Research into the behavioural aspects of slips and trip accidents and incidents

Part 1: Literature review

Prepared by Rossmore MCA Limited for the Health and Safety Executive 2005
Research into the behavioural aspects of slips and trip accidents and incidents

Part 1: Literature review

Rossmore MCA Limited
Cornwall House
Blythe Gate
Blythe Valley Park
Solihull
West Midlands
B90 8AF

The purpose of this document is to outline in detail the focus, approach and initial findings of the literature review being undertaken by Rossmore Group on behalf of the Health and Safety Executive. The focus of this paper is to investigate and critique the literature available on slips, trips and falls and the behavioural aspects that contribute to these accidents occurring, both in the workplace and in public areas. The literature review will also highlight factors that have not been explored with explicit reference to slips, trips and falls but that may point towards areas for future research.

This report and the work it describes were funded by the Health and Safety Executive (HSE). Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive summary</td>
<td>4</td>
</tr>
<tr>
<td>Purpose</td>
<td>6</td>
</tr>
<tr>
<td>Approach - People, Process, Technology within the Environment (PPTE) and experience</td>
<td>6</td>
</tr>
<tr>
<td>Introduction</td>
<td>8</td>
</tr>
<tr>
<td>Slips, trips and falls: the mechanics</td>
<td>9</td>
</tr>
<tr>
<td>Slips, trips and falls: beyond the mechanics</td>
<td>10</td>
</tr>
<tr>
<td>Slips, trips and falls: decisions and behaviour</td>
<td>15</td>
</tr>
<tr>
<td>Conclusions</td>
<td>35</td>
</tr>
<tr>
<td>Recommendations</td>
<td>36</td>
</tr>
<tr>
<td>References</td>
<td>37</td>
</tr>
</tbody>
</table>
Executive summary

Introduction
Consultants from the Rossmore Group have been commissioned by the HSE to deliver an initial literature review and scoping study into the behavioural and human factor causation factors for slips, trips and falls within the UK.

This work was conducted by experienced human factors, operational management and occupational psychologist consultants and represents around ten man weeks work.

Methodology
An extensive literature search was conducted using Internet-based search engines and information repositories. Key words and phrases were established in order to derive the most likely applicable articles. All articles found were then reviewed in detail for applicability and a summary of each can be found in the detail of this report.

Scope
The literature search did not uncover any specific research into this field but it did identify many articles that may be relevant to the drivers and influencers of behaviour.

The decision-making model, developed by Rossmore as part of their STF reduction programme was adopted as a framework for research factors that may have influence over decision-making and therefore behaviour. The Rossmore model has good face and content validity.

The literature search was expanded to include articles that reference key words contained in the decision-making model and the potential relevance to STF causation was established.

Many of these articles were concerning subject matters other than STF causation (such as driver behaviour, risk perceptions in flood risk areas etc.) but the principles of the research may be applicable and relevant to STF causation.

The Rossmore decision making model
The decision-making model was initially developed to understand the influences on the behaviour of members of the public in the railway sector. However, the model would appear to be relevant when applied to other environments and for other stakeholder groups (e.g. employees).

It is important to note that the purpose of this research is to inform the operational management of managed environments such that interventions can be designed to improve safety performance. It should be noted that some of the elements referenced in the model may be considered as significant contributory factors to accident causation, but may not be within the sphere of influence of the management of the environment.

For example, members of the public who choose to wear high heeled shoes within a certain environment could be considered as 'impared'. Understanding this is important but influencing this for a safer outcome may not be feasible.
To this end pursuing research into choice of footwear could be considered as academic and would deliver little value in terms of influencing behaviour. However, the same factor could be influenced by management policies and procedures when applying the model for employees.

In summary this report contains a body of research that can be used to inform management in order to influence decision-making, and therefore behaviour, of users and as such interventions can be designed that can deliver a safer environment.

Conclusions from the study have been drawn and are included on page 35. Based on the conclusions, the following recommendations are made.

**Recommendations**

- To test the model with a longitudinal study in each of the HSE three STF-focus sectors. (Transport, Health & Construction)

  This would allow a reduction programme to be developed to give predictive validity. From previous work in the rail sector, it is estimated that STFs can be reduced by up to 60% after implementation of a comprehensive reduction programme based around the model. A longitudinal study would establish the validity of the model for other sectors.

- To develop a STF reduction programme methodology applicable to multiple sectors.

- To develop a more robust methodology to provide detailed and clear root cause analysis of STFs.

- To develop an improved process for recording near-miss incidents in order to provide a more detailed picture of the scale of the problem.

- To undertake research to provide evidence of which dimensions of risk perception have the most influence on the decision-making process and behaviours to provide insight into STF interventions.
Purpose

The purpose of this document is to outline in detail the focus, approach and initial findings of the literature review being undertaken by Rossmore Group on behalf of the Health and Safety Executive.

The focus of this paper is to investigate and critique the literature available on slips, trips and falls and the behavioural aspects that contribute to these accidents occurring, both in the workplace and in public areas. The literature review will also highlight factors that have not been explored with explicit reference to slips, trips and falls but that may point towards areas for future research.

Approach – People, Process, Technology within the Environment (PPTE) and experience

Rossmore has a long history of working on slips, trips and falls reduction programmes in organisations. A total or ‘holistic’ system approach is used that incorporates not just the physical environment but other factors such as behaviour of users. This approach is encapsulated in the following model (Figure 1):

![Figure 1](image)

The Rossmore Group model

Rossmore Group has undertaken a number of studies with Train Operating Companies to reduce their slips, trips and falls accidents. From this experience, a model has been developed that
encompasses many of the behavioural factors that can contribute to incidents of slips, trips and falls. Whilst this model has been validated by the front-line train and station operating staff we have engaged with during these projects, this literature review will validate these factors by drawing on previous research and findings.

Rossmore Group’s decision making and behaviour model

![Diagram of Rossmore Group’s decision making and behaviour model]

Figure 2
Introduction

Slips, trips and falls are a serious problem for individuals and a variety of organisations from manufacturing firms and construction companies to local councils and NHS Trusts. In 1997 the Department for Trade and Industry estimated that 1,900 deaths per annum due to slips, trips and falls occur in and around buildings in the UK, accounting for 57.7% of home accident deaths and 38% of deaths at work. This makes slips, trips and falls the leading cause of occupational accidents in the UK (Cayless, 2001; Bentley & Haslam, 2001).

The cost to individual life is clear, but there are other direct and indirect costs such as lost days, bad publicity, disruption to services and trauma suffered by those involved with incidents that are hard to quantify. With the growth of the litigation culture, the financial costs of slips, trips and falls accident claims at work and in public spaces are significantly increasing.

For these reasons, there has been an increased interest in slips, trips and falls and the factors that cause them. The Health and Safety Executive has been pro-active in encouraging companies and organisations to take action to reduce the likelihood of these accidents in the workplace, and has sponsored research into understanding the causes of STFs.

The research and practical advice in the arena of STFs, and the broader world of crowd dynamics and management, has focused mainly on the technical and physical aspects of STFs. For example John Fruin, in his chapter entitled ‘Designing for Pedestrians’ states,

“Station planners and operators must understand pedestrian traffic characteristics to provide a convenient and safe passenger environment. This understanding requires knowledge of pedestrian speeds, traffic flow relationships or corridors and stairs, escalators, platforms and fare processing rates.” (Fruin, undated)

Rossmore has worked extensively with companies facing high levels of reported STFs, helping them to diagnose the causes of high incident rates and working with organisations to tackle these problems. This work has provided a unique insight into STFs and it has been established that a multi-disciplinary approach is necessary to get a true understanding of the causal factors leading to STFs.

The approach is summarised in the model shown in Figure 1 - People, Process, Technology and Environment (Adapted from the HSE Publication – Reducing Error and Influencing behaviour -HSG 48 – 1999). This holistic approach is necessary both to establish the root causes of STFs and to provide practical, pragmatic yet innovative ways of reducing occurrences.

This literature review seeks to highlight the work that has been conducted into understanding STFs to date, and to explore further the evidence that the research provides. Research that has been conducted outside of the arena of STFs is then reviewed, using the framework that Rossmore Group has developed through experience.
Slips, trips and falls: the mechanics

It is accepted that to understand how to prevent an incident from occurring, it is important to understand the causal or contributory factors. Recent research into STFs has highlighted that the main problem preventing a full understanding of the incidences is the lack of a detailed framework which fully classifies type and causes of incidents (Davies, Kemp, Frostick, Stevens & Manning, 2003). Much of this debate revolves around the terms used for STFs – for example trip, slip, missed edge, turned ankle, unintended step. The researchers argued this makes it hard to establish a single definition, which has an impact on estimating the true size of the problem from accident statistics and hospital reports.

The more serious implication for the understanding of STFs is the lack of detail and root cause analysis. Whilst understanding the size of the problem is, of course, important, it is more important to understand the influencing factors. Research has focused on trying to determine the immediate causes of an accident and how to address them, possibly because they provide ‘easy’ solutions.

The following research extract highlights this attitude:

“Slipping is considered the most important primary event, precipitated by loss of traction between footwear and floor surface: here, STFs on the level comprised 36 slips and 31 trips, with 39 falls unspecified. Seven were known to have involved icy or wet surfaces. Uneven and badly maintained floors are known to be causal factors in STFs. The severity of injuries from STFs is also partly dependent on the fall impact on the floor” (extract from Cayless, 2001).

The apparent conclusion from this research is that changing footwear and flooring should then eliminate the accidents. In many cases though, this is either not possible or not enough. Research needs to move deeper into the causal factors and the psychology of behaviour to understand how to influence individuals’ actions.

Recent research work has been conducted by the HSL into slipperiness of different floor surfaces and the effect of contamination on these surfaces. This research has resulted in the provision of a one day seminar and a slips index tool aimed at designers, installers, operators and maintainers. This work has highlighted the true characteristics of surfaces and the associated maintenance issues. (Ref: Steve Thorpe, HSL, Stephen Taylor HSE). Whilst this is a significant element of STF causation, it is important to understand that this element accounts for only one part of causation.
Slips, trips and falls: beyond the mechanics

The study of the occurrence of STFs in the work environment has started to look beyond housekeeping issues and into the realms of organisational culture, management practices and employee involvement. Often, the focus of these studies has been on how to influence employees to behave in a safer manner.

An enlightening piece of research has been undertaken at the Royal Mail into the causes of accidents at work. The highest single cause of accidents was falls outdoors (Bentley & Haslam, 2001). The study identified a number of organisational and managerial factors which had a direct impact on the safe working practices of employees. Although these factors did include good safety equipment and footwear, others included workload factors, line managers' attitudes towards safety and incompatibility with quality standards.

This study indicates that although the working environment and safety equipment is an important variable when considering the causes of STFs, it is by no means the only one. People's behaviours at work are influenced by their own attitudes and other people's attitudes, such as line managers. Another key aspect of STF occurrences that this research highlighted was the influence of slip resistant flooring and footwear, workplace design and good housekeeping. These factors have little impact due to the degree of variability within the environment they are exposed to. They produced a model looking at the influences of individual, task-related, environmental, organisational and extra-organisational factors and how they had an impact on safety-related behaviours (see Figure 3 below). The study’s conclusion was that unless a correct organisational climate exists, STF accidents will not be prevented through improvements in environment and equipment alone.
Research into STFs incidents in different occupations also indicates a variety of factors play a role. For example, the inappropriate use of equipment accounted for a large proportion of male injuries at work, compared to female incidents which were more likely to be due to the organisation of tasks. In addition, females were more likely to suffer from STFs incidents in occupations with a high level of contact with other people, possibly due to unexpected interactions (Kemmert & Lundholm, 2001).

These findings suggest there is no 'one size fits all' solution. It is clear that people play an active part in whether they decide to act safely or not, which means environmental influences can only ever be part of the story and attitudes and behaviours must be taken into account. In fact, safety statistics argue that 85% of undesirable safety consequences can be attributed to unsafe behaviours alone (Quintana, 1999).
Work in the field of STFs in the workplace has proven that behaviours are an important part in STF prevention. Specific approaches aimed at changing individuals’ behaviours in the workplace have been developed and often focus on employee engagement and involvement as well as management attitudes. Safety experts agree that between 80 – 90% of all industrial accidents can be explained by ‘human factors’. The degree of importance of organisational and human factors in influencing safety has increased to such a level that it is now becoming regarded as the ‘third age of safety’ (Dejoy et al, 2004). This is particularly relevant when considering STFs due the inability to cure this problem through ergonomic and environmental changes alone.

Safety Culture has subsequently been defined by the Advisory Committee for Safety in Nuclear Installations post the Chernobyl disaster in 1986, as:

“...the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine commitment to, and the style and proficiency of, an organisation’s health and safety management”. (ACSNI, 1993)

Safety Culture forms the foundations for the development and maintenance of individual attitudes towards safety, and resultant safe behaviours. It is the sharing of good practice which organisations must strive to achieve to reduce the risk of accidents. Therefore the issues which constitute safety culture are often less readily visible or measurable (Dejoy et al, 2004).

Recent research has identified key factors which are believed to play a significant role in creating and sustaining a positive safety culture, (Flin et al, 2000).

Organisational management practices
Research has identified two main factors within management which affect safety climate (Flin et al, 2000, Smallman and John, 2001). Management commitment is believed to be a significant predictor of employees’ perceptions and subsequent attitudes towards safety within the workplace. If management commitment is low and there is visibly greater importance placed on productivity over safety then ultimately a weak safety climate will be created.

It is also important to understand the differences amongst each level of management, as each will have its own safety agenda, and will be perceived differently by the workforce. Some researchers have suggested that there is a clear distinction to be made between senior managers and floor managers/supervisors. Senior managers will often be removed to some extent from the shop floor; as a result they influence safety behaviour through indirect means, namely: policies and procedures.

Safety management system
The activities and attitudes of the management system transfer down the organisation to each layer of the workforce.

Successful management safety practices go beyond establishing written safety guidelines and endorsing policies. Often there is great disparity between what should be happening and what actually is. Management safety practices should exert influence through several key activities (Shafi-Sahrai, 1971: Cohen, 1975):

- Presence of upper managers who are personally involved in safety activities;
- Prioritisation of safety in meetings;
- Thorough investigation into accidents/incidents;
- Training for new employees; and
- Daily communication between supervisor and team.
Hoffman et al (1995) believe that there are three key areas that emerge from both case studies and research:

- Management commitment to safety;
- Communication about safety issues; and
- Involvement of employees.

Safety culture can be reflected in the strength of the safety management system.

**Risk perception**
Employees’ risk perception has been widely reported to affect their view of the current safety climate. Three main areas have been discussed within risk perception:

- Risk appraisal;
- Risk taking behaviour; and
- Attitudes towards risk.

**Risk appraisal**
Employees will generally assess the majority of potential risks fairly accurately; however this assessment is often not followed by the correct behaviour.

It is also important to note and allow for differences between work groups within the organisation in regard to risk perception. A clear example of this is the risk behaviour of subcontractors, which is often more likely to be higher in risk-taking than permanent employees. Also groups within an organisation differ dependent on the level of risk and tasks they are involved with.

Another example: employees that have been in the organisation and exposed to the same risks for long periods of time will tend to have a diminished perception of risk.

**Risk taking behaviour**
The issue of adherence to Personal Protective Equipment (PPE) is something of a double-edged sword. There are employees who place themselves at greater risk through non-adherence as they view PPE as a burden which impinges on productivity and comfort levels. Contrary to this some employees place themselves at greater risk as they believe that PPE provides a means of invincibility.

Management acceptance of rule breaking is a strong predictor of poor risk behaviour.

**Attitudes towards risk**
Research has shown that employees display a more positive attitude towards risk if they perceive their physical environment to be continuously improving (Rundmo, 1995). If the physical environment improves to reduce the probability of creating accidents then it is natural that the perception of risk will decrease.

**Work pressure**
Work pressure is comprised of work pace and work load, both of which exert a significant influence on employee behaviour. Employees may face a conflict of pressure between productivity and safety. Within high risk industries, such as petrochemical and nuclear, safety will have a central consideration over productivity, however in some manufacturing organisations employees believe that senior management would put productivity first. Senior management can still put a greater
emphasis on productivity to some extent as long as middle management/supervisors have a strong relationship with front line employees and emphasise the importance of safety.

If managers experience too great a workload then it is natural that the level of attention they can devote to safety will reduce. Overstretched managers will be unable to investigate incidents fully never mind seek continuous improvement.

If employees are experiencing high levels of work pressure then behaviour will visibly change in the form of ‘work arounds’. Employees who attempt to do jobs without the proper equipment may save time and increase work rate however they are at higher levels of risk and are ‘accidents waiting to happen’.

This is again directly relevant in relation to STFs, where work rate may directly have an impact on route choice and pace of movement.

Competence of employees

If employees are not fully developed and educated then they expose themselves to risks through innocence rather than ignorance. Organisations have a clear responsibility to select, train and develop employees to ensure that they behave in a manner which creates a positive safety climate and culture.

The majority of organisations with a positive safety climate have a clear record system in place which details every individual employee’s current training and development and is continually updated. The level of development then is used as a determining factor as to which employees will be given tasks they are capable of doing with minimal risk.

Senior managers in general would appear to receive a reduced volume of health and safety training compared to front line employees due to their reduced level of exposure. However research has reported that this disparity in level of training has a negative effect on the safety climate and employee behaviour (Fuller, 1999). A mixed message is sent through the organisation if all levels of management do not go through the same training as front line staff.

Overall the factors identified within the safety culture literature have direct relevance to reducing STFs. The research emphasises again that improved environments and technology alone will not produce a reduction in accidents: organisational factors and individual behavioural factors must be considered.

In respect to the public domain, little research exists relating to creating a “public” safety culture in terms of behaviour. Most of the research into safety culture has taken place in the workplace. However, the workplace is a very specific environment, and it is not possible to apply many of the recommendations generated to the wider problem of STFs amongst the general public – a problem that is particularly pervasive in the railway industry as well as hospitals, restaurants and shopping centres.

A large body of work has been generated looking into the factors that affect safe behaviours in organisations, the issues surrounding safety and the public have not been so well researched. Whilst the factors influencing individuals’ behaviours may be in some ways similar irrespective of context, the management of individuals in public spaces warrants separate attention as the same techniques and solutions cannot be applied.
For example, types of footwear can be made mandatory in factory environments, but it is unlikely that it would be deemed acceptable for train and station operators to refuse entry to members of the public if not wearing correct footwear.

Although the environment can and must be effectively designed and managed, it is far harder to change people’s behaviours or enforce regulations when there are no direct mechanisms through which to influence them. To help answer these questions, the research must go deeper into psychology to identify and understand factors that are applicable to managed public environments and to determine which of these can be influenced.

Slips, trips and falls: decisions and behaviour

The Liberty Mutual Research Center for Safety and Health remit takes into account need for an understanding of psychology, but limits this definition to ‘perception and response to slipping’ (ARUP, 2005). Psychology is defined as the study of man and mind – providing a far broader remit for the involvement of psychological input in the understanding of the causes of slips, trips and falls.

People often assume that slips, trips and falls are simply errors of execution, e.g. putting one’s foot down wrongly, rather than active failures, which suggest an element of bad planning or decision-making. This second categorisation of slips, trips and falls automatically incorporates a cognitive element – what decisions have been made, what information has that decision been based on and what attitudes, beliefs and motivations have affected the final behaviour displayed.

The decision-making model proposed (shown in Figure 2) is based on this assumption that slips, trips and falls are not just errors of execution but rely on some form of cognitive activity, which we will be referred to as decision-making and can be influenced by a variety of factors both internal to the individual (attitudes, motivations, personality variables) and external to the individual (environmental cues, rules).

This model has been face-validated through workshops with front-line staff in the station environment, as well as other key stakeholders. Independent research has also shown that these factors are important in determining the safe or unsafe choices of the public in managed environments.

Research in the station environment has supported this model. For example, a self-report survey in Auckland, New Zealand revealed the following factors influenced pedestrians’ decision-making and subsequent route choice in a station environment:

- Perception of safety of chosen route and compared to other routes;
- Environmental influences – e.g. weather;
- Behaviour of others;
- Time pressure and ultimate destination; and
- Opportunity e.g. gates left open (Lobb et al, 2001).

There are clear links between the factors highlighted by this individual piece of empirical research and the factor model developed through Rossmore Group’s own experience and work with Train Operating Companies. The remainder of this literature review aims to summarise the research into these factors that influence individuals’ behaviour in public environments, in an effort to provide a
hybrid model that can be used both for planners, operators and front line staff to understand what influences behaviour, and where they can make a difference.

An initial literature search looking for evidence of these factors in the slips, trips and falls literature returned few articles outside of the work environment, and so the search was widened to include research and data from a broader range of contexts where it was felt the findings may have some relevance for understanding individual's behaviour. For example, theories have been taken from Health Psychology, as it has been argued that safe outcomes can be considered on a par with health outcomes because both involve the individuals making decisions about future and possibly ambiguous outcomes that can have dramatic, personalised effects.

Decision-making

Marsden (undated) has postulated that behaviour is goal-directed and behaviours are therefore preceded by active, if semi-conscious, decision making. The Dynamics of Decision Making model incorporates the cognitive element underlined by defining a slip, trip or fall as a mistake, i.e. an error in planning. With reference to the Dynamics in Decision Making model, we have considered two theories in an attempt to understand how the elements of the model fit together and how decisions are made: Expected Utility Theory and Bounded Rationality.

The first theory is known as Expected Utility theory (Coombs, Dawes, & Tversky 1970, Dillon 1971; Luce & Raffa 1957 and Savage 1954). This theory states that humans will weigh-up all the options and choose the option that maximises the expected outcome for them. This assumes that all options are known and that cost/benefit trade offs are consciously made in order to maximise or optimise the outcome.

An alternative to the Expected Utility Theory is that of Bounded Rationality (Simon 1959). This takes into account the cognitive limitations of both cognitive knowledge and capacity and is therefore less suitable for quantitative analysis since it would be very difficult to ascertain quantitative values for these variables.

In practice it can be observed that the behaviour of two individuals can be very different when faced with similar situations. This would tend to prove that the Bounded Rationality theory would be more applicable to the model. However, anecdotal evidence collected from front line staff in the railway station environment would tend to suggest that there are some similarities identified in the behaviours of different groups. By the same token, behaviours displayed by regular commuters may be different to those displayed by infrequent or leisure travellers.

The ‘perception of risk’ element of the model is almost certainly subjected to Bounded Rationality in that people who have not suffered the consequences of a fall are limited in their experience and knowledge and are therefore more likely to make decisions that are less safe. It is also worth noting that the perceived consequences of a fall for a person who has not experienced a serious fall in the recent past is likely to be low or insignificant. To this end, not only perceptions of risk but also perceived consequences associated with risk are likely to influence behaviour.

The role of attitudes and behaviour

The model also assumes that the beliefs and attitudes that individuals hold towards various objects, events and outcomes will affect their decision making and ultimately influence the behaviours they exhibit. There are various models that exist which describe how individuals’ attitudes and ultimately behaviours are formed and sustained. It is outside the scope of the current review to describe these theories in great detail. Instead, two of the main models will be summarised to show that this is an
area which needs future consideration and how they can provide insight into the potential reduction of STFs.

The two theories are the theory of planned behaviours and the protection-motivation theory. One of the most popular theories for the prediction of an individual's behaviour is the theory of planned behaviour developed by Azjen (1980, cited in Azjen and Fishbein, 2000), shown below in Figure 4.

![Figure 4](image)

In summary Azjen and Fishbein (2000) believe that an individual's actions are guided by three factors:

1. **Behavioural beliefs**: beliefs about the likely consequences of the behaviour. Behavioural beliefs produce either a favourable or unfavourable attitude toward the behaviour.
2. **Normative beliefs**: beliefs about the normative expectation of others/peers. Normative beliefs result in an individual's perceived social peer pressure towards the behaviour.
3. **Control beliefs**: beliefs about the presence of factors may be advantageous or disadvantageous to the performance of the behaviour. Control beliefs exert the perceived ease or difficulty of performing the behaviour.

All of these factors influence the overall individual's intent to perform a behaviour - the more favourable the behavioural attitude, supportive normative pressure and feelings of control will increase the likelihood of a behaviour being performed. In relation to STFs, this framework can be used to understand the antecedents of both safe and unsafe behaviour within any given environment.

For example, an individual may run on a wet surface if they feel confident in themselves (behavioural attitude), this may be supported by seeing other people in the area moving at speed (subjective norm) and if they have the freedom of movement and ability to increase pace (behavioural control). Azjen and Fishbein (2000) suggest that this information is available (behavioural attitude, subjective norm and behavioural control) and automatically processed as behavioural actions are being considered.
This view has met with some resistance and been challenged when considering “mindless” behaviour and habit. However there is evidence to support that the process described by Azjen and Fishbein (2000) could and does occur at a subconscious level and has been discussed within literature examining priming (Bargh, Chen and Burrows, 1996, cited in Azjen and Fishbein, 2000).

The Health Belief model was originally developed as a framework to understand and predict an individual’s health behaviour. It has been widely applied across a variety of sample populations and behaviours ranging from smoking cessation to adherence to personal protective equipment. The model consists of two areas, a threat appraisal (of not performing the behaviour) and a coping appraisal (the ability to perform the behaviour and benefit).

This model was revisited by Rogers (1983) and led to the development of Protection motivation theory:

![Figure 5 (Tunner, Day and Crask, 1989)](image)

The elements of this model again can be used to begin to examine behaviour resulting in STF accidents from a more individual user perspective.

- Severity of threat - the potential injury from STFs is largely viewed as insignificant by most;
- Probability of occurrence - vulnerability, is usually again not viewed as significant as most view themselves as being in control of the environment they are in;
- Coping response self-efficacy - the perception that there is a benefit from not running for example on a station platform compared to reduced travelling time; and
- Self-efficacy - the level of confidence that an individual has in performing the behaviour.

These models provide a great insight into understanding how employees can build up inappropriate risk perceptions and attitudes which may lead to a level of learned irrelevance and despondency. If employees build up the perception that the environmental and occupational risks they are faced with daily are of low perceived susceptibility and severity and they have a great level of confidence in their coping appraisal then they will develop a complacent attitude towards “risky” behaviour. Therefore risky behaviour will continue to be carried out with little thought if it is supported and strengthened by the wrong attitudes.

In the case of STFs these models and an understanding of the components which mediate working attitudes and behaviours are a major consideration when trying to decrease the propensity of such accidents. This view again supports the Rossmore Group holistic behavioural model in that any perceived change to decrease the perceived risk in an environment will have to be done carefully in order to prevent an increase in employees’ desensitisation to risk.

Interestingly, both of these models are based on the assumption of rational decision making, like the Expected Utility Model, assuming that people weigh up different courses of action based on the all
the information available to them. These thought processes may be subconscious. However, work on the perception of risk posed from slips, trips and falls suggests that people may not have the correct information on which to base such rational decisions.

Perception of risk from slips, trips and falls
Research into slip resistance has been carried out in laboratories. In 1994 the HSE undertook work on floors in use in an attempt to validate slip resistance measuring instruments and to gain information on surface roughness of floors “in the real world” (HSL, 1994). Part of this research involved asking users about their perceptions of floor slipperiness.

The study showed that the slipperiness of the floor as perceived by the users is affected by:

- Type of shoe being worn;
- User’s age;
- Condition of shoes;
- Contamination on the floor;
- Speed of motion across the floor; and
- Level of lighting.

This would indicate that people’s perception of the risk of a slip increases with these variables. Why then do people run across wet floors or display other similarly ‘unsafe’ behaviours, when their perception of risk of a slip should be high? It is often assumed that accidents happen because there is something “wrong” with individuals’ perception of risk. “Misjudgement” of risk may cause inappropriate decisions as well as unsafe behaviour and “human error”. The findings of the HSE research in 1994 indicate there is nothing ‘wrong’ with people’s understanding of what can contribute to the likelihood of STF accidents.

Theories of accident causation are aimed at explaining why accidents take place. Perhaps even more interesting is to explain and understand why most of the time we so successfully manage to avoid accidents and health injuries. It may be that people at large perceive risk well enough to avoid accidents. Consequently, a strategy in accident prevention could be to build upon and expand the success criteria instead of finding out what went ‘wrong’ when an accident has taken place (Rundmo, 2000).

The theories of expected utility and planned behaviour assume that safe or unsafe behaviours are made using a similar, rational cognitive process that weighs up the pros and cons of a behaviour before it is executed. Risk perception in individuals has been argued to be more complicated and subjective than an objective cost-benefit analysis. Instead, it has been argued that subjective perceptions of risk form the basis for risk acceptance, regardless of the objective or quantified risk, and, as such, they are important for understanding feelings of safety, attitudes to safety, risk-taking behaviour and accident involvement amongst the workforce (Mearns and Flinn, 1995).

Analysis of self-report questionnaires in a traffic safety campaign in Norway indicated there are three dimensions of risk perception - the extent to which the respondent felt safe or unsafe, as well as worried and concerned, the probability assessments, and the third was how often the respondent was thinking about traffic related hazards (Rundmo & Iversen, 2004). A campaign to increase traffic accident awareness led to the greatest increase in probability assessments, then safety and the smallest effect was seen on worry and concern.

Therefore, it has been argued that when asking people to assess the probability of an accident or injury, only part of the risk perception is being asked for, the assessment which is mainly based on
cognition and rational judgements of risk perception rather than asking them about their worry and whether they feel safe or unsafe which measures their emotional component.

This is an important distinction as risk perception has been hypothesised to link to behaviours. Evidence showing which of the dimensions of risk perception has the most influence on decision making and behaviours would be vital in shaping effective interventions for slips, trips and falls.

Recent research has indicated that the emotional component of risk perception is the basic building block of risk perception and evidence from a Norwegian traffic campaign suggests the emotional reaction to risks most strongly predicts behaviour change (Rundmo & Iversen, 2004). The emotional dimension of risk perception may explain why people tend to concentrate on the consequences of the risk, rather than the probability of it occurring (Mearns & Flinn, 1995). More serious consequences, such as a severe injury resulting in hospital treatment, are likely to be more emotive than a financial penalty or similar, and thus perceived as a greater risk. In line with other risky activities, traffic accidents are linked to negative consequences, i.e. damages, injuries, sickness, losses and human suffering. Risky activities or hazard may therefore also be associated with insecurity, worry, and anxiety (Rundmo & Iversen, 2004).

Translated into public behaviour, this may suggest that the pedestrians believe unsafe behaviours, such as running, are acceptable and relatively safe. As long as they do not injure themselves, they only receive positive reinforcement for their behaviour, e.g. catching the train on time. Pedestrians who are more used to the environment, such as regular users, are more likely to become complacent over the dangers, as they believe themselves to be expert in manoeuvring around a particular environment safely. This kind of risk perception failure has been referred to as a 'conditioning trap', when a safe behaviour has been extinguished because the risk is perceived to be so low or a behaviour that is safe in one context is over generalised to another environment where it is not safe (Hutton, Sibley, Harper, Hunt, 2002).

The research into decision-making, attitudes, beliefs and behaviours is a complex field. The different theories and research summarised here offer interesting insights into the factors that may be at play and why individuals may display unsafe behaviours. Theories based on rational decision making can help us determine which attitudes, beliefs and values play an important role in decision making, but cannot explain how decisions are made. For this, we have to look in more detail at the link between attitudes and behaviours.

**Motivation**

Research into people’s behaviours has concluded that motivation plays an important role in determining whether or not people’s attitudes and beliefs regarding their health will actually turn into positive behaviour change (Kelly et al, 1991), so it is important to understand how people are motivated.

Vroom’s (1964) Expectancy Theory is a useful approach to understand how people are motivated and decide between different courses of action. Vroom's theory assumes that behaviour results from conscious choices among alternatives whose purpose it is to maximize pleasure and minimize pain. The key elements to this theory are referred to as Expectancy (E), Valence (V), and Instrumentality (I). Critical to the understanding of the theory is the understanding that each of these factors represents a belief, held by the individual.

Expectancy is the belief held by the individual that they are capable of performing the tasks needed. This is discussed in more detail later in the paper as a personality variable, self efficacy. The concept of Valency is the perceived value of the goal, or the ‘What's in it for me?’ question. A summary of the
research into the role of outcomes and their importance to the individuals is outlined below and, for the purposes of this research, has been termed ‘Consequences’.

The third factor in Vroom’s theory, instrumentality, is the individual’s belief does undertake a course of action, the effort expended is likely to achieve the desired goal.

**Effort**
The Auckland pedestrian study mentioned previously (Lobb et al, 2001) indicates that behaviour is goal directed and that individuals trade-off the effort they are willing to expend with the likelihood of successfully achieving their goal. The participants in this study clearly cited time as a motivating factor in their route choice through the station environment. The route across the tracks was clearly perceived as being faster and easier, with 89% of respondents to a self-report survey stating they walked across the tracks because it was more convenient.

Using expectancy theory to explain this behaviour, it would appear that these people believed the benefits of crossing the tracks and the effort of overcoming these deterrents outweighed the effort and negative consequences of taking other routes and the possible negative consequences.

In addition, when asked, 20% of the sample population rationalised their decision as safe at the time because there was no train in the station or due to arrive. The station was normally unmanned, meaning that people felt the rules could be broken without sanction. The immediate negative consequences were therefore dismissed, whereas the positive consequences and motivating driver of saving time were reinforced.

Pedestrians were willing to walk over the tracks if they perceived it was going to be quicker for them to reach their ultimate destination in the local environment (e.g. platform, shops etc.).

**Outcomes**
Expectancy theory also suggests that a behaviour will only be performed consistently if the individual views the consequences as desirable or valuable. Outcome expectations consist of the beliefs about whether or not a given behaviour will lead to given outcomes.

Evidence from the workplace suggests that all too often, despite initial enthusiasm, employees fall back into previous ways of working. A study by Quintana (1999) into employees’ likelihood to wear ear-defenders found that most employees were initially receptive to tools introduced to develop workplace safety, but may become sceptical if they are not perceived to be practical or worthwhile.

They suggested the following factors may influence the adoption of ear defenders over the long term:

1. Timeframe of outcome       Soon or distant
2. Predictability of outcome  Certain or uncertain
3. Significance of outcome    Important to individual or unimportant

The study found that individuals’ perceptions of timeframe, predictability and significance of the positive outcomes and negative punishments affected their likelihood of wearing the ear defenders, as shown in Figure 6. This example shows immediate and definite negative and positive consequences (discomfort and improved sensory information) of a behaviour balanced against one distant and uncertain consequence (impaired hearing in the future) of the same behaviour.
Impaired hearing in the future could be considered as the most serious consequence of the behaviour to the individual, but due to its distant and uncertain nature of this consequence, to the individual it may be outweighed by the immediate gains of the behaviour.

Research into driver behaviour has isolated intentional dangerous behaviours from unintentional behaviours, or errors (Hutton; Sibley; Harper; Hunt, 2002). These findings re-affirm the work of Quintana in establishing the individual’s perception of the consequences of their actions as a key motivating force. Illegal, dangerous but intended behaviours were found to be maintained because of the relative immediacy and positive nature of the consequences, e.g. arriving on time, which were deemed to be more valuable than the potential negative effects, e.g. a speeding ticket. The key motivating factor is to arrive on time and any negative outcomes of the behaviours required to do this, e.g. speeding, where perceived to be negligible because previous experience had not reinforced them (i.e. they had speeded before and had not been caught).

In the station environment in particular, unsafe behaviours often have clear, immediate and certain positive consequences, such as running to catch the correct train. The negative consequences of not catching the correct train are also often frequently reinforced and fairly certain to occur, e.g. arriving late, missing connections, cost of buying a new ticket, having to stand because of no seat reservation. These consequences are likely to be important for the individual as they relate to time, money and comfort and relate directly to the achievement of their overall goal – to get from A to B within certain constraints. These immediate and salient reinforcers may outweigh in the individual’s mind the possible negative consequences of unsafe behaviours such as running, which may result in falling over and hurting oneself or others.

Individuals may not perceive these negative consequences as important because they perceive the risk of actually injuring themselves to be minimal. It is also possible that individuals do not perceive the risk of falling over as certain as their own personal experiences of running in train stations have not resulted in STFs. The consequences of running can therefore be seen as uncertain in comparison to the certain consequences of missing a train.

This builds on Quintana’s concept of timeframe, predictability and significance of consequences being able to explain, if not predict, individual’s choice of behaviours. It may be that for a member of the public running for a particular purpose (e.g. to catch a train) may have clear beneficial immediate and definite effects, whereas any negative consequences of this behaviour may be perceived as less certain. The negative consequences of not behaving in this way may also be clear, immediate and definite. It may therefore be that choosing to run may be the most appealing decision for an individual. If they have had no experience of falling and injuring themselves in that environment, it may be that they do not even consider the negative, uncertain consequence, i.e. the possibility of falling over and hurting themselves. Therefore, running may not be believed to be a risky behaviour to the individual but the most sensible.
The research summarised in this section reveals how individuals choose behaviours based on their belief that it will enable them successfully to reach their goals. Key motivating factors, such as the cost and time they are willing to expend to reach their goal can influence their decisions and actions.

It is clear though that motivating factors are only one type of influencing variable. As the above research highlights, individuals’ beliefs regarding the possible negative outcomes of their behaviour choices also play an important role in determining why individuals choose to follow one course of action over another.

**Behaviour of others**

The research into safety in the workplace has shown one of the major influencing factors on the successful development of a safety culture is the employees’ perception of management attitudes to safety. For example, research in offshore industries has shown that the working environment and socio-organizational factors can affect risk perception and attitudes to safety, and ultimately risk-taking behaviour and accident involvement. (Mearns and Flinn, 1995) This shows a clear influence of ‘others’ on safe and unsafe behaviour adoption. However, it is difficult to extrapolate from this research whose behaviour may influence the decisions and actions of an individual in a public space.

The Auckland pedestrian study reported that the behaviour of companions was cited by 10% of respondents as influential over their route choice. The only other research outside of the work environment that directly investigated the role of companions or fellow travellers was found in the realms of Traffic Psychology and Driver Behaviour.

Various studies suggest that the presence of passengers positively affected a variety of driver behaviours, such as increased following distance (Evans & Wiesleweksi, 1982); increased safety belt use and correct stopping at lights (Black, 1978); as well as reduced speeding (Lawshe, 1940). However, the effects of passengers on driver behaviour in general are still unclear and the research undertaken so far is inconclusive.

Initial research on the effect of passengers providing proactive, constant feedback to individuals whilst driving has shown substantial effects in reducing driver errors and unsafe behaviour (Hutton et al, 2002). This indicates that drivers who do not detect environmental cues effectively can be influenced by relevant, timely and personalised feedback by a trained individual. However, the one behaviour that seemed to be unaffected was speeding. This is likely to be because drivers are usually aware of their speed and have made a conscious decision that the benefit of speeding outweighs the risks.

This suggests that, in driving behaviour at least, companions can assist by helping drivers recognise hazards that they might otherwise overlook. Passengers who are not driving are likely to be using less cognitive capacity than drivers, and so can act as an extra pair of eyes. It is unclear as to whether feedback from companions can affect safe or unsafe behaviour choices, as there were no recorded changes in other behaviours such as speeding.

This research reveals two important findings to consider in light of individual’s behaviour in public areas. Firstly, even practiced individuals (e.g. drivers) cognitive load can be high when driving and this can contribute to near misses and unperceived hazards. For the operator of a public area, this suggest that even regular users are likely to be distracted by wayfinding, signage and the purpose of their visit or journey, which could contribute to cognitive overload and the mis-perception of hazards in the environment. Secondly, feedback on ‘chosen’ dangerous behaviours, e.g. speeding, were not effective. This suggests that education on dangerous behaviours must be carefully designed and handled if it is to have any effect.
Environmental influences

The role of environmental influences, such as the perceived safety and/or comfort of a route or area, is likely to influence behaviours. For example, if it is raining an individual is more likely to remain inside for as long as possible rather than risk getting wet. Although the influence of these groups of factors appears to be predictable on the basis of common sense, research has indicated their role can be more complicated.

Research into perceived risk for pedestrians in traffic areas has reported that various factors make them feel more or less safe - pedestrians feel greater comfort when a pavement is present, when the pavement is wider and further from traffic, when on-street parking or a line of trees is present, and when there are lower vehicle speeds and volumes (Schneider, Ryznar & Khattak, 2004). Schneider et al (2004) reported in their research that there is sometimes a mis-match between areas that are perceived to be safe but actually are not, and areas that are not safe but are perceived to be safe.

This research suggests that there may be environmental cues that pedestrians look for to ascertain how safe their environment is. A planned, enclosed and managed environment, such as a railway station, shopping centre or hospital, may be subconsciously perceived to be 'safe' as any hazards should be quickly dealt with by the staff.

Anecdotal evidence from a Train Operation Company indicates that people’s behaviour on surfaces is often not appropriate. For example, the public are more likely to walk through a small puddle, even if signs warn that caution is needed, than an area of deep water or pigeon droppings. Research by the HSE has revealed that even a foot that remains damp after walking through a spillage is at increased risk of slipping. It appears though that accident risk is, again, not a salient motivating factor, but damage to clothing/footwear is considered more important. Again, it is possible to explain this by the 'consequence trap'. Stepping in pigeon droppings will have immediate, certain and unpleasant consequences which may appear far more salient to the individual than the fact that their still damp footwear is a potentially lethal hazard.

Further anecdotal evidence implied that the travelling public appear to prefer using an open-air footbridge to an underground subway. One of the cited factors for this preference is that people perceived the subway to be dimly lit, damp and dangerous, making the footbridge the safer option. However, the accident statistics revealed that the stairs and the footbridge accounted for the majority of incidents in the station environment, making it the most dangerous area of the station. Even after the subway had been refurbished with graffiti-proof walls and new lighting, passengers did not want to use it. It is believed that this was because of the low visibility of both the new improvements as there was no publicity campaign announcing the improvements, and the subway itself as the signage was not improved to encourage the usage of the newly refurbished subway. This example shows how multi-pronged strategies (physical improvements, public education and signage) must be used together if any intervention is to be successful in influencing people's behaviour.

This anecdotal evidence is supported by the limited research – it appears that previous experiences and attitudes towards particular environmental cues, whether on a micro or macro level, affect people’s decision making and behaviour, rather than a rational understanding of the realities of the situation and risks presenting themselves.

Rules of the environment

The research so far seems to suggest that individuals are incapable of correctly perceiving and responding to the risks posed in the environment or by their own behaviour. If this is the case, one seemingly simple method of preventing unsafe behaviours is to adapt the environment to make such behaviours impossible.
The suburban train station study in Auckland tried techniques to prevent access for pedestrians to cross over open railway lines, rather than using the pedestrian footbridge. The railway company provided warning signs and repeatedly repaired fences intended to prevent access to the tracks, but the signs were quickly defaced, fences were cut away and pedestrian access to the streets opposite the platforms resumed within 48 hours or less (Lobb et al, 2001). Eventually, the railway company resorted to smearing heavy grease on the bars either side of the newly made gaps in the fences, making it impossible to get through without getting dirty.

“These trespassers include children and adults, people apparently intoxicated elderly folk, women with pushchairs (which they have been seen to throw over the fence before squeezing themselves and their infants through the hole in the fence), people with walking sticks and people with bicycles. In addition, pedestrians were seen climbing on the fences and on the frame and railings of the ramp. This example shows the persistent display of unsafe behaviour despite deterrents and shows how, without education of why route choices have been restricted or limited, unsafe behaviours will persist.”

They also used an educational programme, providing information on the dangers of crossing the rails. This intervention is discussed in more detail below.

**Information**

**Signage and cognitive overload**

It is believed that much signage is ignored. This belief has been supported by research in the area of STFs, where the concept of ‘learned irrelevance’ has been used to explain why wet floor signs are frequently overlooked. Learned irrelevance occurs when individuals start to ignore information that they have been over-exposed to which has led them to conclude that the information is not directly relevant to them. An example of this is the yellow cones used in public spaces to demark a wet area. These are often left out when the wet area has dried or been cleared up, or to mark out other hazards such as uneven floor surfaces that may not be easily noticed. However, when the cones without a clear wet area are seen by an individual, the individual will ignore them until they no longer take any notice of them.

The National Floor Safety Institute (NFSI) undertook the Restaurant Slip-and-Fall Accident Prevention Programme (2003) and concluded that the yellow floor signs commonly employed are familiar in supermarkets, railway stations and cloakrooms, amongst others, but they are over-used and this tends to mean they are ignored. They also suggested that when these cones are left in position after the floor has dried this does not pose a risk, but when the surface is wet there is an obvious problem. The real conclusion of this research is that it is because the cones are left out when the floor is dry that they are over-used and ignored. This behaviour directly contributes to the risk of people ignoring them when there is a real hazard. For example, a study looking into wet floor cones in the United States revealed that 65% of the time that businesses put out a wet floor sign, the floor is not wet. Business owners admitted to encouraging such practices to cover themselves against litigation (NFSI, 2003).

Anecdotal evidence from the United States indicates that making signs ‘out of the ordinary’ helps catch individuals’ attention, simply because it is not what they are expecting e.g., “Wet floor – skate, don’t slip”, but there is no detailed research to back this up (Arup HF Literature Review).

Laboratory studies have shown that when people are directly told by another person that the floor is slippery and dangerous, they adapt their gait, even when specifically asked not to (Cham and Redfern, 2002). This finding suggests that the problem may be that people do not perceive the risks
properly, rather than deliberately ignoring them. This research is also supported by the findings that passenger feedback can help drivers recognise hazards more effectively, as reported earlier.

If the “real” risk is being “misperceived”, as these findings suggest, it should be corrected and if the cognitive demands placed on the individual stretch the individual’s limits in information processing capacity they should be removed to reduce accident rates.

This is the approach that has been taken in a number of recent traffic safety measures in Europe. In Holland and in the UK cases of all signage being removed from the roads in an attempt to reduce cognitive overload, and the reliance of both drivers and pedestrians on man-made cues to evaluate or enforce appropriate behaviours. The idea is that because there are no clear guidelines to follow (e.g. road markings, signs) the responsibility for decision-making and risk perception is placed back on the individual, forcing them to pay close attention to the immediate, dynamic environment around them. In Seend, a village in Wiltshire, the accident rate reduced by 5% after the road markings were removed (Akwagyiram, 2005).

Anecdotal evidence from station operator suggests that inattention or distraction is a primary cause, as passengers move through the station trying to concentrate on Customer Information Signs and wayfinding, rather than focusing on what is immediately in front of them. This evidence is supported by empirical work in Finland which has found that distractions are a key cause of incidents occurring between bicycles and cars. The primary reason for bicycle-car collisions has been cited as attention being drawn away from oncoming traffic/ bicycles (Rasanen and Summala, 1998).

This inability to see cues in the environment that may signal hazards or danger or recognise hazards themselves has been described as a contingency trap. The indications from the research on the effects of passenger feedback for drivers also offers some support for ‘contingency traps’ being a key cause of accidents, as it appears that individuals do not correctly identify hazards.

Using information to educate the public

Public education campaigns have been used as the main way to try to educate pedestrians and others about the risks and consequences of unsafe behaviour in order to deter them from undertaking risky acts.

One example of an on-going public education campaign is London Underground’s accident statistic posters. These posters, which are stylishly produced and prominently displayed, reveal the number of incidents and fatalities on the Underground at various locations and highlight various factors that can influence accidents that are under the public’s control, e.g. drinking alcohol. However, there has been no research into the effectiveness of such a campaign either on safe behaviour (i.e. numbers of accidents since the posters were introduced), on recall (i.e. the number of passengers who remember the posters) or on risk perception (i.e. changes in likelihood of being involved in accidents on the Underground).
Last year: 37 accidents at Canary Wharf Tube station.

Please be careful on the escalator after a few drinks.

MAYOR OF LONDON

Transport for London
Last year: 583 injuries, 5 fatalities.

Please take care getting on and off the Tube.
Few studies have scientifically evaluated the success of such campaigns, and also those that have not shown beneficial effects. Roberts (1994) reviewed reports of pedestrian skills training programmes that had been implemented in New Zealand and elsewhere and found that although knowledge of safe behaviour was sometimes increased; few if any had ever been shown to reduce injury rates. Signs warning of danger, too, have been shown to be ineffective in reducing unsafe behaviour of drivers when approaching an uncontrolled railway crossing (see Lobb et al, 2001).

In 1998 an Australian City Council and an Australian national railway company, together initiated a safety programme, including a public awareness campaign, education in local schools and increased access prevention, in an attempt to reduce illegal and unsafe crossing of the railway tracks by pedestrians at the station. The educational interventions were based on two rationales. Firstly, it was considered important to emphasise the danger involved in walking across the tracks in order to persuade people not to do so. This is consistent with many media campaigns aimed at reducing road injury which show graphic crash scenes to persuade drivers to avoid engaging in particular behaviours such as speeding or drinking and driving. Secondly, it was considered that highlighting the illegality of walking across the tracks might reduce its incidence. While drawing attention to the illegality of various behaviours has frequently been used in traffic safety campaigns (see Donovan et al, 1999) these campaigns have generally also emphasised the penalties to be incurred and the increased likelihood of enforcement, as well as being backed up by police activity. These interventions led to a significant decrease in the number of people crossing the tracks both immediately after, and a further slight reduction 3 months after the campaign had ended. However, as access had been restricted and a public education campaign had been introduced at the same time, it is impossible to tell which was the most effective intervention.

Another key area where unsafe behaviour choices lead to fatalities is on the roads. Pedestrian and driver error are believed to contribute equally to fatalities in residential areas, in particular pedestrians crossing the road on ‘red’, and drivers failing to stop for pedestrians (Harre´ & Wrapson, 2004). Harre´ and Wrapson report a variety of strategies that have been used to improve pedestrian safety at crossings, which focus on providing information to drivers and pedestrians. However, few of these programmes have been evaluated.

Harre´ and Wrapson (2004) undertook a seven week campaign to tackle unsafe behaviours occurring at pedestrian crossings at intersections. This included painting signs on pavements, road surfaces and hanging banners across the cross-roads. Intermittently, mime performers drew attention to how people were crossing the road (correctly, incorrectly) by blowing a whistle and pointing at them, making other pedestrians laugh at them. In addition, rewards were handed out to pedestrians (pens, sweets, etc.) as well as pamphlets with recent crash statistics. The evaluation of the campaign indicated a higher percentage of pedestrians crossing on green and a reduction crossing on red after the interventions had finished, but no significant impact on driver behaviour.

With an awareness of the issues of ‘learned irrelevance’ and cognitive overload, the researchers specifically designed their interventions to stand out clearly against the tall buildings, shop displays, neon lights, people and traffic. The campaign attempted to saturate the target sites with messages that were visually consistent and highly salient. At each intersection the traffic lights poles were painted fluorescent green. This colour also formed the background for pole banners and cross-street banners that were located at the intersections, which featured a stylised person and a speech bubble with messages such as: “Take extreme care at the next pedestrian crossing”. Interestingly, the markings on the pavement had the highest level of recall after the campaign.

Individual differences
An educational campaign in Norway involving showing high school attendees videos featuring role models believed to appeal to adolescents was designed to target young people to adopt safe driving behaviours. In addition, free t-shirts and other reminders were handed out after the initial video
screenings. The campaign was reported to be the least effective by the group who were involved in the most accidents, and most appealing to those in the safest driving group (Ulleberg, 2002).

This research shows the importance of understanding the groups to be influenced in educational campaigns. Recognising and understanding the differences between individuals, such as personality factors, that may mean they are 'high risk' or that can affect their attitudes and behaviours is important in determining which influencing factors are likely to be the most effective for key target audiences.

For example, it appears that there are particular groups of individuals who are most at risk, but these do not coincide with the groups of people most likely to underestimate risks. For example, elderly women are the most likely to have slips, trips and falls accidents, but young men have been found to have the poorest estimation of risks in road traffic research. Studies indicate that young men are less likely to perceive hazards, react to them more slowly and underestimate the difficulty of the manoeuvres they are undertaking to avoid hazards (Rundmo & Iverson, 2004).

The individual differences that have been determined from the literature search as affecting people’s perception of risk, attitudes and behaviours are, (not in order of importance):

1. Age and gender  
2. Desire for control  
3. Self efficacy  
4. Role  
5. Risk taking  
6. Values  
7. Familiarity

The key findings for each variable are summarised.

1. Age and gender  
It is commonly contended that slips, trips and falls occur more commonly amongst the elderly. This has been explained by a lengthening of reaction time with increasing age, resulting in a longer recovery time from a heel slip, and also a loss of muscle strength. The first of these means that the slip is more likely to result in a fall, which in turn may have more serious consequences for the elderly as their bones become more brittle, while the second also means that recovery from the initial slip is harder, also tending to initiate a fall (Arup, 2005). However, recent research undertaken in a clinical setting, interviewing admitted hospital patients, challenges this explanation. They concluded that older people are more likely to suffer fractures from slips and trips, but this tendency was especially strong in females. They also concluded that women were more likely to have underfoot accidents, and that this could not be explained by factors such as osteoporosis (Davies et al, 2003).

This research also indicates that there are other factors at work over and above biomechanics as these factors alone could not explain the high prevalence of incidences amongst the elderly female population. The findings of the study must be interpreted with caution though, as the sample was made up only of those admitted to hospital, and does not consider the occurrence of slips and trips that do not result in hospital admissions.

2. Desire for control  
It has been hypothesised that ‘desire for control’ is a personality variable that individuals will differ in. Studies looking at individual behaviour have shown that those with a greater need for control will also be more risk-taking. For example, research undertaken in a car simulator situation supported the hypothesis that drivers high in desire for control, measured by a self-report questionnaire designed to measure ‘desire for control’, intend to drive faster and indicate that they will pull out into smaller gaps than drivers low in desire for control. Gambling studies have found that those with a higher desire for
control also have a higher perception of their own level of control and so can tolerate higher risk decisions (Hammond & Horswill, 2002).

These findings indicate that those with a high desire for control believe that they actually have a higher level of control, which reduces their perception of potential risk and the possible negative consequences. It would be interesting to discover if those with a high desire for control are more or less likely to be involved in accidents or incidents.

3. Self efficacy

Self efficacy has been defined as one’s beliefs about how capable one is of performing a specific behaviour in particular situations. The concept of self efficacy is believed to be multi-dimensional, including how difficult a task one believes they can perform, how certain one is of one’s ability to perform a specific task and the extent to which efficacy expectations generalise to other situations (Rundmo & Hale 2003).

Self efficacy has been cited earlier, in Vroom’s (1964) Motivation Theory and under the Health Belief Model. It has been conceived as a personality variable, where individuals are presumed to show consistency across a number of situations and contexts. For example, several studies have shown that low self efficacy is negatively associated with problem-solving behaviour. People with low self efficacy avoid seeking help because they believe it implies their incompetence and dependence (Lee, 1997). Low self efficacy has also been found to be positively correlated with dissatisfaction (Begin et al, 1997), mistrust and decreased knowledge (Ross & Reynolds, 1996), anxiety (Fiske et al, 1996), lack of job control coping (Armstrong-Stassen, 1994), and risk behaviour (van Wesenbeeck et al, 1994).

The research on self efficacy suggests it is an important determinant in decision-making, but that it may best be considered as an attitudinal variable in this research context, rather than a global personality variable, as many factors can affect a person’s level of self efficacy towards undertaking a specific task (Bandura, 1997). Using this understanding of self efficacy would also enable research into understanding how self efficacy can be affected.

4. Role

Research has shown that when a person is driving with passengers rather than solo, their driving behaviour has a tendency towards becoming safer, showing a protective element (Vollrath, Meilinger & Kruger, 2002). This tendency is not seen in younger people or in certain situations such as slow traffic, where the likelihood of a having a serious, high-speed accident that could injure the passengers is perceived as lower. Extrapolating this finding to pedestrians, it is possible to imagine that pedestrians with companions who need protecting, such as young children or the elderly, will act in a more safe manner than those travelling alone or with companions who do not need protecting.

5. Risk taking

Research into personality variables related to risk taking and driving behaviour in young adults has found that adolescents scoring highly on ‘thrill and adventure seeking’ and ‘dis-inhibition’ are more likely to be involved in driving violations, e.g. jumping red lights, but were not involved in more actual driving accidents. The researchers discussed the different nature of the risks involved in these behaviours and concluded that the main risk involved in violating traffic regulations is being caught, whereas the danger in a car accident is of physical risk, which may be more of a deterrent (Trimpop & Kirckaldy, 1997).

However, risk taking tendencies are found most commonly in young men, who are particularly well-known for their high involvement in driving accidents (Ulleberg, 2002), which suggests that people who like to take risks may be more likely to be the same people who find themselves in accidents. The link may not be risk-taking personality though. Research on risk perception has shown that young male drivers, the group with the highest levels of dangerous driving also tend to have less
awareness than women and older men of the dangers involved in particular traffic (Lobb et al, 2001). However, the extent to which this reduced perception of risk is a causal factor in their risky behaviour is not clear. It has been argued, for example, that failing to acknowledge the danger in particular road behaviours is a rationalisation motivated by the desire to take risks (Gardner, 1993).

Young men do not appear to be a major contributor to slips and trips. As noted earlier, the predominant category of people in slips and trips accidents are elderly women. This may be due to the reporting regimes that register slips and trips accidents, often in public environments they focus on accidents that require medical treatment. Accidents that do not require medical treatment are rarely reported, either by staff who have observed them because they are not required to do so, or by pedestrians who may be embarrassed, unwilling to cause a fuss or do not wish to take the time to find a member of staff to report the incident if they believe there have been no serious consequences.

This research offers some support for the idea that accidents may be due to poor hazard recognition and awareness, rather than poor decision-making and risk perception abilities.

6. Values
Gjesme (1975) demonstrated that individuals who were strongly oriented toward the future (i.e. had high future time orientation) were more affected by a future goal at a given distance in time (e.g. one year away) than were individuals low in future time orientation. Gjesme explained this finding in this way: individuals high in future time orientation perceived the future distances in time as nearer than did individuals low in future time orientation. It could be argued that for individuals who have high future time orientation, the consequences of their behaviour are clear, real and close - or simply, that they value the future more than those low in future time orientation.

Thus, it can be postulated that the consequences or, goals of high future time orientation persons are to them more real or more valuable than for people with low future time orientation; therefore, they are less inclined to take risks. In other words, the level of risk to health and safety they tolerate (e.g. Wilde, 1982) is less than for those with low future time orientation (Bjorgvinsson & Wilde, 1996).

This individual difference has been called ‘consideration of future consequences’ and an initial scale has been developed that was successfully used to predict health behaviour differences (Strathman et al, 1994). The basic premise behind this idea is that people will be more careful with their life and limb to the extent that they feel that the future holds positive experiences for them. Safety campaigns and techniques should therefore try and enhance positive images of the future e.g. getting home safely (Bjorgvinsson & Wilde, 1996).

This research offers support for the concept of outcome expectations and consequences. If individuals decide a particular goal is the most valuable, they will act accordingly. The research into values suggest that individuals differ on the extent to which they place value on the distant future compared to the immediate or short-term future, which may affect the behaviour they decide to exhibit to reach their immediate goal.

7. Familiarity
Individuals will clearly differ on their familiarity with the local environment within which they behave, ranging from the daily frequent or to the one-off visitor. Their familiarity with the local environment will affect their skill in negotiating the area, and the amount of cognitive effort they have to use for activities such as wayfinding.

For example, novice drivers are typically more mentally and attentionally involved in vehicle handling, and have less mental capacity to spare for anticipatory driving and to cope with distractions inside and outside of the vehicle, such as talking passengers or playing children on the pavement (Trimpop & Kirkcaldy, 1997). In the pedestrian environment, new users may have to use more mental capacity on orientation, and therefore be less likely to notice hazards underfoot.
Anecdotal evidence implies this possibility may be true, as station staff at a major UK interchange station spontaneously reported that pedestrians ‘not looking where they were going’ but checking platform times, changes and signage where a major contributor to slips and trips in station environments. Unless a pedestrian is a frequent user of a route or public environment, they will need to direct some of their attention to way-finding, as although all station/shopping centres/hospital environments are made up of specific components (e.g. ticket office, toilets, customer information screens, platforms) the layout and methods of getting to each component can vary widely (e.g. lifts, subways, footbridges, travelators, escalators etc.). Figures 7 and 8 below show the layouts for two major UK rail interchange environments. Most infrequent users find that way finding in both of these environments difficult, probably due to the quantity of information displayed and complexity of layout.

Figure 7 - Birmingham
Figure 8 – Edinburgh Waverley
Conclusions

Having reviewed the summaries of all literature found the following conclusions have been drawn.

- There is a very limited amount of existing literature which examines the behavioural aspects of STFs. The studies which do attempt to understand the impact of individuals’ behaviour on the occurrence of STFs are limited as they still are predominantly focused around physical and environmental issues.

- STF literature still supports the view that behaviour is a symptom of the environment and one which cannot be controlled easily. There is large support, however, from other areas of psychological research to contradict this view by demonstrating that behaviour is a key causal factor of STF occurrence and can be measured and controlled to some extent.

- There is a need to understand the physical factors in managed public areas which can be influenced e.g. stair handrails to slow descent. However there are some physical factors which may not be influence-able e.g. footwear of pedestrians. This is why there is a need to understand which behavioural factors can influence both staff and public behaviour.

- The literature provides support that there is no “one size fits all” solution to STF problems. However, it is likely that a methodology could be developed which would effectively reduce STF incidence in different sectors.

- There is evidence to support a tangible link between existing psychological literature and the understanding of STFs, however no explicit studies applying these to STFs were found.

- Increasing awareness and improving safety culture in the organisations that manage environments (e.g. railway station operators) may have a direct impact on STF occurrences particularly when trying to decrease employee accidents.

- Employees can directly influence the perception of risk and subsequent behaviour in members of the public.

- The suggested Rossmore Group model holds strong face validity when supported by relevant psychological research to describe several behavioural factors which can have an impact on STFs behaviour.

- Goal-directed behaviour and the motivating factors which encourage individuals to engage in risky behaviour can have a direct bearing on the occurrence of STFs. Therefore, an understanding of individual goals is critical to identifying risk-taking behaviour.

- Decision-making frameworks can help to explain which attitudes, beliefs and values play a role in decision-making, but they cannot explain how decisions are made. There is a need to understand the link between attitudes and behaviour to begin to understand behavioural causation aspects of STFs.

- STFs are attributable to the execution of movement (active failures) but the cognitive decision-making process at an individual level can also be considered as a pre-cursor (or
latent failure). These pre-cursors can be influenced by several factors, both internal and external to the individual. Therefore, the identification of pre-cursors is probably of greater value when trying to reduce STFs.

- STFs must be studied/changed in the context of the ‘holistic system’ comprising People, Process, and Technology within the specific environment.

- If educational campaigns are to be used to influence STF behaviour, then there is a clear need to tailor the message to suit both the environment and the target audience. Also, attempts to study the effectiveness of such campaigns.

- There is clear scope for research into the application of Health Psychology models in predicting STF attitudes and behaviours. This would provide greater understanding of the antecedents of safe and unsafe behaviour.

**Recommendations**

This review has identified many articles that may have relevance to STF accident causation. However, further work will be required in order to realise the potential benefits identified. The following recommendations have been generated in order to progress this area of research and to move towards developing practical and pragmatic solutions to reduce occurrences of STFs.

- To test the model with a longitudinal study in each of the HSE three STF-focus sectors. (Transport, Health & Construction)

  This would allow a reduction programme to be developed to give predictive validity. From previous work in the rail sector, it is estimated that STFs can be reduced by up to 60% after implementation of a comprehensive reduction programme based around the model. A longitudinal study would establish the validity of the model for other sectors.

- To develop a STF reduction programme methodology applicable to multiple sectors.

- To develop a more robust methodology to provide detailed and clear root cause analysis of STFs.

- To develop an improved process for recording near-miss incidents in order to provide a more detailed picture of the scale of the problem.

- To undertake research to provide evidence of which dimensions of risk perception have the most influence on the decision-making process and behaviours to provide insight into STF interventions.
References


Cham, R., & Redfern, M.S. (2002). Change in gait when anticipating slippery floors. Gait and Posture, 15, 159 - 171


HSE Reducing Error and Influencing Behaviour – HSG49 1999


Marsden, A. (undated). Modelling the behaviour of passengers using railway systems – is it really possible? White Paper, Rossmore Group


Shafai-Sahrai, Y., (1971) An inquiry into factors that might explain differences in occupational accident experience of similar size firms in the same industry. Division of research, Graduate School of Business Administration, Michigan State University, cited in Cohen (1977).


Simon, H A 1959 ‘Theories of decision making in economics and behavioural science’ American Economic Review.


MAIL ORDER
HSE priced and free publications are available from:
HSE Books
PO Box 1999
Sudbury
Suffolk CO10 2WA
Tel: 01787 881165
Fax: 01787 313995
Website: www.hsebooks.co.uk

RETAIL
HSE priced publications are available from booksellers

HEALTH AND SAFETY INFORMATION
HSE Infoline
Tel: 0845 345 0055
Fax: 0845 408 9566
Textphone: 0845 408 9577
e-mail: hse.infoline@natbrit.com
or write to:
HSE Information Services
Caerphilly Business Park
Caerphilly CF83 3GG

HSE website: www.hse.gov.uk

RR 396