Influence of Fire Information and Architectural Space on Evacuation Decision-making

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Abstract

In a fire, the “normalcy bias” makes people tend to ignore emergency announcements and waste critical time before they start to evacuate. Most previous research on fire evacuation has dealt with architectural solutions for smoothing movement *after* people decide to take action. The present study focuses instead on the process leading up to the decision to evacuate, examining how it is influenced by the kinds of fire information people receive and the characteristics of the architectural space they are in. For the study, a virtual office room was created inside an audio-visual simulation laboratory using images projected on three front screens (each 2 meters square) covering a 180-degree visual field. The 26 subjects were asked to imagine they had come to this room to perform routine computer tasks. Nine scenarios (settings) combined five patterns of fire information with three types of architectural space, and the subjects acted as they would under each situation; they could, for example, “move” out of the room to see what was happening outside by flipping a switch to change the images projected onscreen. All actions were recorded with a video camera until the subject declared that he/she had decided to evacuate, at which point the experiment was terminated. Findings revealed that 1) hearing a fire alarm and a fire-alarm warning prior to the actual fire announcement encourages earlier decision-making, 2) persistent repeating of fire alarms and announcements is effective in prompting people to investigate their surroundings and therefore decide to evacuate, and 3) decision-making tends to be delayed in a room with no windows along the corridor and higher sound insulation, whereas it is speeded in a room with a corridor-side window or a nearby void space that allows people to more easily see what is going on.

Keywords: fire, information, architectural space, evacuation, decision-making

1 Introduction

The most important thing in a fire is to have people evacuate to a safe place as soon as possible. As shown in Figure 1, the time from when a fire breaks out until evacuation ends can be divided into three phases: 1) the pre-awareness phase, in which people have not yet noticed the fire nor received any information about it, 2) the information-collecting phase, in which they first realize that something unusual has occurred or hear emergency announcements, leading them to investigate their surroundings and decide to evacuate, and 3) the evacuation phase, in which they actually seek to move away from the danger. Most previous research on fire evacuation has dealt with architectural solutions for smoothing evacuation in the third phase. However, as it is often pointed out, the “normalcy bias” makes people tend to ignore emergency announcements and waste critical time in the second phase, even before they decide to evacuate. The present study thus focuses on how the decision to evacuate is influenced by the kinds of fire information people receive and the characteristics of the architectural space they are in.

(Figure 1: From the breakout of a fire to the end of evacuation)

2 Method

2.1 Experimental settings

A virtual office room was created inside an audio-visual simulation laboratory using images projected on three front screens (each 2 meters square) covering a 180-degree visual field (see Figure 2). The 26 subjects (18 male and 8 female university students) were asked to imagine they had come to this room to perform routine computer tasks.

Nine scenarios (settings), shown in Figure 3, combined five patterns of fire information with three types of architectural space. Scenarios 3, 5, and 7 utilized the most basic pattern: First there was a fire alarm, then a synthesized warning notifying people of the alarm and urging them to pay attention to further announcements. This was followed by a synthesized announcement declaring that a fire had occurred, and finally a human-voice fire announcement. In scenario 6, the information was provided in the same order but for longer durations (45 seconds) than in the basic pattern (10 seconds). In scenarios 1 and 9, auditory and visual input from outside the room was added, including footsteps, voices, and figures of people walking along the corridor. In scenarios 2 and 8, this input from outside the room replaced the fire alarm and fire-alarm warning. In scenario 4, no information of any kind was provided before the synthesized fire announcement.

The three types of architectural space (see Figure 4) were (A) a room with sound insulation diminishing the sound level from the corridor, (B) a room with a corridor-side window allowing subjects to see and hear people outside, and (C) a room connected to a corridor with a void space allowing subjects to see into the upper and lower floors. For each room type, wide-angle photos showing the view from inside the room, at the door, in the corridor, and at the staircase were prepared. Animations of human figures and smoke were overlaid on the photos as the scenario demanded.

(Figure 2: The audio-visual simulation laboratory)

(Figure 3: Experimental scenarios [settings])

(Figure 4: Architectural spaces)

2.2 Procedure

To control for experimental order, subjects were divided into two groups: one group moved from scenario 1 to scenario 9, and the other group experienced the scenarios in reverse order. First, subjects were familiarized with the office through a series of photos surveying the room from the entrance. Then the subjects were asked to act as they would under each situation. They could, for example, change the volume of the background music playing inside the room, or they could "move" from the room to see what was happening outside by flipping a switch to change the images projected onscreen (see Figure 5). All actions were recorded with a video camera until the subject declared that he/she had decided to evacuate, at which point the experiment was terminated. The experiment was also terminated if the subject did not declare within 6 minutes.

(Figure 5: Screen images)

3 Results and discussion

3.1 General tendencies

Since no significant order effects were detected, the data obtained from the two groups were treated as one. Figure 6 shows the timing of investigative actions and of evacuation decision-making by subjects in a total of 234 sessions (26 subjects × 9 scenarios). Attempts to investigate one's surroundings were most frequent after the fire alarm, although they also increased after the synthesized fire announcement. Notably, seeing and hearing evacuees along the corridor prompted some subjects to move around to check for safety. As for decision-making, most subjects concluded they should evacuate soon after the synthesized fire announcement, although some waited until hearing the human-voice announcement.

3.2. Influence of fire information and architectural space

Figure 7 shows subjects' choice of scenes after hearing the fire alarm and announcements. The fire alarm triggered investigative actions and movement away from the room. In scenario 6, in which the alarm and announcements were persistently repeated, half the subjects moved to the staircase. Interestingly, the fire-alarm warning suppressed rather than stimulated movement. As shown in Figure 8, after the fire-alarm warning, investigative actions decreased as subjects concentrated instead on waiting for the next announcement (e.g., by turning off the background music) and preparing to evacuate (e.g., by closing the note PC).

Type of architectural space strongly influenced subjects' investigative actions. Subjects moved more frequently to the corridor in scenario 3, which was conducted in a room with a nearby void space, than in other scenarios that required them to move farther away to the staircase to see what was going on (see Figure7b).

Figure 9 compares evacuation decision-making in scenario 7, which utilized the basic pattern, versus in scenario 4, which provided no information before the fire announcement. Clearly, access to preliminary information enables earlier decision-making. Figure 10 compares evacuation decision-making in scenario 7 versus in scenario 6, in which warnings were persistently repeated. Here, too, it can be seen that repetition induces a speedier decision.

(Figure 6: Timing of investigative actions and decision-making)

(Figure 7: Choice of scenes after fire alarm and fire announcements)

(Figure 8: Actions following the fire-alarm warning)

(Figure 9: Evacuation decision-making in scenarios 7 and 4)

(Figure 10: Evacuation decision-making in scenarios 7 and 6)

4 Conclusions

The study revealed the following:

1) Hearing a fire alarm and a fire-alarm warning prior to the fire announcement itself encourages earlier decision-making.

2) Persistent repeating of fire alarms and announcements is effective in prompting people to investigate their surroundings and therefore decide to evacuate.

3) Decision-making tends to be delayed in a room with no windows along the corridor and higher sound insulation, whereas it is speeded in a room with a corridor-side window or a nearby void space that allows people to more easily see what is going on.

References

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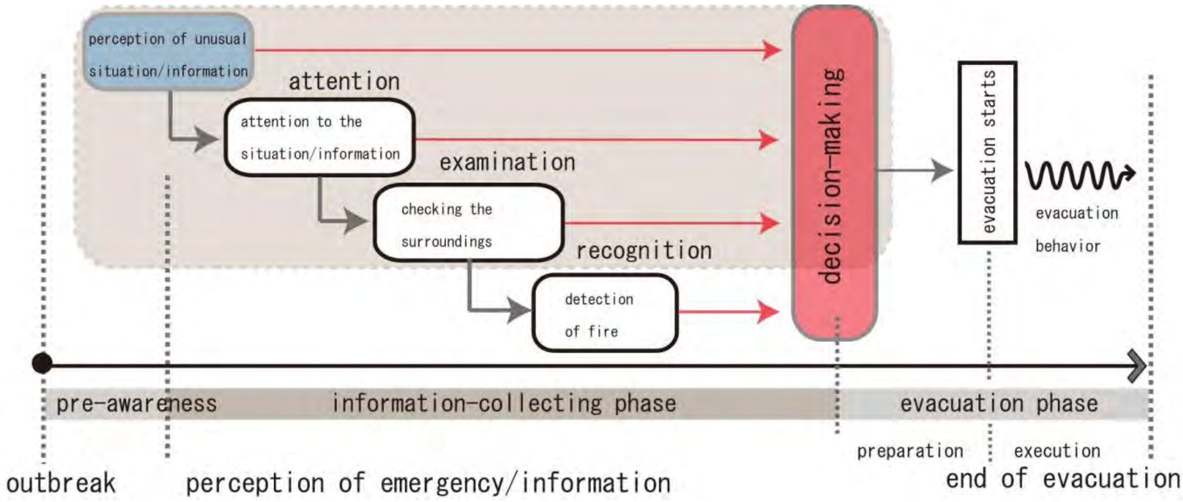

Figure 1: From the breakout of a fire to the end of evacuation)

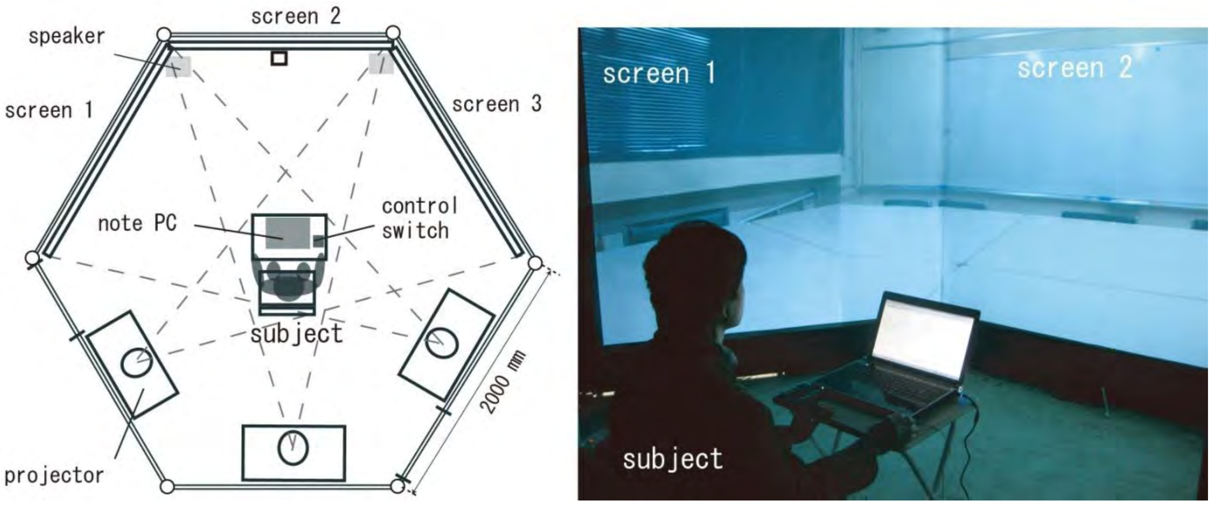

Figure 2: The audio-visual simulation laboratory

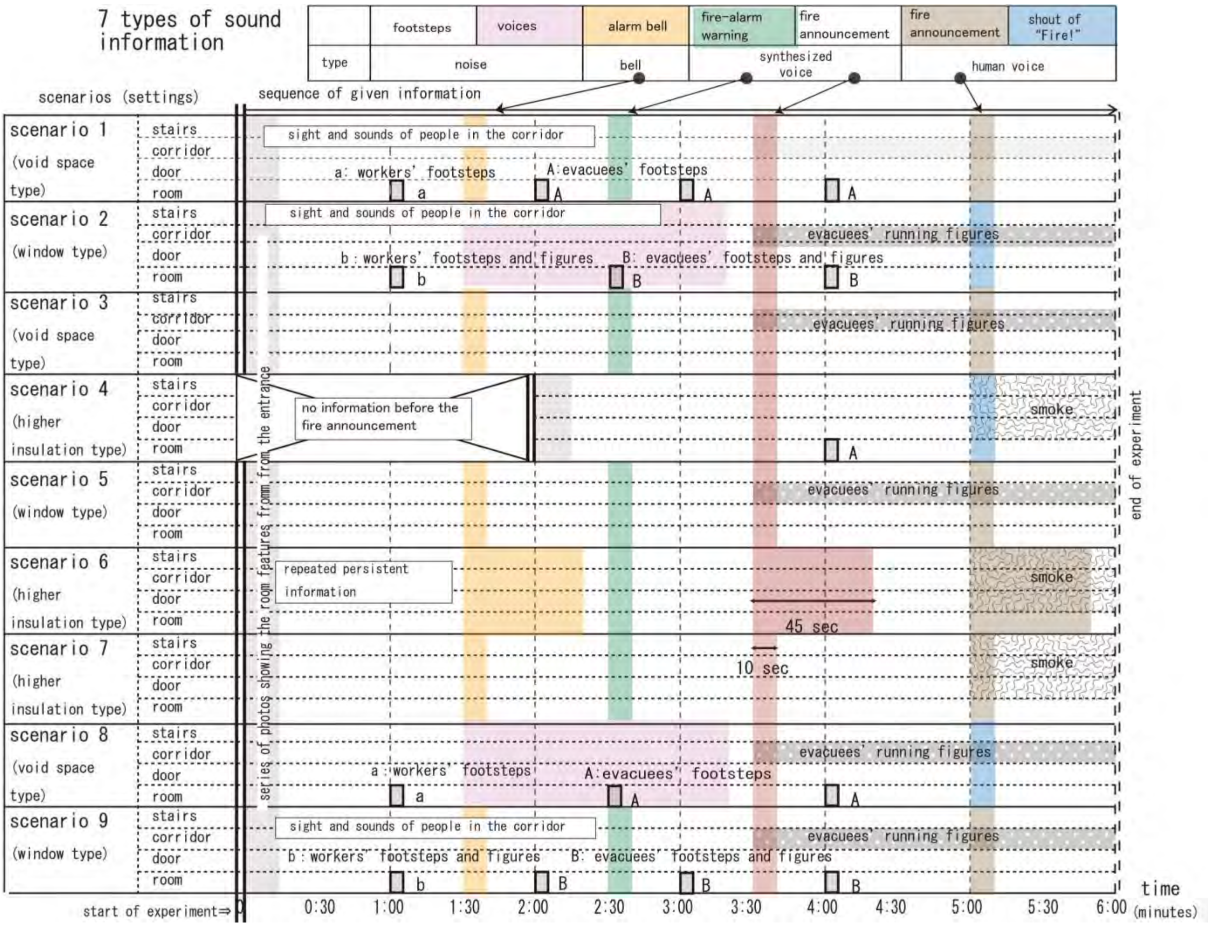

Figure 3: Experimental scenarios [settings]

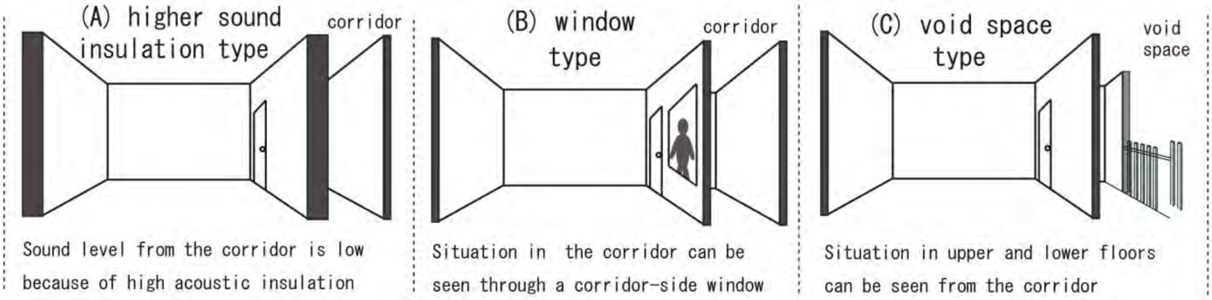

Figure 4: Architectural spaces

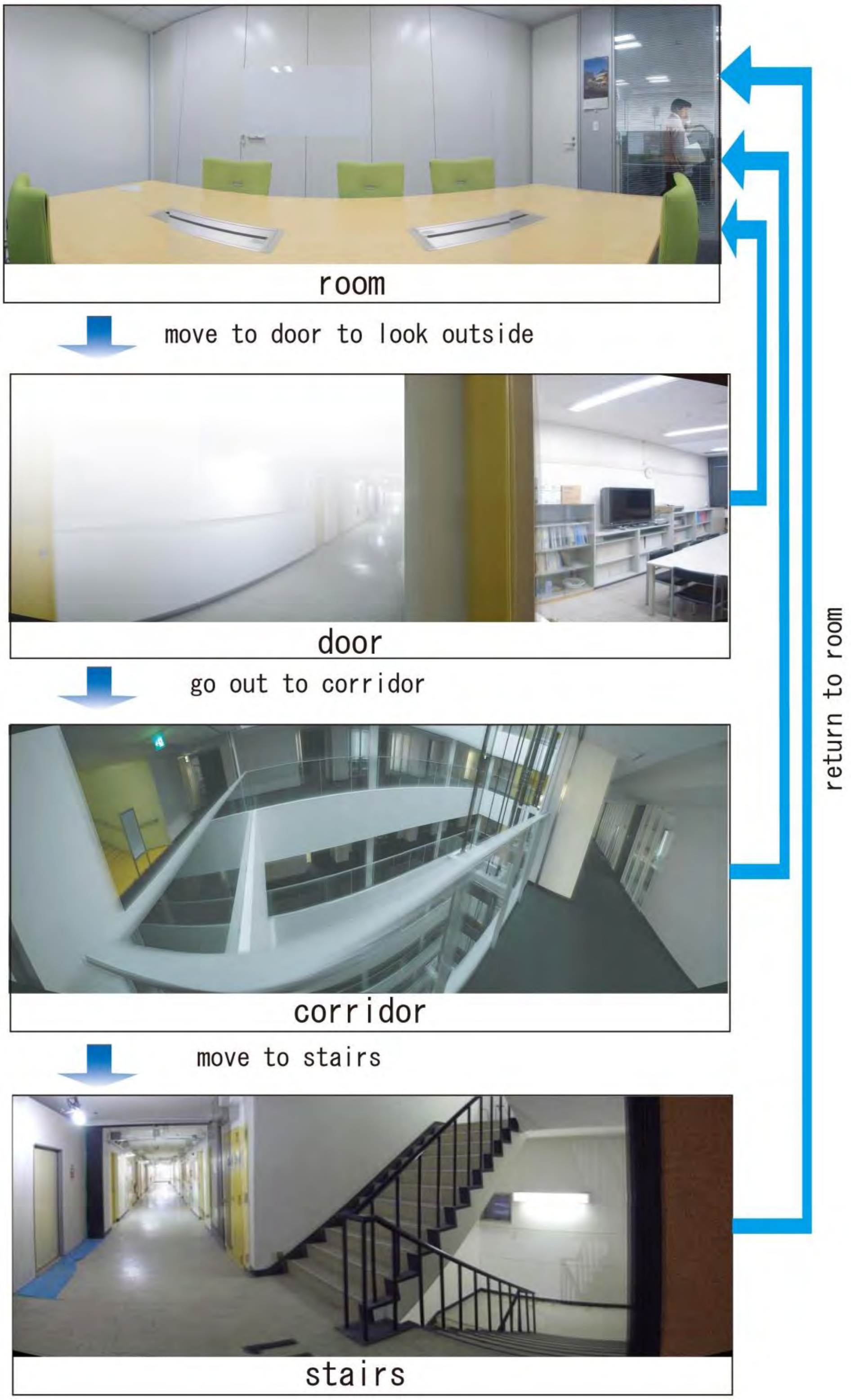

Figure 5: Screen images

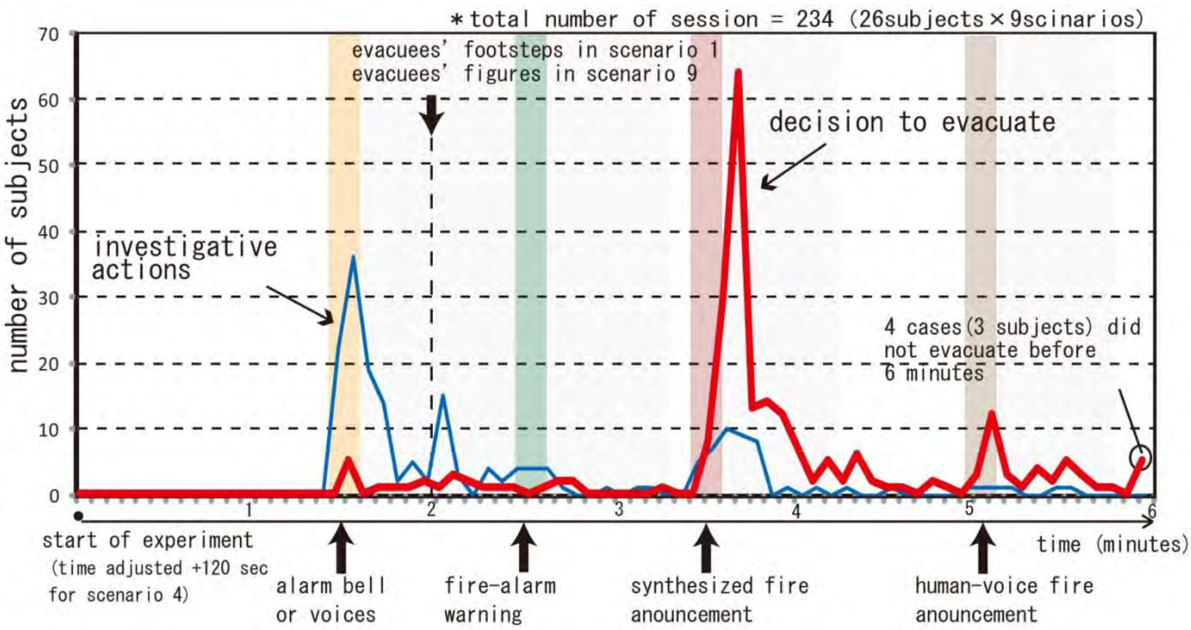

Figure 6: Timing of investigative actions and decision-making

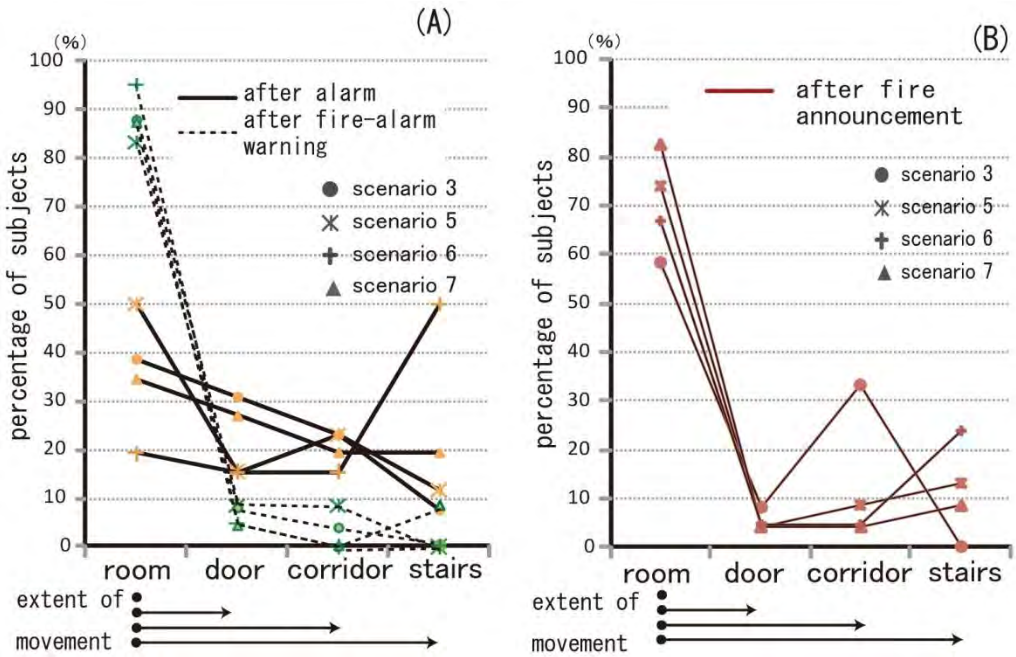

Figure 7: Choice of scenes after fire alarm and fire announcements

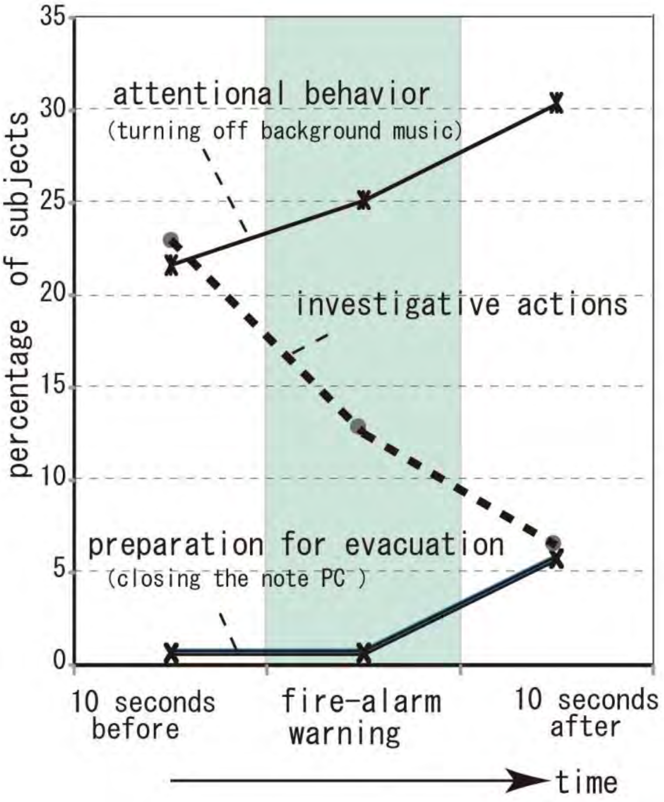

Figure 8: Actions following the fire-alarm warning

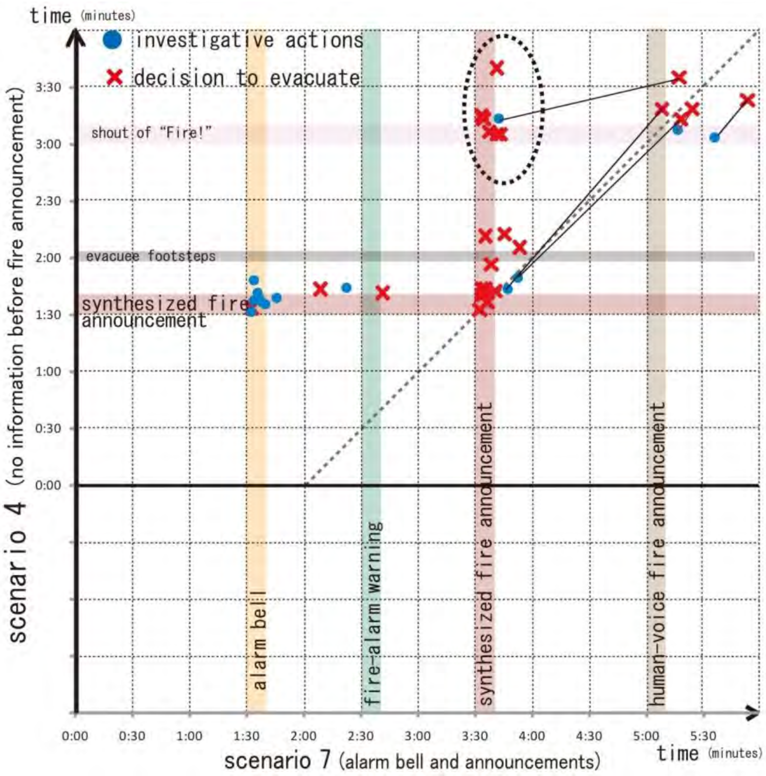

Figure 9: Evacuation decision-making in scenarios 7 and 4

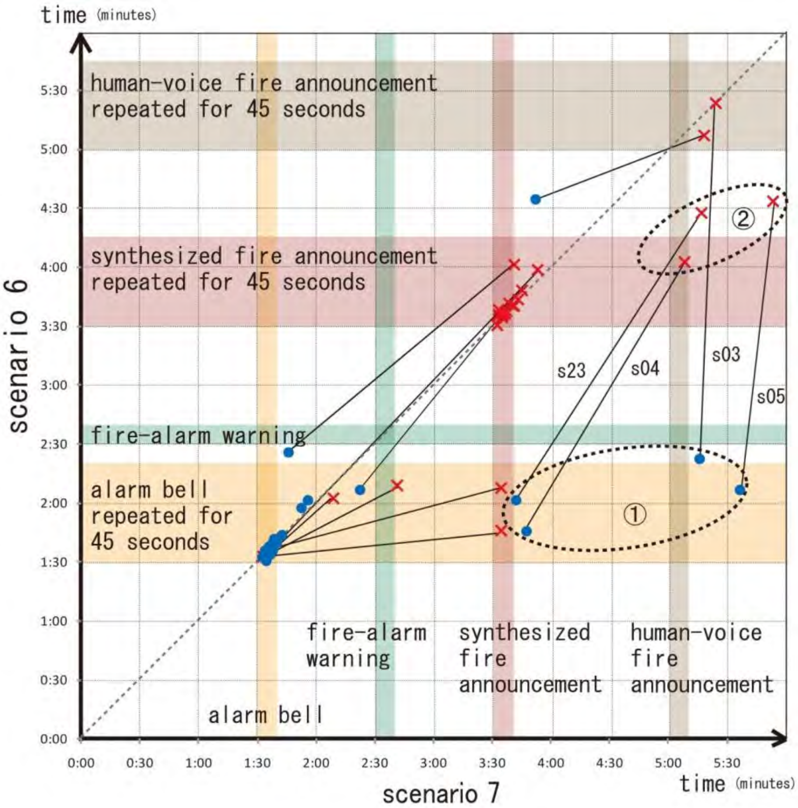

Figure 10: Evacuation decision-making in scenarios 7 and 6