Crowding and Queuing in Entrance Scenarios
Influence of Corridor Width in Front of Bottlenecks

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Introduction

Previous Study

- Different spatial barrier structures in front of bottleneck

→ Question:
  critical corridor width limiting queuing and stimulating pushing?

Source: A. Sieben, J. Schumann, A. Seyfried, Collective phenomena in crowds - Where pedestrian dynamics need social psychology, PLoS ONE 12(6): e0177328 (2017).

New Study

Investigation: influence of the corridor width on

- density and waiting time
- queuing or pushing
Experiments at the University in Wuppertal
- \( b \): Corridor width, 1.2 m to 5.6 m
- \( N \): number of participants, students
- \( h \): motivation, high and low

\[
\begin{array}{|c|c|c|c|c|}
\hline
b & 1.2 \text{ m} & 2.3 \text{ m} & 3.4 \text{ m} & 4.5 \text{ m} & 5.6 \text{ m} \\
\hline
N & 11, 24, 25, 63 & 20, 42 & 22, 67 & 42, 42 & 57, 75 \\
\hline
h & \text{hi, lo} & \text{hi, lo} & \text{hi, lo} & \text{hi, lo} & \text{hi, lo} \\
\hline
\end{array}
\]
Bottleneck Experiments

b = 1.2 m
N = 63
h = high

b = 5.6 m
N = 75
h = high
Bottleneck Experiments
Results: Voronoi Density
Density Time-Series

Mean density within the measurement area

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Density Time-Series

\[ b = 1.2 \text{ m}, \text{ high motivation} \]

\[ b = 3.4 \text{ m}, \text{ high motivation} \]
Corridor Width and Number of Participants

- b=1.2m, N=63, h0
- b=2.3m, N=20, h0
- b=3.4m, N=67, h0
- b=4.5m, N=42, h0
- b=5.6m, N=75, h0

- b=1.2m, N=25, h-
- b=2.3m, N=42, h-
- b=3.4m, N=22, h-
- b=4.5m, N=42, h-
- b=5.6m, N=57, h-

Density $\rho$ vs. Corridor Width $b$ for different numbers of participants $N$.
Corridor Width and Number of Participants

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure.png}
\caption{Corridor Width and Number of Participants}
\end{figure}
Corridor Width and Number of Participants

\[ \rho \text{ / m}^{-2} \]

\[ b \text{ / m} \]

\[ N \]

\[ b=1.2 \text{m}, N=63, h_0 \]
\[ b=2.3 \text{m}, N=20, h_0 \]
\[ b=3.4 \text{m}, N=67, h_0 \]
\[ b=4.5 \text{m}, N=42, h_0 \]
\[ b=5.6 \text{m}, N=75, h_0 \]

\[ b=1.2 \text{m}, N=63, h- \]
\[ b=2.3 \text{m}, N=20, h- \]
\[ b=3.4 \text{m}, N=67, h- \]
\[ b=4.5 \text{m}, N=42, h- \]
\[ b=5.6 \text{m}, N=75, h- \]

\[ b=1.2 \text{m}, N=25, h_0 \]
\[ b=2.3 \text{m}, N=42, h_0 \]
\[ b=3.4 \text{m}, N=22, h_0 \]
\[ b=4.5 \text{m}, N=42, h_0 \]
\[ b=5.6 \text{m}, N=57, h_0 \]

\[ b=1.2 \text{m}, N=25, h- \]
\[ b=2.3 \text{m}, N=42, h- \]
\[ b=3.4 \text{m}, N=22, h- \]
\[ b=4.5 \text{m}, N=42, h- \]
\[ b=5.6 \text{m}, N=57, h- \]
Summary and Conclusion

- Transition between queuing and pushing behavior
- High density ...
  - indicates pushing behavior
  - reduces the participant’s well-being
- Mean density increases ...
  - with increasing corridor width
  - with increasing motivation
- Number of participants also influences the density
Summary and Conclusion

- Transition between queuing and pushing behavior
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Future Studies

- Investigate more intermediate steps of corridor width
- Use the number of participants as controlled parameter
- More repetitions for each corridor width
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Waiting Time and Distance to Target

Run 110, b=1.2 m, motivation= h0

Run 120, b=1.2 m, motivation= h-

Run 030, b=5.6 m, motivation= h0

Run 040, b=5.6 m, motivation= h-
Waiting Time and Distance to Target

Run 110, b=1.2 m, motivation= h0

Run 030, b=5.6 m, motivation= h0

Run 120, b=1.2 m, motivation= h-

Run 040, b=5.6 m, motivation= h-
Bottleneck Experiments

\( b = 1.2 \text{ m}, \ N = 63, \ \text{high motivation} \)

\( b = 5.6 \text{ m}, \ N = 67, \ \text{high motivation} \)
Voronoi Density

Run 110, $b = 1.2$ m, $t = 5$ s

Run 230, $b = 2.3$ m, $t = 5$ s

Run 270, $b = 3.4$ m, $t = 5$ s

Run 050, $b = 4.5$ m, $t = 5$ s

Run 030, $b = 5.6$ m, $t = 5$ s