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A STRESS MODEL FOR PEOPLE FACING A FIRE

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Abstract

The safe evacuation of public buildings in an emergency requires the user to engage in rapid and appropriate decision-making under stressful conditions. To illustrate the complexity of the interaction components and the user's effort to psychologically cope with a fire, a stress model has been developed. This stress model accounts for different emotional stages users can experience during a fire emergency. The emotional stages of control, uncertainty, fear, worry and confusion are defined. The stress model is used to argue that information must be provided during the emergency to motivate evacuation behaviour, reduce stress and support the decision-making process required in a successful evacuation. Although the stress model was not tested as such, results from an evacuation experiment and a real fire report are used to illustrate the model's stages.

Introduction

When an emergency occurs in a public building and an evacuation is required, it is expected that users will move quickly towards an area of safety. Administrators of public places presume users will leave the building immediately by the nearest exit on hearing the sound of an alarm, however, the analyses of people's behaviour in such a situation have revealed a different picture (Wood, 1980; Canter, 1985). Long delays before deciding to move, time spent looking for others or gathering personal items, as well as attempts to evacuate by dangerous routes, were readily observed behaviours.

An emergency, such as a fire evacuation in a public building, can be conceptualized in terms of problem-solving and decision-making. The person facing an emergency has to make decisions and take actions in order to solve the problem of reaching safety. These cognitive processes are, however, constrained in such circumstances. In fact, the characteristics of the emergency will create psychic stress (Wood, 1979). Because too much stress can impair cognitive processes, it must be reduced in such a way as to allow the person to interpret the situation accurately and to take on and execute appropriate decisions. It is argued that providing precise information to users about the situation during an emergency will prompt action, reduce stress and support their problem-solving process.

To develop a stress model for people facing a fire emergency, the literature on information processing, decision-making and problem-solving has been used as a framework. The major elements implied in these cognitive processes are identified. From studies on stress, disturbing effects of psychological stress on cognitive operations are pointed out. It should be noted here that psychic stress is not considered as dysfunctional or maladaptive. In fact, some stress is needed to motivate a reaction, although too much stress can impair the person's response. Stress is defined, according to Selye's work (1974, 1979), as 'a non-specific response to any demand'.

The proposed stress model is an attempt to synthesize a large body of literature and an effort to structure the major items which interfere with the cognitive processes of a person faced with a fire.

Information Available During a Fire

According to the classic model developed by Polya (1957), problem-solving involves four cognitive stages. The first stage is understanding the problem. This involves defining the situation and determining the problem to be solved. Devising a plan is the second stage. This requires looking for information, making decisions and structuring actions. The third stage is carrying out the plan; the execution of the decision taken in the previous stage. Finally, the fourth stage

is looking back, that is, assessing if the action taken worked towards solving the problem.

The relative importance of each of these problem-solving stages depends on the problem to be solved (Howard, 1983). In the case of a fire emergency in a public building, the first stage, 'to define the situation', appears to be the most decisive step. Often undervalued in the literature, this first step is paramount. The time spent in gathering information in order to interpret the situation represents precious seconds, often minutes, invested in non-evacuation behaviour which, by the time the situation has been assessed, could leave very little time to reach safety (Sime, 1986; Sime & Kimura, 1988). Furthermore, the interpretation of the situation is important in determining further decisions. A situation which has been inadequately defined can lead to erroneous decisions (Canter *et al.*, 1980).

This first stage of defining the situation is based on the available information. The information used to interpret the situation can come from different sources. It can be provided by the emergency itself; in a fire it may take the form of smoke or flames. The building can provide information through the sounding of an alarm or public announcements. Other people, either staff or users, could also be a source of information by what they do and say. Along with this environmental information, the user will rely on information already known about the building and similar environments visited previously. Finally, to assess the information, the user can refer to information gathered from past experiences in dealing with emergencies.

Although emergencies vary enormously from one to another, the information available to users during a fire is generally characterized by its ambiguity. Smelling smoke, hearing the sound of an alarm or observing confused behaviour of staff is not straightforward information indicating that 'this is an emergency' or 'there is a fire'. Generally, the information thus perceived is ambiguous because it is unusual and unexpected in a public place.

On devising a plan of action and carrying out this plan, two different types of reaction are observed. When users notice ambiguous information in public buildings, they either ignore the situation, or they investigate (Canter, 1985). Ignoring the situation and pursuing normal activities is a common reaction to ambiguous cues because it corresponds to the users' role in a public building of not taking action. Consequently, users tend to stick to their roles of customers or visitors assuming it is up to the staff to take responsibility for dealing with such a situation. As well, users do not want to overreact to an incident

that is already under control and to lose face in front of others (Latane & Darley, 1968). Only when the person feels challenged or threatened, will he or she interpret the situation as requiring some action.

The other reaction to ambiguous information is to investigate. This plan of action entails consulting others or asking staff about the situation. The person may also take steps to establish the nature of the incident. The latter often implies moving in the direction of the potential danger to gather information. These reactions to ambiguous information suppose that a certain amount of time is spent either ignoring the situation or looking for information.

During the course of the event, the rapidly changing situation will constantly and repeatedly be redefined in relation to new information gathered and feedback obtained from previous decisions (Lazarus & Folkman, 1984). The type of action taken will depend on the interpretation the user has made of the situation and on what the person assumes to be an appropriate reaction to such a situation. To warn others, to fight the fire, to leave the building or to wait to be rescued are all likely behaviours.

Decision-making During a Fire

Janis and Mann (1977) have explained that decision-making during an emergency is different from day-to-day decision-making in two main ways; 'One is that there is much more at stake in emergency decisions—often the personal survival of the decision maker himself and of the people he values the most. A second important difference is in the amount of time available to make a choice before crucial options are lost' (p. 54). To those two main differences, a third one is added for a fire emergency: the ambiguous, incomplete and unusual nature of the information on which to base the decision-making process and usually the impossibility of looking for more appropriate information due to the lack of both the time and the means to get information.

Decision-making during a fire emergency can be related to research done on risk situations. Decision-making during risk situations has generally been studied in the context of games, such as chess and gambling (Benzur & Bresnitz, 1981), in assessment of fictitious situations (Jackson *et al.*, 1972) or purchase options (Wright, 1974). This research has shown that slight changes in task or context could influence decision-making in risk situations (Payne, 1985). Particularly, the information provided to solve the problem, and the time available, will influence the decision-making strategies.

A risk situation, such as an emergency, supposes that decision-making will encounter uncertainty because the information or the knowledge about the situation is incomplete (Scholz, 1983). When a decision has to be made in order to solve a problem, not all possible information and alternatives are considered (Engländer & Tyszka, 1980). In dealing with uncertainty, subjects tend to focus their attention on a few information units disregarding others (Kahneman & Tversky, 1982). The use of a few units of information accords with heuristic models that explain the person's need to reduce the space of the problem to an easily manageable dimension (Gröner *et al.*, 1983). The decision is taken according to Simon's concepts of 'bounded rationality' and 'satisficing', when a good-enough solution for the problem is found (Simon, 1957).

According to the literature on decision-making in risk situations, it might be expected that, in a fire, a person will not refer to all possible information and alternatives, as perceived, known or inferred from the situation. Only a few options, which the subject considers as being more likely to solve the problem, will be retained. A rapid and easy strategy to make decisions and solve a problem is to apply a well-run decision plan (Keating, 1985). Usually, for the user, this translates into evacuation by a familiar route (Sime, 1985). Using a familiar route to leave a building is a less demanding task than developing a new decision plan for a new route (Passini, 1984). In public buildings, this usually means leaving by the main entrance (Sime, 1985). Only when the familiar route is blocked or judged dangerous, will the person try to develop an alternative decision plan.

Another characteristic of an emergency is the time pressure under which the person is processing information, making decisions and executing action. Although research on decision-making under time pressure has usually dealt with the incentive of gain and loss of money (Eysenck, 1983a), which differs from a life threat, some results are relevant to this discussion. According to Wright (1974), decision-makers are inclined to use less information and to accentuate negative evidence when the environment provides high time pressure or distracting conditions. Under these conditions, the decision maker tends to discredit options after looking at only a few salient dimensions. Less risky choices are made under time pressure (Benzur & Breznitz, 1981). Transposed to the emergency, these findings suppose that people will give priority to familiar options disregarding unfamiliar options which they tend to define as likely to increase danger. For example, escaping through an emergency exit is often eliminated as an

egress alternative. Indeed the person may believe that the emergency exit door could be locked or blocked or could lead to unknown corridors or to an unsafe area. Users have no experience with such means of circulation because emergency exits are often prohibited from use during normal occupancy of the building. These findings explain why users tend to evacuate through a familiar route.

The interaction of the perceived threat, the exiguous time to react and the limitation of means to gather information will create psychic stress in the user. Knowing that a decision has to be made in an emergency, and that this decision could be irrevocable, contributes to the stress created. According to Janis and Mann (1977), knowing that you have to make a decision is, in itself, stressful.

Coping with Stress

The performance of the user in coping with a stressful situation will depend on the task demands, the environmental conditions and the subject himself or herself (Wesnes & Warburton, 1983). As described previously, in order to define the task demands, information will be processed by the person so that decisions liable to fulfill the task are made. The limitation on a person's information processing capacity has been pointed out in early work in cognitive psychology (Miller, 1956; Simon, 1957). Miller (1956) suggests that only a few units of information, between three and seven, can be processed at any one time. Consequently, an assumption of the information processing models is that people have limited resources and must allocate resources to one activity or another on the basis of an allocating strategy (Kahneman, 1973; Norman & Bobrow, 1975). According to Bainbridge (1974), the information processing capacity is a function of operations and strategies developed by the person. A large amount of information to be processed quickly in order to solve an unusual problem for which the person has no decision plan, or a lack of specific information, are considered major sources of stress (Bronner, 1982).

The environmental conditions in a fire emergency can create unexpected sequences of events that occur very rapidly. The development of a fire is unpredictable, a room in which light smoke is perceived at one moment could become fully involved in fire seconds later (Purser, 1985; Donald & Canter, 1990a). This destabilizing character of the environment contributes to the person's stress (Evans & Cohen, 1987).

The person's reaction to an emergency is subjective (Lazarus, 1966). Idzikowski and Baddeley (1983) have pointed out three characteristics that will influence the person's reaction to stressful events. The first factor is the person's predisposition to stress and anxiety. It is argued that everyone has a trait-anxiety which does not vary much during one's lifetime and a state-anxiety that differs depending on the situation. Both can influence performance (Eysenck, 1983b). A second factor affecting stress is the subjective assessment of danger. Personal evaluation of the seriousness of danger and the ability to cope with it will influence the stress response (Lazarus & Folkman, 1984). The third factor is previous experience with similar events. What is known or inferred from past incidents will have an influence on the person's reaction to a new situation.

Although it is acknowledged that personal characteristics influence the reaction to an emergency, the manner in which these characteristics determine behaviour and performance is complex. The inclination to feel anxious does not directly lead to worse performance during a stressful event. Kahneman (1973) argues that an anxiety prone person has developed strategies to cope with stress and could perform comparably well to a person with lower trait-anxiety though at a greater cognitive cost. Also, individual evaluation of the situation and previous experience could either improve or decrease performance in coping with an emergency. There are no two emergencies alike, a response that was right for one situation could exacerbate the imminent hazard in another situation (Currie, 1985). On the whole, there is no straightforward relationship between personal characteristics and performance in handling a stressful situation, such as a fire emergency.

During an emergency, the nature of the information provided, the limited time to react and the assessment of danger will create a feeling of stress. It is argued that this stress will be felt from the moment ambiguous information is perceived until well after the event when the person has reached safety. During the course of the event, the intensity of stress experienced will vary as a function of the information newly perceived and the assessment of the decision taken.

A Stress Model

The proposed stress model is an attempt to illustrate a very complex reality in a simplified fashion. The literature on information processing, decision-making,

problem-solving and stress has guided the construction of this model. Previous authors have tended to focus their attention on only one cognitive process at a time, either information processing, decision-making or problem-solving. However, these cognitive processes are interrelated. Information processing is a prerequisite to decision-making which allows problem-solving. Inversely, to solve a problem, it is necessary to make decisions and to process information. These cognitive processes suppose a constant exchange between the person and the environment. Based on these multiple concepts, a stress model in five loops has been developed to describe the stress a person can experience during a fire.

It is considered that every person involved in an emergency will feel some stress regardless of their age, sex or cultural background. This stress is not an abnormal reaction; on the contrary, stress is regarded as a necessary state to motivate reaction and action.

The first loop of the stress model starts with the perception of ambiguous information (see Fig. 1). This information is decoded in the processing system (PS in the figure) for interpretation. Given that the available information may not allow for a straightforward assessment of the situation, people will, at first, minimize or deny the situation. These defensive strategies of avoidance lead to an absence of reaction. The person denying the situation or deriving a positive explanation from the perceived information acquires a momentary feeling of control over the situation.

Although individuals may vary considerably in their appraisal of the same event, the repeated perception of ambiguous information will eventually generate a state of uncertainty which will then induce a feeling of stress. Some time can be spent going repeatedly through this second loop of the stress model.

In work by Lazarus and Folkman (1984), a clear distinction is made between ambiguity and uncertainty. Ambiguity is defined as a lack of situational clarity while uncertainty is the person's feeling of puzzlement about the meaning of information perceived in the environment.

Progressing to the third loop, the person will process new ambiguous information. This could lead to more uncertainty and eventually to the interpretation that there must be 'something wrong' or 'there seems to be a fire'. This situation could be considered as a challenge or a threat. Both circumstances will instigate the need to do something. When it becomes obvious that a decision has to be made, this fact will increase the stress, particularly if the situation is

defined as potentially hazardous for the person or others and requires a specific response to ensure safety. Stress will also increase if the person senses limited time available to respond correctly. Defining the situation as potentially dangerous, or assessing that little time is available for reacting, will heighten arousal and is likely to induce a feeling of fear. As a consequence, the person will try to process as much information as possible in order to decide on an appropriate action. This may create an overload within the information processing system thus increasing the difficulty of making a decision.

The third loop of the stress model is related to the interpretation of the situation as an emergency. The thicker line around the processing system, in Figure 1 (on the third loop), expresses the pressure of the overload of information with which the person tries to deal at once. The fear felt by the person is a manifestation of a specific appraisal of the environment. According to Gray (1971), fear could be defined as the emotion felt due to the 'anticipation of pain'.

The stress, once established, will lead to the formation of irrelevant information within the already overloaded processing system thus creating selective attention (Wine, 1971; Sarason, 1972). The irrelevant information, created by the person, is caused by concern for his or her own performance in coping with the situation. Perceived feelings of arousal and fear, uncertainties regarding how to proceed with the problem, difficulties in interpreting what exactly is going on and self-estimation of the efficiency of already-applied actions all become additional information to process.

Self-concern information, such as, 'I'll never make it', 'I don't know what to do', 'I'm too scared to do anything', may compete for space in the processing system. These worries amount to irrelevant information because they are useless for decision-making and of no help in working towards solving the problem. Irrelevant information, originating from worrying, will compete for space in the processing system with task-relevant information (Eysenck, 1983b). It is estimated that anxiety prone persons use as much as 40% of the available working time on a problem, coping with such interferences (Deffenbacher, 1978). Processing irrelevant information will add a substantial emotional load to the existing quantity of stress. The fourth loop of the model relates to the person's processing of irrelevant information and is represented in Figure 1, by the very thick line around the processing system. This irrelevant information creates worry and more stress.

To overcome the difficulty and competition from

processing excessive ambiguous information and irrelevant information, the person can adopt compensatory strategies. These strategies consist of investing more effort and concentration on the task and trying to control worrying thoughts (Kahneman, 1973). These compensatory strategies could be successful in lowering the pressure in the processing system, reducing the stress and consequently, supporting efficient decision-making, however, these compensatory strategies cannot last long. Fatigue will eventually follow causing inefficiency that will increase stress.

The fifth and last loop of the model supposes an investment of more mental effort to master the problem, momentarily reducing the pressure on the processing system but resulting in fatigue and inefficiency manifested in a state of confusion. As Schönplflug (1983) suggests, 'Inefficiency increases stress, and stress increases inefficiency' (p. 304).

In Figure 1, the left side of the model presents the information to be processed. This information is either perceived, known or inferred by the person. It comes from external demands, such as the environment and the problem to solve, as well as internal demands consisting of factors such as the person's emotional state.

FIGURE 1. Stress model.

Central to the model is the processing system (PS). It is the site of interpretation of the information and it is used for problem-solving and decision-making. The processing system, with its limited capacity, undergoes a lot of pressure from external and internal demands. The pressure comes from ambiguous information, the short time to react, the perceived danger and the personal assessment of the efficiency to cope with the situation.

At the centre of the model, the stress felt by the person is represented. The stress grows from one loop to the other. Different coping strategies can be used by the person in attempting to cope with the situation and trying to reduce the stress. The strategies identified range from denial of the situation, search for more information, self-blame and concentration on the task. These emotion-focused and problem-focused forms of coping strategies are mentioned because they seem particularly appropriate for the fire situation, although a vast array of other strategies exists (Lazarus & Folkman, 1984).

The right side of the model indicates the emotional state of the person. There is a progression in emotional load from control, uncertainty to fear, then worry and confusion. It is important to note that none of these emotional states is judged dysfunctional; appropriate decisions leading to safety can be made under any of them. However, chances to respond efficiently to the threat, and on time, diminish with an increase of stress.

Stress is considered to increase like a 'spiral'; going to the first loop for a certain amount of time before going on to the second loop, and eventually on to the third, fourth, and fifth loops. The time spent on each loop could vary enormously depending on the event and the person facing the situation. Some people may reach safety without experiencing the fourth or fifth loops. Some others may feel fear on the third loop and suddenly process information that decreases their stress and brings them back on to the second loop.

During the event, information is processed and decisions are taken. The feeling of stress decreases if the person assesses that his or her decisions are leading to the problem solution. In fact, some authors suggest that stress is reduced each time a decision is made, regardless of the fact that the danger is still present (Janis & Mann, 1977). When the person believes the decisions taken are appropriate, uncertainty, fear, worry or confusion decrease, momentarily reducing stress. Consequently, the information processing system can focus on more task-relevant information to define and redefine the situation and identify appropriate action.

The last four loops of the stress model can occur at any stage of the problem-solving process. In defining the problem, devising a plan of action, carrying out some actions or reassessing the situation, the person may go through uncertainty, fear, worry and confusion. The stress and related emotional outcome will reduce the processing effectiveness and can impair response performance. The compensatory activities may, however, succeed thus allowing the person to process task-relevant information, resulting in appropriate decision-making and successful problem-solving.

Information as a Stress Reducer

The stress model presented is consistent with the literature rejecting the concept of panic. Sime (1980) has fully explained the arguments to consider the concept of 'panic' as a poor and ineffective explanation of human behaviour in fire. In fact, 'panic', in the form of irrational behaviour, is rare in a majority of fires (Wood, 1979; Keating, 1982; Bryan, 1988). In the stress model, panic would be the fifth loop of confusion pushed to its extreme; a state seldom reached. During emergencies, the anticipation of mass 'panic' has been a favoured argument to delay warning the public. Such delays have contributed to subsequent flight behaviour and the crush of people who had only a few seconds left to react once the situation unexpectedly got out of hand. Consequently, researchers are pleading for early warning for the public to get people to move in the very first minutes of the event thus giving enough time to reach safety. The stress model argues in that same direction.

Providing precise information to users as soon as possible at the beginning of the event would prompt evacuation behaviour. Information will reduce the time spent in denying the situation; a state typified by its lack of action. Causing people to start to evacuate is a major problem in public buildings. Further, because people have difficulties performing cognitive and behavioural tasks under high stress, it is essential to limit the stress progression during the event. Keeping the stress low could enhance the performance in coping with the situation.

Previous authors have recognized that information is needed to support decision-making by people facing a fire (Bryan, 1983; Canter 1985; Sime *et al.*, 1991). The highly ambiguous information relied upon to define a situation and to decide on a course of action renders these operations difficult. Thus, it can be argued that the requirement for reducing

stress in a person involved in a fire is to provide precise information. If the information is plain and precise, the person will be able to interpret the situation accurately. Consequently, Loops 3, 4 and 5 of the stress model could be avoided. The time spent looking for information and defining the situation could also be reduced, leaving more time to take action and reach safety.

The key questions for the management of safety in public buildings are how to provide this information and what information should be given. A majority of public buildings already have different means of providing information to users; staff members, public announcement systems, liquid crystal screens, TV screens, electronic information boards, interactive computers, alarms, etc. In retrofitting existing settings, members of staff and different communication devices could be used to provide the necessary information. For example, the public announcement system, which does exist in a majority of public buildings, could be used to inform the public about the situation and the general actions expected of them.

Research indicates that, for the message, three information characteristics have an impact on the interpretation of the situation and the decision-making process, viz, information quality, information quantity and information relevance. Information quality refers to the content of the information and supposes the user's capacity to perceive, decode and understand the information. Information quantity corresponds to the amount of information provided; either too little or too much information could create difficulties in interpretation. Information relevance relates to the usefulness of the information in defining the situation and solving the problem.

Two Case Studies and the Stress Model

Most studies on stress have been conducted in the laboratory, usually with psychology students. Generally, the subjects know the purpose of the experiment. They also know that ethical considerations limit the degree to which stress stimulus could be harmful to them. A real-life situation has a much greater potential for creating psychological stress than a laboratory experiment. The richness of a real situation is attractive to researchers but, at the same time, the complexity of real-life situations makes them very difficult to study.

Many stress researchers are suggesting that situations with greater ecological validity should be studied. In this respect, the examination of stress in

relation to fire and emergencies in the real world could contribute to the emergency research literature as well as the stress literature. Studying stress in the fire situation is limited by methodological problems in recording and measuring the phenomenon. The simulation of people in a real fire is eliminated because it is impossible to set fire to a building or a room and watch how occupants react—for obvious moral reasons. Consequently, only two other research contexts are left, studying emergency exercises in existing environments and studying victim accounts after a real fire. Both contexts, although imperfect, give insight into the stress experienced by people faced with an emergency.

Two studies of different research contexts are briefly described to illustrate the stress model. The first study is an experiment developed to test the efficiency of providing different types of evacuation warning information to users of an underground subway station. The second study is the description and analysis of the behaviour of passengers in the King's Cross fire. Both examples take place in complex underground stations. However, each example is different; the first was an exercise, while the second was a major tragedy. These studies were not developed to measure the stress of people in fire, however, both studies give interesting insights relative to the stress model because they report timing, behaviour and movement of people during real evacuations.

The first example is a research project commissioned by the Tyne and Wear Metro in Newcastle upon Tyne, England. This communication system is tested to see whether it would ensure a rapid and safe evacuation of the public from an underground station (for a more detailed summary of the field experiment and the actual data collected see Proulx, 1991; Proulx & Sime, 1991).

Five evacuations were organized in which the means and the content of information given to users in evacuating a station were varied. The results revealed that the first evacuation with an alarm bell only was characterized by the 'inaction' of passengers! In fact while the alarm was sounding, passengers pursued their normal activities: entering and leaving the station, reading or chatting while waiting for a train, boarding and getting off trains. For the second evacuation, an alarm bell sounded and two staff members directed the evacuation. This exercise was much more efficient. The passengers evacuated the station rapidly. The lack of a geographical overview, however, prevented staff from fully understanding the situation. For instance, many passengers were directed by staff to what

could have been the most dangerous area of the station, if a real fire had occurred. This evacuation showed that staff, as well as the public, require precise information about the situation in order to make appropriate decisions. The third evacuation, with an alarm bell and minimal public announcements stating repeatedly 'Please, evacuate the station immediately', was a good improvement in comparison with the first evacuation with only an alarm bell. Many passengers evacuated the station on hearing the simple directive, however, this information had no effect on people who had their familiar route to leave the station blocked.

The fourth evacuation with an alarm bell and precise directives given through the public announcement system, emphasized by the verbal commands of the two staff members, was an excellent evacuation. The combination of an alarm bell, staff and precise directives resulted in the rapid evacuation of all passengers. Finally, the fifth evacuation with an alarm bell and precise directives given through the public announcement system resulted in an evacuation comparable with the previous one although no staff members were present. The first sentence, 'There is a suspected fire on the North/South escalators' encouraged immediate movement. Passengers conformed to the instructions given and did what was expected of them.

These results suggest that passengers were probably involved in the first stress loop after hearing the alarm bell during the first evacuation. They denied the occurrence of an emergency and ignored the information. Interviews conducted after the evacuation indicate clearly that the majority of passengers identified the alarm bell as a false alarm or a system test which, in their view, required no specific reaction.

When the alarm bell was supplemented by a minimal message, it prompted evacuation behaviour in passengers who were near an exit. The minimal information, however, appears insufficient to motivate passengers to investigate other ways to get out or to get back on a train to leave the station. The two evacuations with staff members directing passengers were both efficient in urging evacuation movement. Users responded immediately to instructions given by a figure of authority. Messages given through the public announcement system had the same effect and were promptly obeyed. Nevertheless, a majority of passengers interviewed after Evacuations 1, 2, 3 and 4 said that they thought the evacuation was an exercise and not a real emergency. This could explain the lack of apparent stress as exhibited by the expressions and movement of users captured on

the videos. In Evacuation 5, however, a majority of interviewees reported that they believed it was a real emergency. Only the realistic live message stating that 'there is a suspected fire' could explain this difference in assessment of the situation. It is probable that some passengers felt stressed going through a few of the model stress loops during the fifth evacuation. These precise directives triggered sufficient alertness in passengers to initiate evacuation movement right away, while keeping them sufficiently calm to evacuate as directed.

The second example to illustrate the stress model is taken from the Fennell report on the Investigation into the King's Cross Fire (1988), and Donald & Canter's (1990a,b) analysis of human behaviour during the tragedy.

The King's Cross fire, like many other disasters, was an extremely complex event. It is not the purpose here to draw an exhaustive account of the fire or to present the multiple actions of the hundreds of participants. The investigation report and different papers present detailed information of the whole event. King's Cross is mentioned here only to illustrate a few interesting aspects related to the stress model.

The King's Cross fire took place on 18 November 1987, at approximately 1900 h. The fire was detected by passengers under a set of escalators located between train platforms and the ticket hall. Different staff members took a long time to investigate the fire. Policemen were rapidly on location and firefighters arrived some 15 min after the fire was noticed. Trains continued to circulate letting passengers get on and off in the station. Policemen directed passengers arriving by trains via another set of escalators to the ticket hall to leave the station. Flashover suddenly occurred with its resulting flames and black smoke. This tragedy took the lives of 31 people and many were injured (for a full account of the event see Fennell, 1988).

This fire is typical of the long delay people take before deciding to start evacuation. Although passengers perceived some smoke (sometimes thick black smoke) and received warnings from other passengers or underground staff, many continued their normal journey, not bothering with the information. This absence of response is a good illustration of the first loop of the stress model. Perceiving ambiguous information, people denied its meaning, minimizing the threat. In the same line they continued their usual journey in and out of trains, entering and leaving the station.

Although people perceived a variety of cues that could imply an emergency, they seemed unwilling

to interpret this information as a serious threat. Refusing to define the situation as dangerous is a defensive strategy, as explained previously, giving a feeling of personal control over the situation and keeping people's stress level low. As suggested by Donald and Canter (1990a), it is clear that a number of cues should be noticed and collected before any protective action is taken.

One of the difficulties in that fire was for the staff to convince passengers to change their usual journey and be directed in another direction. It seems that instructions given by underground staff members were ignored during the event. However, uniformed policemen and firefighters gave instructions that were followed by most passengers. It is noted that the low confidence passengers put towards underground staff, played a major role in disregarding their directives. In the previous study describing the Metro experiment, instructions from uniformed staff in the station and messages given by officials through the public announcement system were rapidly obeyed. These results would suggest that the individual giving directives is important. Occupants will essentially follow instructions given by figures of authority in which they have confidence of their capacity to deal with an emergency situation. Confidence in the person transmitting instructions becomes an important characteristic related to the information provided to occupants.

It is also interesting to consider the stress felt by underground staff members and policemen during the fire. It can be argued that underground staff may have experienced a few of the stress loops which could explain their actions in the first moments of the fire. Even though they rapidly interpreted the situation as a fire, staff members may have felt stressed with the associated emotions of uncertainty, fear or worry. These emotions were probably not related to the fire threat but rather to the possible outcomes of taking action not covered by their job description, company rules or hierarchy rank. Staff members are concerned by the eventuality of being pointed out as responsible for a bad decision. This would explain why staff, after interpreting the situation as a fire, took no action rather than asking their superiors to confirm the evidence of a fire.

Policemen, on the other hand, are expected to deal with emergencies. It is not surprising then, that they immediately took the responsibility of directing passengers. Many passengers were directed to evacuate the station via an alternative route leading to the ticket hall: a most dangerous location next to the fire. It is suggested that the policemen's lack of geographical knowledge of the station and

the stress, which limited their processing capacity, contributed to this choice of evacuation route. It is interesting to note that staff members in the second evacuation of the Metro experiment also directed passengers towards the most dangerous area if there had been a real fire. This tendency of processing a limited amount of information is also consistent with the stress model (Donald & Canter, 1990b) refer to the same phenomenon as a focusing or narrowing of attention).

The King's Cross fire developed rapidly and unexpectedly. Flames suddenly erupted in the ticket hall killing people on the spot. Some others, who were further away escaped as best as they could by running and crawling in a direction they expected would lead to safety. At this point, it could be suggested that people had reached the fifth loop of the stress model feeling highly confused. Taking flight appeared to be the most sensible decision at that time for that situation.

The analysis of people's behaviour during the King's Cross fire provides a good example of the way rational behaviours are favoured in an emergency. This case study and the previous one, show that precise information about the situation is needed without delay to accurately interpret the situation and start movement. Further, it is clear that some indications are needed by the public to know in what way they are expected to react.

The case studies seem to agree with most of the stress model. The first loop of avoidance-control is obvious in both cases and the last loop of confusion is illustrated in the real fire. Somewhere in between these loops of control and confusion, the limitation of the processing system appears. The intermediate loops of uncertainty, fear and worry, as descriptive of people's emotions, need more research, specifically looking at stress.

Conclusion

A stress model for people facing a fire was developed on the basis of the literature on information processing, decision-making, problem-solving and stress. The stress model presents five stress loops starting with the emotional state of control then uncertainty leading to fear, worry and confusion. It is argued that an adequate way to induce a reaction in a fire and reduce stress is to provide precise information. Precise information will help people to interpret the situation accurately, enhancing the performance of decision-making and problem-solving, consequently decreasing stress. Further research should be done

to verify the likely occurrence of each of the stress loops and the type of information that could best reduce stress during an emergency.

Research should explore different ways of providing information to the public depending on staffing, communication devices available, characteristics of users and the type of public building involved. To ensure an efficient evacuation, it is clear that precise information about the situation, its location and what is expected from users should be transmitted to the public by a source in which people put confidence. The way in which this information should be transmitted, the exact content of the information, and the most effective procedure to adopt coordinating the actions of all the players in an emergency evacuation, are eminently important questions that still need to be explored.

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