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ASSESSMENT OF RISK BY EMPLOYEES IN HAZARDOUS WORKPLACES

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ABSTRACT

Employees in hazardous industries are constantly faced with judging amounts of risk and behaving in accordance with these judged amounts. Much of the current knowledge about risk taking behaviour is based on gambling studies and the psychometric tradition. However, these methodologies may be of limited usefulness to issues relating to occupational health and safety. In this study, repertory grids have been used to elicit the constructs used by workers to describe risky situations. The results show that the dimensions that influence workers perceptions of risk differ according to the nature of the workplace. These constructs were then used to form the dimensions for a Judgement Analysis which models the combination and weighting of factors which influence the assessment of amount of risk by the employees. Results indicate that there is a large degree of variation in the amount of emphasis placed on the different constructs used to make judgements of the amount of risk in hazardous work situations by different employees. Implications for Safety Programs are discussed.

Employees in many industrial contexts are constantly faced with hazardous situations. Safety programs are implemented to reduce risks for workers by removing hazards where possible and where it is not, by encouraging workers to use safe practices. As a safety program can only be as effective as the individuals who use it, accident prevention programs must attempt to identify the reasons that employees use unsafe behaviour (Peters, 1991).

The individual's perception of risk is the critical antecedent to risk taking behaviour (Glendon & McKenna, 1995). The individual must first identify and evaluate risks before making the decision to accept those risks or to attempt to minimise them. This study explores the factors which influence individual perceptions of risk by modelling what cues are used and how they are weighted and combined to judge amount of risk.

DEFINING RISK

One of the most basic definitions of risk, as borrowed from the mathematical literature, says that it is comprised of: the *probability* of a potential loss (chances or likelihood), and some *magnitude* of that potential loss (severity or significance) (Vlek & Stallen, 1980). *Overall risk* is traditionally considered to be the product of these two elements,

$$\textbf{Overall risk} = \textbf{Probability}_{(loss)} * \textbf{Significance}_{(loss)}$$

Safety programs encourage workers to reduce both of these aspects of risk through the use of procedures which reduce workers' exposure to 'hazards', and increase the 'strengths' of any potentially risky situations.

Hazards are those elements which increase the level of the probability and/or severity of a potential loss outcome (i.e. overall risk) (Brearley, 1982). Hazards may be counteracted by *strengths* or manageability, which reduce the level of overall risk. An examination of the risk associated with particular hazards must incorporate these elements of risk: severity, likelihood, and manageability.

The existence of a formula made risk amenable to examination by mathematicians (Bem, 1980). Mathematicians began studying gambling behaviours long before psychology became interested in risk taking behaviours. Later, behavioural scientists began to borrow some of these concepts to apply to decisions made under risk and uncertainty. However, many early studies retained the methodologies used by mathematicians, such as the use of gambling studies.

PAST RESEARCH

The risk formula allowed a precise calculation to be used to discover the exact monetary value of any given gamble by multiplying the probability by the potential gain or loss (i.e the magnitude). However, magnitudes in gambling studies are limited in dimensionality (i.e. money) when compared to everyday risk taking situations in which workers gamble with injury and death. Findings from gambling studies have consistently shown that humans do not appear to guide their decisions upon this objective formula. Although, humans do not follow this prescriptive guide, it does not make them irrational in any but the purely mathematical sense.

The psychometric approach to risk taken by Fischhoff, Lichtenstein, Slovic and colleagues (Slovic, Fischhoff, & Lichtenstein, 1982; Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978) attempted to search for characteristics of risk which could account for the unexplained variance in risk perception by laypeople. The characteristics of risk that these researchers proposed as influencing the judgements of laypeople included;

Table 1. The dimensions proposed by researchers in the psychometric tradition as influencing the risk judgements of laypeople

• controllability	• dread
• new technology	• fatal consequences
• risk to future generations	• equitability
• risks increasing	• risks easily reduced
• who is affected	• voluntariness
• known to those exposed	• observability
• potential for catastrophe	• risks unknown to science
• potential for global catastrophe	• effected delayed or immediate.

These characteristics have been tested with very general types of hazards but have rarely been tested within a single domain. One such test of these characteristics within the domain of car accidents by Slovic, McGregor, & Kraus (1987) seemed to give credence to the notion that they represent a universal way of perceiving risk. However, it is not known whether these dimensions are suitable for industrial contexts. The characteristics of risk examined in the psychometric tradition do not seem to distinguish between the types of hazards encountered in hazardous worksites. It would seem unlikely that these dimensions would be incorporated into judgements of risk made by workers. Consequently, these dimensions do not appear to be of any use to increasing our understanding of behaviour in risky situations relevant to Workplace Health and Safety.

Psychometric studies of risk typically examined risky situations that were unusual or largely unencountered by typical subject populations. This may have resulted in potential methodological problems as perception and estimations may have been guessed at (Glendon, 1987). Participants were unlikely to have had the experience to be able to attempt to estimate likelihoods or understand the consequences of unfamiliar

hazards. A study of reactions to risk by individuals with a high familiarity with the task situation is far more suitable to the study of risk taking behaviour, but has rarely been attempted.

To overcome some of the problems with past studies of risk, research should: 1) not treat risk in a prescriptive manner (i.e. uphold the mathematical formula as the optimal model for calculating risk), 2) not be limited in dimensionality (i.e. comparing loss of money to loss of life), and 3) use risks in a context familiar to the participants. A methodology known as Social Judgement Theory enables the fulfilment of these criteria, and thus provide a useful way in which to examine risk perception in a way which is practical to the needs of Workplace Health and Safety.

SOCIAL JUDGEMENT THEORY

Social Judgement Theory (SJT) is not a theory as such, as it does not provide a testable hypothesis about judgement. Rather, SJT is a set of methodologies which provides insight into human judgement processes, particularly the weighting of information (Brehmer & Joyce, 1988). Therefore, SJT provides a means of exploring the psychological processes involved in the perception of risk. SJT is based upon the lens model which was developed by Brunswik (1956) which defines a task system as being representative of the relations between the cues and the distal variable (i.e. environment) of interest to the individual (See Figure 1).

Brunswik (1956) theorised that the relationship between the distal cues (i.e. the environment) and the proximal cues (i.e. perception of the environment), would never be perfectly reliable. The lens model attempts to capture the entangled and redundant nature of the distal cues which the must be recombined when making judgements (Cooksey, 1996). For instance, a worker faced with a risky situation may attempt to judge the amount of overall risk from a number of cues, some of which may be highly intercorrelated.

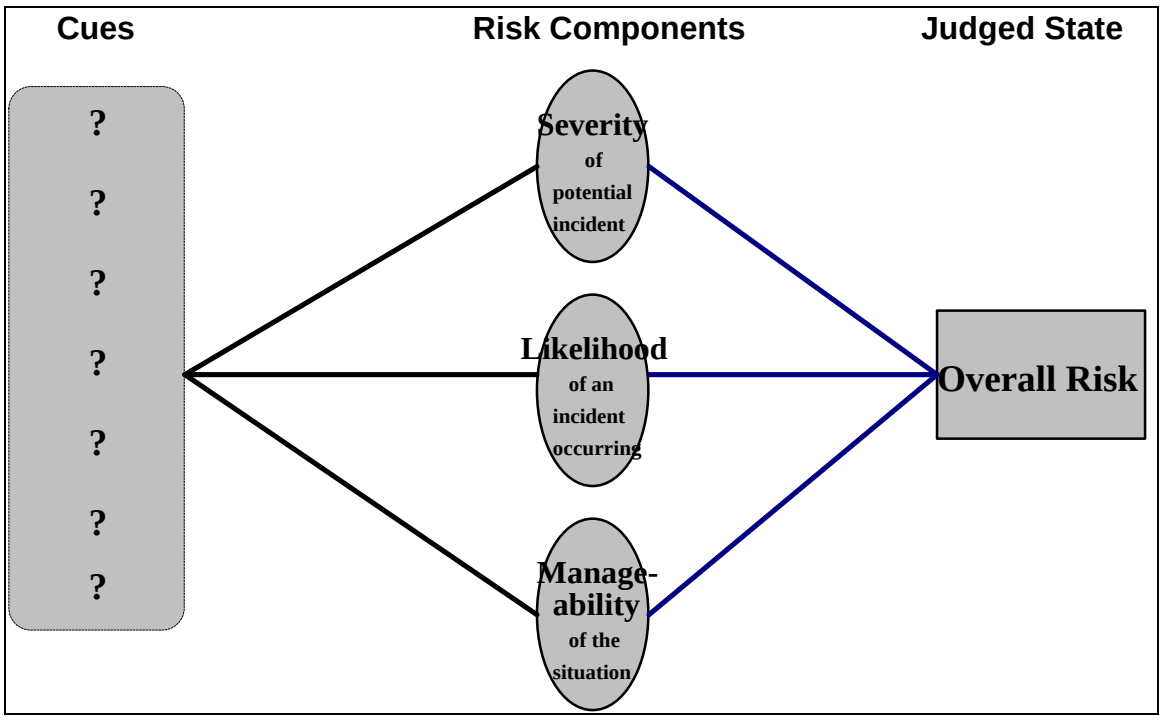


Figure 1. The cues from the environment (i.e. actual state) are combined to form the judgement of overall risk via judgements about risk components.

In this study, SJT will be used to model the way in which cues are used and combined by the individual to arrive at a judgement of overall risk (See Figure 1). SJT describes the quantitative relationship between the cues and the judgement rather than qualitatively describing the psychological processes of making a judgement (Stewart, 1988). A process known as judgement analysis (or policy capturing) is used to

externalise an individual's judgement policy by using regression to derive models of the judgements made about a series of vignettes (Stewart, 1988). Each vignette is comprised of a certain number of cues, the levels of which are varied for each individual vignette. Each piece of information is weighted by its importance and the resulting values are combined to arrive at the judgement model.

The results of the judgement analysis are examined separately and compared across individuals or to a standard. The process of judgement analysis seeks to understand and analyse behaviour at the individual level (i.e. idiographic approach), in contrast to the nomothetic approach (i.e averaging across individuals) traditionally taken by psychological research (Cooksey, 1996).

This study will explore the nature of the dimensions which influence employees perceptions of risk and model the weightings given to each dimension by individuals judging the amount of overall risk.

PHASE 1

The process of judgement analysis presupposes that cues are known *a priori*, consequently other methodologies are needed to explore the nature of the cues. This process of generating cues is important as it forms the foundation for the judgement analysis, affecting its generalizability and validity (Cooksey, 1996) and will form phase 1 of this study. Kelly's Repertory Grids have been previously used by Hale and colleagues (Hale, 1987; Hale & Glendon, 1987) in studies of subjective risk where it allowed participants to define for themselves the situations which they considered to be risky.

The open-ended nature of repertory grids, makes few assumptions about how the subject perceives risk and therefore allows the experimenter to access information that may otherwise be missed (Pope, 1980). As the repertory grid does not predetermine the factors upon which participants rate the critical incidents, the constructs will be representative of worker perceptions. The data gained from the repertory grid will be used to create vignettes which are more appropriate to the population of subjects and hence better able to capture the judgements of the individuals.

It is expected that the dimensions found to influence workers perceptions of risk will be specific to the hazards found in industrial contexts, rather than the generic dimensions which have been found to influence perceptions of risk of general and unfamiliar hazards.

Method

Participants. Six employees from each of four member organisations of the National Safety Council of Australia, participated in the study. The organisations were representative of a broad cross section of industries including; sugar refining, cement production, smallgoods manufacture, and metal foundry.

Procedure. The researcher worked with each participant individually. Workers were asked to describe approximately six situations that they considered to be risky, and a further one which they did not. After describing the risky situations (i.e. the *elements*), each person was asked to consider the first three, and to think of a way in which two them were similar, but different to the third. This response is known as the *construct*. The participant then indicated what was the opposite of this construct (known as the *contrast*) and then rated each risky situation on a scale of 1-6. A rating of one indicated that the element was most like the construct and a rating of six representing an element most like the contrast. This was repeated for each possible triad of elements, or until no new constructs could be identified.

Results

Table 2 presents the main themes obtained from a content analysis of the elicited constructs. This table shows considerable heterogeneity across workplaces as indicated by the existence of different constructs across a number of different industrial contexts.

Table 2. Constructs influencing workers' perceptions of amount of risk across a number of industrial workplaces.

	Workplace			
Themes in Risk Constructs	*1*	*2*	*3*	*4*
1. Experienced/Inexperienced	X	X	X	
2. Foreseeable/Unforeseeable	X	X	X	X
3. Self in control/Other in control	X			
4. High Time Pressure/Low Time Pressure	X			X
5. Emergency/Maintenance	X			
6. Incident would result mainly from carelessness/Incident could occur even following procedures			X	X
7. Others effect own safety/Responsible for other's safety			X	X
8. Few people exposed/Many people exposed		X		
9. Simple tools/complex machinery		X	X	
10. Feels safe when isolated/Does not feel safe when isolated			X	
11. Constant exposure/Periodic exposure		X		
12. Safety training specific to machinery/Not enough training				X
13. Fatigued/Energetic				X

Discussion

The generic set of risk characteristics proposed by the psychometric tradition (See Table 1), does not appear to have been useful for describing the factors that individuals take into consideration when making judgements within industrial contexts. As was expected, the context and the nature of the hazards appeared to influence the nature of the dimensions used to predict the amount of risk in a particular situation. Accordingly, workers perceptions of risk in hazardous situations were influenced by cues (i.e. constructs) not only specific to industrial contexts, but specific to the nature of each workplace (See Table 2). Workers from each of the four workplaces were exposed to quite different hazards, and the resulting constructs reflected these differences as perceived by the employees. Although, the repertory grid is useful for exploring which cues or dimensions are used by workers, it cannot provide information about how individuals combine these cues to make judgements about overall risk.

PHASE 2

The second phase of this study will use the dimensions found using the repertory grids and incorporate them into a judgement analysis. The judgement analysis will explore 1) the way in which these dimensions are combined to predict the three risk components (i.e. severity, likelihood, and manageability), and 2) the way in which these risk components are combined to predict overall risk.

Method

Participants. Three individuals from each organisation who had been part of the previous phase participated in the judgement analysis.

Materials. 60 vignettes were presented in booklets with one vignette per page. Each vignette was comprised of 6 cues (See Figure 2). The relevant constructs from the Repertory Grids were used to create the

appropriate cues for each organisation. The order of both the vignettes and the cues were randomised. The judgement sheets each had a nine point rating scale.

Procedure. Participants were tested in pairs or individually. Participants were required to rate the following components of risk: 1) *overall risk*, 2) *likelihood* of potential harm, 3) *severity* of potential harm, and 4) *manageability* (i.e. *strengths*) of the situation. Participants rated all 60 vignettes on one scale (e.g. likelihood) before repeating the procedure, rating the vignettes on another scale (e.g. severity). The vignettes were rated over two sessions of $1^1/_2$ hours each, 1 week apart.

Case no:- 59	
My Experience:	A great deal
Partner's Experience:	Little
Source of Control:	I will control the equipment; My workmate is closest to the site of danger.
Situation:	Routine
Time Allowed:	Less than I would like.
Foreseeability:	I can readily anticipate a number of dangers.

Figure 2. Example Vignette - Worksite 1 (Cement manufacturer)

Results

The diagrams below are the result of a number of regression analyses. Each diagram illustrates the relative weights of the cues predicting judgements of each risk component and the relative weights for each risk components predicting judgements of overall risk.

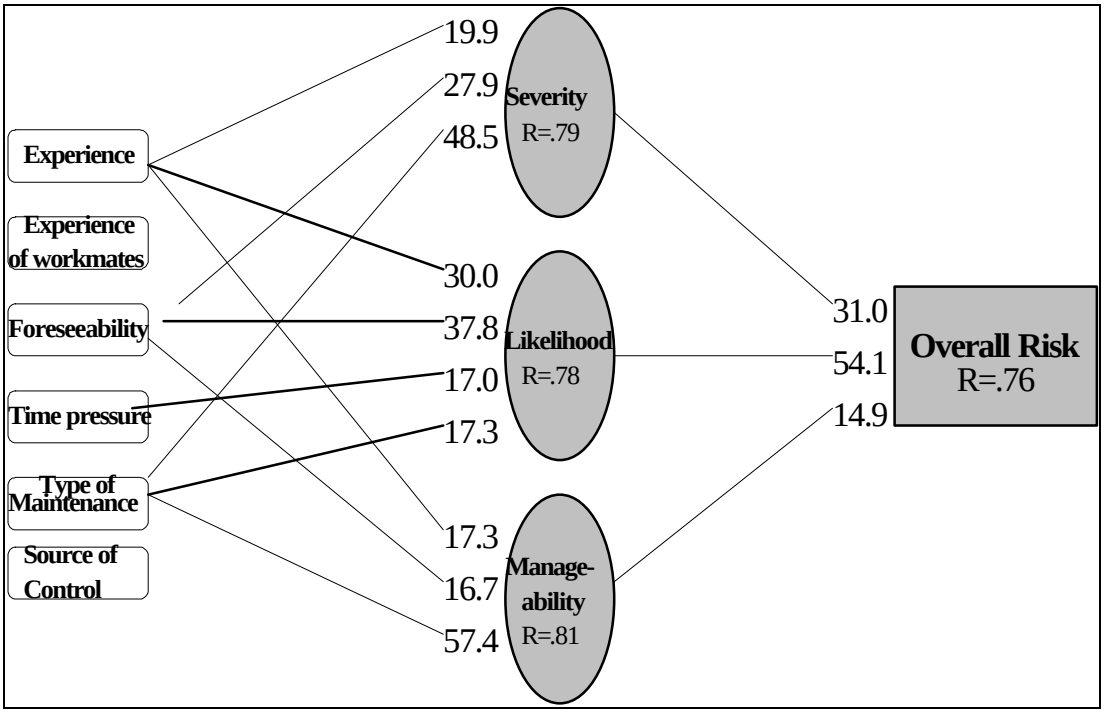


Figure 3. Relationships between cues and judgements as perceived by Worker JM at Worksite 1 (Cement manufacturer).

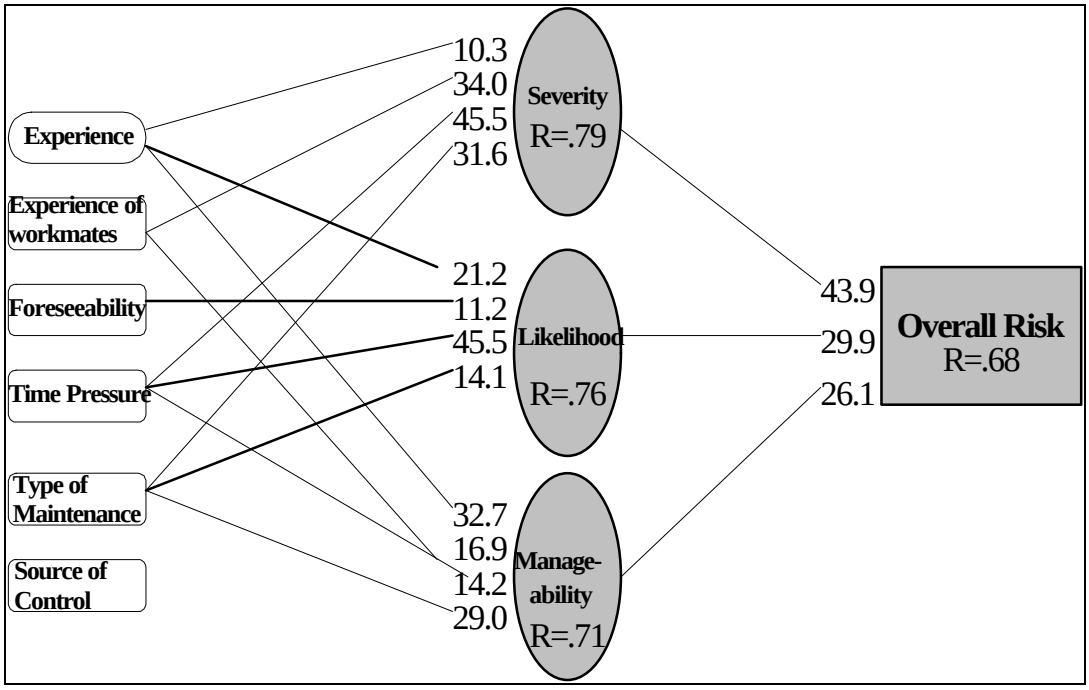
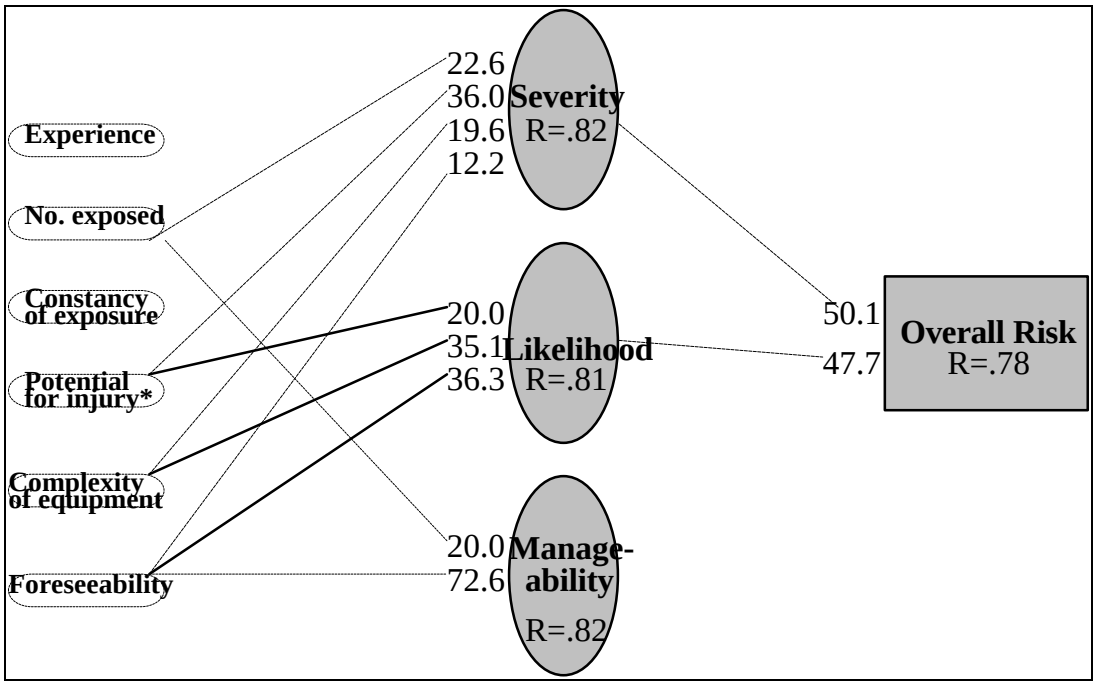


Figure 4. Relationships between cues and judgements as perceived by Worker ST at Worksite 1 (Cement manufacturer).



* Potential for injury even when following procedures

Figure 5. Relationships between cues and judgements as perceived by Worker RW at Worksite 2 (Sugar Refinery).

Discussion

Consistency. The high R values indicate that these employees were highly consistent in their judgements across all the vignettes.

Combination of cues. Individuals within the same workplace placed different emphasis on the same cues, or used a different combination of cues to make the same judgement. For example at Worksite 1, the cement refinery, *likelihood* of an incident was judged using the same cues for both Worker JM and ST. The likelihood of an incident was perceived to be increased when: 1) potential incidents were less able to be foreseen, 2) the worker had less experience, 3) there was less time for task completion, and 4) in emergency situations. However, JM placed greatest emphasis on information about foreseeability and experience, while ST placed a far greater emphasis on the amount of time allowed for completion of a task. Nevertheless, both employee used quite different cues to judge the *manageability* of the situation with only two cues in common, experience and type of maintenance.

Risk Components. Employees were sensitive to the different components of risk. They placed different emphasis on cue information according to the component of risk that they were judging.

CONCLUSIONS

The results of this study provides a number of implications for the development of Safety Programs to be tested in future studies.

1) The different cues used in different workplaces suggest that Safety Programs attempting to educate employees about judging amounts of risk need to be *tailored* for each organisation rather than sold as a generic package.

2) The lack of agreement in weightings of cues between employees within the same workplace may indicate that greater agreement in the judgement of amount of risk could be obtained within a workplace through the use of *cognitive feedback*. These results suggest that it may be useful for future research to examine the effects of feedback about weightings and combinations of cues (i.e. cognitive feedback) on workers' judgements of risk and their safety behaviour.

3) The lack of agreement between use of cues by employees may reflect the highly individualistic nature of perception of risk. Safety Programs which seek to change unsafe behaviours, may be more effective in focussing on changing *thresholds of acceptable risk* rather than influencing workers' judgements of the amount of risk. Making a judgement about the amount of overall risk is clearly not the end of the risk assessment process. The ultimate purpose of risk assessment is to choose between alternative courses of action (Fischhoff, 1989). Once the amount of overall risk has been estimated, the individual must decide upon the acceptability of that overall risk (Lowrance, 1976). If that level of overall risk is not to be accepted (i.e. it is above the individuals *threshold* for acceptable risk), action must be taken to reduce the probability and/or magnitude of that risk. Future research will examine the factors which influence this threshold with the view of reducing the threshold so that employees will take action to reduce risks such as by wearing the personal protective equipment.

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