Study investigates crowd behaviour under stress in a virtual environment

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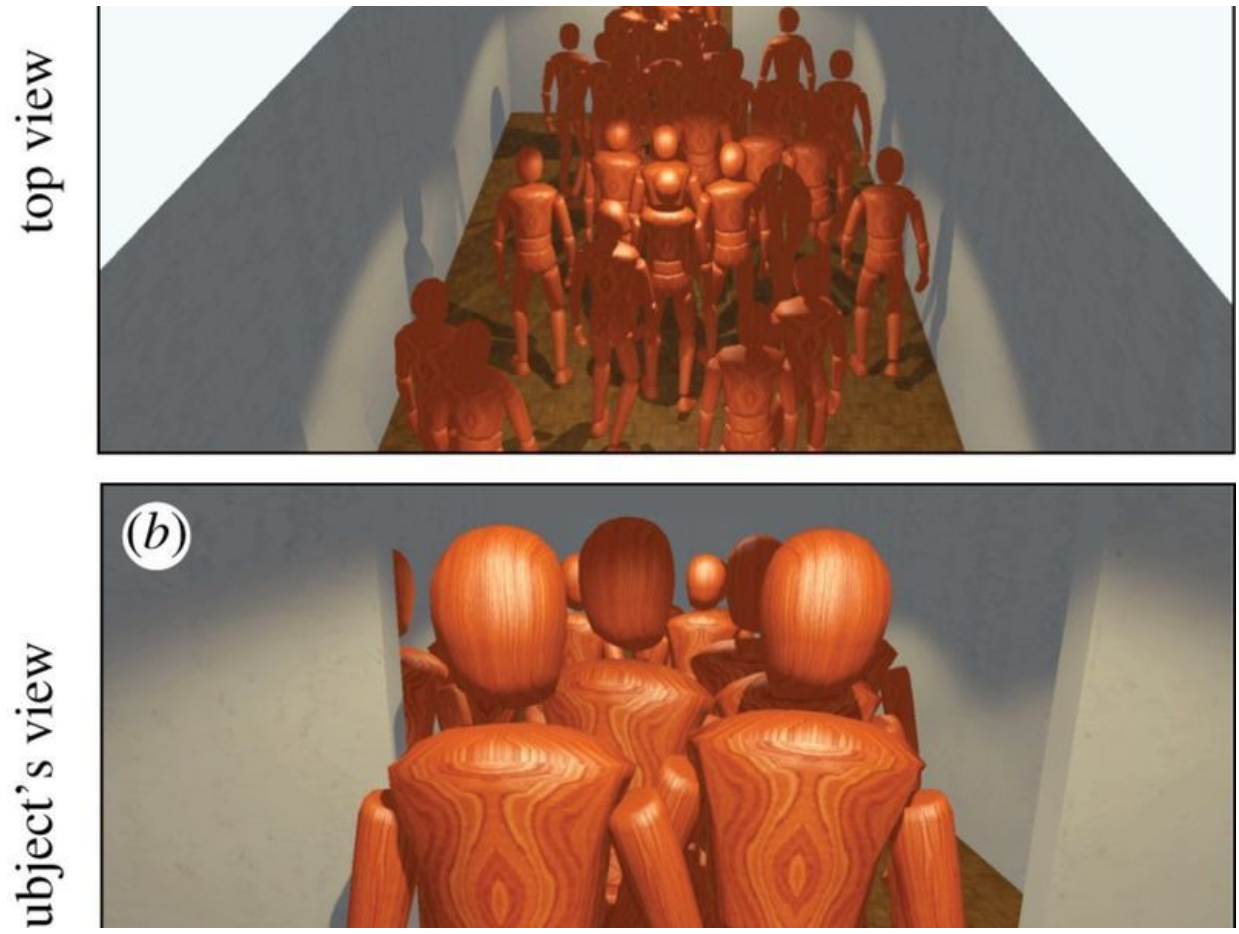

The reserachers could watch in a top-down view the 36 participants passing through a bottleneck during a simple evacuation situation. Each pedestrian was controlled by a real experimental participant who viewed the situation in a realstic way from the middle of a crowd. Credit: MPI for Human Development

In emergency situations such as terrorist attacks, natural catastrophes, and fires, there is always a risk of mass panic leading to deadly crowd disasters. But what causes mass panic and where are the danger zones? Researchers from the Max Planck Institute for Human Development, Disney Research Zurich, ETH Zurich, and Rutgers University have examined these questions in a virtual environment. Their results have been published in the *Journal of the Royal Society Interface*.

Why are emergency situations such as evacuations of buildings so often characterized by mass herding and overcrowding? And which areas of a building are particularly dangerous in emergency evacuations? Because these questions are difficult to study in the real world, the international research team exposed 36 participants to an emergency in a three-dimensional virtual environment. Each participant simultaneously navigated an avatar through virtual space on a computer screen. The researchers studied the participants' behaviours in several experiments, setting them various tasks under high-stress conditions.

The researchers were able to show that participants' behaviour in the virtual environment was largely consistent with real-world behaviours. For example, participants were asked to move their avatar through a narrow corridor without bumping into any of the other avatars. The avoidance behaviours seen in the virtual environment were consistent with those observed in a real-life experiment: 95% of participants chose to pass each other on the right-hand side. Previous studies have shown that Europeans tend to intuitively walk on the right-hand side. "Our experiments have shown that virtual environments can help us investigate human behaviour in emergency situations – something that isn't possible in the real world for ethical and safety reasons," says Mehdi Moussaïd, researcher in the Center for Adaptive Rationality at the Max Planck Institute for Human Development.

To find out how the participants reacted in an emergency situation, the

researchers simulated an evacuation from a complex building with four exits, only one of which was usable. Although most of the group did not know which was the correct exit, some participants were directed to it by an arrow at the top of their computer screen. Participants knew that some group members were aware of the correct exit, but they did not know who those people were. In addition, the researchers increased the stress level by putting participants under time pressure and monetary pressure: Participants had to escape the building within 50 seconds to avoid a substantial loss of points. At the end of the session, the points won were converted into monetary bonuses. Further stress-inducing elements were poor lighting, red blinking lights, and fires at the blocked exits.

More collisions under stress

The experiments showed that collisions and pushing increased quickly under stress. The most dangerous zones were places where decisions had to be made, areas where bottlenecks occurred and caused congestion, and dead ends where participants were forced to turn around and walk back against the flow of the crowd.

The researchers also looked at group dynamics during the stressful evacuation situation. Their analyses revealed that individuals were exposed to much stronger social signals under high stress and high density levels than in less stressful situations. In other words, they were more aware of where the group was going, what it was doing, and how it was feeling, and were thus more strongly influenced by the group. The study's findings indicate that individuals are more likely to follow a group under the influence of these strong social signals. This can quickly lead to mass herding and dangerous overcrowding.

"Our findings show that human behaviour in virtual environments is consistent with the behaviours seen in real life. Immersive virtual

environments are thus promising tools for behavioural research and beyond. For example, urban planners and architects could use them to test evacuation plans," says Mehdi Moussaïd.

More information: Mehdi Moussaïd et al. Crowd behaviour during high-stress evacuations in an immersive virtual environment, *Journal of The Royal Society Interface* (2016). DOI: 10.1098/rsif.2016.0414

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