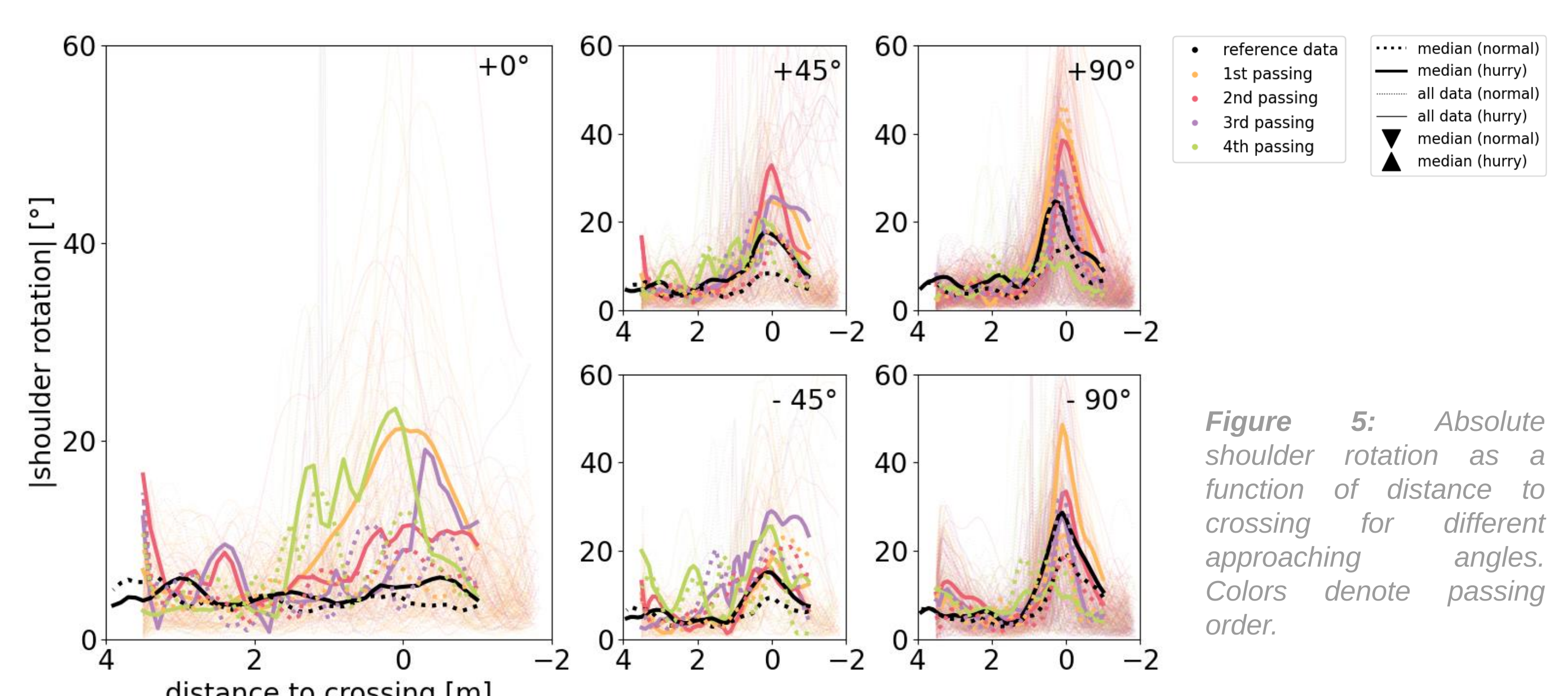


Figure 4: Normalized heatmap of centre of mass trajectory for (upper panels) normal and (lower panels) hurried motivation. Columns show probability of presence for reference data (left), reference data minus persons passing 1st (middle) and reference data minus persons passing 2nd to 4th (right).

Shoulder rotation



- Definition of shoulder rotation: angle between movement direction and vector pointing from left to right shoulder.
- Maximum amplitude of shoulder rotation is executed close to the crossing of the bottleneck.
- Greater rotation amplitudes
 - in hurried compared to normal walking condition,
 - the larger the approaching angle,
 - in the presence of other pedestrians compared to individual movement.
- Order of maximum shoulder rotation is reversed to the order of passing for large approaching angles.

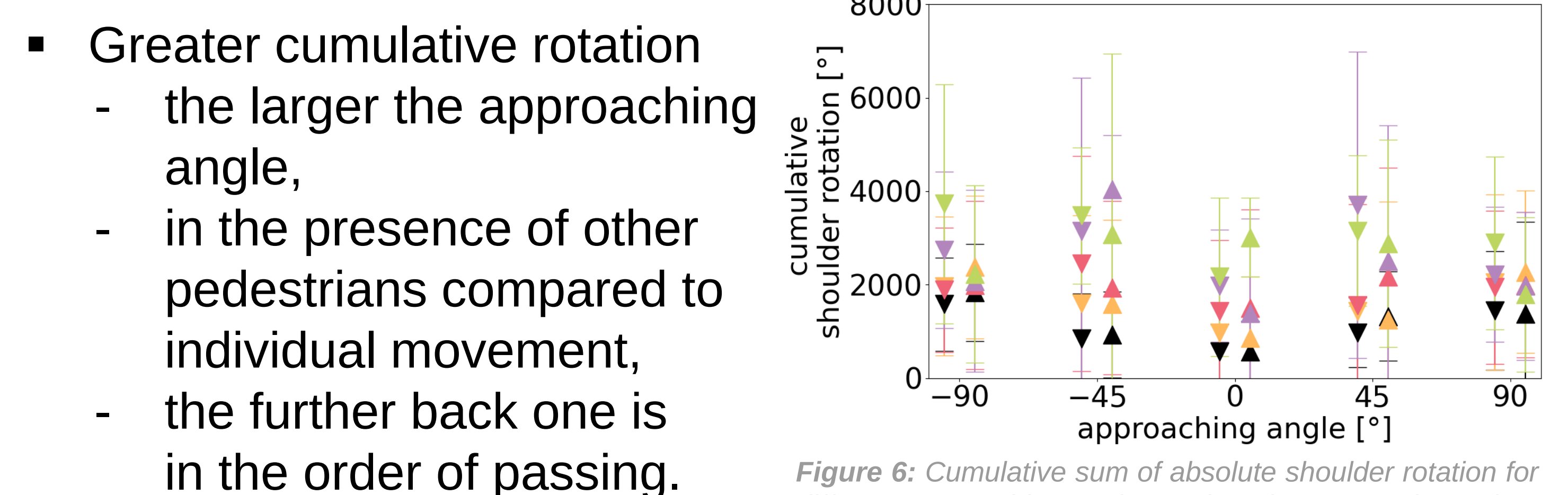


Figure 6: Cumulative sum of absolute shoulder rotation for different approaching angles. Colors denote passing order.

- Greater cumulative rotation
 - the larger the approaching angle,
 - in the presence of other pedestrians compared to individual movement,
 - the further back one is in the order of passing.

