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Social influence during the initial phase of a fire evacuation—Analysis of evacuation experiments in a cinema theatre

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ABSTRACT

Unannounced evacuation experiments in a cinema theatre were analysed. The analysis focused on investigating if people are influenced by others during the initial phase of a fire evacuation. This type of influence is called social influence. Three separate behaviour types were identified and studied and the recognition and pre-movement time was measured. The results suggest that social influence is an important factor and that it becomes more important when the fire cue, e.g., the alarm, is unclear or uninformative. Results also indicate that social influence increases with decreasing distance between visitors. This result implies that individuals are influenced more by people who are close than by people who are further away.

1. Introduction

A central principle of performance-based fire safety engineering design of buildings is that the time available for occupants to escape should be greater than the time required [1]. This principle is essentially identical in many guidelines although the nomenclature may vary [1–3]. The time that is required for occupants to escape is often called required safe escape time (RSET) [1].

The estimation of RSET is an important step in performance-based design and computer software, such as Simulex [4] and STEPS [5], is often used. These programs are capable of simulating evacuation from buildings of many people simultaneously. They also enable the user to specify occupant characteristics. In computer simulations, it is often assumed that each occupant is exposed to a fire cue and starts to move towards an exit after a certain delay, which is often called pre-movement time. This time period starts when the occupant is exposed to a fire cue and ends when he or she starts to physically move to a safe place, typically to an emergency exit. A fire cue can be for example a fire alarm or smoke, i.e., a cue that signals that a fire emergency may have occurred. In the programs, the user has to specify the pre-movement time used in the simulation.

The pre-movement time can be difficult to quantify. It includes a wide range of behaviour, such as recognising the fire cue, deciding what actions to take and preparing to move to an exit. The pre-movement time is sometimes divided into two separate phases, namely recognition and response [1]. The recognition phase is the period between the reception of a fire cue and the occupant's first response. The response phase is the period between the occupant's first response and the time when he or she starts to physically move towards an exit. It has been recognised that the pre-movement time may be as important as the time it takes to move to an exit [6]. Therefore, it is imperative that the estimation of the pre-movement time is as accurate as possible.

Many full-scale evacuation experiments have been conducted in order to study evacuation from buildings and to quantify the pre-movement time. Experiments have been performed in a wide range of building types, such as apartments [7], stores [8,9] and cinemas [9,10]. Many of these experiments have been used to develop recommended pre-movement times for different combinations of building types and alarms [1]. Recommendations are often used in hand calculations and computer simulations of fire evacuation.

People will most likely be influenced by others and their behaviour during the pre-movement phase. If someone starts to move towards an exit it is likely that others will follow. Similarly, inactivity of others may also inhibit people's actions. This type of influence is sometimes called social influence and is seldom taken directly into consideration when RSET is estimated.

The importance of social influence was demonstrated in experiments at Columbia University [11]. In the experiments, students were exposed to artificial smoke while they were filling out a questionnaire in a small room. The students were not

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informed about the simulated emergency beforehand, but instead they were told that they were going to take part in an interview about urban life. Three different cases were studied. The students took part either alone, in groups of three or one student together with two passive confederates. All confederates were informed about the experiment, but were instructed not to act or report the smoke. The experiments at Columbia University revealed that students who were alone were most likely to report the smoke. Students who were alone also reported smoke more quickly than those who were in the presence of others. Hence, the presence of others seemed to inhibit the students from taking action. This trend was particularly clear when two passive confederates were present. The study clearly demonstrates that people can be influenced by others in fire emergencies.

Social influence does not apply exclusively to emergencies and it can be observed in many different settings. A distinction between normative and informational social influence has been identified based on a study of individual judgement [12]. The normative part is the result of the individual's desire to conform to the expectations of other people. People want to act in accordance with what is expected and may not want to stand out or make a fool of themselves. Individuals will also study other people and their behaviour to gain information about the current situation. The actions or inaction of others may influence people's perceptions of the situation and their subsequent behaviour. This latter type of influence is called informational social influence.

Research about helping behaviour has suggested that social influence may be more important for ambiguous emergencies [13]. This may also be relevant for fire emergencies. If the fire cue is clear, e.g., an informative pre-recorded message, it is possible that social influence may be less important. For ambiguous cues, e.g., a fire alarm bell, it is likely that social influence becomes significant. In the latter case, people may not want to make fools of themselves, which will inhibit their response. At the same time, they might interpret the inaction of others as a sign that the situation is not a real emergency. This may also inhibit their response.

If the pre-movement time is based solely on the type of building and alarm no direct account will be taken of the social influence. However, implicitly some of the influence will be taken into consideration since certain building types are often associated with specific social settings. One example is cinema theatres where groups of visitors usually sit in seats facing a screen. An estimation of the pre-movement time that is based on experiments or real fires in cinemas will be exclusive for that type of setting.

The purpose of the present study was to investigate social influence in a fire emergency setting, namely during evacuation from a cinema theatre. It was hypothesised that the social influence would be more important for an ambiguous than for a clear fire cue.

2. Evacuation experiments in a cinema theatre

A series of unannounced evacuations were performed by Bayer and Rejnö in a cinema theatre in Sweden in autumn of 1999 [9,10]. The purpose of the experiments was to test how different alarms affected the pre-movement time. Six types of alarms were tested, namely an alarm bell, an alarm tone signal, an alarm bell together with a flashing light, an alarm bell together with an information sign and two pre-recorded messages. One of the pre-recorded messages was recorded by a man and the other by a woman. Each alarm was tested three times and the total number of evacuation experiments was 18. All evacuations were performed in the same cinema theatre, but each participant only took part once.

Table 1
The type of alarm that was used in the experiments and the total number of participants

Experiment	Type of alarm	Total number of participants
A1	Alarm bell	88
A2	Alarm bell	100
B1	Pre-recorded message (female)	113
B2	Pre-recorded message (female)	135
B3	Pre-recorded message (female)	135

Five of the 18 evacuation experiments were included in the following study (see Table 1). The selection was based on the type of alarm and the number of participants. Experiments with two types of alarms, namely an alarm bell and a pre-recorded message (female), were chosen. These alarms were selected since they represent two distinct levels of ambiguity. The pre-recorded message is a clear cue and informs the evacuees about what has happened and how they should behave. The alarm bell is considerably more ambiguous, since it does not provide any specific information. Only experiments in which the cinema theatre was at least half full were selected. This meant that one of the three experiments with an alarm bell was excluded.

The five evacuation experiments selected for this study are described in the following sections. The description is generally applicable to all 18 experiments, but some details are specific. In Table 1, the type of alarm that was used in the experiments is shown (see Table 1). The experiments with the alarm bell will be called case A and the experiments with the pre-recorded message (female) will be called case B in the following text.

2.1. Participants

The participants consisted of cinema theatre visitors who had bought tickets for the shows that were chosen for the experiments. This meant that the number of participants and the composition of people could not be controlled directly. The table above shows the number of participants who took part in the five evacuation experiments (see Table 1). The number of participants was determined through observation of video recordings of the experiments. All participants were asked to fill out a questionnaire after the experiments. The questionnaire contained questions about their age and gender. The table below shows the age and gender distribution based on the participants' answers (see Table 2). None of the participants were informed about the evacuation prior to the experiment, but they were given information afterwards.

2.2. Cinema theatre

The cinema theatre that was used in the experiments took a maximum of 135 visitors (see Fig. 1). It consisted of nine rows with 15 seats each. On each side of the nine rows, there were stairs from the front to the back of the cinema theatre. This meant that the visitors could exit a row both to the left and right. Two doors connected the cinema theatre to other parts of the building. One door was the entrance and it was placed in the back right corner. The other door was located in the front left corner. Both doors were equipped with standard emergency exit signs.

The video camera that was used to document the experiments was placed in a dark box and mounted in the front right corner of the room. This location provided a good overview of the entire cinema theatre. The alarm bell that was used in experiments A1 and A2 was placed along the left wall and was clearly visible. The pre-recorded message in case B was played using the cinema