Risk perception and risk communication: A review of literature

Prepared by the Health and Safety Laboratory for the Health and Safety Executive
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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.
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1.0 INTRODUCTION

This review reports on the now extensive literature on risk perception and risk communication. Its primary purpose is to attempt to summarise the principal insights and conclusions which can be drawn from this work, with a view to helping to inform future HSE policy on the communication of workplace hazards. There have been a large number of reviews of the literature in this area, probably the most significant, within the UK context in recent years, being the Royal Society Report on Risk (Pidgeon et al., 1992). In many respects the current review takes the conclusions of this document as its starting point, however, where this review deviates from the Royal Society Report is in having as its central focus of interest the workplace, rather than wider cultural and societal contexts.

The study of risk, and people's reactions to it, has been a topic of empirical investigation and philosophical debate for several decades now. However, there remain significant controversies regarding basic issues, such as how risk should be defined and the range of variables which should be taken into account when evaluating it. Over the years a number of different definitions have been proposed, the majority of these sharing the common basis of having been founded upon some notion of mathematical probability (likelihood of occurrence), frequently combined with [aspirations towards] some objective measure of severity.

Historically, based upon such conceptualisations, it has been common to distinguish between objective and subjective risk, this dichotomy having provided the backdrop for much of the social science research on risk perception. In contrast to objective risk, subjective risk has been viewed as relating to the psychological dimensions associated with perceived danger. The degree to which this distinction can be viewed as valid and, possibly more importantly, the extent to which it is useful, has been the focus of considerable debate.

Much of the foundation work on risk perception has taken place within the discipline of psychology. Of particular note are the contributions from the cognitive and psychometric paradigms. The former has its roots in, fundamentally, economic models of rationality and rational decision theory. The latter, by contrast, while largely building upon the insights of the former, has sought to investigate the range of subjective criteria which lay people commonly use in their assessments of risk. Both of these approaches have been extremely influential, and have helped to identify and clarify the types of variables which people include in their conceptualisations and reactions to risk, and in particular how these deviate from rationalist conceptions, in taking account of a broader range of qualitative hazard criteria.

Arguably, the most significant insight from psychological research in this area, has been the recognition that perceptions of risk are not only multidimensional, in terms of the range of the qualitative variables which lay people consider salient but are, to some extent, culturally defined. Evidence provided by findings from cross-cultural research, for example, has revealed the presence of significant differences regarding those risks, and features of risks, which are considered important in different societies. The principal implication of such

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1 This is not intended to suggest that the contexts are wholly discrete, rather that it is possible to make a distinction with regard to the central point of interest.
findings, now widely accepted amongst social scientists but less so elsewhere, has been the realisation that notions of risk are, at least to some extent, a social construct.

The importance of social and cultural influences on perceptions of social phenomena has long been recognised by social anthropologists and sociologists. However, the contribution to risk research from these disciplines has been a relatively recent development. The principal insight from these perspectives has been the suggestion that perceptions of risk have the potential to go beyond the risk object per se, relating to broader social group issues, to the extent that risks assume a 'cultural profile'. In highlighting the presence of plural rationalities, differing perspectives, or 'world views', between social groupings, findings from cultural theory are suggestive of the need for risk communications to be sensitive to the frame(s) of reference used by the 'target audience'. In particular, findings suggest that the broader value and belief systems, associated with people's world views, may mean that the credence placed in risk information may have as much to do with levels of perceived credibility and trust in the information source as the content of the information itself.

Until the late 1980s, distinct boundaries were apparent between the various disciplines and paradigms involved in risk perception research. These still exist to a large degree, however, several attempts have been made at the integration of socio-cultural and psychological approaches, with varying degrees of success. While there remain significant ideological and methodological differences between the disciplines, there can now at least be said to exist a growing consensus that, in order to understand people's judgements about, and responses to, risk it is necessary to understand something of the context(s) in which they are formed. As the Royal Society report noted: "From the perspective of the social scientist, risk perception involves people's beliefs, attitudes, judgements and feelings as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits." (Pidgeon, et al, 1992).

The central point of interest for risk perception and risk communication research to date has been, almost exclusively, at the societal or community level, focusing upon lay understandings of risk. Perhaps surprisingly, given its intuitive relevance, comparatively little work has been conducted on risk perception and risk communication issues in workplace contexts. Furthermore, much of that which has been conducted might be viewed as somewhat atheoretical. The central purpose of the current review rests with attempting to establish an insight into the extent to which the, now extensive, literature on risk can be applied to hazard communication in the workplace.

During the course of conducting the current review it became apparent that it was possible to identify a number of recurring themes within the literature, which are of relevance to the understanding of the range of variables which have been identified as impacting upon risk perception and which have implications for risk communication. In order to keep the main body of the review within manageable proportions it was considered inappropriate to include any detailed discussion of these themes in that context.

Summaries, and a limited discussion of selected themes, are therefore provided in the form of an informative annex, and supplement to the current review. Although no claims are made with regard to the extent to which identified themes constitute a comprehensive summary of
research findings, it is hoped that they will be accepted as a reflection of principal findings. In most instances, it will be seen that there are insights and contributions from a range of perspectives, it is considered that such apparently corroborative evidence might be viewed as contributing to the strength of these findings. In addition, it will be observed that the treatment of themes as discrete is, in many cases, somewhat artificial, and that a degree of overlap is, as a consequence, frequently present.

Authors note:

Although there is a growing literature centred on factors which lead to the social amplification of risk, it is considered that this topic lies largely outside the scope of the present review. This conclusion is based upon the premise that, with a relatively small number of notable exceptions\(^2\), the role of risk communication in workplace contexts is primarily one of hazard awareness raising.

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\(^2\) Examples include work-related musculo-skeletal disorders and sick building syndrome.
2.0 RISK PERCEPTION

2.1 Behavioural decision theory

Summary

Early psychological work on risk centred around risk acceptability and was based upon economic models of rationality and, in particular, the concept of equilibrium. The focus of attention during the 1970 and 80s, however, changed to a concentration upon lapses from rational decision making and, in particular, the potential for cognitive errors and biases. One of the most enduring findings from this work has been the identification of a particular type of cognitive bias, termed, ‘framing effect’. This is said to constitute a particular source of contextual bias which arises from the way risk information is presented, which serves to impact upon decision choices in a predictable manner. Although offering a number of useful and influential insights, behavioural decision theory has however been criticised of late, for overstating the case for human irrationality and for failing to take account of potentially important social, cultural and situational influences on risk decision-making.

The largest contribution, by volume, to the wealth of social science literature on risk perception comes from within the discipline of psychology. The early psychological work in this area, during the 1950s and 60s, tended to concentrate upon risk in relation to gambling, and adopted a fundamentally behaviourist approach, drawing heavily upon rationalist economic models of human action, based upon [expected] utility maximisation.

Dissatisfaction with the gambling paradigm, principally due to its relative lack of ecological validity, and real world relevance (see Lopes, 1983 & 1987; Brun, 1994) lead to the pursuance of more valid approaches. Of particular importance, during this period, was the work of Starr, (1969) and the concept of ‘revealed preferences’, central to which was the notion that ‘risk acceptability’ reflects a perceived value trade-off, or equilibrium, between risks and benefits within society. The principal contribution of this work was that it provided the fillip for much of what was to follow, within the cognitive paradigm, over the following two decades. As Short & Clarke note “Psychology has been especially important in drawing attention to technological risks, while economics has long provided general theories of decision making under conditions of risk and uncertainty.” (Short & Clarke, 1992; p.28). Although the ‘rational’ assumptions underlying economic theories of decision making have been widely questioned, (see, amongst others, Fischhoff et al., 1981) the intuitive clarity, and resultant appeal, of the approach have no doubt contributed to its resilience, despite the mounting evidence against it.

The development of cognitive psychology effectively provided the first real critique of the Paretian model of rationality, as an explanation of risk decision behaviour. While retaining the central premise that people actively evaluate risk(s) in terms of costs and benefits, cognitive research during the 1960s and 70s shifted the emphasis towards a concentration upon ‘errors’ and ‘biases’, in decision making processes, or lapses from optional rationality (see Henle, 1982; Evans, 1970; Johnson-Laird, 1975). A principal contribution in this area is
the foundation work of Tversky and Kahneman (1974, 1979 & 1981). These authors provided extensive empirical, laboratory-based, evidence of instances in which human decision making deviated from Bayesian logic, and concluded that biases, errors and misconceptions typify much of human decision making in the presence of risk.

However, rather than simply dismissing human decision-making as being fundamentally 'non-rational', these authors attempted to explore those factors which engendered such perceptual biases. Central to their explanation of the presence of misconceptions and errors in decision-making is the notion that people rely upon a finite number of mental strategies, termed cognitive heuristics\(^4\), in order to make sense of the world around them. Although heuristics are viewed as fundamentally useful, if not essential, aids to reducing task complexity, the suggestion is that they can frequently be misapplied, or contain misconceptions, which impact upon the quality of decision outcomes. "Although these rules [heuristics] are valid in some circumstances, in others they lead to large and persistent biases, with serious implications for risk assessment" (Slovic, 1987; p.281). These errors are said to be not simply random, but to be systematically related to non-logical features of decision tasks, such that they constitute sources of bias. One of the most widely evidenced sources of identified bias relates to the ease with which risks can be brought to mind (availability bias). An example of this is the tendency to overestimate infrequent causes of death and underestimate frequent ones (Johnson et al, 1983). A similar effect has been found where causes of death are perceived as dramatic or sensational (Slovic et al, 1982). An important conclusion from this work was that expert\(^5\) risk judgement appears to be prone to many of the same biases as those of the lay public, particularly where experts are forced to go beyond the limits of available data and to rely upon their intuition. (Tversky & Kahneman, 1986).

Arguably one of the most significant and enduring findings from the early experimental work has been the identification of a range of contextual biases, or 'framing effects' (Ettenson & Coughlin, 1982; Fagley & Miler, 1990; Kahneman & Tversky, 1979; 1981 Kahneman & Miller, 1986; Levin et al, 1987; Lindberg & Frost, 1992 and others), which relate to the decision maker's conceptualisation of a given risk. It is a basic tenet of rational theories of rational decision making that logically equivalent descriptions of a decision problem should lead to the same choices, or decision outcomes, irrespective of the manner in which these choices are portrayed. Various investigators have, however, been able to demonstrate that actual decision behaviour sometimes violates this principle in a predictable manner, at least in terms of textual representation of risk in laboratory contexts (Fischhoff, et al, 1980; Tversky & Kahneman; 1981; and Hogarth, 1982). In the case of framing effects, potential sources of bias are said to arise directly from the way in which risk information is portrayed (framed), rather than as a result of the application of heuristics as such.

The effects of framing bias, where decision choice is influenced by the manner in which risk alternatives (outcomes) are portrayed, have been widely demonstrated, one of the most widely evidenced being 'domain effect' (see, in particular, Kahneman & Tversky, 1974; McNeil et al, 1982), which highlights a generalised preference for risk options which are framed in terms of 'gains', rather than 'losses'. Although the concept has gained widespread acceptance, the effects of information framing on decision choice are now considered to be

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\(^4\) Heuristics - 'rules of thumb' used to reduce the complexity and cognitive load experienced when attempting to conceptualise salient risk variables.

\(^5\) The term 'expert' is used throughout the current document to refer to mainstream scientific and technical understandings of risk, in to contrast to lay/understandings and expertise in this respect (see Grinyer, 1995).
smaller than was reported in the early studies. This has led to some speculation over the extent to which framing influences may be moderated by variables such as individual differences; features of decision scenarios - such as information specificity; or risk dimensions such as the degree of apparent gain or loss; and the probability of success of the risky option, as well as contextual variables such as ownership and who will be affected by risk outcome(s) (see, for example: Johnson & Fisher, 1989; and Levin & Chapman, 1990).

In addition, while the influence of framing effect has been widely demonstrated under a variety of experimental conditions, little is currently known about the circumstances which engender it in real world contexts. A principal difference in this respect being that the statistical probabilities of outcome alternatives is generally absent from 'naturally framed' risk decision-making contexts (Brun, 1994). A possible exception, however, are findings which highlight the importance of time frame as a source of perceptual bias (see, Bjorkman, 1984; Jones. et al, 1973; Nissan & Minkowich, 1973 and others). Some researchers report the influence of cognitive bias relating to the degree of delay between performance of a risk act and the [possible] onset of undesirable consequences, it being widely accepted that immediacy of effect has the potential to be a salient factor in the decision frame. In reviewing the literature in this area, Bjorkman (1984) concluded that "...man is captured in a narrow time space capsule." A principal implication here is that salience of risk is a function of delay in outcome manifestation. In addition, there is evidence that repeated exposures are frequently perceived by people as discrete, rather than as a pattern of increased risk through repeated exposure (see, for example: Doyle, 1997). [For a more detailed discussion of these issues see below].

Although studies of framing effect have been criticised on the grounds of being principally laboratory based (see below), and for being subject to a range of moderating influences, as well as potentially overplaying human irrationality (Lopes, 1991; Evans, 1991), the existence and influence of framing effect has received widespread support, and has now effectively achieved the status of 'normal science'. With regard to the relevance of insights relating to framing influence to risk communicators in devising risk communication media, a number of guides have highlighted research findings on this topic. (For example: Sandman et al, 1988). However, as the Royal Society report noted, decision research development appears to have largely stagnated in recent years regarding the insights which it is able to offer. (Pidgeon, 1992).

2.2 The psychometric approach

Summary

During the late 1970s and 80s the focus of attention shifted to the mapping of societal risks which aroused public concern. The psychometric approach to risk research built upon insights from decision-making work on heuristics and biases (see above) in attempting to reveal people's 'expressed preferences' with regard to the relative tolerability of a wide range of societal risks. Findings from this work highlight the
importance of two underlying qualitative dimensions with the potential to impact upon people’s perceptions of risk: seriousness of consequences (perceived dread) and, degree of familiarity / uncertainty (unknown risk). More recent studies in this area have, however, highlighted the presence of cross-cultural differences in people’s perceptions of risk, and hence, are suggestive of the importance of social influence in this respect. An important premise within this tradition is that the concept of risk is inherently subjective, and that the results of studies in this area should not be interpreted as providing confirmatory evidence of people’s irrationality and ignorance of risk.

Largely building upon the insights afforded by the work on heuristics and biases, and in response to increased public concerns with regard to technological and environmental risks, the focus for risk perception research during the 1970s and 1980s shifted to the issue of evaluating and mapping public perceptions of risk. The psychometric approach to risk perception, principally developed by the 'Decision Research Group', at the University of Oregon, (see Fischhoff, et al, 1978; 1983; Slovic, et al, 1980; 1982; 1984 & 1985) centred on the identification of those societal risks which aroused greatest public concern. This work, using the methodologies of attitude research, sought to reveal people’s expressed risk evaluations. This work has involved the development of taxonomies of risks, the primary purpose of which was to define those risks which people fear and those which they will tolerate, i.e. their 'expressed preferences'. Findings from this research were largely interpreted with reference to earlier cognitive discoveries regarding the role of heuristic schemas (see above). Specific objectives of this research have been defined as: to gain an insight into people’s perceptions of the frequency and probability of risks, with a view to establishing the extent to which they are biased or contain inaccuracies; and to understand the cognitive processes underlying such judgements (Otway & Tomas, 1982).

Early work in this area centred upon requiring respondents to make fatality judgements, or to judge the probability of undesired events, for a wide range of risk variables, and subsequent evaluation in terms of known public health statistics (e.g Lichtenstein, 1978). Findings from this early work highlighted systematic differences between mean lay estimates and actual fatality rates, and between lay and expert risk judgements. In particular, responses were said to reflect availability bias, principally, the tendency to overestimate unlikely, and underestimate likely, risks. (Lichtenstein, 1989). However, although substantial inaccuracies were apparent for many risk estimations (particularly those at the extremes of the distributions⁸) comparative risk estimates (risk rankings) were found to be substantially accurate. As Pidgeon et al (1992) note, such a finding is perhaps hardly surprising, given the complexity of, and lack of familiarity with, many of the risk judgements required. This finding did, however, highlight the potential utility of the use of comparative risks to enhance relative risk judgements⁹. Furthermore, the fact that members of the lay public were able to demonstrate an ability to make relatively well calibrated estimates of fatality rates suggested that these discrepancies were not simply due to erroneous calculations, and led to the conclusion that explanations had to be sought elsewhere.

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⁸ For example: ‘Very likely’ and ‘very unlikely risks’.
⁹ A technique which has been widely applied in the intervening period.
This insight resulted in a considerable amount of research effort being expended in attempts to identify a finite number of core 'risk evaluation dimensions', or 'risk characteristics' used in lay assessments of risk. Hence, rather than simply identifying the relative risk rankings, research moved on to address, what would seem to be, the theoretically more important issue of attempting to identify the range of psychological mechanisms which underlie people's reactions towards hazards, and the psychological laws governing people's risk judgements.

The application of psychometric analytic procedures to attitudinal data, for a wide range of risk variables, has resulted in the identification of a finite number of underlying factors, or risk evaluation criteria, which are claimed to impact upon the lay public's perceptions of risk. A number of replications of this approach are reported to have reliably revealed two (in some instances three) risk dimensions onto which the 'personalities' of individual hazards can be scored, and mapped. The factors identified are: 'Perceived dread'\(^{10}\), 'Unknown risk'\(^{11}\); and, in some studies 'Number of individuals exposed'\(^{12}\). It has been reported that the reliability of this factor model has been successfully replicated on a variety of population samples, both within the USA and elsewhere. In addition, it appears to be broadly consistent with findings from other studies, using different investigatory techniques (see Vlek & Stallen, 1979). Although it is perhaps tempting to characterise the first and third factors as both relating to consequence / severity and the second factor to uncertainty, this has been said, however, to represent something of an over simplification (Pidgeon, 1996).

Studies of US populations are reported to have demonstrated a high degree of homogeneity (see Slovic et al, 1980; 1985; Johnson & Tversky, 1984), both in terms of factor structure and risk item rankings. However, replications, involving populations sourced from outside the USA have revealed both striking similarities, in terms of the identified and named factors (Englander, et al, 1986; Teigen, et al, 1988; Keown, 1989; Gosczynska et al, 1991), and the presence of important cross cultural and social group differences, with regard to the 'relative positions' of individual risk items. (Englander, et al, 1986; Teigen et al, 1988; Hoefer & Raju, 1991; and Gosczynska et al, 1991).

Several methodological criticisms have been levelled at the psychometric approach, particularly with regard to the extent to which findings may have been influenced by the hazard sets used, this having lead some authors to conclude that: "The underlying dimensions are, in effect, little more than a reflection of the researchers' original intuitions." (Otway & Tomas, 1982) - this being the product of an essentially 'top-down' approach. More recent studies in this area (eg Slovic, 1993), however, have adopted methodologies with a more organic basis, and have attempted to combine qualitative and quantitative study methods. Other criticisms of the psychometric approach relate to the types of analytical techniques used and the statistical treatment of results, as well as the validity of samples, in terms of their size\(^{13}\), structure and representativeness\(^{14}\) (see: Gardner & Gould, 1989; Pidgeon, et al, 1992). More recent studies appear to have attempted to address some of these criticisms by drawing

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\(^{10}\) Dread risk - this is said to be the most important dimension, appearing to be linked with a hazard's catastrophic potential - death; injury or ill-health (independent of probability) and level of involuntariness, as well as lack of control over exposure. Some researchers have labelled this factor control.

\(^{11}\) Unknown risk - this dimension reflects various aspects of people's knowledge about the hazard - and appears to be related to knowledge of the underlying science and the extent to which the hazard is familiar to the perceiver.

\(^{12}\) Numbers exposed - relates to the number of people who will likely be affected should the event occur (number of deaths; injuries or rate of ill health).

\(^{13}\) Much of the initial psychometric work was conducted on relatively small samples.

\(^{14}\) Frequently samples comprised students or members of pressure groups.

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Questions have also been raised regarding an apparent lack of comparability between studies, principally for methodological reasons, due to variations in the degree of sophistication involved in the use of analytical techniques, this having lead to some differences in factor structures\(^\text{16}\). (see Arabie & Maschmeyer, 1988). A more fundamental criticism of method, however, relates to the use of population means and correctional inference, specifically the risk of under representing the spectrum of opinions on risk (Harding & Eiser, 1984; Gardner & Gould, 1989). It should be noted that many of these criticisms relate to the general technique of factor analysis, rather than its specific application to risk perception research per se.

Although the results of the psychometric studies can be seen to differ in detail, with regard to the factor structures derived, Slovic, et al (1986) contend that they have demonstrated that perceived risk is both quantifiable and predictable. A reappraisal of the initial premise, which aimed to identify universal, shared attributes or characteristics of risks which impact upon the way in which they are perceived, and in recognition of apparent cross-cultural influences, has led these authors to conclude that "...psychometric techniques seem well suited for identifying similarities and differences among groups with regard to risk perceptions and attitudes. They have shown that the concept of risk means different things to different people." (Slovic et al, 1986). The recognition of the potential for measurable differences between population groups has, possibly most importantly, served to highlight the presence of cultural influences on perceptions of risk and to bring with it something of a socio-cultural dimension to the more recent work within the psychometric paradigm. "In judging the magnitude of risks, people from different cultures could be expected to differ on two counts: firstly, because they live in objectively different risk environments, and secondly, because they perceive their environments differently." (Teigen, et al, 1988; p.127).

Although the psychometric paradigm has been claimed to provide a useful framework for conceptualising the importance of social contextual influences on risk perception (MacGreggor & Fleming, 1996), it has provided rather less in the way of specific information about how people reason about risks, in particular about how new information about a given risk will be integrated into what people already know, believe or perceive. More fundamentally, although the most significant contribution of the psychometric work is now generally accepted to be the finding that perceptions of risk are influenced by social and cultural differences, methodologically, it has remained centred upon the psychology of the individual, and as a consequence, while inferring the importance of social process, has largely failed to broaden its scope, to make any significant contribution to the understanding of such issues (see below). It is the absence of a social perspective within the paradigm which has been the most significant source of critique of the approach. In particular critics have questioned the validity of the assumption that risks have an independent, objective, existence which is separate from the social and institutional contexts in which people experience them (Nelkin, 1989; Turner & Wynne, 1992).

\(^{16}\) Differences in the nameable factors identified.
A common interpretation of the findings of the psychometric research, amongst both technocrats and policy makers, has been that they simply provide confirmatory evidence of the public's ignorance and irrationality with regard to risk issues. However, Fischhoff (1990) contends that such claims are unwarranted, and go beyond the results of the research evidence. Rather "Studies of how hazards are viewed in terms of more qualitative risk characteristics provide an opportunity to capture lay conceptions of risk, but are also useful in that they provide an insight into the lay person's general reactions towards hazards and hazard management. Studies within the psychometric tradition have especially addressed this problem." (Fischhoff, 1990).

An important premise within this tradition is that risk is inherently subjective. Risk does not exist 'out there' waiting to be measured, but is an abstract concept which has been developed to understand and cope with the dangers and uncertainties of life. In sum, the evidence from the psychometric research suggests that lay conceptualisations of risk are both complex and multidimensional (Slovic 1987; 1992). It has further been suggested that both objective risk assessments (eg fatality rates) and subjective risk judgements can be seen as alternative risk perceptions, made by the experts or by the lay public, respectively (Fischhoff, 1989).

2.3 The mental models approach

Summary

Building upon insights from cognitive and psychometric psychological research the mental models approach to risk research relates to a technique developed at Carnegie Mellon University, in the USA. The approach is designed to elicit insights into lay people's understandings of hazards and to map these onto expert models of risk. The primary propose of the technique is to identify 'critical knowledge gaps' in lay understandings of risk, with a view to tailoring risk communication material to meet this need. The technique is reported to have been successfully applied to a number of risks, including HIV, naturally occurring radon and electromagnetic fields. The approach is claimed to have revealed a number of important deviations between lay and expert models of risk. Criticisms of the approach centre around the use of narrow rationalist models of risk; a tendency to overplay the degree of unity within expert models of risk; and, the failure to take account of broader social and cultural influences on risk perception. With regard to this last point, researchers in this area would only claim to be addressing cognitive aspects of risk perception and risk communication.

Although arguably remaining fundamentally methodologically asocial, a more recent research development, which has attempted to address a number of the above issues, is a mental models approach, developed at Carnegie Mellon University. The concept of a mental model relates to the process by which individuals manipulate internal representations of reality, in the course of thinking about, and making sense of the world around them, (the concept having been generally attributed to Craik, 1943). Mental models are viewed, within psychology, as a primary mechanism by which individuals construct explanations of events.
and experiences, this comprising an integration of knowledge, attitudes, beliefs, impressions and images. In essence, mental models are cognitive tools, which allow people to reason and put in order what would otherwise be disordered and incomprehensible. As such they can be applied as a psychological tool for understanding the world and thereby reducing uncertainty (MacGregor & Fleming, 1996). However, as Fischhoff et al (1997) note, where people's mental models contain 'bugs', or misunderstandings, they can lead to erroneous conclusions. In the case of risk perception this can lead to people being exposed to harm while considering themselves to be safe, due to the presence of flaws and inaccuracies in their mental model for a particular risk.

The mental models approach, in risk perception research, has been used in an attempt to elicit information on lay people's reasoning with reference to a range of hazards and risks (see Jungerman et al, 1988 and MacGregor, 1989). The technique, described in the Royal Society report (1992) as "A novel and highly promising approach."

largely builds upon the insights of previous cognitive research, while at the same time, attempting to access a more detailed insight into qualitative aspects which impact upon perceived risk, including social influence variables. Significant methodological deviations from the more traditional, top-down approaches adopted in the majority of psychometric studies, are apparent. "Determining what people know - and need to know - about [hazards] requires quite different research strategies than the study of summary estimates." (Bostrom, et al 1992). In contrast, proponents of the mental models approach advocate the use of, largely unstructured, individual interviews as a means of eliciting qualitative information on perceived risk, at least in the first instance, using a combination of 'think aloud' and 'free-associative' interview techniques as well as structured interviews. A central objective of this essentially qualitative approach is "...to elicit people's beliefs that neither puts new concepts in their minds nor leaves existing ones unstated." (Bostrom, et al, 1992; - see also: Jungerman, et al, 1988; Bostrom, 1990; Roth et al, 1990; and others). This process is claimed to provide an insight into both the appropriateness and accuracy of people's risk beliefs (mental models), and to permit some evaluation of the strength of such views through the identification of recurring themes.

Having derived an understanding of lay perceptions for the risk topic of interest, this information is mapped onto an expert model of the risk(s) associated with that substance or activity. Influence diagrams and decision-trees are typically used to graphically illustrate linkages. This information is then, typically, used to inform the development of a structured questionnaire, for distribution to a wider sample, upon which some form of confirmatory analysis can be performed regarding the nature and extent of lay beliefs. The questionnaire "should address all significant expert and non-expert concepts, translating abstract technical material into concrete language appropriate for lay respondents." (Morgan, et al, 1992).

Where discrepancies are apparent between lay and expert models it is suggested that these can be used to guide the format of risk communication material, the performance of which can evaluated on a sample representative of the target population. "Many of the concepts in the expert model were simply absent from the lay model...... Bridging the gap between lay mental models and expert models would require adding missing concepts, correcting mistakes, strengthening correct beliefs and de-emphasising peripheral ones." (Fischhoff, 1997).

A number of recent psychometric studies have adopted a more organic ('bottom-up') approach during the early stages of the investigations. eg: Tyszka & Gosczynska, (1993) & Thomas & McEwan, (1988).
Findings from this research are claimed to have highlighted important insights into people's perceptions of risk. MacGregor et al (1994 & 1995), for example, report a number of deviations between expert and lay models of risk associated with electromagnetic fields. With regard to chemical exposures, lay perceptions appear to operate largely independent of 'dose-response' relationships. Similarly, Morgan et al, (1992), when investigating perceived risk from naturally occurring radon, report "Important pieces of the indoor radon exposure and effects processes were often missing from our respondents mental models.... Other erroneous beliefs (eg: radon causes breast cancer), peripheral beliefs (eg: radon comes from industrial wastes) and indiscriminate beliefs (eg radon makes you sick) seem to be derived from mental models of various hazardous processes, rather than a core mental model for radon." (Morgan et al, 1992; p.2053). "Many of the concepts in the expert model [eg: 'radon decays quickly' and 'radon causes lung cancer'] were simply absent from the lay model." (Maharik & Fischhoff, 1992). ".....people's understanding of the radon problem seems not only incomplete but also incoherent..." (Bostrom, et al, 1992).

Such findings have led other authors to make the, somewhat contentious\(^{18}\), point that "...lay models of toxicology, and of chemical risk, are not only less complex [than those of experts] they are primarily composed of beliefs, attitudes, perceptions and impressions that are loosely organised according to intuitive principles." (MacGregor & Fleming, 1996). These authors further highlight what they believe to be errors and biases in the causal inferences which people make about the effects of chemical exposure on symptomatology. They suggest that erroneous causal associations, frequently occur due to cerebral contiguity\(^ {19}\) and that this can be viewed as part of a natural, psychological adaptation in which individuals seek to decrease their uncertainty about the factors or conditions that cause them to feel as they do (MacGregor & Fleming, 1996). In short, people have a tendency to search for casual meaning. Examples of such effects might include instances where flu or other viral symptoms are misattributed to chemical exposure.

The majority of work in this area has concentrated upon lay perceptions of risks relating to specific substances (eg: radon, electromagnetic fields, and HIV). Research on perception of HIV risk (Linville, 1987), for example, has highlighted the presence of an 'accumulation bias', relating to difficulties experienced in people's comprehension of the difference between the risk associated with a single exposure and repeated exposures on the likelihood of contracting the virus; and framing biases, where logically equivalent risk options are perceived as posing differential levels of risk, this being dependent upon the manner in which the information was linguistically framed; as well as an 'optimistic bias', whereby individuals consider the risk to their own health to be smaller than that to others exhibiting similar behaviours. In addition to the work on perceptions of HIV risk, the technique has been applied in a range of other public health contexts (see, for example: Jungerman, et al, 1988).

A number of the findings, however, appear to have some potential to map onto broader categories of risk. MacGregor, et al (1995), for example, report that people's perceptions of chemical risks frequently appear to be independent of dose-response considerations, a conceptualisation fundamental to the expert model, exhibiting similar reactions irrespective of the size of exposure. However, the generalisability of this finding may be questioned, if

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19 The tendency to make a causal association between two events simply because they occur close together.
viewed in the light of findings which suggest that biases are also present with regard to the effects of cumulative exposure, whereby individual exposures tend to be viewed as discrete rather than as part of a pattern of risky behaviour\(^20\). Although lay conceptualisations frequently include some notion of risk changing with repeated exposures, these have frequently been found to deviate from probabilistic models of cumulative risk. As Linville et al (1997) note "Difficulties in understanding how risk accumulates can clearly lead to poor decisions." (the effects of accumulation bias have been widely reported, see, for example: Fischhoff et al, 1978; Schwalm & Slovic, 1982; Shaklee & Fischhoff, 1990).

Although such findings provide valuable insight, they might be criticised on the grounds that they appear to offer a somewhat pessimistic, if not in some instances disparaging, view of lay toxicology, implicitly referencing all such perceptions as deviations from the expert model. A number of authors have contested this view, in particular the tendency to undervalue the relevance of lay toxicology - this contributing to the misconceptions and biases present within expert models of risk (see Wynne 1989; 1992 & 1993). In this sense, the mental models approach can still be considered to retain elements of the 'subjective' versus 'objective' debate.

A further, and related, criticism which has been levelled at the approach, relates to the tendency for its advocates to at least implicitly, overplay the degree of unity within natural science, and as a consequence underplay, frequently encountered difficulties involved in achieving consensus within the scientific community. Such consensus logically constituting a prerequisite for the development of 'expert models' of risk, "It should be conceptually straightforward to identify those bits of potentially available information whose provision would have the greatest impact on recipients ability to make decisions...." (Bostrom, et al, 1992). Although such arguments are, at one level, bound up with broader issues relating to the philosophy of science, a number of recent examples associated with food scares have highlighted problems of disunity in science contributing to a lack of trust and perceived credibility in sources of risk information. (see MacGregor & Fleming 1996).

2.4 Value expectancy models

Summary

A number of broadly compatible models have been developed designed to provide an insight into the range of variables which impact upon people's motivation to adopt cautionary, self-protective behaviour. Applications of these models, to date, has principally been in the area of health behaviour, and typically in non-workplace contexts. A central assumption common to these models is that levels of perceived susceptibility / vulnerability constitute an important influence on motivation to adopt precautionary action. More recent studies have attempted to address criticisms centred on the tendency for applications of these approaches to underplay social, cultural and situational influences on behaviour. There exists some debate regarding their success in this respect. More fundamental criticisms of work in this area relate to the validity of the central assumption, common to all models within this framework, that there exists a strong positive association between attitudes and

\(^20\) This tendency has been further linked with notions of personal control and susceptibility.
behaviour. Opinions on this issue are divided, however, the absence of a strong relationship may go some way towards explaining the relatively poor predictive power reported in many studies. Questions have also been raised regarding the quality of many studies in this area.

The general area of health behaviour has advanced a number of theoretical models to explain why people do not engage in various health-enhancing and medically beneficial activities, such as vaccinations, not smoking, seat belt use and safe sexual practices. However, as Dejoy (1996) notes, although there would appear to be obvious links between these models and workplace self-protective behaviour very little attention has been given to workplace contexts in this respect.

The majority of value expectancy models relate to health behaviour and have their underpinnings in behavioural decision theory (see above), possessing the common assumption that risk behaviours reflect a conscious decision process, where outcome alternatives are evaluated in terms of their utility (relative benefit). The various value-expectancy models can be seen to possess four common characteristics: (a) that motivation for self-protective behaviour arises from the anticipation of negative consequences and the desire to minimise these outcomes; (b) that the impact of an anticipated outcome on individual action is dependent upon perceived seriousness of consequences; (c) that the impact on motivation dependence upon the perceived likelihood of such an event occurring; and (d) the expected benefits of a particular action must be weighed up against evaluated in terms of the costs of taking this self-protective action. (Weinstein, 1993).

The best known\(^1\), and most influential models in this area: 'The theory of reasoned action' (Fishbein & Ajzen, 1975); 'Theory of planned behaviour' (Ajzen, 1991) and 'The health belief model' (Janz & Becker, 1984) share the common ancestry of being based upon 'Subjective expected utility theory'\(^2\) (see above) and the central notion that health considerations, and subsequent behaviour, are based upon some form of subjective cost benefit analysis.

Both Weinstein & Niclich (1993) and Van der Pligt (1996) highlight the existence of considerable overlap between the models proposed by Fishbein & Ajzen and Janz & Becker, in terms of the manner in which they attempt to explain human motivation to engage in precautionary behaviour. However, it is the latter, the health belief model, which constitutes the most widely applied of these frameworks, in the quest to describe conscious decision-making processes and to identify those factors which underlie them. Fundamentally, the model holds that five factors determine the adoption of precautionary action: 'perceived vulnerability' (susceptibility); 'perceived severity of health risk'; 'perceived benefit of precautionary behaviour'; 'perceived barriers to precautionary action' and 'health information sources' (risk knowledge). A principal assumption of the model is that an individual's predisposition towards the adoption of precautionary action is strongest where

\(^1\) Other noteworthy models include 'Protection motivation theory' - Rogers; and the 'Precaution adoption process' - Weinstein.

\(^2\) Subjective expected utility theory is based upon the economic conceptualisation of rational behaviour - based upon maximising personal benefit from actions taken.
knowledge of risk is substantially accurate, perceived severity, susceptibility (vulnerability) and perceived benefits are high, and where the costs of compliance are low.

There have been a number of reviews of the literature in this area. Although Janz & Becker, (1984) report considerable support for the model, more recent reviews by Harrison et al, (1992) and Van der Pligt (1998) conclude that, while most applications of the model have reported positive associations between the variables of 'perceived barriers' and 'vulnerability', and motivation toward precautionary behaviour, not all findings are positive in this respect. Furthermore, in many instances, where associations have been reported, they are frequently weak.

Much of the research in this area builds upon the insights provided within the cognitive paradigm, in particular the influence of framing effects on health risk information, as well as widespread evidence of misinterpretations of probabilistic risk information and effects relevant to cognitive availability. e.g: the overestimation of the likelihood of susceptibility to 'sensational' or 'dramatic' risks. (see: Agans & Shaffer, 1994; and Van der Velde et al, 1994). Other findings have demonstrated that the ease with which individuals can visualise themselves as victims can be an important determinant of perceived susceptibility / vulnerability. However, Ronis (1992) and Sheeren and Abraham (1996) highlight a number of limitations of the model, in concluding that greater clarity is needed regarding the precise nature of perceived vulnerability.

Also of relevance, and linked with notions of vulnerability, is a widely reported attributional bias relating to the tendency for individuals to consider themselves to be personally immune, or at a lower risk of harm than others similarly exposed. The apparently widespread personal predisposition towards 'unrealistic optimism' (Weinstein, 1980; 1984), with regard to social comparison, has received considerable attention amongst risk researchers, particularly in the areas of driver behaviour (eg: Naatanen and Summala, 1975; and Svenson, 1981) and HIV risk (eg: Linville, et al, 1987; Kirsch and Joseph, 1989 and Basil and Brown, 1997).

Although the determinants of such optimistic bias are not well understood, contributory variables which have been identified include perceived personal control, experiential learning effects (such as familiarity) and coping strategies, which reduce dissonance (such as denial responses) (Linville, 1987).

However, taken in summation, both Rothman, et al (1996) and Van der Pligt, (1998) conclude that research findings suggest that the predictive power of such comparative risk appraisal is at best modest. It has also been suggested that optimistic biases arise more due to the fact that people overestimate the average risk of their peers than because they underestimate their own risk. In addition, respondents seem to exhibit a generalised desire to preserve their 'below average' status, this suggesting the presence of attributional biases.

It, therefore, seems likely that 'unrealistic optimism' is associated with broader social comparison processes and, as such, should not be viewed as constituting a primary determinant of precautionary health behaviour. "Overall, research findings suggest that the predictive power of comparative risk appraisal is extremely modest...... It could be that comparative risk appraisal primarily triggers social comparison processes and is not a primary

Relating to broader effects of 'self vs others' biases', in particular the generalised tendency for individuals to view their own actions in a more favourable light than ostensibly equivalent behaviour in others.

Principal objections to value expectancy models relate to reports of relatively modest associations between perceived risk and precautionary behaviour where social influences are of relevance. "The main difficulty with this kind of approach can be succinctly stated: theories of risk behaviour which conceptualise risk behaviour as volitional and individual acts are inappropriate where risk behaviour involves two parties, or more. i.e: where there are social and group effects." (Bloor, 1995).

Although more recent applications of the 'Health belief model' and the 'Theory of reasoned action' have highlighted the importance of self-efficacy24, and some researchers have attempted to take account of social constraints on behaviour (for example: Rickett, et al, 1998), there is, arguably, a contradiction apparent here. Principally, the source of contradiction lies in attempting to graft a social element onto what is, essentially, a model based upon individual decision making, particularly where the primary method of data gathering is attitudinally based, and where dependent variables are restricted to past behaviours and / or behavioural intention.

As DeJoy (1996) notes, threat-related beliefs about susceptibility are common to all three models. Equally, all seem to contain some element of an acceptance that self-efficacy is an important criterion. Barriers to precautionary behaviour (social and physical) which emerge from the Health belief model literature have been widely cited as the best single predictor of protective behaviour. Workplace examples include: research on the use of personal protective equipment (Acton, 1977; Cleveland, 1984; and Terrell, 1984).

While concluding that threat-related beliefs and response efficacy are likely to be the most important variables during hazard appraisal, Dejoy (1996) concludes that what is required in this area is an integrative framework, which takes account of situational, socio-environmental variables as well as personal characteristics, such as personal beliefs about hazards. "The importance of environment in enabling and reinforcing safe workplace behaviour cannot be overemphasised." (DeJoy, 1996).

Questions have also been raised regarding the quality of many of the studies conducted in this area. Weinstein et al (1995), for example, suggest that, of the sixty or so studies which they reviewed, a high proportion suffered from serious methodological and conceptual flaws, possessing the additional methodological shortcoming of attempting to attribute causality on the basis of correlational findings. Further methodological criticisms relate to the presence of evidence which suggests that question format can influence, for example, the extent of expressed optimism (Otten & Van der Pligt, 1998). A more fundamental criticism of the approach, however, relates to the relationship between attitudes and behaviour. Historically, all value expectancy models have assumed a strong linkage in this respect. Although authors typically attribute the poor predictive power of models to methodological weaknesses within studies (see Poppen & Reisen, 1997), there now exists substantial empirical evidence which highlights the relative weakness of this relationship. (Green, 1998).

24 Self-efficacy def: the extent to which individuals feel confident that they are capable of performing, or are in a position to take precautionary action. Broadly comparable concepts are 'focus of control' and 'agency' (see informative annex, Section 4).
2.5 Socio-cultural insights

Summary

Researchers working in this area maintain that peoples' perceptions of risk are in some degree socially defined, and frequently extend beyond attributes of the risk object itself. Cultural theorists advance a model which attempts to explain the basis for sectional differences in society with regard to perceptions of risk. One explanation for this apparent selectivity is said to relate to the desire to defend certain preferred lifestyles and to reflect sectional interests within society. Other studies highlight the importance of social process, in particular group and community influences, in defining risk, in terms of its acceptability, and shared understandings in this respect. A number of authors in this area suggest that there is a tendency within the scientific community to underplay lay expertise derived from contextual insight and understanding of the risk environment. As such, scientific and technical models of risk are frequently viewed as being unreasonably restrictive and narrow. Socio-cultural approaches are critical of mainstream cognitive psychological work on risk, on the grounds that it is said to underplay social, cultural and situational influences which relate to how risk is understood and defined, as well as the range of socially legitimised reactions to it. In short, theorists working in this area view cognitive risk research as providing, at best, a partial understanding of risk perception and people's reactions to hazards.

A number of authors have suggested that there has historically been something of an over concentration upon the cognitive and psychophysical aspects of risk, with the result that this has had the effect of diverting attention away from intuitive and emotional aspects of risk perception. (Brehmer, 1987). While, on the one hand, risk perceptions can be seen to constitute individuals' reflections and private understandings, on the other, there is evidence that they are the product of a continuous process of communication and interaction as members of a social milieu. This includes both informal (e.g: friendship, kinship) and formal (e.g: authoritarian, workplace, commercial) networks whereby communication and dialogue with others can serve to confirm and verify already held positions or perhaps lead to revisions of these norms, attitudes, beliefs and practices (MacGill, 1988).

The anthropological work of Douglas (1966; 1970; 1986 and 1992), and in particular Douglas & Wildavsky (1982), has been widely cited as playing an important role in the development of research interests in socio-cultural influences as explanations of bias in perceptions of risk, in particular with regard to environmental and public health issues. The basis of Douglas's earlier work, and that of those who have since worked within this framework, appears to be centred on the issue of why different cultures select different risks as the focus of their attention (Krimsky, 1982). Central to cultural interpretations is the concept of the 'grid group' approach, a typology of social structures which are claimed to reflect a range of identifiable 'world views', or social orientations, which impact upon and account for differences in people's perceptions of risk, in a predispositional sense. According to cultural theory selective attention to risks can best be understood in terms of two linked domains, which constitute a way of life: cultural biases, which equate to shared values and
beliefs - ie: world views or cosmologies; and social relations, which are defined within cultural theory as one of five patterns of interpersonal relationships: hierarchical; egalitarian; individualist; fatalist and hermit.

Socially variable combinations of cultural biases and social relations are referred to in cultural theory as 'ways of life', each is hypothesised to engender distinctive representations of what constitutes a hazard and what does not. "Those risks selected for worry or dismissal are said to be functional, in the sense that they strengthen one of these ways of life and weaken the others." (Dake, 1991; p.65). As the Royal Society report (1992) highlighted, the principal implications of the approach for risk perception are that "...people select certain risks for attention, to defend their preferred lifestyles and as a forensic resource to place blame on other [interest] groups." (p.7). In short, "An act is said to be considered culturally rational if it supports one's own way of life" (Wildavsky - cited in Earle & Cvetkovich, 1997, p.55). Douglas & Wildavsky effectively assert that people do not necessarily focus on risks simply to protect their health and safety, but may also do so as a means of expressing wider socio-political interests and agendas.

Although influential at a theoretical level, there have been relatively few attempts to subject Douglas's approach to empirical evaluation, notable exceptions being Dake (1991); Jenkins-Smith, 1993; Slovic et al, (1994); Peters & Slovic, (1995). Direct application of the theory within workplace contexts appears to be restricted to a single study by Rayner (1986), who reported the presence of different 'world views' of risk amongst different personnel groups in health care environments. However, complementary findings are arguably apparent within the safety culture literature (see below).

Some authors have attempted to make linkages with findings within the psychological literature. Douglas, for example has suggested that heuristics can operate as cultural conventions, shared within a community. "In this capacity they are the essential element of the cultural process. Not only do they aid in making risk assessments, but they enable each member of the community to predict what the others will do in a given context...... It is not enough to treat heuristics as mere cognitive aids to the individual decision maker. By clarifying options and establishing expectations they create some predictability and enable cultural values to be agreed." (Douglas, 1985, p.80). In addition, empirical research has produced findings which suggest that world views can be considered to operate in a predispositional sense, acting as 'cognitive filters' (Dake, 1991; and Kaspersion, et al, 1988).

However, other findings suggest that the influence of world views is limited in this respect (Sjoberg, 1993 & 1995). Criticisms of Dake's interpretation, from social and cultural perspectives, relate to the contention that it remains rooted in narrow, individualist, conceptions of human action and is, hence, lacking social context, with the result that it is in contradiction with the basic premises of the cultural insight (Johnson, 1991; Walker et al, 1998). Dake, however, contends that "The cultural and the psychological approaches to world views are fundamentally compatible in that both cultural biases and contemporary

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25 Such arguments are long established and are commonly encountered in social history texts, having been advanced as explanations of historical changes of allegiance in pressure group membership - eg: membership of trades unions; Chartism and the anti-corn law league have been found to vary in line with the economic cycle and are, hence, viewed as alternative vehicles in pursuance of the quest for social change..
world view may be analysed as [personal] dispositional constructs." (Dake, 1991, p. 77). Johnson, (1991), however, does concede that despite its problems, Dake's work has gone further towards the integration of these issues than much of the other work in this area.

Several authors have advanced more fundamental criticisms of the cultural approach. While conceding that the grid group analysis provides a viable explanation of cultural differences, these authors suggest that it might be criticised on the grounds that the model is fundamentally Durkheimian and static, in so far as it fails to provide an explanation of social process, and in particular how people's cultural world views might change over time (Bulley, 1990; Pidgeon, 1996; and Wartofsky, 1996). Other authors have suggested that the concept oversimplifies the complexities of social differences (Turner & Wynne, 1992; and Marris et al, 1996). However, it seems that the strength of the approach has been that it has at least served to "...offer the opportunity to explore how conflicts over risk can be understood in terms of plural constructions of meaning which are culturally framed." (Gabe, 1995; p. 7). In addition, it has been suggested that a primary impact of the approach has been that it has ".served a valuable function in helping to open the minds of more scientisitically inclined policy makers to an appreciation of divergent value systems in risk assessment." (Stirling, 1998).

A principal contention of those working within the social and cultural frameworks is that the cognitive psychology work on risk during the 1970s and 80s, while highlighting the presence of differences between lay and expert views on risk, in concentrating upon bias with reference to rational scientific models, implicitly underplayed the potential for cultural bias amongst members of the scientific community itself. Covello & Johnson (1987), for example, suggest that there exist strong social and cultural influences which play a potentially important role for both lay and expert groups. Similarly, Jasenoff (1986) contends that cultural predisposition also influences expert perceptions of risk, such that their perceptions are influenced by institutional values, and are constrained by the boundaries of normal science.

Empirical findings reported by Wynne (1992), further highlight the presence of differences between lay and expert frames of reference in risk appraisal. Significantly, and in contrast to the mainstream cognitive approach, Wynne does not claim that one frame should be considered as better or more accurate than the other. However, he does highlight a number of pitfalls associated with failure to take account of lay knowledge in the generation of risk models, not least in terms of potentially detrimental influences on the credibility of expert knowledge, where this model lacks potentially important insights present within lay understandings. "What is taken by technical experts and policy makers to be an irrational rejection of scientific information may instead be a rejection [by the lay populous] of naive assumptions [within expert models] about an ideal world, both social and material, which is embedded in the 'expert' model of risk taking." (Wynne, 1992; p.32).

Such findings have served to highlight the fact that both expert, as well as lay, perceptions of risk can constitute important sources of inaccuracy and bias, as well as insight. In contrast to essentially positivist interpretations, which effectively view [individual] lay understandings of risk with reference to 'objective', rational, probabilistic models, social theorists have advanced the proposition that lay conceptualisations of risk should be viewed as not only
broader than traditional conceptualisations but as reflections of social understandings of risk (Gardner & Gould, 1989; and Wynne, 1992). "Rather than seeing people's anxiety and fear simply in individual terms, however, we can also set them in a broader context and consider the extent to which they are linked to wider socio-cultural processes and configurations."

These theorists claim that the evidence for viewing lay interpretations as broader and more embracing is present within the psychological literature, within findings which suggest that people conceptualise risk in terms of a wide range of variables, such as controllability, voluntariness, catastrophic potential, dread and immediacy of effect. It is not so much the issue of the broader conceptualisation of risk which is at issue here amongst social theorists, this is generally accepted within the psychometric tradition (see, for example, Fischhoff, 1995), rather it is the status which is ascribed to lay knowledge, and the extent to which subjectivity is accepted as being present within all conceptions of risk.

2.6 Safety culture

Summary
Although less well defined than other frameworks, a growing body of, principally psychological, research appears to highlight the importance of cultural influences on risk perception and risk behaviour in the workplace. While empirical evidence of the effects of culture on risk behaviour remains limited, findings which demonstrate the presence of substantially complete risk knowledge amongst operational staff might, at least by inference, be considered suggestive of social and cultural influences on risk behaviour. The degree of homogeneity in study findings is also limited to some extent, however, there appears to be a growing acceptance of the importance, and centrality, of management prioritisation and commitment to health and safety. Earlier psychometric studies in this area effectively sought to map and define safety culture at the level of the organisation, and to identify the features of 'successful' organisations in terms of some measure of safety performance. However, more recent findings are suggestive of plural rationalities and subcultures within organisations, delineated, for example, in terms of a range of social and professional groupings and their respective common experience and understandings of risk. A principal contribution of the research in this area is that it has further highlighted the need to take account of social, cultural and situational influences, when attempting to understand people's responses to hazards.

Although not easily referenced to any single paradigm, a growing body of research has developed, broadly within the framework defined by Zohar (1980), which emphasises the importance of the role of culture in safety management, within workplace contexts. As Pidgeon (1991) notes, much of the research activity in this area to date has been somewhat atheoretical. However, a common strand, possibly reflecting the essentially exploratory nature of many investigations, has been the increasing widespread use of multivariate analysis, based upon attitudinal data (eg: Zohar, 1980; Dedobbeleer & Beland, 1991 and HSE

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In this respect the area shares something in common with psychometric approaches to risk perception.

Currently, there remains much debate over precisely what is meant by the term 'safety culture' and the extent to which it should be considered as distinct from 'safety climate', as well as the range of variables which have the potential to engender positive or negative influences in this respect (see, for example, Cox & Flin, 1998). The concept of culture is widely used in cross-cultural psychology, as well as other areas of social science, and a multiplicity of definitions are available. The ACSNI report (1992), for example, adopted a social psychological position, in defining the concept as "...the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment, and the style and proficiency of, an organisation's health and safety management." Similarly, Turner et al (1989), conceptualise safety culture as "...the set of beliefs, norms, attitudes, roles and social and technical practices that are concerned with minimising the exposure of employees, managers, customers and members of the public to conditions considered dangerous or injurious." (cited in: Newby, et al, 1997, p.134). This latter definition sees safety culture as a socially constructed system of meanings through which individuals, and groups of individuals, understand the hazards within their world or work. "Such a constructed meaning system specifies what is important and legitimate to them, and explains their relationship to matters of life and death, work and danger. A culture is created and recreated as members of it repeatedly behave in ways that seem to them to be the natural, obvious and unquestionable ways of acting, and as such will serve to construct a particular version of risk, danger and safety. Such reactions to the perils of the world also will embody culturally distinctive explanatory schemes, which will provide appropriate accounts of accidents, and how and why they happen." (Pidgeon, 1991).

In contrast to the majority of findings reported within the literature on public perceptions of risk, findings from a number of safety culture studies have contributed to an apparently growing body of empirical evidence which suggests that individuals frequently possess substantially accurate perception of risk in industrial contexts (Ostberg, 1980; Rundmo; 1992 & 1994; Flin et al 1996; Rundmo & Sjoberg, 1997; Fleming, et al, 1998 and Weyman, 1994). These findings, in the main, however, relate to understandings of physical risks in high hazard environments. Other findings suggest that this effect may be substantially weaker for perceptions of risks posed by hazardous substances and amongst those working in complex environments, where the scope for cognitive models to contain omission errors might be viewed as greater, for example: where risks are less immediate or observable and, hence, tend to be manifested beyond individual experience. (DeJoy, 1996; Weyman et al, 1995; Weyman et al., 1996; and Weyman & Scobbie, 1998).

The primary significance of these findings can be seen to be the fact that they counter the traditional view that risk taking, at least with regard to observable physical hazards, can be principally attributed to ignorance, misconception or misinterpretation of risk on the part of the risk taker. Rather, in common with a number of findings from within the Value expectancy paradigm (see above), the implication is that in many instances perceived risk may constitute a relatively minor variable in predicting precautionary behaviour, where job
related barriers are taken into account, such as availability of safety equipment and resources, as well as the influence of social reinforcement by peers and significant others (DeJoy, 1996). Similarly, Cvetkovich & Earl (1992) suggest that findings from work on public reactions to radon (see Bostrom et al., 1992) highlight the presence of some limits to the common sense conclusion that people do not respond to hazards simply because they lack information about them.

Although the concept of safety culture has generally been applied at the organisational level, logically, it could equally be applied to subdivisions of an organisation, such as individual departments, workgroups or individuals of similar employment status. Indeed, questions have been raised regarding the extent to which it is legitimate to assume homogeneity of culture within a single organisation (see, for example, Guest, 1992) and to seek to differentiate between organisations in this respect (Mearns et al., 1998), this being a common feature of much of the psychological work in this area to date.

Adams & Ingersoll, (1989); Pidgeon (1991) and Mearns et al (1998) talk in terms of safety subcultures27 within the workplace. Research evidence which highlights the importance of organisational role could be viewed as indicative of such effects. Marek et al (1985) and Tangenes & Hellersoy (1985), for example, talk of different worlds of risk for different occupational groups in the offshore industry. However, the degree of consensus regarding the precise nature of the influence of organisational role on perception of risk currently appears to be limited. Lee et al (1993), for example, provide findings which indicate that managers and supervisors tend to be significantly more cautious in their approaches to risk than workmen. By contrast, other studies have shown that supervisors are poor sources of risk information, and have a tendency to underestimate risk, reportedly because they are ‘too far removed from operations to make meaningful assessments’ Rosner & Markowitz (1995), or ‘more exposed to production pressures than other staff’ Ostberg, (1980), see also Rushworth et al, (1986). Research into perceived HIV risk amongst hospital staff (Fergusson & Cox, 1994) is further suggestive of the salience of contextual influences (public and private) on risk judgement. However, in this case, such effects seem likely to owe more to notions of personal control than occupational role.

The above evidence is suggestive of the fact that perceptions of workplace risks are, at least to some degree, culturally defined by organisational factors, such as occupation role or hierarchical position. "That is, the prevailing social and behavioural norms impact upon each group's 'frame of reference' in relation to risk, as well as their attitudes towards safety. Importantly, these norms are thought to reflect and be determined by the organisation's safety culture." (Cooper et al. 1995). Although limited, the available evidence of differences in perception of risk due to organisational role, appears broadly compatible with cultural explanations, highlighting the presence of plural rationalities in organisational contexts (see, in particular, Rayner, 1986).

As yet, the area of safety culture does not appear to have received any significant attention or contribution from either cultural or social theorists. However, it seems likely that there would be a degree of criticism of the approaches adopted to date, from these perspectives, principally with regard to methodology, and that these would likely mirror those levelled at

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27 While this is likely to be substantially accurate, the term is somewhat value-laden, due to its association with deviancy, to the extent that its use may be at risk of misinterpretation.
the psychometric work. A further methodological concern, which might be raised regarding much of the safety culture work, relates to what might be seen as an inherent contradiction in the use of individual attitude scales to measure social phenomena.

Despite its largely atheoretical nature, the work on safety culture appears to have provided a number of interesting findings, possibly most importantly relating to the importance of context on perceptions of risk. It is now generally accepted that safety climate serves as a frame of reference for guiding relevant behaviour in the workplace and that "employees develop reasonably coherent expectations regarding behaviour outcome contingencies in their environment." (De Joy, 1996; p.67). Arguably, the principal contribution of this work to risk research is that it has served to further highlight the need to take the unit of study beyond the individual per se. In particular, it is suggestive of the need to take account of social, environmental and cultural variables, in order to understand responses to hazards. It also has therefore, highlighted the need to move on from purely psychological explanations of individual risk appraisal. (Pidgeon, 1994).

It would seem reasonable to view much of the development of work on safety culture as comparable to that within the psychometric paradigm, in so far as its primary impetus has been an attempt to identify the finite number of variables which have greatest impact in defining safety culture, except that rather than attempting to define the 'personality profile of risks' it seeks to define the 'cultural personality of organisations', which predispose their consistent members to take risks. Although there exists some variation and inconsistency in study findings, a degree of consensus seems to be emerging regarding the factor models identified by psychometric approaches in this area, principally with regard to the dimensions of 'management commitment to safety'; 'workforce involvement'; 'attitudes to hazards'; 'personal responsibility'; 'compliance with safety rules' and 'workplace conditions' (Cox & Flin, 1998). Questions have been raised, however, regarding the generalisability of findings and the stability of factor models derived (Cox & Flin, 1998). Furthermore, where studies have attempted to test the predictive power of identified constructs, they have tended to rely upon methodologically weak and potentially unreliable dependent measures, such as self-reported accident data. This has led some authors to conclude that while having face validity at an intuitive level, the validity of the safety culture concept remains largely unproved (see Rycraft, 1997).

In addition, to date, very little work appears to have been done in this area aimed at unpackaging the range of variables which underlie those constructs which have been identified. In general, studies have concentrated upon high hazard industries, focusing upon macro level organisational factors which are said to impact upon safety standards, with little illumination of the cultural influences and social processes which impact upon perceptions of risk and risk behaviour. The general area of safety culture, and its potential influence on risk perception and predisposition towards risk behaviour does, however, appear promising and ripe for further investigation and development.
3.0 RISK COMMUNICATION

Summary

There is now a widespread acceptance that, to be effective, risk communication needs to extend beyond the mere provision of scientific and technical information regarding risks to individuals and groups, and that there is a need to address broader qualitative understandings as well as social and cultural influences in this respect. To achieve this, there is a need to gain an insight into the current risk understandings, concerns, priorities and insights of the target population(s). A broad distinction which may be made in this area relates to the presence of micro versus macro levels insights. At a micro-level, there is widespread acceptance of the need to devise risk communication material which is cognitively accessible, in the sense that it maps onto and addresses current understandings of the target population(s). At a macro-level, broader influences, relating to issues surrounding the cultural profile of sources of risk information, can be seen to be of relevance. Of particular salience in this respect are issues of institutional trust and credibility. Psychological work in this area has tended to concentrate upon micro-level issues, or to view issues of trust in a relatively narrow and constrained sense, as a facet of attitude or belief, referenced to the individual. Other theorists, by contrast, highlight the importance of social and cultural influences. These authors suggest that macro level influences such as trust and credibility in sources of risk information reflect socially derived, shared, understandings. This may vary between different cultural groupings / target populations, and frequently include attributes which extend beyond the characteristics of the hazard itself. A central finding in this area is that levels of institutional trust in government as a source of risk information is frequently limited. However, research findings relating to the social profile of individual agencies and institutions of state with responsibility for risk management are sparse. In short, there is now a growing consensus amongst researchers that effective risk communication frequently has as much to do with the perceived characteristics of the source of this information as features of the hazard itself.

Since the late 1970s, the central point of interest for much of the research on perception of risk has been within the applied context of risk communication. Although this interest in risk communication constitutes a relatively new topic, research into persuasive communication, in general, has a long and established history within social psychology. "Typical findings are that success of any communication depends upon the characteristics of the sender of the message, and the receiver. For risk communication research, a clear conclusion to be drawn from this work is that if the message is not appropriately matched to the frame of reference of the audience then the communication may fail (or even prove counterproductive)." (Pidgeon, 1992, p.178).

A major influence on the development and funding of research into risk perception and risk communication, particularly within the United States, has been the presence of significant opposition amongst interest groups, as well as broader public disquiet, to societal risks in
particular 'technological risk(s)'. The perceived need to allay such public fears can be seen to have been a primary objective of both government and industry (Otway & Wynne, 1989). Furthermore, as Gardner & Gould (1989) note, "Many technical experts believe that this opposition [to, for example: technologies such as nuclear power or genetic engineering] results from an overestimation by the public, of the risks of technology, caused by a lack of technical education, misinformation appearing in the media and even irrationality." (Otway & Wynne, 1989; p.225). Additionally, such opposition has generally been perceived as evidence of the general public's inability to perceive the benefits of such technology.

Historically, a fundamental assumption amongst technocrats, industrialists and legislators, has tended to be that a particular activity or process is free from substantial risk and that the public has a tendency to exaggerate the risks. Such a view has generally led to the logical conclusion that effective communication about health and safety is what is required, in order to 'educate' the public regarding the true risks and benefits, in order to allay these 'irrational' fears. As Pidgeon (1992) notes, such an assumption is not uncontroversial. This situation might reasonably be predicted to be in contrast with workplace contexts, where much of the available evidence appears to suggest that more commonly encountered attitudes towards risk reflect reduced levels of anxiety and concern, at least in part due to the effects of familiarity and habituation. In the workplace, the role of risk education is generally viewed as one of awareness raising designed to increase levels of motivation towards cautionary action.

Although a significant amount of research effort has been expended on the topic of risk communication, much of that which is available has been reported to be of varying quality. (see Otway & Wynne, 1989; Pidgeon et al, 1992). In addition, several interrelated factors are said to have led to the emergence of interest in risk communication. One reason can be seen to be a desire to raise awareness in order to protect the public; generally with regard to public health issues, a second, however, has been the desire by governments to find ways of alleviating public concern and the potential for social conflict over risk(s), notable recent UK examples relating to 'food crises'.

Perceiving risk assessment to be essentially a technical matter, to be resolved by developing more accurate scientific information, industry and policy makers have historically placed greatest emphasis upon the development of quantitative measures and the communication of this information to the lay public. (Nelkin, 1989). Furthermore, as Covello (1996) notes, many government officials and experts are largely insensitive to, and unaware of, the information needs (desires) of the lay public. Unsurprisingly, they frequently assume that the lay public share their frame of reference for evaluating and interpreting risk information. Traditional risk communication has tended to be a one-way process, aimed at the distribution of essentially probabilistic, rational, 'scientific' risk information, designed to inform the general populous (see Lee, 1986). As noted in the Royal Society report (Pidgeon et al, 1992), the 'one-way model' has been the target of extensive criticism, principally on the grounds that it assumes an altruistic communicator and risks undervaluing the perspective and knowledge of the receiver.

A further criticism of the traditional risk communication model relates to the range of information sources which are typically drawn upon to inform risk messages, this tending to be scientific and technocratic in both nature and conceptualisation of risk. Findings from the
early psychometric research, principally the discovery that marked differences exist between experts and members of the lay public with regard to the criteria evaluated when considering risks, combined with evidence from socio-cultural theorists, indicates that lay perceptions reflect broader conceptualisations of risk than those adopted by scientists and technocrats (see Fischhoff, 1995 and Walker et al, 1998). Fundamentally, these findings bring into question the utility of basing risk communications upon mainstream scientific knowledge alone (Wynne, 1992).

It is now generally accepted, at least within the social sciences, that effective risk communication must be based upon not only 'scientific knowledge', but also on an understanding of the range of factors which influence both individual and group responses to risk. For psychologists this has been interpreted as a need to address, and gain an insight into, the beliefs, attitudes, expectations and behavioural intentions of the target population. For social and cultural theorists, however, what is required is a broader perspective in this respect, based upon the premise that the relative success of communications on risk(s) tap into much broader social issues than the risk object itself.

The Royal Society report (Pidgeon et al, 1992) highlighted the mental models approach as offering a new and methodologically interesting way forward for the psychological work on risk. Indeed, research within this framework has continued to develop during the intervening period. The mental models approach (Jungeman et al, 1988; Bostrom, 1990; Bostrom, et al; 1992; Morgan, et al, 1992; Maharik & Fischhoff, 1992; Atman, et al, 1994; MacGregor, et al, 1994 & 1995; Fischhoff, 1995; and Fischhoff, et al 1997) can be seen to have gone some way towards addressing a number of the issues raised above, a basic premise being that people's mental models of risk have the potential to contain "critical bugs" (Fischhoff 1997), which can lead to erroneous conclusions, even amongst those who are otherwise well informed. Whatever the goal of communication, its designers need to address the mental models that recipients bring to it, that is, the pattern of knowledge gaps, overly general understandings, and outright misconceptions that can frustrate learning." (Atman et al, 1994). Although the mental models approach clearly draws upon both the decision-making research on heuristics and biases and findings from the psychometric research, arguably its most significant deviation from this earlier work is with regard to the method of elicitation of lay people's views and understandings of risk (see above).

In summary, the approach can be conceptualised as a four stage process: (i) Open-ended elicitation of people's beliefs about a hazard - allowing the articulation of both accurate and inaccurate beliefs; (ii) Structured questionnaires - designed to determine the prevalence of these beliefs; (iii) Development of communication material, based upon insights from steps one and two; and (iv) Iterative piloting of successive versions of communication material with a sample drawn from the target population.

Having gained an insight into lay perceptions of risk the technique requires that this information should be compared with an expert model of the risk(s) of interest.
"Discrepancies between this model and recipients existing mental models then indicate the content of [subsequent] communications." (Atman, 1994). "Bridging the gap between lay mental models and expert models would require adding missing concepts, correcting mistakes, strengthening correct beliefs and de-emphasising peripheral ones" (Fischhoff, et al,
The approach is claimed to possess three basic tenets, firstly the recipient of communicated messages needs a basic understanding of the exposure, effects, and mitigation processes relevant to making decisions about the hazard(s); secondly, recipients existing beliefs affect how they interpret and use any new information; and thirdly, the information should be presented with an appropriate text structure, consistent with general research findings on textual comprehension.

Fundamentally, the basis of the mental models approach is that it aims to find ways of presenting information to people so that they can make informed judgements. This is said to be achieved by 'fitting' information on risk to people's intuitive ways of thinking. "People can be hurt by inaccuracies in their risk perceptions. They can also be hurt by inaccuracies in what other people believe about those perceptions.... If their understanding is overestimated, people may be thrust into situations that they are ill-prepared to handle....If their understanding is underestimated, people may be disenfranchised from decisions that they could and should make (Fischhoff, et al, 1997; p.387). Clearly, the approach is appealing in that it appears to provide a pragmatic way forward for risk communicators to understand more about how people conceptualise risk. Empirical evaluations of the technique are suggestive of significant improvements in people's understandings of hazards. For example: work on radon (Morgan et al, 1992).

A number of objections, although not unique to the mental models approach, have been raised by social and cultural theorists, in arguing that it takes too narrow a view of science and that it fundamentally remains locked into the subjective objective conceptualisation of lay and expert models of risk, still largely viewing the latter with reference to the former. This point appears to be exemplified by the following statement: "If lay people were trained decision analysts then it would be straightforward to determine what information they need." (Morgan et al, 1992).

In this sense, it would appear that the ethos of the mental models approach remains bound up in notions of risk education, and that it merely suggests that the education material should be tailored to the needs of the receiver. Furthermore, the approach would appear to be in, at least partial, contradiction with previous conclusions on the role of risk education (Slovic et al, 1974 & 1981). While it seems undeniable that there is merit in the approach, principal objections which have been raised relate to the risk of overplaying, or at least implicitly assuming, a high degree of unity within the scientific community over risk issues. Although some authors within this framework acknowledge such effects, MacGregor & Fleming, (1996), for example, comment that the debate and confusion in science and the fact that this is reported in the media contribute to people's lack of faith and trust in expert sources (see also Kraus, et al, 1992), others appear to risk underplaying the issue.

Wynne (1992) highlights the fact that this is not merely a philosophical debate but one which has important implications for risk communication. "...much of the impetus for the current interest in this subject stems from a broad anxiety among scientists and policy makers about what they see as the public's inability, or unwillingness, to understand 'correct' messages about risks as given to them by the experts." (Wynne, 1992). An underlying premise of this position is the view that scientific knowledge is essentially neutral, unproblematic stuff, concerned with truth about the physical world as defined by experts. As a consequence, the task of risk communication is viewed as fundamentally educational, to enhance the public's
understanding of science (Irwin & Wynne, 1996) Such conceptions of science are increasingly viewed as naive and unduly positivist, firstly on the grounds that they underplay the presence of difference and sectional interest within the scientific community. Secondly, with regard to risk communication, they fail to take account of evidence which indicates that people's experiences of risks, risk communication, or any other scientific information are to some degree socially framed, and as a consequence can never be viewed as a purely intellectual process about perception or knowledge per se. Wynne, (1992), therefore, suggests that issues of public understanding and perception of risk are not so much about this, as about their perceptions of trust and credibility in science, government and state institutions.

Citing examples from empirical work involving nuclear contamination of the area around Sellafield, following the Chernobyl disaster, Wynne (1992) further highlights the fact that not only can lay knowledge make a valuable contribution to scientific models of risk, but that, if the scientific model is incomplete, and is perceived as such by those in possession of lay expertise, there is a danger of undermining the credibility of expert knowledge, and as consequence any risk information which is provided by that source. Similarly, it has been noted that "Official information is only one of a number of different routes through which a hazard is understood." (Bloor, 1995; p.49). Although both of these authors admit that there is a danger of idealising lay expertise, and that it is necessary to acknowledge that lay experiences may be subject to the same process of social construction as the 'expert' knowledge, this is not considered to invalidate the central thesis.

Evidence of the need to include lay expertise in models of risk might intuitively be considered to be of particular importance in workplace contexts, although research evidence in this area is currently sparse. Wynne (1989), however, suggests that a misunderstanding of the social world and a failure to recognise the importance of lay knowledge and insight was apparent in the risk models used by the Pesticides Advisory Committee, in drawing up health and safety regulations for the use of 2, 4, 5-T on farms, and the European Commission's Expert Advisory Committee, in developing guidelines for the use of animal growth hormones. In both of these instances, the 'expert' committees are said to have produced policies which reflected 'ideal' working conditions and, as a consequence, failed to take into account the practicalities and realities which typified the risk environment (Wynne 1989).

Evidence cited by Bloor (1995) highlights further implications of the failure to take account of lay conceptualisations and insights into risk, in workplace contexts. "Where the risk advice does not fit well with the experiential learning of workers the credibility of this source of expert advice risks being significantly undermined, to the extent that it may no longer be viewed as credible, not only on this but also on subsequent occasions." (Bloor, 1995; p.42). These conclusions appear to effectively endorse those of Wynne (1989; 1992; 1993) and Nelkin & Brown, (1984).

With regard to risk management and communication there is increasing evidence of the importance of trust and credibility in information sources (for example: Fishbein & Ajzen, 1975; Lee, 1986; Mitchell, 1992; Covello, 1993; Simmons & Wynne, 1994; Fischhoff, 1995). Furthermore this finding appears to be common to all disciplines within the risk perception / risk communication area. Possibly of greatest significance is the presence of a widespread consensus regarding the fact that problems of trust and credibility cannot be overcome simply by improving the quality of risk communication material. Walker et al, (1998), for example,
suggest that the question of public trust, or more accurately distrust, in risk management institutions is central to understanding the public's perceptions of risk (see also Slovic, 1993; Wynne, 1989; Renn & Levine, 1991; Kasperon et al, 1992; Slovic, 1993; Wynne, et al, 1993; Jungerman, et al, 1996). Similarly, distrust in the competence or willingness of private organisations to manage risk has been linked to heightened perceptions of risk in a number of studies (Burns et al, 1993; Freudenburg, 1993) - and visa versa (see Fitchen et al, 1987; Kivimaki et al, 1995). As the Royal Society report (Pidgeon et al, 1992) anticipated, the issue of trust has become a central point of interest, and convergence, for both psychological and socio-cultural approaches.

However, although studies which highlight the importance of trust are numerous, most provide relatively little practical advice on methods of enhancing credibility in this respect, with much of that which is provided at a rather high level of generality. For example: The authorities should "...try to improve the credibility of those information sources in which the public has presently only little trust.... [and]... they should organise the provision of information in accordance with the target recipients' specific information preferences and interests." (Jungerman et al, 1996, p.261). Similarly, Renn & Levine (1991), suggest that there are at least five attributes of trust: (i) competence - appropriate technical expertise; (ii) objectivity - are the messages free from bias; (iii) fairness - are all points of view acknowledged? (iv) consistency - of risk messages and behaviour over time? (v) faith - a perception of the good will of the message source.

A further factor frequently linked with notions of trust is the need for perceived independence and impartiality of the information source, this having been identified as an important criterion, in a number of studies (see Renn & Levine, 1991). A criticism of much of the empirical work in this area, however, is that it appears to be based upon the premise there exists a single, objective basis for social trust, and that this can be reduced to a simple factor model (Cvetkovich & Earle, 1992). Wynne (1992) also sounds a cautionary note, with regard to the tendency to view the basis of trust and credibility as unambiguous, or as quasi-cognitive categories of belief or attitude, which people supposedly choose to espouse or reject. Rather Wynne says that credibility and trust are analytical artefacts which repress underlying features of social identity.

In addition, findings presented by Jungerman et al (1996) suggest that the situation is rather more complex than this, with trust in information source apparently being dependent upon the characteristics of risk under consideration. In the case of environmental risks, for example, environmental and nature conservation pressure groups tend to be seen as the most honest, as well as competent source; private companies / industry as the least honest; and political / administrative sources as neither honest nor competent. Conversely, respondents are said to prefer information on product and production risks from the producer and information about health risks from university scientists and environmentalists. Findings from this work also indicated that people frequently desire information from multiple sources, apparently based upon the recognition of the potential for information source bias and a desire for personal evaluation (see also Petts, 1998).

There is a growing consensus within the risk communication literature that issues of trust and credibility in information sources have implications which go beyond the psychology of the
individual, however, it would appear that much of the work which has been done to date largely fails to address this issue. The principal implication of this conclusion is that issues of trust and credibility cannot be overcome by simply improving the quality of risk communications, in a narrow and specific sense, without addressing broader social and institutional issues (Walker et al, 1998).

Numerous studies have highlighted the lack of trust in government as a significant obstacle to effective communication (see Wynne, 1992; Slovic, 1993; Covello, et al, 1987; Covello, 1996; and Jungerman, et al, 1996). Slovic (1993), for example, emphasises the need for trust in government and democracy if people are to believe the information they are given. Other authors suggest that trust in government is linked to trust in industry, and to the extent to which hazards are amenable to control (Bord & O'Connor, 1992). Perhaps unsurprisingly, cross cultural differences have also been reported with regard to the degree of trust in government (Jungerman, 1996).

The extent to which these studies differentiated between the respective legislatures and institutions of state is frequently unclear, however, it would intuitively seem to be an issue which should to be addressed further. The degree to which private industry, government agencies and institutions are perceived as being independent of the legislature, might equally be predicted to reflect cultural differences. Coates (1992), for example, makes the point that the notion of whom to trust politically and of whom to trust for health and safety information are likely from two different groups. As yet there appears to have been little quality research on this potentially important topic, possible exceptions, however, being Houwen, et al, (1986) and Petts (1998).

A number of detailed risk communication guides, aimed at improving the performance / success (in this respect) of regulatory officials and plant managers have been published (eg: Raynor & Cantor 1987; Hance et al, 1987; NRC, 1989; and Sandman et al, 1988). Although there appears to be some admission of their practical utility, a number of criticisms have been levelled at such publications. These have centred around their tendency to amount to "cook book" solutions, with a disproportionate concentration upon cognate models, to the extent that they largely ignore broader communication issues. They might be further criticised on the grounds that they tend to concentrate on factors which lead to the social amplification of risk, and their amelioration, but offer very little advice regarding how to deal with the effects of attenuation of risk, something which might reasonably be predicted to be of greater salience in workplace contexts (see above). As Pidgeon (1997) notes, they frequently fail to take account of broader cultural influences which appear likely to explain why some serious hazards remain hidden, or attenuated. eg: where they affect marginal or sectional group interests; or conflict with deeply held values other than safety. The Royal Society report concluded, on this issue, that "...although much of the available literature purports to give practical advice for risk managers, to date few empirical studies of risk communication, and in particular of its consequences and effectiveness are available." Pidgeon, (1992). More fundamental criticisms relate to undertones of propaganda and social manipulation (Otway & Wynne, 1989), and claims that much of the advice fails to stand up to empirical validation (Morgan et al, 1992). The apparent absence of significant developments in this respect leads the current author to concur with the conclusion of the Royal Society on this issue, "...It seems unwise to reproduce here the practice of providing seemingly authoritative advice while the field is still relatively poorly grounded empirically..." (Pidgeon et al, 1992).
4.0 CONCLUSIONS

It is apparent that the degree of consensus, between the differing and frequently competing, theoretical frameworks remains modest, and that there has been little change in this respect since the Royal Society report (Pidgeon et al, 1992) came to a similar conclusion over half a decade ago. Although treated as largely discrete within the current review, it is clear that each constitutes a 'broad church', with regard to the relative positions of their constituent members, and the extent to which they embrace, or reject, insights from alternative paradigms. However, what is apparent is that each perspective appears to be troubled and challenged by the insights and work of the others. No single paradigm, therefore, has as yet proved to be sufficiently embracing and comprehensive, in terms of the insights it has to offer, to render the alternative approaches redundant. Rather, each approach can be considered to possess certain strengths, while challenging perceived theoretical and methodological weaknesses in its 'competitors' (Kemp, 1996).

The Royal Society report, (Pidgeon et al, 1992) identified four key trends within the research on risk perception: firstly, that the distinction which had historically been made between subjective and objective risk was no longer a tenable position. A second, related, and arguably more significant, conclusion was that it is now widely recognised that social, political and cultural variables play an important role in shaping an individual's attitudes towards risk. There appears to have been an increasing acceptance of these issues in the intervening period, at least amongst social scientists. Thus, in contrast to the earliest psychological explanations of perceived risk, there is now an established consensus regarding the finding that, in order to understand peoples reactions to risk, it is necessary to take some account of the social and cultural contexts in which hazards arise, and the manner in which these variables shape people's attitudes, beliefs and behaviour. In addition, at least amongst social scientists, there is now a general acceptance that perceptions of risk cannot be reduced to a single subjective correlate of a particular mathematical model of risk, such as the product of probabilities and consequences, because this imposes unduly restrictive assumptions about what is an essentially human and social phenomenon (Pidgeon, et al, 1992). As Newby (1997) notes, however, the concept of risk being a fundamentally social construct has met with some resistance amongst technocrats and natural scientists.

As Johnson & Covello (1987) note, the claim that risk is a social construct, stemming primarily from social and cultural factors raises an interesting and difficult philosophical issue. Principally, if people are incapable of perceiving what is really hazardous, since there are no actual objective risks in the world, merely subjective perceptions, then logically the perceptions of one person should be viewed as no more valid than those of another. ie: a fundamentally relativist position. A somewhat less radical conclusion, however, might be to view risk as a fundamentally social construct, but as not only a social construct, as "...the science cannot simply be explained away as, for example, some cultural anthropologists have sometimes appeared to imply." (Newby, 1997; p. 134). A principal insight from the social process theorists, on this issue, appears to be the view that traditional technical and scientific models of risk are frequently insufficiently embracing, not only in terms of the risk evaluatory criteria used by the lay population, as the psychometric research highlighted, but because the technocratic model may be epistemologically incomplete in terms of the criteria
it uses in evaluating risk. Although empirical evidence on this issue is limited within the literature (see Wynne, 1989; 1992; & 1993), at an intuitive level the importance of lay (worker and user) expertise might be considered to be of particular relevance in workplace contexts.

The apparently increasing interest in workplace safety culture, although arguably theoretically underdeveloped, in many ways mirrors earlier cognitive and psychometric research in terms of its concepts and methodologies, in at least initially viewing risk-taking behaviour as resulting from inaccuracies and misunderstandings of risk. The conclusions of much of this work, however, indicate that perceptions and knowledge of observable physical (safety related) risk in the workplace are frequently substantially accurate, which would seem to imply that bias and misunderstanding in many instances should not be viewed as the primary determinants of risky decision-making, rather disposition towards risk is considered to be determined by a range of contextual variables. In this sense, findings appear compatible with those from the value expectancy framework, which also highlighted the importance of physical and social barriers to caution, i.e: social and cultural influences are a more significant determinant of risk behaviour.

Other findings, however, indicate that the scope for cognitive bias and fragmentation of risk knowledge is greater where risks are manifested in complex ways, or where their effects are less tangible, or diffused, for example, by delays between exposure and the onset of symptoms of ill health, as is the case for many hazardous substances. Value expectancy research on public health risks, such as HIV infection appears to be broadly supportive of this view.

Still further findings are suggestive of social and cultural influences on perceptions of risk, for example insights relating to effects of organisational role. However, there has as yet been very little detailed research into the effects of cultural and sub-cultural influences on perceptions of risk in workplace contexts, and how these might interact with cognitive variables. For example, there has been little empirical investigation of how perceptions of risk might change over time as a function of social interaction, exposure or experience, where cognitive variables such as familiarity, perceived control or confidence might be hypothesised to be of salience. The recognition, in this area, by psychologists of the importance of cultural influences, the potential effects of social interaction and the interplay with cognitive aspects of the decision-making process appears to have the potential to offer an interesting way forward for multidisciplinary risk research, which as yet remains largely under explored.

The Royal Society report (Pidgeon et al, 1992) also concluded that the insights provided by the early work in decision-making, which highlighted the presence of a range of cognitive influences, said to act as systematic biases impacting upon perceptions of risk; and the psychometric work, which indicated that the qualitative characteristics of risk can be reduced to three principal independent dimensions (perceived dread; knowledge about the hazard and number of people likely to be affected) has led to the psychology of risk perception having matured into an established and widely accepted field of enquiry. However, it was further noted that the contribution of these perspectives, although providing useful insights and having achieved the status of 'normal science', has more recently, begun to stagnate in terms

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28 Observable, tangible, immediately manifested safety related risks, as distinct from hidden, intangible, frequently delayed, effects posed by risk to health and well-being.
of the explanations which it is able to offer. This appears to remain the case, furthermore, it would appear that although they are still widely used, similar conclusions could be drawn regarding insights provided by value expectancy approaches. Taken in summation, there now appears to be an established acceptance, amongst researchers working in these areas, of the limitations of approaches which fail to take account of social, cultural and political factors.

On a more optimistic note, the report highlighted the development of the mental models approach as having the potential to take mainstream psychological research forward. This appears to have been the case, with continued development in this respect in the intervening period. Although the technique appears 'more social' than the majority of previous psychological work in this area, at least in terms of its methodology, having embraced the use of qualitative methods, and in this sense sharing a degree of commonality with socio-cultural approaches, it remains fundamentally cognitive and rooted within the psychology of the individual. In addition, in constructing expert models of risk it is unclear from the literature precisely how these models are derived, in particular regarding the range of 'expert' sources which are drawn upon in the generation of these models, and the extent to which this satisfies the issues raised by social process theorists. It is further unclear how the technique resolves situations where consensus over the salience and nature of risk attributes is either limited or absent.

However, on balance, it seems that with some further development, the approach has the potential to offer further useful insights regarding lay interpretations of risk, and there seems little reason to doubt that it could be profitably applied in workplace contexts. What does seem clear, however, is that in order for it to gain wider acceptance, proponents of the technique need to address the process by which expert knowledge is defined, and in particular to examine the need and scope for broadening this definition. This requirement might be considered to be of particular salience in workplace contexts, where it might reasonably be hypothesised that perceptions and understandings of risk will be more complete and firmly established than in the non-work contexts, in which the method has been applied to date.

The Royal Society report further acknowledged that the development of cultural and social perspectives provided a useful theoretical basis for understanding public perceptions of risk, while at the same time noting that the empirical basis for this work was, at that time, limited. The most significant attempt at the empirical evaluation of cultural theory, combined with an attempt at integration with findings from psychology remains that provided by Dake (1991), in suggesting that 'world views' can be considered to operate as cognitive filters, in a predispositional sense. This interpretation has met with some support, although others have questioned the degree to which Dake's conceptualisation is sufficiently social and embracing. This issue remains, as yet, largely unresolved.

A further observation of the Royal Society report (1992) was that risk communication had emerged as a key topic of concern, and that there was some unity between the disciplines and perspectives in this respects. As the report predicted, this area has seen continued development, and appears to be an area in which there is a growing consensus between psychological and socio-cultural approaches regarding the central issues. Although the different academic disciplines have frequently preferred to focus on either the cognitive or the socio-cultural dimensions, there is now a general acceptance that effective communication is
multidimensional, involving far more than the expression of probabilistic information, and that there exists a need to attend to broader qualitative interpretations of risk. The mental models approach appears to demonstrate considerable promise as a method of eliciting lay views on risk and has gone some way towards exploring appropriate means of framing technical risk information based upon these insights. However, there remains some scope for further development and refinement of the method (see above). Possibly, of greater importance has been the realisation that effective risk communication frequently has as much, in some instances more, to do with perceived characteristics of the risk information source as perceptions of the risk object itself.

A number of studies have demonstrated that issues of trust, responsibility and blame are intrinsically linked with those of risk perception. Of particular significance, in the current context, is the finding that levels of institutional trust in information sources, particularly that in government, is frequently reported to be limited. Part of the problem is said to stem from the insensitivity of many government officials and experts to lay conceptions of risk, as well as an unwillingness to either acknowledge problems or to share risk information (see: Hance, et al, 1987; Covello, 1992). In addition, issues of perceived inconsistency (in risk messages) and perceived group interest, of risk information sources, have been cited as playing an important role in the public's perceptions of institutional credibility and trust. Psychological approaches to trust and credibility have tended to see these 'variables' as further quasi-cognitive dimensions of attitude and belief, by contrast social and cultural theorists view them as broader issues bound up with social identity. As has been the case with other topics, there has been much debate over this. A conclusion which can be drawn, however, is that the issue of perceived credibility in information sources is almost certainly bound up with historical experience, and with issues of institutional trust which extent beyond the topic of risk management.

In considering the principal findings of the risk communication framework, in pragmatic terms with regard to workplace contexts, there would appear to be significant scope for the continued application and development of mental models approach (see above), at least at the micro-level, where the aim is to produce risk information which fits the frame of reference of the target population. Turning to the more macro-level issues of trust and credibility in information source(s), although there appears be very little empirical evidence on this topic directly relevant to workplace contexts, a notable exception being Nelkin & Brown (1984) it would seem reasonable to conclude that findings relating to perceptions of the state and government (see above) might extend to perceptions of company management. However, this would logically vary in terms of the prevailing safety culture(s) within the organisation.

Similarly, there has been little empirical research aimed at determining the credibility of individual government departments and agencies, a notable exception being Petts, (1998). It seems likely that there will be variations between institutions in this respect, this likely being dependent on the historical profile of each, and how their roles are perceived by the range of 'target' publics. In addition, it might be hypothesised that perceptions of these institutions will vary in terms of the extent to which they are viewed as independent of the legislature, and that this will interact with the degree of perceived trust and credibility in the legislature itself, which cannot be considered static and unchanging. With regard to institutional trust,
therefore, it would seem reasonable to conclude that there would be merit in conducting baseline research to establish current public perceptions of the various government departments and agencies involved in risk communication. Insights provided by the work on safety culture might also provide a way forward for similar exercises at the company and organisational level.

Clearly a range of institutional and organisational routes, or 'amplification stations' (Kasper, et al, 1988), other than government, are available for the communication of health and safety information aimed at workplaces. Intuitively, and implicitly reinforced by evidence provided by existing social and cultural theory, it seems likely that some of these potential information sources will be viewed as more credible and trustworthy than others, and that this is likely to vary, both in terms of the nature of risk under consideration and the 'target' population. It would, therefore, seem reasonable to conclude that empirical investigation of this issue may provide further insight relevant to the enhancement of future risk communication strategies.

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30 Examples include: government departments & agencies; professional and trades associations; trades unions; and product manufacturers.
Annex 1

SUMMARY AND DISCUSSION OF THEMES
WITHIN THE LITERATURE
SUMMARY AND DISCUSSION OF THEMES WITHIN THE LITERATURE

1.0 INTRODUCTION

During the course of conducting the current review it became apparent that it was possible to identify a number of recurring themes within the literature which are of relevance to the understanding of the range of variables which have been identified as impacting upon risk perception, and which have implications for risk communication. In order to keep the main body of the review within manageable proportions it was considered inappropriate to include any detailed discussion of these themes in that context. Summaries and a limited discussion of selected themes are, therefore, provided in the form of an informative annex and supplement to the current review. Although no claims are made with regard to the extent to which identified themes constitute a comprehensive summary of research findings, it is hoped that they will be accepted as a reflection of principal findings. In most instances it will be seen that there are insights and contributions from a range of perspectives, it is considered that such apparently corroborative evidence might be viewed as contributing to the strength of these findings. In addition, it will be observed that the treatment of themes as discrete is, in many cases, somewhat artificial, and that a degree of overlap is, as a consequence, frequently present.

1.1 Identified themes

- Perceived control
- Psychological time and risk
- Familiarity
- Perceptions of vulnerability
- Framing effects and frames of reference
- Numerical representations of risk
- Perceptions of hazardous substances
- Risky situation or risky individual

2.0 PERCEIVED CONTROL

The concept of control is seen as important in a number of areas and in various ways with regard to risk perception and risk decision-making. At a personal level, perceived control has been viewed as operating at a dispositional level, as a personality trait, reflecting differences between individuals in this respect. (see Burger, 1992). However, within the risk literature it is more commonly conceptualised as a more general influence. Insights from the psychometric tradition, for example, where aggregate risk values, from a number of diverse population samples, have been derived for a range of sources of risk, highlighted the importance of perceived control with regard to notions of personal vulnerability. Linkages have also been made with the extent to which exposure is perceived to be under people’s own volition (voluntariness of exposure). These are considered to be important qualitative variables used in lay evaluations of risk, contributing to the widely identified ‘dread’ dimension. (eg. Fischhoff, et al. 1978). Other investigatory approaches have revealed similar
findings. Stallen (1981), for example, reported that personal control over exposure to risk was an important factor in determining acceptability of risk.

At a more personal level, Kasperton et al (1988) note that direct experience of risk can either be reassuring or anxiety inducing, this largely being dependent upon the type of feedback obtained, the degree of threat and perceived levels of control over salient aspects of the risk environment. Weinstein (1980) talks of control as a source of cognitive bias, contributing to ‘unrealistic optimism’, and notions of personal invulnerability (see below). Research on driver behaviour (Svenson, 1981; and Bragg & Flin, 1986) construction safety (Zimalong, 1986) highlights the effect of perceived control leading to attributional bias. In the case of car drivers, there is, for example, a tendency for people to perceive themselves to be at less risk than their passenger(s) and other drivers. This is linked with broader findings which highlight the tendency for individuals to believe themselves to be more skilled (and hence better able to control risk) than their peers (a social comparison effect - see below) the suggestion being that such attitudes lead to reduced levels of caution. This last example can be seen to highlight a further widely reported facet of control, voluntariness of exposure to risk (Wildavsky, 1986; Lyng, 1990).

Voluntary exposure to risk has been found to be associated with higher levels of self-efficacy, compared with involuntary exposure (Weigman & Gutteling, 1996). An example of such effects is reported by Greishop & Styles (1989) who found more positive attitudes to pesticide use in the home, compared with other contexts, such as agricultural or horticultural use. Similar contextual influences have been reported with regard to the public (workplace) and private (non-work) exposure to HIV infection (Ferguson & Cox, 1994). These authors concluded that levels of anxiety were moderated by the extent to which health care workers felt able to control their exposure, with respondents typically perceiving greater control in non-work contexts.

Cognitive strategies of coping behaviour are also relevant here. Feelings of being in control, either by being able to ward off an accident or by being able to mitigate its effects, are said to contribute to a person’s psychological state of well being. Collins, et al, (1983); Rudmo (1992); Cox & Cox, (1993) and Ferguson & Cox (1994), for example, all provide findings which indicate that perceived control can have the effect of reducing levels of stress experienced, which can in turn reduce levels of anxiety which may compromise safety performance.

The role of control is also recognised in more recent studies within the value expectancy framework. Ajzen (1991), for example, talks of ‘perceived behavioural control’ which might be considered to be broadly synonymous with Bandura’s (1989) concept of ‘self-efficacy’, and Fishbein & Ajzen’s (1975) concept of ‘perceived barriers’. In this context control is viewed as a potential moderator of precautionary behaviour.

Other insights suggest that trust in government and trust in industry, with regard to risk management, are linked with the extent to which hazards are perceived to be amenable to control (see Bord & O’Connor 1992 and Stallen & Tomas, 1988). A related influence is said to be the extent to which people feel empowered to influence conditions which have the potential to affect them. Social theorists refer to this as ‘agency’, although in many respects
the concept is similar to those of 'locus of control' and 'self-efficacy', more commonly used by psychologists (Wynne et al, 1993).

3.0 PSYCHOLOGICAL TIME AND RISK

Evidence provided by a number of studies (Jones et al, 1973; Nisan & Minkowich, 1973; and Bjorkman, 1984) highlights the presence of a potential source of cognitive bias relating to the amount of delay between the performance of a 'risk act' and the [frequently only possible] onset of undesirable consequences. This suggests that there is a tendency towards reduced levels of caution where undesired consequences (eg: the onset of ill-health) are distal, as for example, is the case with exposure to a wide range of hazardous substances. Hence, 'immediacy of effect' would appear to be a potentially important factor. In reviewing empirical research on this topic, Bjorkman (1984) concluded that 'man is captured in a narrow time space capsule, located around 'here and now'. One consequence of this being that 'risk willingness' increases as a function of time, being greatest when the consequences are furthest distant.

Further evidence of cognitive bias with regard to 'time effects' has been widely reported in relation to the misunderstanding of the manner in which [probabilistic] risk accumulates (eg: Fischhoff & Lichtenstein, 1978; Schwalm & Slovic, 1982; Ronen, 1983; Shaklee & Fischhoff, 1990; Linville et al, 1987; and Weyman, & Anderson, 1998). Linville et al (1987), for example, report on a study where perceived levels of protection from HIV infection afforded by condom use were underestimated, with regard to repeated exposures with the same HIV positive partner, and overestimated with regard to single encounters with multiple (positive) partners. Similar effects have been identified involving the risk behaviour of coal miners (Weyman & Anderson, 1998), where workers appear predisposed to treating each exposure as discrete, rather than as a pattern of risk behaviour. For example, coal face workers may habitually expose themselves to the risk of unsupported ground, but will seek to minimise the amount of time exposed on each occasion.

Other findings relating to cumulative probability, however, are suggestive of complementary effects, Shaklee & Fischhoff (1990), for example, report on an experiment where participants were asked to judge the cumulative probability of avoiding unwanted pregnancy by means of various types of contraception, ie: a comparison exercise. They found that over half of the subjects judged the cumulative effect (conjunctive probability) to be constant - like tossing a coin - implying that the chance of avoiding a pregnancy remains constant over time. Such effects have been attributed to the fact that probability judgements are made by intuitive heuristics, such as anchoring and adjustment and representativeness (Tversky & Kahneman, 1974).

Taken in summation, findings suggest that people possess a generalised awareness that risk changes over time. However, their conceptions are frequently based on mental models or heuristics which can be a source of bias, when such judgements are compared with the laws of formal probability. Difficulties in understanding how risk accumulates can clearly lead to poor decisions.
Although the effects of cumulative bias have been widely demonstrated, it should be noted that objections might be raised regarding the central assumption that the probability of comparative events remains constant. In reality, almost no two risk situations can be considered identical. In the case of risk from HIV infection, for example, when considering the risk from multiple partners, people may be taking into consideration variables other than the fact that they are simply having intercourse with another person. Salient variables might include, the number of previous partners, the prospective partner has had before; whether they are in a 'high risk group', such as intravenous drug user etc. Clearly, even those who rigidly adhere to logical probability would not argue that the risk is the same between members of these groups. Similarly, in the mining example the probabilistic risk might, equally, be considered variable from one exposure to the next, due to the fact that in reality physical aspects of the work environment [and associated risk] are in a constant state of flux. Hence, questions might frequently be raised regarding the extent to which such real world risks lend themselves to direct comparison.

Further, and more positive, effects of 'time', as a source of cognitive bias, are reported by Weinstein et al (1996). They consider that the strategy of portraying risk in terms of varying time intervals, for example, risk x would be expected to kill one person every 3,500 years or risk y one person every four months etc, is more dramatic and effective means of presenting information than traditional statistical expressions of probabilistic risk. These authors suggest that such concepts are particularly useful in the communication of risk information regarding rare events, or risks with a low probability of occurrence (see below).

4.0 FAMILIARITY

A number of related facets of familiarity are apparent within the literature. Findings from the psychometric framework highlight the centrality of familiarity as a qualitative influence on lay evaluations of risk, it having been associated with the broader construct of 'unknown risk', (see reviews by Slovic et al, 1987 & 1992). Familiarity in this context, can be seen to be linked not only with personal experience of risk, but also to be subject to the effects of media coverage of hazards (Van der Pligt, 1998). Familiarity with risk has also been found to have associations with issues of risk knowledge and perceptions of controllability (see Pidgeon et al, 1996 & Van der Pligt, 1998).

With regard to the influence of familiarity on perceptions of risk, contributions from cognitive work on decision-making suggest that there is a general tendency for people to underestimate familiar risks and over estimate those which they are unfamiliar with. Sources of cognitive bias relating to familiarity are said to relate to availability and simulation heuristics (Tversky & Kahneman, 1974; and Slovic, et al, 1979). These, principally, refer to the ease with which instances or associations (based upon prior experience) can brought to mind. Recent examples of such effects are provided by Greening (1997) who talks about personal experience of climatic disasters seeming to heighten 'victims' mental visualisation and memory for such events, this leading to elevated perceptions of risks for future events of a similar type. That is, direct experience of risks can lead to the perception that future, similar outcomes are more likely than they actually are. Availability, in the sense of ease of recall, has further been linked to the extent to which risks can be viewed as sensational, this
reportedly leading to an overestimation of risk (e.g., risk of HIV infection - see Van der Velde et al, 1994).

Other cognitive influences of familiarity have been found to relate to concepts of perceived control and skill (see above). Findings centred on the, now widely researched, concept of 'unrealistic optimism' (Weinstein, 1980 - see below) suggest that the source of such, 'frequently over optimistic' bias can be linked with situations in which the risks posed by hazards are 'low enough', or infrequently manifested, to the extent that individual experience in this respect is overwhelmingly benign, this potentially contributing to notions of control over risk i.e., situations in which direct experience of hazards is not associated with undesirable outcomes. Such effects are said to be further enhanced where external sources of information, in particular the media, serve to reinforce the view that such accidents happen to others. "Given such misleading experiences, people may feel justified in refusing to take precautionary action, such as wearing seatbelts." (Slovic, et al, 1986). As Kaspersen et al (1992) note, direct personal experience of risk can either be reassuring or anxiety inducing, this largely being dependent upon the type of feedback obtained.

In summary, as a source of cognitive bias, familiarity is said to operate at the level of personal experience, suggesting that, in the absence of negative outcomes, it can lead to reduced levels of caution. Conversely, familiarity with risk has also been found to be related to heightened perceptions of risk where such hazards are easily visualised, imagined or recalled, due, for example, to their 'high dread' associations, or the extent to which they are sensational. This is 'experience' is frequently likely to be related to indirect information sources, and is, hence, effectively 'second hand'. With regard to public perceptions of risk, an important source of this 'experience' is said to relate to media attention.

Questions may be raised regarding the fact that many of the psychometric studies have required lay people to make judgements about hazards which, in many cases, it seems unlikely that they will have articulated before, and to which they may not have devoted much consideration. While this may, at one level, have implications for the reliability of findings, it might equally be considered to be a qualitatively different situation from workplace contexts, where people will frequently be familiar with hazards and, it might be hypothesised, are more likely to have given them some consideration, at one time or another (see Nelkin & Brown, 1984).

Socio-cultural insights highlight instances where familiarity has led to reduced levels of anxiety. Walker et al (1998), provide evidence which suggests that individuals who reside in the locality of high risk installations frequently exhibit reduced levels of caution (see also: Melber & Rankin, 1983; Stallen & Tomas, 1988; and Earle & Lindell, 1984). However, these findings further indicate that locality may be insufficient in itself to explain reduced levels of anxiety, given evidence which suggests that, where the local populous is socially divorced from the hazard-producing site, in the sense that they have no direct involvement in its operation, levels of anxiety may actually be enhanced. Walker et al (1998) suggest that where members of the local community have direct experiential knowledge of the site, and are economically involved and dependent upon it, levels of anxiety tend to be reduced (see also, for example, Rogers, 1984).
Some authors have suggested that reduced levels of anxiety, due to familiarity with major hazard sites may reflect either social learning effects engendering an optimistic bias, in the absence of negative feedback, such as an accident (Weigmann et al, 1991). Others have suggested that proximity and familiarity effects, in this context, may lead to dissonance, hence more positive attitudes towards hazard sources may reflect a coping strategy. However, empirical evidence for this latter effect has been found lacking (Rogers, 1984).

The extent to which such attitudes towards risks associated with major hazard sites reflect the effects of familiarity (due to geographical locality), in a cognitive sense (see above), or are a reflection of fundamentally economic cost benefit trade-offs or vested interests' of stakeholders (employees) is to some extent a debatable point. However, it seems likely that the answer resides within some combination of such variables.

A further effect of familiarity can be seen to relate to the status of 'local knowledge'. Wynne (1989, 1992, & 1993), for example, cites instances where lay knowledge and familiarity with environmental variables has had the potential to inform and contribute to expert models of risk, although this is said to be frequently ignored by those in possession of 'expert', technical risk knowledge. In such instances, lack of familiarity and underrating of salient contextual variables, combined with a failure to pay sufficient cognisance to lay insight, is said to have the potential to lead to significant omissions from expert models of risk. Such effects can be viewed as having implications, not only for the accuracy and completeness of risk assessments, but also as having potentially negative influences on the credibility of expert sources of risk information. "People react against not having their expert / lay knowledge of conditions at the coal face taken into account. Furthermore if the advice given by the authorities and scientists is clearly flawed to the extent that it demonstrates their ignorance of real world conditions this will further serve to undermine their credibility." (Wynne, 1992). This is likely to be the case in situations in which there are clear inconsistencies between precautionary advice on dealing with hazards and the physical and social reality of the risk environment. The effects of familiarity with regard to the status of lay knowledge might be considered to be of particular relevance in the workplace. In this context, expert knowledge can be seen to be that held by management and safety policy makers, many of whom may lack direct insight into prevailing task and environmental factors within the working environment.

Issues of (un)familiarity have also served as a central point of interest amongst those involved in the development of risk communication material. A central premise of the mental models approach, for example, being that the apparent inability of the public to understand risk communication material, is that it frequently contains jargon and formats which are unfamiliar (Morgan, et al, 1992). Similarly, it has been stressed that a prerequisite for the design of effective risk communication material is a need to gain an insight into the knowledge and understanding(s) of the target audience (see Bostrom, et al 1992; & Atman, et al, 1994).
5.0 PERCEPTIONS OF VULNERABILITY

The concept of perceived vulnerability is common to most of the widely used models of health protective behaviour. (eg: 'Theory of reasoned action' - Fishbein & Ajzen, 1975; 'Precaution adoption process' - Weinstein, 1988; 'Health Belief Model' Janz & Becker, 1984; Weinstein, 1988; 'Theory of planned behaviour' - Ajzen, 1991). All models possess the further common trait of assuming that a prerequisite for behavioural change is that people have to accept that the risk under consideration is significant; that they are personally vulnerable and that they are able to adequately assess the risks associated with their behaviour.

An important influence on perceptions of vulnerability has been said to relate to issues of social comparison. Since Weinstein's (1980) seminal paper on 'unrealistic optimism', a significant amount of research has been conducted on the topic of comparative risk evaluation, a number of studies having highlight the influence of attributional biases, whereby individuals typically view themselves to be at lower risk of ill health or injury than similarly exposed others (eg: Svenson, 1981; - driver behaviour; Bauman & Seigel, 1987; - HIV risk; McKenna, et al, 1993 - cigarette smoking). Similarly, 'availability bias' (Tversky & Kahneman, 1974) has been associated with perceptions of vulnerability, principally in relation to the ease with which people can visualise themselves as victims (see Sherman et al, 1985; Agans & Shaffer, 1994). There have also been widespread reports of gender differences with regard to perceived vulnerability, with women generally having been found to perceive themselves as more vulnerable than men (eg: Vlek & Stallen, 1979; Stallen & Thomas. 1988; Fischer et al, 1991; Weigman & Gutting, 1995; Davidson & Freudenberg, 1996), however, there appears to be little consensus regarding its basis.

Questions have been raised, however, regarding the strength of the relationship between perceptions of vulnerability and motivation to adopt self-protective behaviour. In a review of studies in this area, Harrison et al (1992) report that, in most instances relationships reported were modest or, at best, of medium strength. Similarly, Van der Pligt (1988), suggests that other factors, such as the costs of preventative behaviour, social pressure and perceived self-efficacy frequently play a more important role in determining behaviour. "Generally, the perception of personal vulnerability seems to be a necessary requirement for people to consider behavioural change, but is not sufficient [in itself] to actually induce change in risky practices." (Van der Pligt, 1998).

Taken in summation, the available evidence indicates that in many circumstances the provision of risk information is insufficient in itself to foster behavioural change. However, there appears to be a general acceptance that the concept of vulnerability can be of utility in risk communication, although, in view of the above, its primary role should perhaps be viewed as one of raising awareness or risk. Van der Pligt (1998), for example, suggests that risk messages should focus on immediate affective consequences of specific (unhealthy) behavioural practices, eg: anxiety, regret or worry. However, Vaughan & Seifert (1992) warn against the presentation of risk information which highlights the vulnerability of particular social groups, as was the case with early advice on HIV risk in the USA. An undesired consequence of this is said to have been that it had the effect of marginalising the risk, and reducing the extent to which members of the wider public identified with these 'out groups',

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this reportedly contributing to perceptions of invulnerability. Communicating images which lead to empathy and personal identification with 'at risk' groups or populations has been widely identified as an important framing influence on people's beliefs regarding their own susceptibility (see Jurich et al, 1992; Weinstein, 1988; Weinstein et al, 1991; and Basil & Brown, 1997).

It has further been noted that many health education programmes have the common, and rather complicated, dual aims of, on the one hand, informing, creating and maintaining levels of anxiety sufficient to motivate risk reducing behaviours, while on the other, ensuring that levels of anxiety created are not so high as to engender potentially negative responses. "For these reasons it is essential that health education programmes also stress how to change behaviour and take preventative action, ie: increase self-efficacy and provide examples and role models of how to effectively change one's behaviour." (Van der Pligt, 1996).

In addition, it should be remembered that because lay persons frequently frame risk issues to a personal level, their decision making may involve factors which are at variance with those used by experts viewing from a population or societal perspective (see Jeffrey, 1989; Needleman, 1987). Furthermore, risk communications may evoke very different responses from different individuals and social groups, depending upon the perceived personal relevance of the risk situation, and the characteristics of those individuals emphasised as being of social significance - the exposed population. Similarly, there is evidence that people interpret personal and societal risk separately. Personal level risk assesses individual vulnerability, e.g: 'How likely am I to get the disease?', whereas societal risk examines a person's estimate of the generalised risk to the rest of the population eg: 'How likely are others around me to get the disease?' Tyler & Cook (1984).

6.0 FRAMING EFFECTS AND FRAMES OF REFERENCE

Possibly the most significant and enduring finding from the early cognitive work on decision-making has been the identification of a range of contextual biases, which have been termed 'decision framing effects' (Tversky and Kahneman, 1981). In the case of framing effects, the source of bias is said to arise directly from the way in which risk information is portrayed (framed), rather than as a result of the application of heuristics as such.

A basic premise of rational theories of decision-making is that logically equivalent descriptions of a given decision problem should lead respondents to the same choices. There is, however, widespread empirical evidence that actual decision behaviour sometimes violates this principle (see Tversky & Kahneman, 1981; Ettingson & Coughlin, 1982; Kahneman & Miller, 1986; Levin et al. 1987; Linville et al, 1987; Fagley & Miller, 1990; Lindberg & Frost, 1992 and others). Cognitive 'framing effects', therefore, refers to the decision-makers conceptualisation of a given problem, which can be influenced by semantic differences in the manner in which risk information is presented.

Although a range of framing effects have been identified, probably the most widely researched is that of 'domain effect'. This class of violation arises from changing the textual description of a given risk from positive to negative ('gains' versus 'losses', or 'costs'
versus 'benefits'). Here findings suggest that in situations where risk information is framed in the domain of 'gains' people are generally risk-averse, conversely, where decision options are framed in the domain of 'losses' people tend towards risk-seeking, in order to minimise loss. Similarly, people prefer a 'sure thing', if it is available, but will opt for a risky, long odds, option of success if the alternative is a certain loss. Foundation work by Tversky & Kahneman (1981), for example, reported on an experiment where respondents' choices between two decision alternatives - regarding finding a cure for a life threatening disease - of equal expected value, differing only in the degree of risk, produced results which revealed divergent preferences for decision alternatives (chance of success in effecting a cure) where risk (long odds) options were phrased in terms of lives lost (cost) and, conversely, a risk averse option where the problems was phrased in terms of lives saved.

Although the concept is now widely accepted, some authors have questioned whether the impact of framing effects on decision choice is as strong as was originally thought. Most studies have produced findings which suggest that framing influences have at best a modest influence upon decision choice, and interact with a range of other variables which can serve to amplify, or moderate, framing effects (see Fagley & Miller, 1997). Levin & Chapman (1990) and Schneider, (1992), for example, provide evidence which suggests that variables such as gender features of the decision problem, as portrayed (such as information specificity - or risk dimensions such as the degree of apparent gain or loss - or variations in the probability of success of the risky option); as well as contextual variables such as ownership and who will be affected by the consequence of risk actions; are all said to be salient variables in this respect.

For the risk communicator the insight into these violations of formal logic have led some authors to conclude that it may be possible to manipulate people's risk decision choices by the manner in which risk information is presented (Linville et al, 1987). Brown (1989), for example, report on findings which suggest that the manner in which questions are phrased, regarding the risks associated with nuclear energy, can have an influence on respondents' expressing 'favourable' or 'unfavourable' attitudes. However, it has been noted that such an approach "... can lead to suspicions of manipulation in the choice of frame." (Fischhoff, 1995). The concept of framing information, in terms of gains rather than losses, has not gone unnoticed in the advertising industry, recent examples including the tendency to advertise products as "X% fat free", rather than "contains Y % fat".

Other findings highlight the potential for negative influences, where insufficient cognisance is given to the framing of risk consequences. Vaughan & Seifert (1992), for example, cite unintended framing effects in relation to early US public health information which is said to have placed emphasis on the vulnerability of certain minority 'high risk' groups in terms of their susceptibility to HIV infection. Framing the risk in this manner was said to have served to marginalise the issue by reducing the extent to which members of the wider population identified with members of these groups, and to have had a consequent, negative, impact upon disposition towards self-protective behaviour amongst the general population.

While the effects of framing influence have been widely demonstrated under a variety of experimental conditions, and this can be seen to be of potential relevance in the production of risk communication material, little is actually known about the conditions which lead to
framing effect, or the conditions which might prevent it, beyond textual descriptions of risk. Hence, it's impact upon real life decision-making, where decision options are 'naturally framed', and where the probability of alternative outcomes is unlikely to be known, is largely a matter for conjecture and further research. Whyte (1989), in discussing the influence of framing effects on group decision-making processes, suggested that real world risk decision alternatives can frequently be characterised as choices between two or more unattractive options. In such instances 'gains' can be perhaps more accurately viewed as the minimisation of 'losses'. In conclusion, as Fagley and Miller (1990) note, while it seems possible that cognitive bias due to framing effect may extend to contextual factors other than phraseology, this needs to be further researched.

Although experimental studies have reliably demonstrated how the format of textual information can influence the way in which risks are conceptualised, information frames also result from what might be termed 'predispositional variables', such personal beliefs and values, as well as past experience and the socio-cultural context in which risk responses occur. Findings highlighting the potential influence of social framing (social construction) effects on perceptions of risk have been identified by a number of authors. Wynne (1989, 1992 & 1993); Thompson, et al (1990) and Walker et al (1998), for example, highlight a principal difference in this respect between expert and lay framings of risk. Expert understandings are said to principally relate to positivist conceptualisations of risk, based upon statistical models. Conversely, lay models are said to be broader, in so far as they take into account a wider range of variables. There now exists a significant degree of consensus over this issue, between socio-cultural interpretations and the findings of the psychometric tradition. A principal difference between these two positions, however, relates to the status ascribed to lay framings of risk. Broadly speaking the psychometric tradition has viewed lay conceptions as deviations from rational models of risk, whereas socio-cultural theorists merely emphasise 'difference' in this respect, while at the same time suggesting that there is risk of undervaluing lay conceptualisations.

With regard to the range of variables which have been found to influence social framings of risk, a number of studies have investigated proximity effect, and in particular the effects of geographical locality, in relation to sources of risk. Walker et al (1998), for example, highlight variables such as social reference groups, and the interdependence of members of the 'at-risk group' with the source(s) of risk. Evidence from the safety culture literature is further suggestive of differences in terms of frames of reference with regard to perceptions of risk, and in particular provides findings which are suggestive of the importance of organisational role and workgroup (see, in particular, Ostberg, 1980; Marek et al 1985 and Tangenes & Hellersoy, 1985; Hollander, 1991; Pidgeon, 1991).

Taken in summation, the above evidence suggests that framing effects can have an impact upon perceptions of risk at a macro level, essentially in a predispositional sense, with people's 'world views' having the potential to act as cognitive filters (Kasperon, 1988), as well as at a micro level, where it has been demonstrated that there is a potential for framing effects to impact upon individual and / or group decision choices.
7.0 NUMERICAL REPRESENTATIONS OF RISK

Historically, it has been common to define risk with reference to some, 'objective', numerical value, grounded in formal probability theory, this being expressed in terms of likelihood of consequences, combined with some estimation of their severity. Significant objections have been raised regarding the expression of risk in these terms, to the extent that it is now widely accepted, at least amongst social scientists, that risk is a fundamentally social construct and that, as a minimum requirement, there is a need to take into account a number of, additional, qualitative characteristics in order to conceptualise hazards (this issue is discussed in some detail in the main body of the review). This conclusion, clearly, has implications for risk communication, principally that it is necessary to provide risk information which contains broader conceptualisations than numerical expressions alone. It further raises at least two questions, firstly, regarding the extent to which numerical information should be included in risk communication material at all and, secondly, if used what format should it take in order to be comprehensible to the target population. As Morgan et al (1992) note, apparently accepting a principal objection of social and cultural theorists, "Even where trust [in information source] is complete, numbers alone may not suffice, especially when they refer to very small quantities or are expressed in unfamiliar units, the numbers may simply not 'speak' to people."

Much of the early psychological research made use of probabilistic representations of risk, based upon utility assessment. One finding from this work was that many people experience difficulty in understanding and interpreting statistical probabilities. In an attempt at overcoming such difficulties, and likely, in part, in recognition of the limitations of probabilistic information, a number of researchers have adopted the use of qualitative, Likert-type scales in their research, typically requiring respondents to assess risk in terms of scale values, or semantic differentials. Typically such scales have required respondents to classify sources of risk using expressions of amount, of a type nominally ranging from 'extremely unlikely' to 'extremely likely', in terms of probability of occurrence, and/or 'very slight' to 'very serious', in terms of consequences.

However, objections to such techniques have been raised, principally on the grounds that they are not well suited to the evaluation of very low probability, unlikely, risks (Linville, et al, 1987). Other objections to the use of subjective scaling techniques, relate to difficulties in interpreting results, principally because expressions of amount, particularly for multi-faceted items (as is the case for many real world risks) are likely to vary, both between individuals and between different groups of individuals (Fischhoff et al, 1990). It is also perhaps worth noting that frequently what people want to know is not summary estimates, but substantive information of what a hazard is and how it works. (Bostrom, et al, 1992).

Fischhoff at al (1995) note that a failing of much risk communication material is the absence of any numerical information regarding the magnitude of risks. These authors highlight the tendency for risk information to contain bland statements such as 'practice safe sex', rather than providing the target audience with the precise information they need on how to avoid a particular risk, the appropriateness of precautionary action, or what measurable level constitutes acceptable risk. In summary, although Fischhoff concedes that "Accurate risk estimates alone cannot tell people what actions are possible, or what goals are worth pursuing
and they might not even show what risks are worth worrying about.... None the less, some notion of risk size is needed, just to begin focusing one's attention." (Fischhoff, 1997). The strength of the mental models approach is said to be that, in 'filling in the gaps' in people's understandings of risk, it allows them to make well informed choices. "When this happens, people need quantitative estimates of the critical parameters in their decision-making models." (Bostrom et al, 1992).

The issue of how to represent probabilistic risk information highlights the potential influence of framing effects as a source of cognitive bias (see above). MacFarlad & Miller (1994), for example, provide evidence which suggests that people respond differently to equivalent forms of relative risk frequency, depending upon how this information is presented. In one experiment participants were given an ability test and provided with feedback regarding their performance, relative to other individuals, with (logistically equivalent) variations made in terms of how this information was expressed. eg: 3rd out of a group of 10; or 300th out of a 10,000). These authors concluded that as reference group size increased people become increasingly pessimistic about their performance. Similar results have been reported by other authors, Denes-Raj & Epstein (1994), for example, found respondents generally preferred a 9/100 chance of winning to 1/10. In both of these examples there appears to be a source of bias which equates to a 'numerator effect' (see also Yamagishi, 1997). The cognitive mechanism underlying this influence is said to be the effect of the judge's picking upon a judgement cue from the task, this having the effect of 'anchoring' their responses. Denes-Ray & Epstein suggest that a possible explanation for such findings is that respondents appear to be more sensitive to the likelihood of winning values (numerator) than the likelihood of losing (denominator) value. This effect has been attributed to the fact that such judgements are typically made using intuitive heuristics, principally anchoring effects (Tversky & Kahneman, 1974). ie, the process by which people exhibit a tendency to pick-up on a numerical cue from the judgement task, this 'anchor' impacting upon the judgement process. Broadly similar results are reported by Yamagishi, (1997).

There is now widespread empirical evidence that people frequently experience difficulty in conceptualising the effects of cumulative risk (eg: Bar-Hillel, 1973; Fischhoff & Lichtenstein, 1978; Schwalm & Slovic, 1982; Ronen, 1983; Shaklee & Fischhoff, 1990; Linville et al, 1987, Doyle, 1997; and Weyman & Anderson, 1998). Available evidence suggests that this type of cognitive bias is present at both a behavioural level and with regard to the interpretation of textual representations of probabilistic risk. At the behavioural level, it appears that people are frequently predisposed towards perceiving each risk act as a discrete event, even when substantially identical acts are repeated on a regular basis, rather than conceiving such activity as a pattern of risky behaviour, with a consequential increase in the likelihood of injury or ill health. Cognitively, people appear to generally possess some notion that risk can accumulate with repeated exposure, however, evidence suggests that these understandings are frequently at odds with mathematical models of probability. What people appear to have most difficulty with is in accurately judging how quickly probability accumulates over time. Again, such effects have been attributed to the fact that probability judgements are typically made with reference to intuitive heuristics, such as anchoring and adjustment and representativeness, (Tversky & Kahneman, 1974) (for a further details on this effect see 'Psychological time' above).
Empirical evidence suggests that, with regard to more effective means of communicating cumulative risk information, there is a need to provide some indication of how the risk changes over time, rather than, for example, a single encounter risk estimate, or (single) annual risk rates, etc. For example; where two contraceptives are rated at 90% and 95% effective in preventing pregnancy, when used in a single year there may appear to be little to choose between them. However, if the time frame is extended to five years, the difference in performance grows to 17.5%, and after 15 years to 39.7% (Doyle, 1997).

In recognition of the widespread presence of 'cumulative probability bias', Linville, et al (1987), suggest that risk communication should not simply give people single encounter risk information, and then assume that they will draw the appropriate inference from this. Because people are likely to underestimate the cumulative risk that they control, some attempt should be made to express the manner in which risk accumulates with repeated exposure.

Further evidence of framing influences can be seen to relate to problems associated with the expressions of magnitude of risk. This issue can be seen to be of particular relevance when dealing with small numbers, where risk outcomes are unlikely. eg: a rise from 0.5% to 1.0% represents a 100% increase, however, questions might be raised with regard to the extent to which this represents a meaningful increase in risk to the individual (Fischhoff, et al, 1997). The issue of repressing small or unlikely risk outcomes in risk communication material has also been highlighted as having the potential to raise ethical issues. The risk of HIV infection amongst the heterosexual, non-intravenous drug using population, for example, is generally accepted to be comparatively small compared with other groups. However, from a public health point of view, it is clear that few would be comfortable in producing risk information which effectively told people they were worrying unnecessarily (Linville, et al, 1987).

A frequently encountered method of representing numerical risk information is by means of risk comparison. The appeal of the technique can be seen to relate to the pursuance of at least two goals: firstly, in an attempt to convince people that the risk in question is no greater than other risks, which (it is generally assumed) they find acceptable (see Fischhoff, 1995), and secondly, in an attempt to anchor risks which are unfamiliar to those which the people have a more complete understanding of.

The use of such comparative techniques has, however, been criticised on the grounds that they rest upon a narrow, unidimensional view of risk, specifically one which relates to the likelihood of undesired consequences, usually the projected number fatalities, injuries, or ill health. Given that it is now widely accepted, within the social sciences, that lay conceptions of risk are frequently broader than this, questions have been raised regarding the utility of these types of comparison, and the extent to which they are sufficiently embracing. Such comparisons frequently ignore important risk evaluation criteria, such as differential levels of control over risk (voluntariness of exposure) and diverse cost benefit criteria. In addition, questions might be raised on ethical grounds, regarding the extent to which such comparisons might be used in a misleading manner.

Details regarding the relative effectiveness of various types of risk comparison in changing risk attitudes are provided by Sandman et al (1988). Although containing useful insights, this
text has been criticised on the grounds that, contrary to the intentions of the authors, it has undertones of social manipulation. In addition, critics have highlighted the fact that research in this area is not as extensive as might be hoped, with the result that the empirical validity of some of the advice contained in such texts may, in some instances, be questionable (Roth et al, 1990; Morgan et al, 1992).

8.0 PERCEPTIONS OF HAZARDOUS SUBSTANCES

Hazardous substances are now an important, and in many instances inescapable, part of modern life and are frequently perceived by the public to pose a significant threat to human health and well being. For some substances, these perceptions broadly correspond to natural science models of risk, in other instances, however, significant differences are apparent. Although the psychometric studies (principally Slovic et al and Fischhoff et al) were not specifically centred on perceptions of risk associated with hazardous substances, they revealed that products such as automobile exhaust emissions; food preservatives; food colourings and pesticides scored fairly highly on the ‘dread’ dimension (characterised by: ‘perceived lack of control’, ‘threat’ and ‘seriousness of consequences’) and ‘unknown’ dimension (characterised as being: ‘non-observable’; ‘novel’; ‘delayed negative consequences’). On the basis of this evidence it might be considered justifiable to draw the general conclusion that chemicals will tend to score highly on the ‘dread’ dimension and moderate to high on the ‘unknown’ dimension, this suggesting that perceived risk may be heightened by a number of factors, such as unfamiliarity, lack of control, perceived consequences, and the extent to which they are viewed as catastrophic and / or having long lasting effects (Kelly & Garwood, 1994). Cvetkovich (1988); Weigmann & Gutteling, (1995) and Raats & Shepherd (1996) would appear to be broadly supportive of this view. Slovic et al (1987) further highlight the fact that certain substances evoke highly emotional or affective reactions, this further serving to heighten the salience of fears associated with exposure to such substances. Clearly the role of direct experience and, likely more importantly, the role of the media, have the potential to make major contributions to the cultural profile of such substances (MacGregor & Fleming, 1986).

Important contributions regarding the public’s perception of chemical hazards are provided by Greishop & Styles (1989); McCallum et al (1990); and Kraus et al (1992). Taken in summation, these findings suggest that significant differences are prevalent between lay and expert conceptions, not only of the risks posed by substances, but with regard to which substances should be regarded as ‘chemicals’. As Green (1991) notes, product manufacturers appear to have tapped into the social framing of chemical risks, in frequently referring to products as “additive free”, or ‘containing only natural products’, when a chemist would, on many occasions, maintain that they still contain some chemicals. In such instances advertising companies are, probably unwittingly, using a discourse analysis, or lay interpretation of what chemicals ‘means’. One reasonable conclusion which might be drawn is that the whole idea of ‘chemical’ is one of ‘harmful substance’, or alternatively an ‘unnecessary additive’, not an element or compound." (Kelly & Garwood, 1994). Such findings are, likely, indicative of the social profile of chemicals, and the extent to which they are perceived, accurately or otherwise, to be sources of harm.

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Available evidence would further suggest that lay perceptions of chemicals are to some degree influenced by the extent to which such products are considered to be natural or man-made, with natural substances tending to be seen as inherently safe, in this respect (Kraus, 1992; Raats & Shepherd, 1996). Other effects identified relate to increased perceptions of risk where chemicals are added to natural substances. Examples might include the addition of fluoride to water and the treatment of foodstuffs with preservatives or pesticides (see Pimentel, 1989; and Raats & Shepherd, 1996). In such circumstances, perceptions of risk, and associated causes of concern, might be considered as having as much, if not more, to do with notions of human interference with nature, than any specific risk feature of the substance added (be that 'natural' or 'man-made').

Complementary findings from workplace contexts might include instances where perceptions of risk amongst timber treatment operatives have been found to be less for water-based pesticides than for solvent-based products (Weyman et al, 1996). The basis for this difference appearing to relate to perceptions of water as a fundamentally inert substance, leading operatives to underestimate the risk from the pesticide itself. Further contributory factors leading to reduced levels of caution in this respect likely relate to the absence of perceptual cues such as odour and skin irritation for water-based products, (present with solvent-based products) thus reducing both the immediacy of effect and 'subjective' feedback with regard to concentration levels within the work environment.

It further seems clear that some chemicals arouse more anxieties than others. Although empirical evidence on this issue is limited, it seems generally accepted that the media performs an important role in this respect. Walker (1992), for example, suggests that concern over aluminium seems to be associated with its association with Alzheimer's disease, irrespective of the context and form in which it is encountered (see also: Kelly & Garwood, 1994 and MacGreggor & Flemming 1996).

Again, as in other areas, the issue of the context in which chemicals are encountered appears to be an important factor. Greishop & Styles (1989), for example, found tolerance levels for 'home pesticides' to be greater than that for pesticides used in other contexts, such as agricultural usage. These authors suggest that an important factor here, likely, relates to the level of perceived control on the part of the user (see above).

Other evidence that people differentiate between chemicals, in terms of the level of perceived risk associated with them, is provided by work on prescription drugs. Lappe et al (1989), for example, suggest that, in general, perception drugs are viewed as being high in benefit, and relatively low in risk. However, exceptions to this general rule include drugs with apparently more negative connotations, such as sleeping pills and antidepressants. Again, a principal implication seems to be that such attitudes are associated with lack of control, although this may well be a broader concept, likely associated with concepts of self-control, in this context, than the desire for control over exposure per se. Furthermore, although a general finding appears to be that the lay public hold broadly positive views regarding prescription drugs, viewing them as substances from which benefits can be derived, a significant source of interest relates to the potential for the presence of associated side-effects (Kelly & Garwood, 1994).
Central to the natural scientific model of chemical hazard is the notion of 'dose-response' relationships. However, there is evidence that this distinction is frequently absent from lay understandings. MacGreggor & Flemming (1995), for example, provide findings which suggest that people can be sensitive to chemical exposures irrespective of size. However, evidence from previously cited work on asbestos exposure, (Weyman, et al, 1995 - see above) suggests that lay perceptions can include some notion of dose-response, although clearly in this instance the model can include potentially important misunderstandings.

Taken in summation, available evidence suggests that lay knowledge of chemical risks frequently contains inaccuracies and misunderstandings of risk, much of which seems likely to relate to limited, and restricted, access to hazard information of an appropriate type. In addition, however, there is evidence that expert models of risk in this area are not always complete, and may benefit from the inclusion of, and/or revision in the light of, lay insights and understandings (Wynne 1989; 1992 & 1993).

The principal contribution of lay insights with regard to risks associated with hazardous substances in workplace contexts, seems likely to relate to the relevance of behavioural variables, specifically to methods of use and other contextual insights, which may be absent from the expert model. For example, the use of any chemical or other hazardous substance in workplace settings is invariably associated with some form of container, applicator or process, and associated ergonomic and other task-related variables.

Intuitively, the scope for misconception and misunderstanding of risk appears to be greater for substances than for physical hazards, with much of the available evidence relating to this latter category suggesting that perceptions of risk in the workplace are frequently substantially accurate, if not in terms of probability of injury, at least in terms of sources of potential harm (see section on safety culture). Given the limited exposure to 'accessible' knowledge, which typifies many people's understandings of hazardous substances, it is perhaps not surprising that this knowledge frequently appears fragmented.

Where health information advice is given, examples are frequently encountered where information provided is ambiguous or insufficiently specific, having failed to take account of important lay understandings, this being a central tenet of the mental models approach (see main review). Advice to refrain from smoking in the presence of certain solvents, for example, has been found to lead to a number of interpretations 'the product is inflammmable' being the most common, however, the intention of such advice may relate to the need to avoid ingestion of a substance or equally relate to the interaction between a substance and the properties of cigarette tobacco (Weyman & Scobbie, 1998). Similarly, work on indoor radon has revealed significant inaccuracies and misunderstandings, such as 'radon comes from industrial wastes' or 'radon makes you sick' (Morgan et al, 1992). Such findings have led other authors to conclude that "...lay models of toxicology, and of chemical risk, are not only less complex [than those of experts] they are primarily composed of beliefs, attitudes, perceptions and impressions that are loosely organised according to intuitive principles." MacGreggor & Fleming, (1996), p.777. Although authors such as Wynne (1989; 1992 & 1993) have taken issue with such conclusions, in general it seems that the potential for inaccuracies with regard to lay understanding of toxic risk remains substantial.

31 'Accessible' - in this context is considered to relate to both availability and interpretability of risk information.
Where there does appear to be some common ground between cognitive and socio-cultural theorists, however, is in the recognition of the need to gain an insight into lay understandings, the central point of divergence being the nature of the models against which such understandings are evaluated and the nature of the conclusions drawn from this. A broader view of that knowledge which is granted the status of scientific insight may go some way towards redressing this issue (a more detailed discussion of this topic is provided in the main body of the review).

Although the workplace arguably constitutes the point at which direct exposure to hazardous substances is most likely, comparatively little work has been conducted with respect to attitudes towards hazardous substances in this context. By far the majority of research activity has been concentrated in assessing the attitudes and understandings of the general public.

Although a number of authors have highlighted concerns amongst workers with regard to the chemicals and other substances which they are exposed to in the workplace (eg: Nelkin & Brown, 1984), on the whole the issue of risk communication in the workplace can perhaps best be conceptualised as one of 'awareness raising'. In this sense, it can be seen to contrast with much of the psychological work on public perceptions of risk, which has commonly been associated with attempts to allay 'irrational' fears amongst the general populous. Insights from the general literature suggests that notions of 'control', 'familiarity', 'immediacy of effect' (delay between exposure and onset of symptoms) and 'observable physical characteristics' (eg: odour, colour, impact on non-human agents) are likely to play an important role in workers' perceptions of risk of hazardous substances, particularly where such substances are routinely encountered in the work environment, and where the availability of accessible risk information is restricted.

9.0 RISKY SITUATION OR RISKY INDIVIDUAL?

A significant topic of debate amongst social scientists relates to the relative importance of the 'situation' versus the 'individual', as explanations of risky decision behaviour. In their extreme forms, situationalists argue that behaviour is largely a function of context, whereas individual difference theorists contend that an explanation at the level of the individual is sufficient in itself. Arguably, more enlightened authors (Daniel & Dropova, 1979; Sarman, 1977; Endler, 1973; and others), however, hold the view that a combination of both positions offers the greatest potential insight. As Endler (1973) comments "Asking whether behavioural variance is due to either situations or to persons.....is analogous to asking whether blood or air is more essential to life". The more sensible question, this author suggests, is 'how do individual differences and situations interact in evoking risk taking behaviour?' Unfortunately, this conclusion has not been carried over into the majority of studies of perception of risk, or risk-taking behaviour, most of which, although frequently acknowledging the influence of the other, effectively remain entrenched within one or other paradigm.
Numerous studies (Wallach and Kogan, 1967, Sarmany, 1977, Kozielecki, 1974, Stewart and Hensley 1984; Yabukara, undated; Zaleski 1984; Zuckermann & Eysenck, 1978; and others) have attempted to define the personality profile of risk-takers.

In this, as in other spheres, individual difference theorists implicitly assume aspects such as personality and cognitive style remain consistent traits of the individual, irrespective of context. As Plax and Rosenfield (1976) note: "Much contemporary risk taking research assumes that individuals' risk criterion is pervasive and affects all of his / her perceptions and behaviour" (p. 413). For example, in attempting to investigate the personality profile of gamblers, Morris (1957) noted that 'high risk takers' tended to be 'more secure'; 'dominant'; 'masculine' and 'less responsible'. Similarly, Scodel, et al, (1959) concluded that high risk takers were more 'other directed' and 'socially assimilated'. Myers and Cameron (1966) found that risk takers scored highly in terms of 'exhibitionism', 'aggression' and 'dominance. More recently, Zuckerman and Eysenck (1978) speak of the 'sensation seeking personality', with, Eysenck typifying the 'risk taker' as scoring highly in terms of extraversion (see also, Stewart & Hensley, 1984). However, it should be noted that a number of authors have raised objections to this (see for example: Cochrane, 1974; Heather, 1976; and Hampson, 1982).

Similarly, Daniel and Droppova (1979), report "...strong correlation's between personality type and risk taking behaviour." However, closer examination of their methodology reveals that they did not measure risk taking in behavioural terms, therefore, it seems likely that they were measuring either risk perception and / or the respondents attitudes to risk, and not behaviour as they claim [for a discussion of attitudes as predictors of behaviour see Wicker (1969). The factors which they identified were, however, 'determination to succeed', which correlated positively with 'successfulness in task fulfilment' and 'professional training'.

A number of other authors have attempted to investigate the potential influence of differences in cognitive style, in relation to decision making under risk (Henderson & Nutt, 1980; Blaylock, 1985; Fagley & Miller, 1990; and Sarmany & Skovayova, 1992). Although there exists some debate regarding the extent to which some of the research in this area is actually tapping into cognitive styles, or merely differences in ability (see Guilford, 1980; and Tiedman, 1989), Blaylock (1985) makes the assertion that the cognitive style literature has proved more useful in interpreting differences in risk perception and preparedness to take risks than that rooted in personality differences. The principal advantage of the former, he contends, is that it not only attempts to explain "why" an individual assesses risk, but also "how" they do this, though he further notes that the majority of work in this area has failed to take account of situational variables.

A notable exception to Blaylock's assertion is provided by Henderson and Nutt (1980). These writers suggest that the point of interest, regarding explanations of risk taking, should shift away from simply describing the intended actions / attitudes of 'situation free' individuals, towards analysing the specific interactions between environmental conditions and cognitive / behavioural aspects. Their findings suggest that decision makers cognitive styles remain uninfluenced by variations in environmental factors, hence they conclude that environmental contingencies do not influence the nature of decisions made. However, it is perhaps worth noting that their research environment was laboratory based and their attempt to take account of situational influence extended no further than verbal descriptions, which Blaylock (1985)
has criticised on the grounds that they 'depicted insufficiently dissimilar environments to produce an effect.' Blaylock's (1985) own findings, however, perhaps unsurprisingly, suggest that an interactive process is at work, between the cognitive style of the decision maker and those aspects which constitute the decision environment.

Fagley and Miller (1990), in attempting to clarify the findings of previous research, (principally Fagley's, 1985, investigation into apparent gender differences with regard to framing effects) speculate that the finding that only men demonstrate 'symptoms of' framing effects, may be due to differences in male / female cognitive style, principally, field dependency. However, in a subsequent investigation of this hypothesis, using the vignette technique to provide a degree of context, Fagley and Miller, (1990) produced findings which were more consistent with those of Henderson and Nutt (1980), in concluding that they found no evidence of a significant interaction between framing effect and cognitive style.

Other studies (Kogan and Wallach, 1961; Vroom and Phal, 1971; Roy and Chaudhery, 1987) report links between maturity and risk taking. Conversely, evidence provided by Spencer et al (1974) suggests that there are no apparent differences in terms of age with regard to either risk perception or willingness to take risks. It would also seem possible, as noted by Fortenberry & Smith (1981), that some studies in this area may have confused the apparent 'recklessness of the young' with their relative lack of experience.

On balance, it is likely, as Sarmony (1977) notes, that predisposition towards risk taking behaviour takes place on two levels, involving (a) personality factors and (b) important environmental variables. For Daniel and Droppova (1979), however, there is a third contingency, which they label 'extra task factors'. In the context of work, they suggest that factors such as 'appreciation [of risk] by the organisation' and the 'structure of the organisation' itself can mitigate to encourage risk taking. These authors further conclude that the role played by each of these factors varies from one situation to the next (in short - 'safety culture'). However, they contend that the task [situation] factor predominates in most instances. Similarly, Helander (1991) in his study of safety in the construction industry, concluded that "...personality characteristics of workers seems to have little influence on their safety performance." (p 222).

The relative lack of success of the 'individual differences' approach in this area, as noted by the numerous authors, from both cognitive and socio-cultural paradigms, appears to reflect a general consensus that perceived risk likely owes more to the situation than the individual. It is perhaps worth noting that one reason for this conclusion might be the fact that a significant proportion of the research effort on risk perception has been funded, and directed, by public policy considerations, in particular attempts to enhance risk communication, an environment in which individual difference explanations might be viewed as at best 'unhelpful'. That said, the growing evidence, from a range of mainstream research positions, demonstrates a high degree of consensus regarding the primacy of situational variables.

Fundamentally, the situationalist stance is that individual characteristics, such as personality and cognitive style are relatively unimportant in explanations of risk taking behaviour, simply because their effects are likely to be swamped by what are viewed as highly pervasive situational variables, these constituting far more powerful determinants of human action.
Situationalists typically do not deny the existence of individual differences, but are of the opinion that, in real world contexts, they merely play a relatively minor role in mediating the effects of situational variables.

Of those authors who have concluded that patterns of personal risk acceptance are more related to fundamental characteristics of risky decision situations, rather than individual types or traits, Nelkin & Brown (1984), for example, suggest that factors such as 'one's relative freedom of choice'; the 'amount of control an individual has over decision consequences' and the 'nature of the basic need or desire' which is either fulfilled or frustrated by the final consequences of the risk taking action, constitute significant determinants of behaviour.
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