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The Impact of the Herd Splitting Effect on Pedestrian Risk Decision-Making Behavior During Fire Evacuation in School Library

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Abstract

Fire is a major issue that threatens the safety of people's lives and property, so it is important to enhance research on the safe evacuation of fires. This study is based on an immersive virtual reality (VR) experiment that examines the wayfinding choices made by pedestrians during a library fire under conditions of reduced ambient visibility due to smoke generation and the simultaneous presence of different herd splitting patterns as indicated by non-game players. Participants were asked to engage in evacuation tasks in a random order across six different experimental scenarios. Results showed that pedestrians generally avoid using smoke routes for evacuation, but make risky decisions to cross smoke routes when they are consistent with the majority of the crowd's evacuation choices. Secondly, under the influence of the herd splitting effect, pedestrians tend to follow the route chosen by the majority of the evacuating crowd. Thirdly, increasing smoke concentration weakens the influence of the herd splitting effect and pedestrians choose to avoid smoke. In addition, Men and women showed significant gender differences in evacuation time and evacuation route choice when faced with the same evacuation scenario. This experiment extends the study of pedestrian wayfinding behaviour in fire situations and provides some empirical evidence for further improvement of fire evacuation.

Keywords

Immersive virtual reality; Pedestrian wayfinding behavior; Fire emergency evacuation; Herd splitting effect; Fire smoke; Risk decision.

1. Introduction

Indoor fire has a high incidence. According to data released by the Fire and Rescue Bureau of the Ministry of Emergency Management, in the decade from 2012 to 2021, 1,234,000 indoor fires occurred nationwide, resulting in 11,634 deaths, 6,738 injuries, and direct property losses of 7.77 billion yuan. The casualties and property losses caused by indoor fires cannot be ignored [1]. Studies have shown that the complex structure of indoor buildings, the large number of combustible materials and their rapid burning rate, the uncertainty of fire propagation and the threat of emergency evacuation for pedestrians make it necessary to further study the evacuation of pedestrians from indoor fires[2]. Existing evacuation efforts have focused on the development of evacuation routes based on the construction layout of the building prior to a fire, with no specific implementation measures proposed for the self-evacuation of pedestrians during a fire [3]. Evacuation involves physical and behavioural characteristics of people, but human behaviour is often unpredictable and variable, so there is a need to explore how people behave in a fire situation [4]. The aim of this experiment is to investigate the specific human

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response to a fire emergency in a high-rise building, based on the context of an indoor library building layout and supported by VR technology, to provide empirical research support for a crowd evacuation model.

The wayfinding options of pedestrians in fire situations are a key factor affecting evacuation . Studies have shown that pedestrian wayfinding is influenced by internal and external factors, (1) external factors include the physical characteristics of the building itself: such as width and inclination of stairs, length of corridors, angle of corners; physical factors in hazardous situations: such as size of the fire, temperature, degree of spread of toxic gases, smoke concentration; and measures to guide evacuation: such as evacuation signs. (2) Internal factors include gender differences, individual evacuation experience, and the herding behaviour, which means the clustering of pedestrians following others to evacuate together[5,6]. The degree of influence of each factor on pedestrian wayfinding choices varies and interacts. The reader has found fewer studies in recent years that have experimentally explored the interaction between limited visibility conditions and the herd splitting behaviour, so this study attempts to investigate pedestrian wayfinding choices in the presence of both variables.

In a fire emergency evacuation situation, pedestrians use visual, auditory and olfactory perceptions to respond to different sources of information about the evacuation path[7]. According to existing studies, pedestrians perceive three main types of information: static information,which is most notably building layout and evacuation signs[8]; dynamic information, which is expressed in the behaviour of people around them and their interactions with each other [9]; and memory information, which is expressed in the level of awareness of the current building layout, familiar corridors, staircases, and evacuation routes and so on [10]. In practice, this information does not exist in isolation, and research has demonstrated that these perceived factors do not affect pedestrian evacuation decisions in isolation, and it is necessary to assess the impact of the combination of these information. While there is no doubt that the consistency of direction exhibited by the combined information is highly indicative of pedestrians, it is unclear what the preferred information choice of pedestrians is when the perceived information is contradictory, when pedestrians are faced with an evacuation route choice and factors that convey an indication signal occur simultaneously with factors that convey an avoidance signal. respectively, as guiding information for three evacuation routes to observe pedestrians' propensity choices. Current research focused on studies that are also directionally indicative, with little study of avoidance information interacting with indicative information. This experiment attempts to investigate this aspect by interacting smoke information with crowd information and exploring the tendency of crowds to respond.

2. Related Studies

2.1. Herding behavior

When individuals evacuate a building in an emergency, they often exhibit a cluster phenomenon of following others to evacuate together, a phenomenon defined as the herd effect [11], and a large number of experimental studies have concluded that there are two main factors that influence the occurrence of the herd effect: firstly, it is moderated by specific environmental and situational factors, specifically, in familiar spaces such as residential buildings, pedestrians will tend to weigh all factors and choose whether to follow their neighbours for evacuation, while in unfamiliar public spaces they are more likely to follow the crowd for evacuation [12]; secondly, it depends on the evacuees' personal experience judgement and whether they show a tendency to follow the crowd, while the wayfinding choices made by individuals under stressful conditions are usually not dependent on the urgency of the environment. Research suggests that the occurrence of the herd behaviour is beneficial in saving evacuation time and increasing evacuation efficiency, while some studies suggest the opposite, stating that the

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occurrence of the herd behaviour can instead prolong evacuation time and reduce evacuation efficiency [13]. A comprehensive analysis of several studies in the literature found that whether the occurrence of the herd behaviour is beneficial needs to consider the density of the crowd evacuation,the familiarity of evacuees with the environment [14]. In actual evacuation situations, the main manifestation is the herd splitting effect: that is, instead of the majority of pedestrians choosing a single route for evacuation, they disperse into different groups choosing different routes for evacuation, and the proportion of people in these groups is generally inconsistent [15]. Although the herd behaviour has been extensively studied by many scholars, and there are various models and theories to explain the herd behaviour. there are still some shortcomings; the condition factors of the herd behaviour are fickle, the emergency evacuation scenarios are diverse, and there are fewer specific studies on the herd splitting behaviour, thus generating inconsistent explanations in different studies about the herd behaviour, by continuously expanding the experimental research scenarios of the herd behaviour to extend the understanding of the herd behaviour and facilitate the exploration of the general patterns of the herd behaviour.

2.2. Limited visibility

In a fire emergency, it is common for evacuees to choose smoke routes for evacuation. The physiological effects of smoke are manifested in reduced environmental visibility, which affects the blink rate of evacuees and reduces the reflective effect of objects, thereby obstructing visual access [16]. Most of the evacuees' information sources are obtained mainly through the visual channel, and when visibility decreases, the ability to recognize available evacuation information is then reduced. When the uncertainty of the external environment increases significantly, evacuee exhibits more hesitant behaviour in wayfinding navigation, affecting evacuation walking speed. The psychological impact is felt in the development and spread of pedestrian panic. Studies have identified panic as a key factor in fire tragedies, where the stress level of evacuees rises and their ability to react to unexpected situations decreases, and where the emotion is rapidly contagious, causing those around them to collectively show fear and panic, resulting in evacuation chaos [17]; there is also a large body of analysis and research based on factual case studies that show that panic is inevitable, but evacuees still show adaptive and rational caution in response to emergencies. This study aims to observe the real-life reactions of pedestrians under the influence of panic in a virtual reality scenario to demonstrate whether the behaviour of pedestrians under the stress of panic is controllable, which is important for the authorities to make adaptive evacuation strategies.

3. Method

3.1. Sample

This experiment recruits volunteers by posting information through email, mobile phones, and online social media platforms. The majority of volunteers participating in this experiment were students from Sichuan Normal University. The participants were required to have normal or corrected to normal vision, no colour blindness, normal mobility, and no history of heart disease or related medical conditions. A total of 42 participants, 22 males and 20 females, with a mean age range of 19-27 years (SD= 2.4), were enrolled in the experiment.

3.2. Apparatus

The experiments were conducted in a VR system incorporating a binocular display with a resolution of 1080 (horizontal) x 1200 (vertical) pixels. The experiment was modelled and rendered using 3D Studio Max software and then imported into the Unity3D game engine platform. the Unity3D particle system was also used to visualize the scenes and the participants were able to see the experiment scenes and the fire smoke and were provided with realistic

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burning sounds of the fire occurring through a headset. During the experiment, participants remain standing and interact with IVE by manipulating the handles. Specifically, they manipulate the handles and move through the IVE, moving forward, backward, left or right at their own speed.

3.3. Virtual displays

The experimental scenario was modelled based on the environmental layout of the third floor south area of the library at the Chenglong campus of Sichuan Normal University, as shown in Figure 1. Evacuation scenarios, with elements including a shelf display area、a student study area、and two evacuation routes, each of which was marked with evacuation signs, Route 1 and Route 2 are both evacuated via stairs. In order to facilitate effective investigation of the experimental question, the presence of non-player characters (later replaced by NPCs) was added to the scenario, and the NPCs were unevenly distributed in the study area and the shelf display area before the participants started evacuating, performing normal library study and reading behaviour, and the NPCs did not know each other and did not interact with each other. The NPCs did not know each other and did not interact with each other. The pentagram was used as the formal evacuation starting point for the participants. Based on this experiment to investigate the effect of crowd splitting on the participants' choice of evacuation routes, the layout of the evacuation starting point was designed to ensure that the NPCs made their choice of evacuation routes before the participants in varying proportions when the participants reached the route selection decision point during the formal evacuation. The tables and chairs in the study area are arranged in an orderly manner and are spaced so that they do not interfere with the evacuation of the participants. Depending on the arrangement of the experimental scenarios, the concentration of smoke produced by fires varied from one scenario to another, with the main three scenarios being no smoke, sight smoke and dense smoke. It is worth noting that this experiment ensured that the participants were fully familiar with the environmental layout and the two available evacuation routes in the southern part of the third floor of the library, in order to exclude the interference of the participants' choice of evacuation routes due to their different familiarity with the environment.

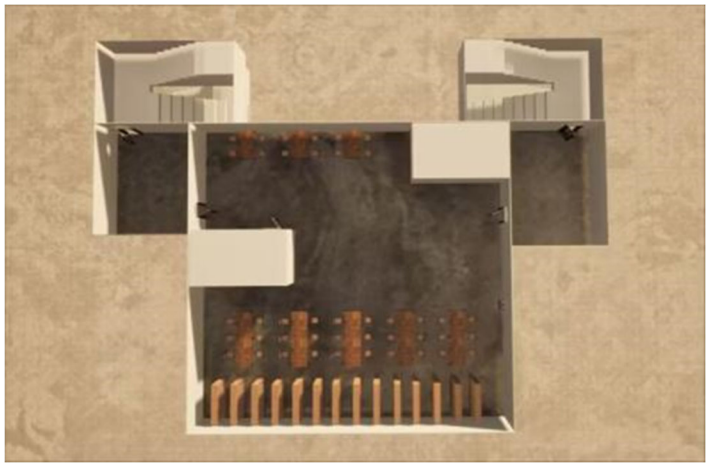

Figure 1. Evacuation scenarios

3.4. Experimental design

This experiment was designed to investigate the wayfinding choices of pedestrians in a fire emergency evacuation situation, in the face of conflicting dynamic information about the interaction of different smoke concentrations and different herd splitting patterns:

To effectively explore the experimental question, we designed two independent experimental variables: smoke concentration and herd splitting patterns, with the potential variable present

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being the psychological stress of evacuees, based on existing research showing that higher smoke concentrations lead to lower visibility and greater hazard attributes, resulting in greater psychological stress for evacuees, with psychological stress being positively correlated with smoke concentration.

In the different scenarios of this experiment, the virtual smoke manifested itself in the form of no smoke, sight smoke, and dense smoke, as in Figure 2. The virtual smoke in the IVE, in a no smoke environment with no other obstructions within the experimental scenario that blocked the visual pathway of the evacuation route to affect visibility; the proportion of herd splitting patterns was 80%-20%, as in Figure 3, and the NPCs in the scenario were selected for evacuation routes at different scales, and NPCs moved at speeds ranging from 2.3 m/s to 2.5 m/s.

(**a**)Slight smoke (**b**)Dense smoke

Figure 2. The virtual smoke in the IVE

(a)Route① 80%---Route② 20% (b)Route① 20%---Route② 80%

Figure 3. Crowd split pattern in the IVE

participants were randomly assigned to use the stairs connected by either Route 1 or Route 2 to reach the southern of the third floor of the library, arriving at a designated starting point next to a bookshelf. When a fire broke out, an alarm sounded and the NPCs began to select Route 1 and Route 2 for evacuation in proportion to their needs, while smoke from the fire spread rapidly to Route 2 as required by the experimental scenario, ensuring that by the time participants reached the route decision point, the factors influencing the wayfinding choice were already present. The experiment consisted of six different scenarios, as shown in Table 1, with 42 participants participating in each scenario, each in a completely randomised order, and each set of scenarios taking approximately 3 minutes.

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Table 1. The details of experimental scene

NO.	Smoke level	Crowd split pattern
1	No	Route① 80%---Route② 20%
2	No	Route① 20%---Route② 80%
3	Sight	Route① 80%---Route② 20%
4	Sight	Route① 20%---Route② 80%
5	Dense	Route① 80%---Route② 20%
6	Dense	Route① 20%---Route② 80%

3.5. Experimental procedure

1. During the preparation phase 42 participants signed an informed consent form for the experiment and a pledge of no heart disease or related medical history. The participants were informed that the experiment was designed to assess the effectiveness and experience of the virtual reality technology, and were promised that any discomfort during the experiment could be stopped immediately without explanation.

2. The participants were asked to fill in a questionnaire containing basic demographic information and the PANAS mood scale.

3. participants were asked to read an instruction manual on how to navigate the VR, and were then asked to put on an HMD and immerse themselves in an open, empty space for a brief demonstration to familiarise themselves with the operation of the VR equipment and the immersion of the virtual environment.

4. At the start of the formal experiment, the participant enters the virtual experimental scenario and according to the randomly assigned results, arrives at the southern of the third floor of the library via the staircase connected to Route 1 and Route 2 and follows the requirements of the experimenter's instructions to reach the designated shelves and look for the corresponding books, 20 seconds after the participant arrives at the starting point, the fire alarm sounds and the screen displays "Please evacuate quickly "The participant started to evacuate. The experiment ends when the participant has successfully reached the stairway exit.

5. At the end of the experiment, the participants filled in the PANAS emotional scale and the questionnaire about the experiment again and the experimenter explained the purpose of the experiment and thanked the participants for their active participation.

4. Experiment Results

After collecting the formal experimental data, an analysis involving variability was first conducted. The participants' evacuation route choices in different smoke scenarios are summarised in Table 2, where 55.9% of the participants evacuated via Route 1 in sight smoke and 79.7% in dense smoke. The results of the chi-square test showed that smoke level had a significant effect on participants' evacuation route choice based on smoke level and participants' route choice ($p<0.05$).

Table 2. Participants' route choice at different smoke levels

Participant's route choices	Smoke level			X^2	p-value
	no smoke	sight smoke	dense smoke		
Route 1	42	46	64		
Route 2	42	38	20		
Percent of route 1	52.3%	55.9%	79.7%	13.661	0.001***

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The effect of different herd splitting patterns on participants' choice of evacuation routes was further explored. In the six experimental scenarios, 72.2% of the participants chose route 1 when a large number of NPCs chose route 1 for evacuation, and 53.2% of the participants insisted on choosing route 1 when a large number of NPCs chose route 2, and no more participants chose route 2, as in Table 3. The results of the chi-square test showed ($p<0.05$) that different herd split patterns had a significant effect on participants' choice of evacuation routes.

Table 3. Participants' route choice under different split patterns

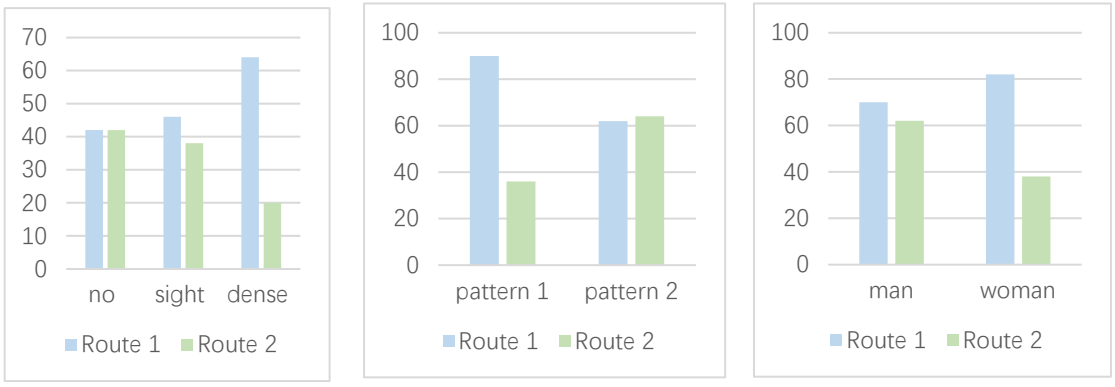
Participant's route choices	split pattern		X^2	p-value
	pattern 1	pattern 2		
Route 1	90	62		
Route 2	36	64		
Percent of route 1	72.2%	53.2%	12.998	0.000***

participants of different genders showed a preference when making route choices, and although the choice for Route 1 was relatively high, the female preference for Route 1 was significantly higher than the male preference, again probably taking into account the effect of Route 2 being a smoky route, as in Table 4. The results of the chi-square test showed ($p<0.05$) that gender differences had a significant effect on participants' evacuation route choices.

Table 4. Gender differences in participants' route choice

Participant's route choices	gender		X^2	p-value
	man	woman		
Route 1	70	82		
Route 2	62	38		
Percent of route 1	56.1%	70.0%	6.15	0.013**

To visualise the statistical results of the participants' evacuation route choices, this paper presents them in the form of a histogram, as in Figure 4.



(a)Route choice at different smoke level (b)Route choice under different split patterns (c)Route choice for different genders

Figure 4. Participants' route choice

Logistic regression models were used to predict the effect of each factor on participants' route choice after adjusting for gender, smoke level, and herd split pattern, and the results are

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summarised in Table 5. As the number of participants increases, the percentage of people choosing to evacuate using Route 2 decreases in the dense smoke scenario; the percentage of people choosing to evacuate using Route 2 decreases when the split pattern is pattern1 (i.e. Route ① 80% - Route ② 20%).

Table 5. Binary logistic analysis predicts subjects' route choice results

Independent variable	B	S.E	Wald	P	OR	95% CI	
						Upper	Lower
Sex - man	0.729	0.28	6.783	0.009***	2.072	1.198	3.585
dense smoke	1.265	0.353	12.849	0.000***	0.282	0.141	0.564
sight smoke	-0.12	0.324	0.418	0.518	0.811	0.43	1.53
pattern 1	1.037	0.28	13.711	0.000***	0.354	0.205	0.614

5. Discussion

5.1. The effect of ambient visibility on evacuation performance

Smoke is often generated in fire situations and the main hazards of smoke include asphyxiation hazards from inhalation, high temperature burns, and impact on environmental visibility [18]. In most cases, pedestrians will evacuate avoiding the route of smoke spread, but it has been found that under certain circumstances, such as when the smoke route is connected to an exit that is visible, pedestrians will choose to cross the smoke route to evacuate[19]. This phenomenon was also found in the present experiment, where participants in the experimental scenario with sight smoke showed a tendency to follow the smoke route when they saw most NPC choosing it for evacuation; in the experimental scenario with dense smoke, the number of participants showing the behaviour of crossing the smoke was significantly lower. This indicates that the higher the smoke concentration, the stronger the avoidance message conveyed. Combined with the post-experimental questionnaire, pedestrians' perception of their surroundings was not significantly reduced under conditions of increased psychological stress, and although the smoke generated avoidance, pedestrians also weighed the pros and cons of choosing an evacuation route appropriately when other instructive factors were also present: when the smoke concentration was not high and the majority of people chose to cross the smoke, pedestrians perceived this evacuation route as relatively safe When a route with dense smoke is still chosen by the majority, the perceived avoidance factor is strong, the herd effect is less effective, and pedestrians tend to avoid the route where the smoke is spreading. Smoke can significantly influence pedestrian evacuation route choices and pedestrians will make risky decisions in certain situations, so the development of effective fire smoke evacuation systems is key to reduce fire casualties.

5.2. Impact of crowd diversion on evacuation performance

In the experiment, pedestrians start evacuating as soon as they hear the fire alarm. When they reach the route decision point, pedestrians perceive evacuation information from the surrounding environment to obtain signals for safe evacuation. According to existing studies, the evacuation information perceived by pedestrians is divided into dynamic information and static information. Static information mainly includes emergency lighting, distance to exits, evacuation signs, corridors, stairs, lifts, and alarms; dynamic information includes the behaviour of the surrounding people, the fire and the spread of smoke generated [20]. Dynamic crowd messages were found to be significantly more useful in this experiment for guiding pedestrians, especially for the majority of the chosen evacuation route directions. In a no smoke environment, the majority of participants chose to follow 80% of the crowd for evacuation, and

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the questionnaire was used to understand that when participants were making decisions about evacuation routes, the direction chosen by the crowd concentration was considered safer and the direction in which a large number of people evacuated showed a sharing of safety information, so they chose to follow. A smaller number of participants chose to follow 20% of the crowd for evacuation. The results of the questionnaire indicated that the subjects were mainly concerned about the crowd density causing congestion, which in turn was not conducive to a quick escape. However, in the scenario of this experiment, except for the majority of NPCs who chose the smoke route evacuation scenario, participants all tended to follow the majority of people in the herd split and only a smaller number of participants chose to follow a smaller number of NPCs for evacuation. All participants under this experiment were aware of the structural layout of the experimental scenario and the two evacuation routes conveyed the same static evacuation message of safety. This demonstrates that regardless of the effect of different familiarity of the evacuees, pedestrians are more likely to follow the majority of people when the static information is more consistent. Future research could investigate the effect of crowd density on pedestrians' willingness to follow, and define a range of crowd densities that travellers are willing to follow.

5.3. The interaction between flock splitting and environmental visibility

The interaction between herd splitting patterns and ambient visibility had a significant effect on pedestrian evacuation times and route choice. In an experimental scenario in which one of the evacuation routes had sight smoke, when the direction of mass crowd flow avoided the smoke route, most participants had less hesitation time to make a route-finding choice and quickly chose the no smoke route for evacuation. When the information with directional and avoidance information did not appear in the same evacuation route, most participants would choose the route with directional information, which had a positive effect on the evacuation time and evacuation speed of the participants; when the direction of the large number of people flowed in the same direction of the route produced by the smoke, it would significantly increase the hesitation time of the participants to make a route choice and reduce the evacuation speed, but the pedestrians were the ones who tended to follow the majority of the crowd through the smoke route for evacuation. According to the post-experiment questionnaire survey, when pedestrians perceived smoke, they chose to follow the majority of the people to evacuate because they believed that the majority of the people knew the layout of the environment better and had a greater certainty of safe escape, which indicated that the pedestrians' choice of evacuation routes based on the increased pressure was based on rational thinking and was not an unconscious behaviour under the emotion of panic. In one of the experimental scenarios in which the evacuation route had dense smoke, the number of pedestrians who chose to follow the large crowd to make the risky decision of crossing the smoke was significantly reduced when the direction of flow of the large crowd was the smoke route. Although participants tended to follow the majority of the crowd in evacuation, as the smoke concentration increased, weakening the effect of herd behaviour, participants followed more often choosing to avoid the smoke route. It is also important to pay particular attention to pedestrians' evacuation preferences for an alternative route to the smoke route and to develop reasonable measures to intervene in the congestion problem.

5.4. Differences between men and women facing emergency evacuation situations

A large number of current VR-based experimental studies have pointed out that gender differences do not have a significant effect on studying pedestrians' behaviour responses in sudden emergency evacuation situations . However, in this experiment the researchers found an interesting phenomenon that men and women showed significant gender differences in reaction time, evacuation time, and evacuation route choice when faced with the same

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evacuation scenario. Specifically, more females chose to follow the majority of NPCs for the same route evacuation (80% of NPCs' chosen routes), and a greater percentage of males chose to follow the route chosen by a smaller number of NPCs (20% of NPCs' chosen routes) for evacuation, compared to females. Overall, a lower percentage of females chose the smoke route compared to males. According to the experimental statistics, compared to women, male evacuation speed is faster and evacuation takes less time; from the aspect of biological characteristics, male physical fitness is better than female, which is more advantageous in terms of evacuation speed; from the aspect of psychological characteristics, male is more daring, dares to carry out risky behaviour and has more competitive characteristics, and compared to women, male is not inclined to follow the route choice of the majority of the people, which also to a certain extent avoids congestion caused by crowd concentration to a certain extent. Women, on the other hand, show stronger empathy, tend to cooperate with others, and follow the majority of people to evacuate. Women are more sensitive to the perception of risk, and tend to carry out activities in familiar and safe areas, so in the face of the smoke route and the majority of the crowd evacuation routes are the same, women show more obvious hesitation behaviour, resulting in the prolongation of the effective evacuation time. Research has shown that high pressure affects the brain's ability to process information, somewhat influencing pedestrians to make a reasonable evacuation performance. Based on the results of a post-experimental stress questionnaire, females showed higher levels of stress than males in a fire evacuation situation with visible smoke. Future research could focus on the different performances of men and women during a joint evacuation, which could lead to further research on the development of effective measures for evacuation.

6. Conclusion

This experiment combines VR technology to explore the participants' routing choices in an immersive virtual library environment when a dynamically moving crowd delivering safety messages and smoke delivering avoidance messages are present simultaneously. According to the experimental results, it is shown that people's psychological pressure is significantly affected at different levels of hazardous urgency, and the higher concentration of smoke perceived by the participants leads to higher psychological pressure, and the higher the likelihood of the participants avoiding the smoke route. In an evacuation scenario with a high concentration of smoke routes, a large number of participants chose no smoke routes for evacuation even though 80% of the NPCs chose smoke route for evacuation. Therefore, a reasonable guess can be made that the more urgent the evacuation situation is, the higher the psychological pressure of the crowd is, and the tendency to avoid danger will be significantly higher than the tendency to respond to safety instructions. Individuals' perception of perceived information affects people's wayfinding decisions, and the most easily perceived dynamic evacuation information in the evacuation scenario of this experiment is the route chosen by the centralised evacuation of the crowd and the route filled with smoke, and participants will make different wayfinding decisions depending on their processing of the information. According to the results of the post-experimental questionnaire and the results of the Personal Riskiness Assessment Scale (PRAS), participants with a lower level of perception of the danger of smoke were more likely to make risky decisions and choose the smoke route for evacuation. participants with risky personality traits also tended to make risky decisions. participants who held the belief that the majority of people's choices are correct and reliable conception of the herd behaviour would tend to follow the majority of people, while participants who held that the herd behaviour is prone to congestion would tend to choose different evacuation routes than the majority of people. In high-risk environments human behaviour is complex and unpredictable, the experiment also observed a small number of participants with regret behaviour, in the process of choosing the smoke route to evacuate the evacuation occurs retreat

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behaviour, choose another route to evacuate, in this condition is easy to cause confusion and increase the evacuation time. Based on this study, it is shown that most people are able to maintain rational thinking under high-pressure conditions, so in the future fire fighting knowledge learning and drills, we should try to guide people to reduce the risk of decision-making, to maintain order in the evacuation, and not to change the route decision easily.

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