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Judging dread: A quantitative investigation of affect, psychometric dread and risk consequence

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Judging Dread:

A Quantitative Investigation of Affect, Psychometric Dread and Risk Consequence

by

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Bachelor of Counter Terrorism, Security and Intelligence, 2009

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ABSTRACT

Risk is generally understood as a product of the likelihood and consequence of an event. However, the way in which estimations of consequences are formed is unclear due to the complexities of human perception. In particular, the influence of Affect, defined as positive or negative qualities subjectively assigned to stimuli, may skew risk consequence judgements. Thus a clearer understanding of the role of Affect in risk consequence estimations has significant implications for risk management, risk communication and policy formulation.

In the Psychometric tradition of risk perception, Affect has become almost synonymous with the concept of Dread, despite Dread being measured in a way which excludes emotional elements. One of the most consistent findings of the Psychometric Paradigm is that the level of Dread associated with a hazard is the best predictor of perceived risk. However, there is debate over whether Dread risk is associated with Affect, or whether the factor is dominated by severe consequences. The purpose of this study was to ascertain the association of Affect with Dread risk characteristics and risk consequence judgements. The study investigated whether the predictive power of Dread should be attributed to negative Affect, or to cognitive estimations of the magnitude and severity of consequences.

The study employed a three Phase between-subjects design, with respondents from 28 countries (N=1838) completing emotionally and neutrally worded research instruments based on the Psychometric Dread risk model. Results were assessed via descriptive data analysis, *t*-tests, Factor Analysis and Multidimensional Scaling. The study found that the association of Affect on estimations of risk consequence was largely confined to the Dread risk characteristics of personal control and voluntary choice. These were secondary to the much larger influence of the consequence severity characteristics, estimations of which were unmoved by negative Affect. The study concluded that the Dread risk factor is primarily an unemotional measure of the severity of risk consequences, and the role of emotion in Dread risk is a separate factor related to control and choice.

The declaration page
is not included in this version of the thesis

DEDICATION

For Heath; my beautiful wife and soulmate.

Your love and your presence in my life are the ultimate inspiration.

I love you always and forever.

For Owen my perfect boy, for whom I began this journey;

For our beautiful little Froggy, whose timing is impeccable;

For Bella and Wyatt, my beloved duo of distraction –

I love you all so much.

And for Awel, for your tireless support & belief.

Thank you!

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Finally, I would like to acknowledge all of the researchers whose fascinating work inspired this thesis.

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CHAPTER 1: INTRODUCTION

Psychometric risk research provides insights into the way in which risks are perceived, which has implications for understanding risk behaviour in response to risk issues. The Psychometric Dread risk factor is widely regarded as the most important factor to emerge from the Psychometric Paradigm of risk perception (Taylor-Gooby & Zinn, 2006a); however the broadening of the meaning of Affect to include the concept of Attitude has resulted in the findings of Affect Heuristic research being linked to the Psychometric concept of Dread risk (Sjöberg, 2006b). Thus the literature suggests that there may have been some "questionable assumptions and overly strong generalizations" (Sjöberg, 2003a, p. 109) made regarding the Dread risk factor. This study sought to clarify some of these assumptions and generalisations by exploring the concept of Dread risk in terms of Affect and risk consequence.

1.1 Background of the Study

This section highlights the major findings in the literature in relation to risk and the Psychometric paradigm. The major themes are defined and the development of research in the area is outlined. The context of this Thesis has its foundations in the concept of risk. Risk may be defined as the effect of uncertainty on objectives (Standards Australia, 2009), and the way that risk is perceived and assessed is influenced by many factors: however, perceptions do not always match reality. Conceptual meaning is dependent on perceptual processes (Eysenck & Keane, 2005) and objective risk is necessarily dependent on "subjective and assumption-laden" (Slovic, 1999, p. 690) risk perceptions.

The development of research in the area has its foundations in early probability theory (later developed into Decision Theory), which asserts that humans are rational optimisers, making choices of the highest expected utility through estimations of value and probability (Gardner, 2008). It was recognised however, that the view of humans as rational optimisers could not account for many aspects of human behaviour. In 1957,

Herbert Simon developed the theory of Bounded Rationality, which attempted to capture the limitations of human cognitive capacity (Simon, 1956). Bounded Rationality Theory posits that decision alternatives are sought until "an alternative is found that reaches or surpasses the aspiration levels on the goal variables" (Selten, 2002, p. 14).

In the 1970s, Kahneman and Tversky (1974) sought to define the boundaries theorised in Bounded Rationality, finding that "people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations" (p. 1124). Research suggests that judgemental operations in relation to risk are formed by employing both Affective and cognitive information processing, rather than by using either of these information processing models alone (Booth-Butterfield, Cooke, Pearson, Lang, & et al., 1994). This view supports modern cognitive psychological theories which, according to Slovic et al. (2011), show that the "rational and the experiential systems operate in parallel and each seems to depend on the other for guidance" (p. 1).

Given this theoretical setting, Psychometric risk research thus aimed to provide insights into the role of the rational and experiential systems in the perception of risk. Researchers of the Psychometric paradigm developed a methodology for producing "quantitative representations or cognitive maps of risk attitudes and perceptions" (Slovic, 1987). These cognitive maps employ two factors, Dread and Knowledge, to form a spatial representation of risk perceptions (Slovic, Fischhoff, & Lichtenstein, 1982) (figure 1.1).
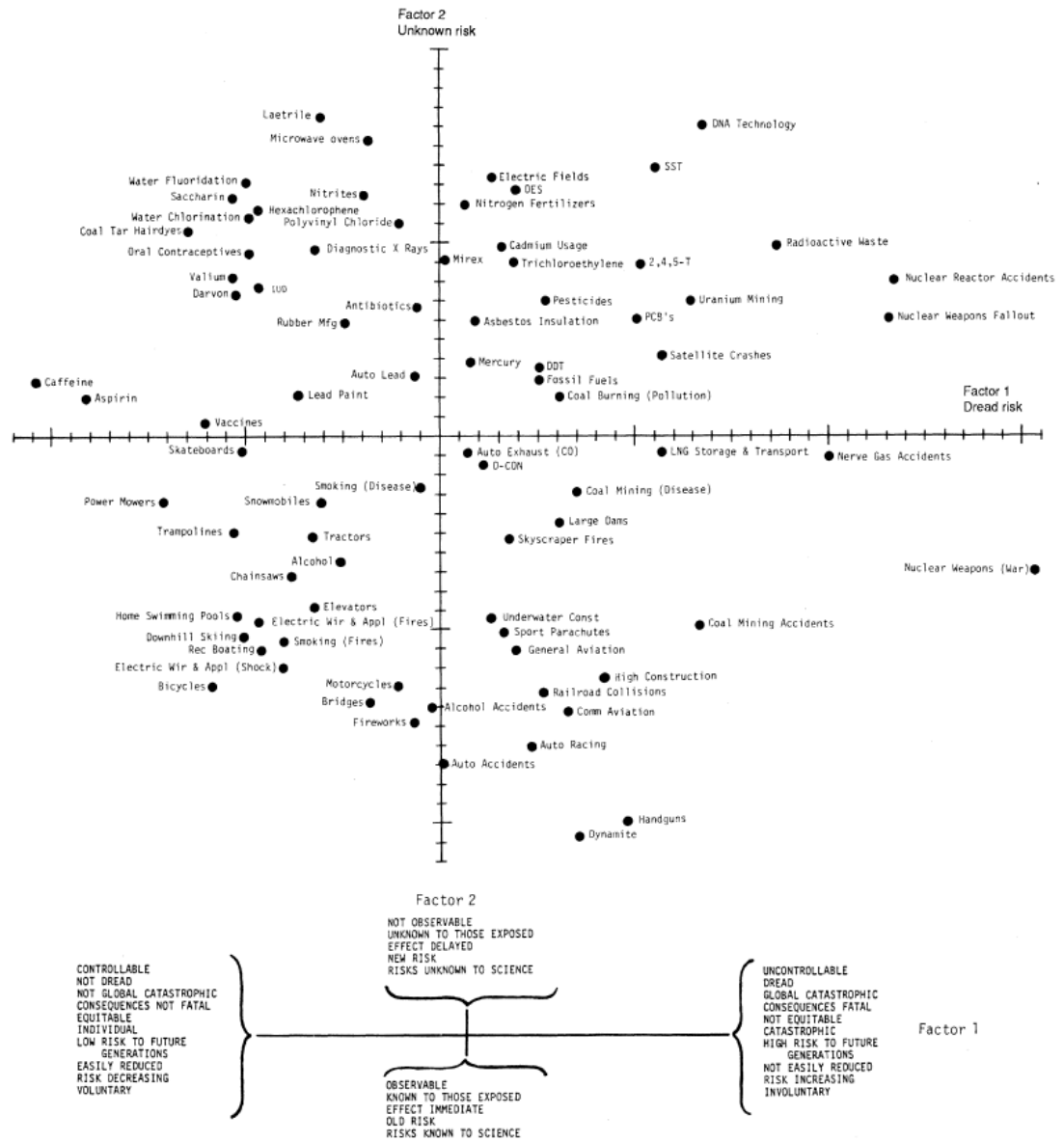
Figure 1.1. The Psychometric factors of Knowledge and Dread (Slovic, 1987, p. 282).

According to Slovic, Finucane, Peters, and MacGregor (2007), risk research was focused for many years on cognitive processes, rather than Affective impacts on decision making. One of the early proponents of the significance of the role of emotion in decision making was Zajonc (1980), who asserted that "affective judgments may be fairly independent of, and precede in time, the sorts of perceptual and cognitive operations commonly assumed

to be the basis of these affective judgments" (p. 151). Research into the pre-cognitive impact of emotion on risk judgements resulted in the proposal of an Affect Heuristic (Slovic et al., 2007). In this context, the term Affect refers to "the specific quality of 'goodness' or 'badness' experienced as a feeling state (with or without consciousness) and demarcating a positive or negative quality of a stimulus" (Slovic, Finucane, Peters, & MacGregor, 2007, p. 2).

Emotional Affect is essentially a "subjectively experienced feeling or emotion [together with] the observable behaviour that represents it" (Fielder & Bless, 2001). In the early 1990s, risk researchers began to increasingly shift their focus away from cognitive heuristics, and began to inquire after the heuristic basis of emotion. The view that emerged from research into the Affect Heuristic was that "emotional reactions to risky situations often diverge from cognitive assessments of those risks. When such divergence occurs, emotional reactions often drive behaviour" (Loewenstein, Weber, Hsee, & Welch, 2001, p. 276). As a result, it is now widely conceived among risk researchers that risk perception "is mainly governed by emotional processes" (Sjöberg, 2006b, p. 101).

1.2 Statement of the Problem

The gap in the knowledge found in the body of literature is summarised by Sjöberg (2006b), who states:

> It can be concluded that the received message from 25 years of risk perception research, viz. that emotional factors dominate the picture, is due to the misleading name given to an assortment of very different items, only one of which explicitly denotes emotional reactions. The importance of 'Dread' is due to the importance of severe consequences, which proves nothing about the role of emotions. When tested empirically, emotions by themselves play a minor role (p. 106).

Much of the success in the field of risk perception research may be attributed to the Psychometric Paradigm, and to Dread risk in particular. Since its inception, research has refined the concept of Dread risk to an emotional factor, principly in light of research

stressing the importance of the Affect Heuristic to perceived risk (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, Finucane, Peters, & MacGregor, 2002; Slovic et al., 2007; Slovic, Peters, Finucane, & MacGregor, 2005). This bridging of Dread and Affect has led to the view that fear is the major determinant in risk judgments and that "people will make their [risk] decision based on the dread of a particular event, rather than based on the actual harm that may be inflicted" (Smith & Brooks, 2013, p. 55). However, this widely held view has been called into question.

Sjöberg (2006a) asserts that "a close look at the definition of Dread shows that it is measured wholly, or mostly, with non-emotional components which can be best summarised as measuring the perceived severity of consequences" (p. 7). Such a view is supported by Schusterschitz, Schütz, and Wiedemann (2010), who found that "the explanatory power of the Dread factor is strongly influenced by the Severity of Consequences" (p. 394).

Sjöberg (2003) has previously highlighted the need for an investigation of the Affective relationship to Dread risk items, stating that these "dimensions may have a relationship to emotional processes but they are not emotional *per se* and their emotional significance remains to be documented" (p. 109). Thus the need for research to address this gap in the knowledge was identified in order to assess whether the prevailing interpretation of Dread risk as a measure of risk-as-feelings is a valid view, and to understand the relationship between Dread risk and severe consequences. This was accomplished in the study by exploring the concept of Dread risk in terms of Affect and risk consequence.

1.3 Significance of the Study

The general theoretical literature on risk and specifically in the context of Psychometric risk perception leaves several vital questions relating to Dread risk and Affect unanswered. The literature reveals that there is some debate over the nature of Dread risk and its relationship to Affect. Determining how Affect is associated with Dread risk

characteristics and whether the factor is dominated by severe consequences would contribute to a more accurate conception of Dread. Addressing this research problem has theoretical and policy implications for a range of risk governance areas.

One of these areas is risk management, as "many aspects of risk management are highly subjective and are greatly influenced by the perceptions of information providers, analysts, and users of the products" (Standards Australia, 2006, p. 20). Despite evidence for the need to include Psychometric dimensions in risk assessments, it is unclear how these factors should be incorporated into "decision frameworks" (Gregory & Mendelsohn, 1993, p. 259; Merkhofer, 1987). The implications of addressing the Dread risk issue directly impacts risk management by clarifying the association of Affect with Dread risk characteristics, especially those related to risk consequence.

The study outcomes are also significant to risk communication, as it has long been recognised that "risk communication would benefit from a shift in attention from message construction to audience analysis" (Marris, Langford, & O'Riordan, 1998, p. 646). The role of Affect is particularly significant to this domain, as Sjöberg (2007) asserts that risk communication based on the "notion of the primacy of a primitive initial emotional reaction" (p. 223) will likely fail. Addressing this research problem also has implications relevant to policy formulation, as an awareness of the impact of different risk judgements is "of intense practical significance" (Viscusi, 1997, p. 1658) to policy development.

1.4 Research Questions

The study was set out to explore the concept of Dread risk in terms of Affect and risk consequence. The study responded to two questions arising from the identified gap in the general theoretical literature on risk Psychometric risk perception:

1. *How is Affect associated with the Dread factor's risk characteristics?*

The study sought to investigate whether perceptions of the Dread risk characteristics would be significantly different if perceptions were influenced by Affect. It was reasoned that if Dread risk characteristics were associated with Affect, it would support the view of Dread risk as a measure of "the level of fear… of an event occurring [which] elevates perceptions of the risk beyond reasonable norms" (Standards Australia, 2006, p. 20). If Affect were not found to be associated with Dread risk, the results would support the view of Sjöberg (2006b), who asserts that the factor consists of items largely unrelated to Affect.

2. *How is Affect associated with risk consequence?*

The study also sought to investigate whether Affect was associated with risk consequence estimations and Dread risk characteristics related to risk consequence, and whether these items were dominant in the factor. The findings would offer some insight into the nature of the Dread risk factor and provide empirical evidence to either support or contest the conception of Dread as Affect.

1.5 Review of the Methodology

The focus of this Thesis was to understand the impact of Affect on Dread risk characteristics, particularly perceptions of risk consequence characteristics. A methodology was sought that could provide an avenue to make such an assessment. This summary of the methodology contains a brief outline of the participants, the materials, and the procedure. Participants were recruited via Amazon Mechanical Turk, an online service which crowd-sources tasks that "require human intelligence to complete" (Paolacci, Chandler, & Ipeirotis, 2010, p. 411). The study consisted of three Phases, the first two of which employed a total sample size of N=200. The third study Phase employed a total sample size of N=1638. The study attracted respondents from 28 countries and participants ranged in age from 18 to 71.

The materials used in the study included the Affective Norms for English Words list (ANEW), produced by the University of Florida, which provides a "set of normative emotional ratings for a large number of words in the English language" (Bradley & Lang, 2010, p. 2). This list was used to determine specific wording for a Psychometric Dread risk research instrument, resulting in two versions, one with words reflecting negative Affect, and the other with emotionally neutral wording.

These Psychometric Dread risk surveys consisted of ten Dread risk factor items in the context of six different hazards (Slovic, 1987). The Psychometric Knowledge factor was outside the scope of this research, and was thus not assessed. The hazards chosen for the study have been demonstrated in previous work to represent a spread of risk perceptions from low to high Dread (Slovic, 1987). In addition to these instruments, a set of questions relating to the risk consequences of the six hazards were devised and worded into Affective and neutral versions. A seven point Likert scale was used to measure all responses.

The study applied a positivist research approach together with a quantitative methodology. The research instruments for the three study Phases were developed into online versions. The Amazon Mechanical Turk service (Amazon.com, 2014) was used to recruit participants, who were then redirected to the online surveys. Phases One and Two of the study were executed simultaneously, and involved two independent cohorts in a between-subjects design.

The first cohort (n=100) completed the neutral Psychometric Dread risk survey and the neutral Risk Consequence Task, while the second cohort (n=100) completed the affective versions of the same research instruments. Phase Three of the study combined and replicated the procedures of Phases One and Two. The data of the three Phases were analysed via descriptive data analysis, Independent Samples *t*-tests, Multidimensional Scaling analysis, Factor Analysis and Cronbach's Alpha. These statistical measures were used to assess any significant differences or associations between neutral and Affective perceptions of the six hazards in the context of risk consequence and the Dread risk factor characteristics.

1.6 Thesis Proceedings

The Thesis is comprised of nine chapters inclusive of this introduction. The proceeding chapters are summarised here:

Chapter 2: Literature Review

The intention of this chapter is to provide context in order to illustrate gaps in the current understanding of Psychometric Risk. The review of the literature provides a contextual foundation for the study and highlights the elements that were fundamental in the shaping of the aim and objectives. It also offers a framework and justification for the Research Questions and the development of the study methodology.

Chapter 3: Theory Supporting the Study

This chapter highlights the significant findings in Psychometric risk perception research as well as outlining the criticisms of the approach. The Theory Supporting the Study chapter provides a deeper understanding of the Psychometric Paradigm and Dread risk and the association with Affect.

Chapter 4: Methodology

The chapter details the methods and procedures used in the collection of data in the three study Phases. The reasoning behind the study design is discussed, as is the theoretical basis for the research instrument design. The procedure is detailed and the approaches to data analysis, reliability and validity are outlined. The chapter concludes with a summary of the methodological limitations.

Chapter 5: Phase One

This chapter details the implementation of the first study Phase, including the design, procedure and data analysis. This Phase involved participants completing either a neutral-worded or an Affective-worded Psychometric risk survey in a between-subjects design. The analyses of data using various statistical measures are presented, together with a summary of the results. The limitations identified in this initial Phase are also outlined, together with improvements for the second and third Phases of the study.

Chapter 6: Phase Two

This chapter details the design, procedure and data analysis of Phase Two of the study. This Phase involved participants' completing either a neutral-worded or an Affective-worded Risk Consequence Task in a between-subjects design. A summary of the results is presented and the chapter concludes with a review of the Phase Two design, implementation, and outcomes.

Chapter 7: Phase Three

This chapter reports the results of Phase Three of the Study. The third Phase combined the first two study Phases, and replicated the procedures with some methodological improvements. The Phase Three results are presented and the chapter concludes with a summary of the Phase Three outcomes.

Chapter 8: Interpretations and Limitations

This chapter offers an interpretation of the results and a response to the Research Questions. The interpretations of the study findings are discussed in conjunction with the relevant literature, and exceptions and alternate explanations are outlined. An overview of the implications and significance of the research outcomes is provided, and the limitations of the study are detailed. The chapter concludes with a summary of the interpretations and Responses to the Research Questions.

Chapter 9: Conclusions and Recommendations

This final chapter provides a synthesis of the empirical findings of the study and shows how these converge in response to the Research Questions. The theoretical and policy implications of the research outcomes are also discussed, demonstrating how the findings of the study may influence further understanding and application of knowledge in the risk domain. The chapter concludes with recommendations for future investigations and closing remarks on the significance and contribution of the research.

1.7 Conclusion

This introductory chapter presented the background to the study, highlighting the major findings in the literature in relation to risk and the Psychometric paradigm. The identified gap in the knowledge framed the research problem, and the significance of addressing the knowledge gap was outlined. The study's methodology was discussed and a summary of the Thesis proceedings was presented. The following chapter offers a review of the

relevant literature in order to provide a contextual foundation for the study, and to highlight the theoretical elements that were fundamental in shaping the study objectives and methodology.

CHAPTER 2: REVIEW OF THE LITERATURE

2.1 Introduction

The previous chapter provided an overview of the gap in the literature leading to the research problem, and framed the Research Questions that the study would address. The intention of this chapter is to provide context to the identified gaps in the current understanding of Psychometric Dread risk. The review of the literature provides a contextual foundation for the study and highlights the elements that were fundamental in shaping the approach taken. It also offers a framework and justification for the Research Questions and development of the methodology of the study.

This review of the literature includes a discussion on the definition and nature of risk, and the fundamental aspects of reality and subjectivity that underpin the concept. The various perspectives of the major theories of risk perception are discussed, and the justifications and criticisms of each are analysed. The review then examines the literature concerned with the more fundamental aspects of perception, grounded in cognitive psychology and follows these concepts through to the evolution of theories of decision making. Issues relating to emotion and cognition are introduced, and the various heuristics and biases that have been proposed to explain irrational behaviour are discussed.

The impact of emotion and framing effects on risk judgements are then examined, finally leading the literature review to a discussion of the influence of each of the discussed elements on perceived risk, assessments of probability and consequence. Throughout the review of the literature, references are made to how each of the discussed concepts relates to Psychometric Dread, leading to questions of the accuracy of its conception and efficacy as a predictor of perceived risk.

2.2 Objective and Subjective Risk

Risk is a concept that governs all aspects of human life. The review of the literature reveals a search for rationality among misperceptions, and makes clear that much of what was once thought of as rational decision processes may be relics of an earlier age in human history. These evolutionary by-products in the form of hard-wired rules-of-thumb often perform poorly in a modern context.

The literature review indicates that the distillation of risk to the fundamental concepts of probability and consequence is flawed in the context of human decision making and obscured by the complexities of human perception. In an effort to understand the predictably irrational nature of human decision making, risk perception research has shown that the controllability and manageability of future events are largely illusory. The body of literature on perceived risk abounds with examples of fear and irrationality in an increasingly unpredictable world, and the search for an understanding of subjective human perception within the objective reality of risk.

Risk may be defined as the effect of uncertainty on objectives (Standards Australia, 2009), and the way that risk is perceived and assessed is influenced by many factors. However, perceptions do not always match reality. Although perception may be defined in direct terms as "the acquisition and processing of sensory information" (Eysenck & Keane, 2005, p. 31), some theories of cognitive psychology assert that perception is an active process that involves the construction of categories that are influenced by culture, values, beliefs, attitudes, expectations, knowledge, language, and education (Falikowski, 2002). This value-laden construction of categories results in different perceptions of risk and highlights the subjectivity of risk perception, especially in regards to intuitive interpretations of risk.

The subjectivity of intuitive risk has led some to argue that risk assessment is more of an art than a science (Broder, 2000, p. 1). If the perception of risk is fundamentally subjective, then any attempt at critically assessing risk will be influenced by the value laden assumptions and resulting intuitive reactions that the risk elicits. Ferrier and Haque (2003) illustrate this point, stating that "in some cases, human perception is greater than objective reality... in other cases, the perceived experience of a hazard is lesser than the reality" (p. 277). The difficulty in determining how the subjectivity of risk perception influences the assessment of risk is an issue that has been recognised within the literature of risk research. A matter of debate for many years has been whether the concept of risk is an objective reality, a social construct, or a subjective individual perception (Lupton, 1999, p. 22).

If conceptual meaning is dependent on perceptual processes (Eysenck & Keane, 2005, p. 309), then objective risk, including its tools and methods, are necessarily dependent on "subjective and assumption-laden" (Slovic, 1999, p. 690) risk perceptions. Despite the subjectivity of perceived risk, this does not detract from the objective reality of risk. The subjectivity of perceived risk does not infer that there is no danger in reality, but rather that hazards are, in part, socially defined and distinguished by boundaries created by social agents (Clarke & Short, 1993, p. 379; Douglas & Wildavsky, 1982).

Explanations of the perception of risk through the anthropological lens has given rise to several social theories of risk, such as Cultural Risk (Douglas, 1992), and the Social Amplification of Risk which attempt to explain variations in risk perception as a product of a society's collective beliefs, attitudes, and judgements about risk (Kasperson et al., 1988). Other researchers have attempted to explain risk subjectivity through the psychological view, an avenue which has given rise to the Psychometric paradigm of perceived risk (Fischhoff, Slovic, Litchtenstein, Read, & Combs, 1978; Starr, 1969).

2.3 Perspectives of Risk

In the 1960s, researchers began investigating social risk attitudes such as those expressed towards voluntary and involuntary risks in order to understand the apparent disparity in the estimation of risks between experts and lay people (Starr, 1969). From this initial research, a psychological approach was developed based on concepts of heuristics and biases in the information processing and decision making of individuals (Tversky & Kahneman, 1974). This approach in turn led to the development of the Psychometric paradigm of risk perception.

Researchers of the Psychometric paradigm have developed a methodology for producing "quantitative representations or cognitive maps of risk attitudes and perceptions" (Slovic, 1987). These cognitive maps employ two factors, Dread and Knowledge, to form a spatial representation of risk perceptions (Slovic, Fischhoff, & Lichtenstein, 1982). However, critics of the Psychometric paradigm have claimed that the Dread factor has been inadequately quantified, that the model fails to explain much of the disparity between lay and expert risk assessment, and that Psychometric risk can be identified as a contributing factor to risk communication failures (Sjöberg, 2006a). Critics have also argued that the Psychometric paradigm has a committed realist perspective that essentially makes each man an island in terms of their risk perceptions, to the exclusion of their cultural and social context (Cutter, 1993; Lupton, 1999; Wilkinson, 2001).

In contrast to the Psychometric paradigm's focus on individual risk perception, the Cultural Theory of risk defines social groups, rather than individuals, as the basis of risk perception and judgements and "argues that risks are defined, perceived, and managed according to principles that inhere in particular forms of social organisation" (Rayner, 1992, p. 84). Wilkinson (2001) eloquently summarises the central thesis of the theory of Cultural Risk, describing it as a "structural-functionalist interpretation of risk perception, which proposes that what we conceive as the 'reality' of risk is determined by our prior commitments towards different types of social solidarity" (p. 1).

The Cultural Theory of risk features four worldviews which are defined by their position within 'grid' and 'group' topologies (Douglas & Wildavsky, 1982). The theory defines worldviews as either high or low group, indicating degrees of binding to social groups, and either high or low grid, indicating degrees of socially defined circumscription (Thompson, Ellis, & Wildavsky, 1990). From the grid/group topologies emerge four worldviews that are labelled Hierarchical, Individualist, Egalitarian, and Fatalist (Figure 2.1).

Grid

High	
Fatalistic	Hierarchic
Low	High
Individualistic	Egalitarian
	Low
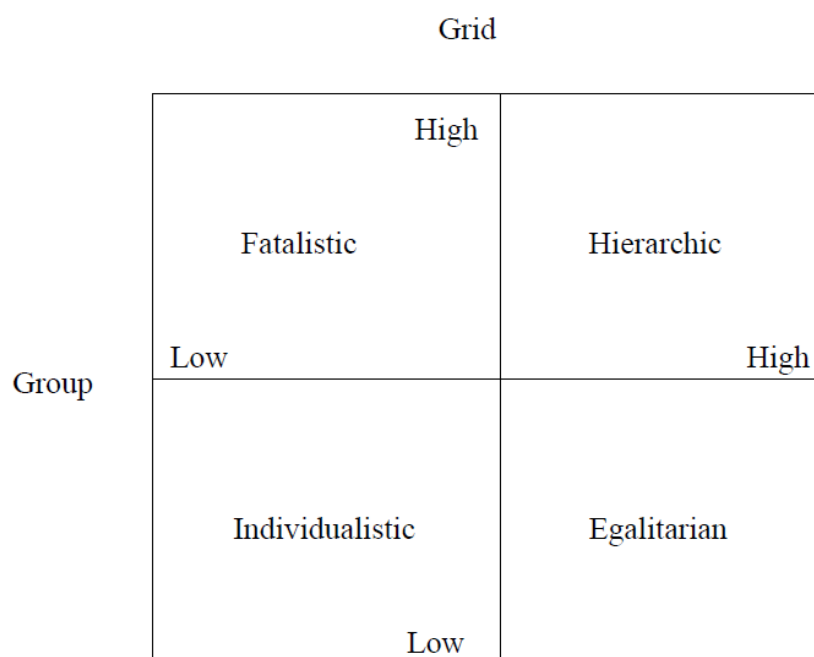
Group

Figure 2.1   Cultural Risk's grid – group model (Oltedal, Moen, Klempe, & Rundmo, 2004, p. 19).

The Cultural Theory of risk claims that different risks will cohere with one of these worldviews, and adherents of particular worldviews will bias their perceptions of risk accordingly (Douglas, 1992). Criticisms of the Cultural Theory of risk include the failure of the model to explain the potential for individuals to move between, or express more than one of the four worldviews (Lupton, 1999; Marris, Langford, & O'Riordan, 1998), as well as the lack of internal validity found by many researchers in the use of separate

scales to measure worldviews (Kahan, 2008). The Cultural Theory of risk however, is not the only model of risk perception to be developed with a view of incorporating the myriad of elements which have been shown to impact on risk judgements.

The Social Amplification of Risk Framework (SARF) was developed in an attempt to fuse the Psychometric Theory of risk, the Cultural Theory of risk, and theories of risk communication into an integrated framework in order to overcome many of the shortcomings of each of these theories. Kasperson, Kasperson, Pidgeon, and Slovic (2003), state that the framework was developed to "describe the various dynamic social processes underlying risk perception" (p. 13). According to Kasperson, et al. (1988), the framework incorporates Psychometric and Cultural factors to describe how these elements influence the way risks are socially perceived *en masse,* by either amplifying or attenuating the communication of risk (p. 177). Kasperson and Kasperson (2005) assert that various ripples, or higher order impacts result from risk events, and serve to amplify the adverse impact of the initial risk, creating a self-correcting system of societal risk perception.

The amplification of perceived risk through individual, social, and cultural mechanisms serves to more completely define the consequences of that risk, providing a collective representation of the nature of the hazard. The SARF approach has been criticised, especially from the constructionist perspective which, by effectively determining there to be "no risk in reality" (Ewald, 1991, p. 199), considers the very idea of a 'risk event' to be a flawed foundation. Furthermore, it is the impressionability or "malleability of risk perception" (Clarke & Short, 1993, p. 379) that must be fundamentally addressed. If interpretation of an initial risk event is a product of perceived risk, then any amplification or attenuation thereafter may actually have little bearing on the reality of the risk. The need for a theory of risk that incorporates the anthropological view while reproducing the explanatory success of the Psychometric approach has continued to be a central theme for

risk perception researchers, and has led to the development of alternative theories, such as Cultural Cognition.

Cultural Cognition is a conception of the Cultural Theory of risk, and a methodology designed to empirically test the theory by using a similar approach to the Psychometric paradigm. Cultural cognition is founded on two key premises, the first being that cultural predispositions are better predictors of risk perceptions than gender, race, political, or economic demographics (Kahan & Braman, 2005; Kahan, Slovic, Braman, & Gastil, 2006). The second premise is that there is a connection between an individual's cultural outlook and their perception of risk based on identifiable psychological processes or mechanisms, essentially addressing the question posed by Clarke and Short (1993) and Kahan (2008) of *why* "individuals are disposed to form risk perceptions" (p. 10).

The Cultural Cognition approach combines the Cultural Theory of risk's grid/group topology with the Psychometric paradigm's two-axis spatial representation approach, rather than the four scale approach typical of other conceptions of Cultural Theory. This approach results in the two continuums of hierarchy-egalitarianism (high-low grid) and individualism-communitarianism (low-high group). Cultural Cognition's two-scale approach has been found to be reliable (Griffiths & Brooks, 2012; Kahan, 2008), and solves the issues of multiple expressions of worldviews associated with other Cultural Risk methodologies (Dake, 1991; Douglas & Wildavsky, 1982).

The Cultural Cognition approach has also received criticism, however. One of the shortcomings identified in the Cultural Cognition model, and to Cultural risk theories in general, has come from one of the founders of the cultural approach. Douglas (2003) explains that although Cultural approaches to risk offer "a way of stratifying the public according to their deepest allegiances" (p. 1350), it is these same deep allegiances in the researchers that may bias the design of the research. Sjöberg (1996) asserts that the Cultural approach to risk accounts for very little variation in risk perception, and that

many of the results of statistical significance have little actual importance of any substance.

Each of the abovementioned approaches to the assessment of perceived risk have received fair criticism for their shortcomings, and none of them account fully for the major findings of risk perception research (Sjöberg, 2006a). To assert that the concept of risk "is strongly influenced by our perceptions" (Hopkins, 2005, p. 114) offers little in the way of understanding those perceptions or the major drivers behind risk perception. It does, however, highlight the subjective nature of risk, an aspect which may be better understood with reference to one of the key themes of modern psychology; the subjectivity of perception (Weiten, 2005). Understanding how the perception of risk influences risk assessment may be better addressed by focusing on attempts to understand the major influences on risk perception. Research into cognition and decision making offers some insight into the mechanisms underlying how perceptions are formed and according to Slovic, Fischoff and Litchenstein (1985), "risk perception research has been and continues to be grounded in basic cognitive psychology" (p. 84).

2.4 Risk and Decision Making

The constructivist view of Cognitive Psychology asserts that a rapid process of forming and testing hypotheses regarding *percepts* (or mental concepts) occurs in the process of perception (Nickerson, 1998). While sensation provides a process for converting stimuli into neural impulses, perception provides a method whereby sensory stimuli is processed, compared and interpreted to give meaning (Simon, 1990). Burton, Westen and Kowalski (2006), define perception as the "process by which the brain selects, organizes and interprets sensations" (p. 121). Essentially, the process combines sensation and perception to aid the interpretation and understanding of the environment.

Any discussion of the impact of perception on judgement must necessarily involve a discussion of decision making. The method by which perceptions are interpreted and ascribed meaning is instrumental to the decision making process, and therefore essential to providing a clearer view of the nuances of risk assessment. Many theories have been developed to understand the relationship between perception and decision making. Early probability theory (later developed into Decision Theory), asserts that humans are rational optimisers, making choices of the highest expected utility through estimations of value and probability (Gardner, 2008). This view asserts that humans make decisions based on rational calculation. According to Savage (1954):

> To say that a decision is to be made is to say that one of two or more acts is to be chosen, or decided on. In deciding on an act, account must be taken of the possible states of the world, and also of the consequences implicit in each act for each possible state of the world. A consequence is anything that may happen to the person. (p. 5)

However, this classic version of Decision Theory was found to have limited descriptive validity by economists, sociologists and psychologists, failing in many cases to explain and predict behaviour. In 1956, Herbert Simon developed the theory of Bounded Rationality, which attempted to capture the limitations of human cognitive capacity (Simon, 1956). According to Richardson (1999), Bounded Rationality Theory asserts that:

> We make choices between alternatives in light of our goals, relying on incomplete information and limited resources. As a consequence, PROBLEM SOLVING cannot be exhaustive: we cannot explore all the possibilities which confront us, and search must be constrained in ways that facilitate search efficiency even at the expense of search effectiveness (p. 44).

In Bounded Rationality Theory, decision alternatives are sought after until "an alternative is found that reaches or surpasses the aspiration levels on the goal variables" (Selten, 2002, p. 14). In the 1970s, Kahneman and Tversky (1974) sought to define the boundaries theorised in Bounded Rationality, finding that "people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgmental operations" (p. 1124).

Both Classic Decision Theory and Bounded Rationality Theory are based on the concept of utility maximisation, and in the early 1980s, the Satisficing Heuristic came to dominate the literature of utility maximisation (Cole & Withey, 1981). Bounded Rationality is seen by some theorists as nothing more than the use of "satisficing strategies when capacities are overwhelmed" (Klaczynski, 2001, p. 858). The Satisficing Heuristic encourages an individual to choose the first option that meets or exceeds expectations when delay is not in their best interest. However, Selten (2002) argues that the satisficing strategy does not adequately sum up Bounded Rationality Theory, as aspiration levels are "dynamically adjusted to the situation" (p. 14) depending on the ease with which a satisfactory alternative can be found.

In response to the shortcomings of classic Decision Theory, the Ernst Strüngmann Forum initiated a project in 2011 to develop a new Decision Theory that includes the two factors of evolution and cognitive mechanisms which are disregarded in classic Decision Theory (Ernst Strüngmann Forum, 2011). The consideration of evolutionary and cognitive mechanisms in decision making takes into account that fact that humans are not rational optimisers, but rather rely heavily on biases, emotions, expectation, misconceptions and conformity in order to make decisions, including risk judgements. Essentially, human decision making is a process of two minds.

2.5 Apollo and Dionysus

Friedrich Nietzsche conceptualised the rational and emotional sides of human nature as the mythical figures Apollo and Dionysus, where the Apollonian drive gives rise to rationality and knowledge, and the Dionysian gives rise to the emotional and irrational (Tarzwell, 2009). In a metaphysical sense, Apollo may be thought of as the systematic or analytic system of human perception, and Dionysus as the experiential or heuristic system. Slovic, Finucane, Peters, and MacGregor (2011) assert that current cognitive psychological theories also point to two fundamental systems by which risk is perceived and understood.

The first is the slower more laborious Apollonian mental process called the 'analytic system', which is in contrast to the faster, automated and more intuitive Dionysian mental process known as the 'experiential system' that represents risk as a feeling (Sharot et al., 2011). These two fundamental processes have parallels to the Heuristic-Systematic information processing model (HSM), which presents risk judgment as a product of both unconscious heuristic and conscious systematic processing (Trumbo, 1999). As the persistence of rationality-based Decision Theories attest, the idea that good decisions are made through rational, conscious thought has been a fundamental tenet of behavioural inquiry for many years. According to Dijksterhuis et al. (2006), "conscious deliberation is the ideal (if not always attainable) way to approach a decision forms the backbone of classic as well as contemporary perspectives on decision making and attitude formation" (p. 1005).

However, research into the role of subconscious deliberation has found that complex decisions may be best left to subconscious heuristic based thought. In a series of four studies, Dijksterhuis et al. (2006) found that "purchases of complex products were viewed more favourably when decisions had been made in the absence of attentive deliberation" (p. 1005), whereas simple decisions were best aided by conscious thought. It might be argued that there is a fundamental difference between the efficacy of

subconscious deliberation on the purchase of complex products and the efficacy of the same type of decision making in judging risk. Judgements of risk tend to carry more severe consequences for poor decisions.

The finding of Dijksterhuis et al. (2006) agree with Simon's (1990) assertion that heuristic based decisions are "examples of rational adaptation to complex task environments that take appropriate account of computational limitations—of bounded rationality" (p. 11). This research would indicate that when faced with a complex decision, the human mind is best adapted to employ subconscious heuristic-based deliberation to arrive at a satisfactory solution. Simon (1990, p. 11) emphasises that the heuristic system holds a great deal of explanatory power for understanding the human capacity to make effective complex decisions, notwithstanding the computational limitations imposed by Bounded Rationality.

2.6 Putting Your Heads Together

Despite the appeal of the concept of the human mind unconsciously distilling and simplifying complex choices in order to make effective decisions, an increasingly held view is that Systematic and Heuristic mental processes are not mutually exclusive. Research suggests that risk judgments are formed by employing both Heuristic and Systematic information processing together, rather than by using either of these information processing models alone (Booth-Butterfield, Cooke, Pearson, Lang, & et al., 1994). This view supports modern cognitive psychological theories which, according to Slovic et al. (2011), assert that the "rational and the experiential systems operate in parallel and each seems to depend on the other for guidance" (p. 1).

The Heuristic-Systematic information processing model (HSM) presents risk judgment as a product of both Heuristic and Systematic processing and provides a useful method for evaluating risk judgment (Trumbo, 1999). Systematic processing occurs when an

individual attempts to assess risk by analysing and comparing risk information. According to Trumbo (1999), while Heuristic processing requires less effort and utilises simple decision rules to arrive at a risk judgment, Systematic processing requires individuals to exert "considerable effort in a search for information and a scrutiny of arguments, maintaining higher standards for the quality of information used in decision making" (p. 392).

It appears, however, that an effortful scrutinising of information via the Systematic processing system may be hampered by Optimism and Confirmation biases. These biases use the Heuristic processing system to seek information that confirms, and to screen information that disconfirms, existing beliefs. Sharot et al. (2011) conducted a study where participants were presented with a series of descriptions of adverse life events and were asked to estimate the likelihood of an event occurring to them. They were then presented with the average probability of that event occurring to them. Not only did participants consistently underestimate the likelihood of the risk, they also "updated their beliefs more in response to information that was better than expected than to information that was worse" (Sharot et al., 2011, p. 1475).

Such bias towards the underestimation of risks indicates an evolutionary preference for optimism in the face of reality. However, the tendency for individuals to continue to underestimate risks in the face of evidence to the contrary is equivalent to what Nickerson (1998) refers to as *selective case building* in which individuals unconsciously gather selective information and give undue consideration to "evidence that supports one's position while neglecting to gather, or [discount], evidence that would tell against it" (p. 175). The fundamental nature of this tendency to seek confirmatory evidence while discounting facts to the contrary was also illustrated in a study by Westen, Blagov, Harenski, Kilts, and Hamann (2006). The researchers found that different parts of the brain are active when an individual processes information that runs contrary to strongly

held beliefs, compared with the processing of neutral or positive information (Westen et al., 2006).

This bias is referred to in the literature as the Confirmation Bias. According to Evans (1989), the Confirmation Bias is the "most widely accepted notion of inferential error to come out of the literature on human reasoning" (p. 41). This type of error also extends to numerical estimations. In a seminal study by Wason (1960), participants were presented with three successive even numbers and were asked to determine the rule that would predict the next three numbers in the sequence by asking if a particular number would fit the rule. The correct rule was any three numbers in ascending order, however, most participants determined the rule to be numbers increasing by two. Participants tended only to ask if a particular number *confirmed* the rule they suspected, by rarely asked whether a number which *disconfirmed* their rule would fit the pattern. When heuristics and biases are considered within the context of risk perception, it raises the question of how much of the assessment of risk is reliant on subjective and intuitive subconscious reactions.

2.7 Mental Shortcuts to Risk Judgement

The literature suggests that intuitive risk appears to be fundamentally based in heuristic processing and the application of rules formed via previously successful choices. Heuristic processing is employed most often when "probabilities or utilities are unknown [and] multiple goals and ill-defined problems prevent logic or probability theory from finding the optimal solution" (Gigerenzer, 2008, p. 20). The purpose of risk assessment is to provide analysis and judgement of the unknown and the poorly defined, and as such, is a particularly well placed activity for reliance on heuristics and their associated biases. Because heuristic assessment occurs "prior to any conscious thought... it shapes and colours the thoughts that follow" (Gardner, 2008, pp. 222-223), a situation which makes the study of the impact of heuristics on risk perception particularly challenging.

Various researchers have established several intuitive judgement drivers as accepted heuristic processes. According to Gilovich and Griffin (2002), the early research pointed to three "general-purpose heuristics – availability, representativeness, and anchoring and adjustment – that underlie many intuitive judgements under uncertainty" (p. 5). These early heuristics were developed within the bounded rationality model, and focused on cognitive heuristic strategies (Tversky & Kahneman, 1974). Initially, these heuristic processes were seen as evidence of the intuitive system being a 'cognitive miser'. However, more recent evidence suggests that the heuristic processing system "is always in operation – not just when motivation is low and judgements are made on the cheap" (Gilovich & Griffin, 2002, p. 12). Despite the evidence of cognitive heuristics and their potential impact on risk perception, some researchers felt that research into emotional, or Affective, reactions to risk may reveal more about how perceptions of risk are formed.

According to Slovic, Finucane, Peters, and MacGregor (2007), descriptive decision research in general was focused for many years on cognitive processes, rather than Affective impacts on decision making. One of the early proponents of the significance of the role of emotion in decision making, was Zajonc (1980), who asserted that "Affective judgments may be fairly independent of, and precede in time, the sorts of perceptual and cognitive operations commonly assumed to be the basis of these Affective judgments" (p. 151). Research into the pre-cognitive impact of emotion on risk judgements resulted in the proposal of an Affect Heuristic (Slovic et al., 2007). In this context, the term Affect refers to "the specific quality of 'goodness' or 'badness' experienced as a feeling state (with or without consciousness) and demarcating a positive or negative quality of a stimulus" (Slovic, Finucane, Peters, & MacGregor, 2007, p. 2).

The pre-cognitive view shed new light on the research of Fischhoff, et al. (1978), who found a strong correlation between the way risks are perceived and the level of negative Affect they elicit. In the early 1990s, risk researchers began to increasingly shift their

focus away from cognitive heuristics, and began to inquire after the heuristic basis of emotion. The view that emerged from research into the Affect Heuristic was that "emotional reactions to risky situations often diverge from cognitive assessments of those risks. When such divergence occurs, emotional reactions often drive behaviour" (Loewenstein, Weber, Hsee, & Welch, 2001, p. 276). As a result, it is now widely conceived among risk researchers that risk perception "is mainly governed by emotional processes" (Sjöberg, 2006b, p. 101).

2.8 The Affect Heuristic

The association of Affect with decision making has been well established in the literature. According to Slovic et al. (2007), "many theorists have given Affect a direct and primary role in motivating behaviour" (p.4). This essential role of Affect in rational decision making was made apparent by Damasio, Tranel, and Damasio (1990), who found that patients suffering ventromedial frontal cortical damage to their brains were unable to associate emotions with decision consequences, rendering them socially dysfunctional and unable to make rational decisions. This finding suggested that "feeling [is] an integral component of the machinery of reason" (Damasio et al., 1990, p. XII). Damasio (1994) concluded that "emotions and feelings [are] connected, by learning, to predicted future outcomes of certain scenarios" (p. 174). The judgement of consequences had previously been illustrated as a major source of uncertainty in the risk assessment process, and the impact of Affect was now centre stage.

Judgements of consequence values are not constant; they not only vary between individuals, but also over time and place (Rowe, 1988). Estimating an accurate consequence value ideally requires some historical data from which to infer the potential magnitude of similar future events. It also provides a measure of the acceptability of the risk to society, as well as a feel for the level of regulation required to accurately interpret the needs and values of the risk agents being represented (Cole & Withey, 1981).

However, risks with a very low probability of occurring and a very large consequence value are particularly difficult to assess for two reasons. Firstly, the risk estimator is unable to infer the consequence value from historical data if the event has not, or has very rarely, occurred. Second, the highly subjective nature of consequence valuing means that any assessment of such low probability risks becomes laden with Affective assumptions. Cox (2009) asserts that these difficulties can result in risk assessments that are "worse than useless" (p. vii).

An example of the Affective influence on risk judgements can be illustrated by the number of Americans who, post 9/11, dreaded flying due to the low-probability / high-consequence terrorist attack. As a result of the Affective influence on perceptions of terrorism risk, these people now tended to choose driving over flying. Gigerenzer (2006), examined road fatalities in the 12 months following the September 11 terrorist attacks and found that, when compared with the previous five years of data, the number of fatal traffic accidents in the United States increased for the 12 month period after the attacks. The increase in the number of people killed on the roads in this period was six times greater than the number of airline passengers killed in the attacks, providing support to the hypothesis that the negative Affect created by the attacks caused a "mediated secondary death toll" (Gigerenzer, 2006, p. 350) by skewing risk perceptions and therefore risk judgement.

Another factor that impacts estimations of consequence values is the propensity for individuals to assign a higher consequence value to consequences that are experienced personally (Rowe, 1988). Paradoxically, the larger the population that is exposed to a risk, the lower the consequence value that will be assigned, due in part to the increasingly impersonal nature of such large numbers of people, and the inability of the Affect Heuristic to 'feel' the magnitude of large numbers (Slovic et al., 2007). This degree of personal separation from exposure to the consequences is not only influenced by Affect, but also to the perceived degree of control over the risk. Note that it is not the real or

actual amount of control, but the perception of control that makes this a "major factor in determining risk consequence value" (Rowe, 1988, p. 135).

Slovic, Peters, Finucane, and MacGregor (2005) demonstrated that "when consequences carry sharp and strong Affective meaning, as is the case with a lottery jackpot or a cancer, variation in probability often carries too little weight" (p. 38). The impact of Affect on consequence estimations is significant to risk perception research, in that it may alter estimations of risk probability, which indicates that risk judgements under uncertainty are sensitive to the *possibility* of outcomes, rather than the *probability* (Loewenstein et al., 2001). Equally significant to the formal risk assessment is a finding by Slovic et al. (2005), who state that if a high consequence / low probability risk is "reduced but not eliminated, the fear... may remain and continue to drive high-risk perceptions despite the actual reduction of risk" (p. 38).

Unfortunately, confidence in one's own objectivity in formally assessing risks is of limited value. In one study, Murphy and Zajonc (1993) showed an image of either a smiling face, a frowning face or meaningless polygon to respondents a fraction of a second before images of Chinese ideographs. Respondents generally rated the positively primed ideographs as more preferable. However, none of the respondents reported feeling any emotion, and the impression persisted, even after the positive and negative images were switched. Taylor-Gooby and Zinn (2006a) assert that this type of Affective priming provides a frame of reference through Affective experience, and that any assessment is necessarily subject to context and framing.

2.9 Affect and Framing Consequences

Framing refers to the way a problem is presented and the impact this has on judgement. Taylor-Gooby and Zinn (2006a) assert that "although the concept of rationality assumes that the same problem should always lead to the same result, even though the contexts

differ, the formulation (framing) of a problem influences the judgement" (p. 28). By definition, rational choice "should satisfy some elementary requirements of consistency and coherence" (Tversky & Kahneman, 1981, p. 453); however, framing effects highlight the fact that divergences from the ideal of rationality not only influence preferences in decision making, but also perception.

In a seminal study on the influence of framing on decisions and the psychology of choice, Tversky and Kahneman (1981) performed a series of surveys on university students in a classroom setting, and presented them with problems with identical outcomes, framed either in terms of gain or in terms of loss. The study found a "pronounced shift from risk aversion to risk taking" (Tversky & Kahneman, 1981, p. 453) depending on how the problem was framed. The preferences expressed in the presence of framing effects "may plausibly be explained by positing that human cognitive processes are in some aspects ill-suited to dealing with complex social situations because they developed at an earlier evolutionary stage" (Taylor-Gooby & Zinn, 2006b, p. 399). The overlap of Affect and cognition has also been proposed as an explanation of such anomalies of rationality.

The influence of Affect on judgement and decision making may be thought of as "nonrational associationistic thinking" (Epstein, 1994, p. 718) and may lead to probability neglect and behaviour that is irrational. In a study demonstrating nonrational associationistic thinking, respondents were presented with a vignette describing a rich benefactor who promises $100 to each of three protagonists if they can each toss a coin that comes up heads. In the scenario, only one protagonist does not flip heads, and the respondents were asked to rate the emotions of the three protagonists. Most respondents said that they thought the two successful protagonists would feel negatively towards the unsuccessful one, that such behaviour was irrational, and that knowledge of probability had no impact (Epstein, 1994). Affective reactions to risk may not only prompt probability neglect, but also heighten avoidance of risk consequences, depending on the evaluability of the risk.

Rottenstreich and Hsee (2001) demonstrated the link between Affect, risk consequence, and probability, finding that participants in their experiments were hypothetically willing to pay $18 to avoid a 99% probability of losing $20, but only $1 to avoid a 1% chance of losing $20. When the monetary loss was replaced with the probability of receiving an electric shock, participants were willing to pay $10 to avoid a 99% probability, but would pay $7 to avoid a 1% chance of electric shock. The visceral Affective reaction to the thought of an electric shock prompted probability neglect and a focus on avoiding the risk consequence, compared with the reaction to the money scenario. The evaluability of risk judgement has been shown to be closely associated with Affective reactions, and these reactions may trump the consideration of more justifiable factors.

Hsee's (1996a) notion of 'evaluability' was based on the observation that "when making judgments, one may encounter not only justifiable factors… but also unjustifiable factors" (p. 122). Hsee (1996a) defined justifiable factors as characteristics which the risk evaluator *thinks* should be taken into account, and unjustifiable factors as those characteristics which the risk evaluator *wants* to take into account. These findings were further developed into the evaluability hypothesis, which posited that "when two options involving a trade-off between a hard-to-evaluate attribute and an easy-to-evaluate attribute are evaluated, preference between these options may change depending on whether these options are presented jointly or separately" (Hsee, 1996b, p. 265).

Hsee (1996a) observed that "as long as there is a conflict between the 'should' and the 'want', elasticity in the situation will shift one's final decision toward the 'want' side" (p. 128). This drive to take the unjustifiable into account in judgement is associated with the precision of Affective impressions. In a between-groups study, Slovic et al. (2007) found that support for an airport safety measure was higher when saving a percentage of 150 lives was proposed, than when a total of 150 lives was proposed, indicating that "saving 150 lives is diffusely good, hence only weakly evaluable, whereas saving 98% of

something is clearly very good because it is so close to the upper bound on the percentage scale, and hence is readily evaluable and highly weighted in the support of judgment" (p. 19). Slovic et al. (2007) found that "more precise Affective impressions reflect more precise meanings (i.e. greater evaluability) and carry more weight in impression formation, judgment, and decision making" (p. 20).

However, when risk consequences "carry sharp and strong Affective meaning" (Slovic et al., 2007, p. 19), feelings of dread and negative Affect have an all-or-none characteristic, in that they "may be sensitive to the possibility rather than the probability of negative consequences" (Loewenstein et al., 2001, p. 276). Tversky and Kahneman (1981), demonstrated the impact of Affectively 'framing' risks, finding that "framing influences the experience of consequences" (p. 458). The Affective framing of risk consequences not only influences the perception of those consequences, but it also alters the value of risk probabilities in the mind of the perceiver. Sunstein (2004) suggested that the Affect Heuristic has a major impact on the ability to correctly interpret probabilities, suggesting that when risk consequences conjure vivid mental impressions, they tend to produce visceral reactions where "the question of probability is neglected" (p. xi).

Sensitivity to perceiving risk as all-or-none is not only Affectively driven, but is also linked to the way that risk is expressed in language. When the meanings of risk were examined by Hamilton, Adolphs, and Nerlich (2007), they found that risk is semantically expressed as a "degree of risk ranging from instances in which the risk is perceived to be non-existent… to instances where it is perceived to be low… to those where it is perceived to be high" (p. 174). The linguistic assessment of risks as either absent, low or high underscores how precognitive Affective impressions of risk shape perceptions based on good/bad or like/dislike (Zajonc, 1980), which are in turn mapped to estimations of probability and severity of consequences.

The view that Affective reactions are inextricably linked to linguistic meanings of risk provides the Psychometric paradigm of risk with a vehicle for assessing risk perceptions. Although Starr's (1969) seminal work on the perception of risk focussed on *revealed* preferences, the Psychometric paradigm attempts to explain risk perception through *expressed* preferences via standardised questionnaires (Fischhoff et al., 1978; Slovic et al., 1985). Slovic et al. (2007) asserts that language has a significant impact on the Affect Heuristic, stating that "attempts at Affective manipulation often work directly on language" (p. 32). How risks are expressed and framed in language has an impact on the Affective meaning of the risk, influencing estimations of the probability and consequences.

When risk consequences have strong Affective meaning, perceptions of probability carry too little weight; however, when outcomes do *not* have strong Affective meaning, perceptions of probability are highly evaluable (Slovic et al., 2007; Zajonc, 1980). The pre-cognitive Affective impact results in a neglect of probability, and subsequent risk judgement is based on the Affective reaction to the risk consequence (Zajonc, 1980). However, the magnitude of a risk consequence may be weakly evaluable and convey little meaning, as "amounts of anything, no matter how common or familiar or intrinsically important, may in some circumstances not be evaluable" (Slovic et al., 2007, p. 20).

This is especially so for risks which carry a catastrophic potential that is "seen as so horrible or catastrophic that even the smallest probability acquires an unbearable emotional weight" (Zinn & Taylor-Gooby, 2006a, p. 66), such as the belief that vaccination causes autism, or that nuclear energy should be disregarded entirely due to the vast impact that a serious nuclear accident may cause. Consideration of the disconnect between emotion and rationality has been a somewhat thorny and neglected issue in risk perception research (Loewenstein et al., 2001; Zinn & Taylor-Gooby, 2006a). The

overwhelming impact of Affective reactions on rational judgement often impedes rationality, despite conscious awareness of the problem (Rolls, 2000).

2.10 The Impact of Affect on Risk Judgements

In terms of behavioural theories, Affect has only relatively recently been viewed as a significant factor in judgement and decision making. In this context, Affect is viewed both as a feeling state, and as a "quality… associated with a stimulus" (Finucane, Alhakami, Slovic, & Johnson, 2000, p. 2). Finucane, et al. (2000) argue that the neglect of Affect in risk perception research was due largely to the rationalistic and cognitive roots of decision research, from which many theories of risk perception have grown. From the work of Friedman and Savage (1948), who suggested that "reactions of individuals to risk can be rationalised by a rather simple extension of orthodox utility analysis" (p. 279), to the reorientation of the field by Simon (1956), who suggested an approach "more closely related to psychological theories of perception and cognition" (p. 10), decision research was firmly anchored to the notion of the rational actor for many years.

Tversky and Kahneman's (1974) work offered some departure from this view, by demonstrating the frequent biases present in judgement, and the heuristic thinking mechanisms which underlie many aspects of decision making under uncertainty. Although casting doubt on the efficacy of the bounded rationality approach, the heuristic mechanisms they described, such as availability, representativeness, and anchoring and adjustment, were nevertheless cognitive heuristics. Zajonc (1980) was one of the first researchers to assert that Affective reactions may precede and influence cognitive assessments, although the significance of Affect in decision making and judgement was slow to be recognised. For example, Shafir, Simonson, and Tversky (1993) conceded that Affect may *sometimes* impact on judgement, stating that "people's choices may

occasionally stem from Affective judgments that preclude a thorough evaluation of the options" (p. 32).

By 1994, however, Damasio (1994) had developed the somatic marker hypothesis, in which it was asserted that the imagery of thought is labelled by the mind with markers of either positive or negative Affect, leading to decisions based on liking or disliking which are rationalised post-hoc. Sjöberg (2007) asserts that the term Affect, although commonly used to denote emotion, may also mean evaluation. According to Alabarracín, Johnson, and Zanna (2005), the term attitude may also be used to denote evaluation, in the sense of judgement of the goodness or badness of an object or concept. However, this raises the question of how much of what is commonly referred to as Affect is based on emotion, and how much is based on attitude or evaluation.

This definitional quagmire results in a simpler connotation of Affect that fits well with Damasio's (1994) hypothesis, as well as later research into the Affective impact on risk judgement. Later research found that Affect could be reduced to feelings of like or dislike for a particular activity, and was linked to the perceived benefit of the risk (Alhakami & Slovic, 2006). Slovic, Finucane, Peters, and MacGregor (2002) assert that if individuals "like an activity, they are moved to judge the risks as low and the benefits as high; if they dislike it, they tend to judge the opposite-high risk and low benefit" (p. 14). The somatic marker hypothesis of Damasio (1994) and the role of Affect in motivating behaviour espoused by Epstein (1994) led to the proposition of an Affect Heuristic by Finucane et al. (2000). The Affect Heuristic, it was asserted, marked images with "positive and negative Affective feelings, [which] guide judgement and decision making" (Finucane et al., 2000, p. 3).

Essentially, the proposed Affect Heuristic denoted a process whereby Affect is consciously or unconsciously associated with objects and events, providing cues for judgement, in much the same way as the cognitive heuristics described by Tversky and

Kahneman (1974). Another stream of research which led to the proposition of the Affect Heuristic, was the early findings that perceptions of risk were strongly associated with the feelings of dread that a particular risk elicits (Fischhoff et al., 1978; Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1980). The increase in research attention to the role of Affect and its importance to risk judgement was bolstered by the prevailing view that Psychometric Dread was a dominating factor in risk perception. As a basis for research on Affect, however, the importance of Dread as an explanatory factor in perceived risk raises some issues.

Sjöberg (2007) asserts that, as a factor in the Psychometric paradigm, Dread is somewhat of a misnomer, and that only one of the ten items of the factor is related to emotion or Affect. The single Affective item within the Dread factor, he argues, is "only weakly related to perceived risk" when tested in isolation, and that the bulk of the explanatory power of Dread Risk is "carried by the non-emotional content of the Dread factor" (Sjöberg, 2007, p. 2) related to the severity of risk consequence. However, whether accurately captured by Psychometric Dread or not, there is evidence to suggest that Affect as emotion does have some impact on perceptions of risk consequence, despite the association being unclear.

When risk consequences increase in catastrophic potential, the Affective system is increasingly unable to feel such large changes in magnitude. Slovic, Finucane, Peters, and MacGregor (2004) assert that:

> The Affective system seems designed to sensitize us to small changes in our environment (e.g., the difference between 0 and 1 deaths) at the cost of making us less able to appreciate and respond appropriately to larger changes further away from zero (e.g., the difference between 500 and 600 deaths) (p. 9).

Fetherstonhaugh, Slovic, Johnson, and Friedrich (1997) suggest that the inability to feel the magnitude of a catastrophic loss of life is a form of *psychophysical numbing, "*a phenomenon that could impair our ability to make consistent, equitable, and wise decisions" (p. 284). Paradoxically, when risks with potentially catastrophic consequences are considered, psychophysical numbing may dampen the Affective reaction, skewing its association with risk and benefit.

Fetherstonhaugh et al. (1997) found that "the perceived benefit of saving lives changes when interventions saving the same number of people are implemented in tragedies that differ in magnitude" (p. 285). Fetherstonhaugh et al. (1997) also found that differences in the framing of the life-saving interventions changed the degree of numbing; when the interventions were framed in terms of the magnitude of the consequences, psychophysical numbing was frequent, but when the focus was on intervention outcomes, psychophysical numbing was reduced (Fetherstonhaugh et al., 1997). The authors also suggest that psychophysical numbing is due in part to an inadequacy in language to "discriminate among degrees of harm or destructiveness" (Fetherstonhaugh et al., 1997, p. 298). These views cast doubt over the efficacy of rational decision making, particularly for catastrophic risk consequences, and brings into focus one of the fundamental questions concerning probability, consequence, and perceived risk.

2.11 Consequence and Perceived Risk

The mid-20th century saw a growing interest in probabilistic risk assessment of complex technologies, due in a large part to the fact that catastrophic consequences of such technologies were viewed as "extremely low, assuming various design and operational conditions" (Wynne, 2002, p. 467). It was this engineering perspective, involving a strong conception of the article at risk, that provided the basis for defining risk as a socially manageable product of consequence and probability (Wynne, 2002). However,

when applied to other domains of risk management, this approach has highlighted some limitations of the probability and consequence model.

This limitation is especially apparent in cases of risks where the probability of occurrence is very low, but the consequences of the event are high. Pidgeon, Simmons, and Henwood (2006) emphasise the difficulties in describing some risks in probabilistic terms, and assert that descriptions of such risks "often contain such uncertainty that experts themselves disagree about the likelihoods and consequences" (p. 94). Conversely, risks where the consequences of a risk event are uncertain but have the potential for irremediable negative consequences are similarly problematic.

Such risks are often addressed using a precautionary principle that Taylor-Gooby and Zinn (2006b) describe as a strategy of avoidance, "promoted in order to manage irresoluble uncertainties and provide a way of deciding which risks we are willing to take" (p. 46). The issue of how problematic risks should be managed within the prevailing probability and consequence paradigm, stems from discrepancies between objective and subjective risk perspectives, and feeds back into the overarching problem of decision making under uncertainty. Bernstein (1998), illustrates this point well, stating that:

> any decision relating to risk involves two distinct and yet inseparable elements: the objective facts and a subjective view about the desirability of what is to be gained, or lost, by the decision… the risk-averse make choices based on the consequences without regard to the probability involved… the foolhardy make choices based on the probability on an outcome without regard to its consequences. (p. 100)

The degree of uncertainty that is often present in risk assessments outside of technical risk analysis is due in large part to the multifaceted and inimitable interactions that occur between human actions and the consequences. As a result, perceptions of risk are far

more multidimensional and sensitive to the overall context than technical definitions and measures of risk account for (Bostrom, 1997).

Wynne (2002) asserts that the adoption of the technical probability/consequence paradigm of risk has led to the development of a normative, yet ill-fitting framework, which implies that modern risk analysis is an appropriate tool for the identification and domestication of "all significant future consequences of the relevant actions" (p. 469). In this view, uncertainty, uncontrollability, and unforeseen consequences are outside the current scientific body of knowledge, and are therefore conveniently disregarded, feeding the myth that lack of full control and unpredictable consequences are somehow abnormal (Wynne, 2002).

The misperception of risk analysis as a tool for maintaining full control of potential consequences frames risk management as an arbiter between risk and normality. Such misperception persists, despite research indicating that although the probability/consequence model provides an acceptable definition for technical risk calculations, it also presents a misrepresentative view of risk as an objective reality (Rayner & Cantor, 1987). Misperception of the nature and limitations of risk analysis has led to much debate regarding the differences between perceived risk and formally measured risk, and between lay and expert risk perceptions. Wynne (2002) asserts that the description of these differences "as a dichotomy between 'perceived' versus 'real' risk implies that the latter play a normative and prescriptive role, and that risk perceptions are somehow flawed or incomplete" (p. 102).

The apparent discrepancies between lay and expert perceptions of risk have long been documented (Fischhoff et al., 1978). Research has suggested that these dissimilarities are a result of the differing conceptions of risk as they are used by experts and lay people. Marris et al. (1998) affirm this view, suggesting that "lay people and experts do not use

the same definitions of 'riskiness' when assessing risks" (p. 635), and that lay people tend to also include qualitative dimensions in their assessment of risk.

However, to draw the conclusion from such findings that lay risk perceptions are "somehow flawed or incomplete" (Wynne, 2002, p. 102) may simply be an artefact of an artificially narrow conception of risk as solely a product of probability and consequence. Braman and Kahan (2002) argues that research in this area has not adequately addressed the true concerns underlying lay risk perceptions. Certain risky activities and objects may be valued as symbols with both positive and negative associations, and perceptions of risk may "depend a lot on the social meanings… and not just on the consequences" with which risks are framed (Braman & Kahan, 2002, p. 3).

In addition to the social meanings associated with risky activities, differences in lay and expert perceptions of risk may also stem from differences in understandings of the fundamental concepts associated with the probability/consequence conception of risk. Sjöberg (2006a) supports this view, and asserts that "probabilities are usually of little concern to the public who find them hard to understand, based on questionable assumptions, and irrelevant. Consequences are what should addressed, not probabilities" (p. 13). Botterill and Mazur (2004) also note that a disproportionate amount of public attention is garnered by risks which have "potentially severe consequences on people's lives, even if the statistical likelihood of their occurrence is 'insignificant'" (p. 15); however, this overweighting of risk consequence relative to probability is not the sole domain of the lay public, nor is it unwarranted.

According to Smith and Brooks (2013), the consequence of an event may be considered to be more significant that the probability, and should therefore be more heavily weighted to reflect the greater ease with which individuals can relate, understand, and picture the outcome of an event. However, Woodruff (2005) argues that a "continued overemphasis on consequences when making risk-based decisions will over time have a negative

impact… leading to risk averse… opinion formers, decision makers and practitioners setting the agenda of what constitutes acceptable or tolerable risk" (p. 346).

The lay perception of risk may therefore be strongly influenced by risk consequences, an influence which in turn may impact on expert risk analysis. Although a greater emphasis on risk consequences may potentially generate more risk-averse assessments of hazards, this does not imply that expert assessments reflect the true nature of risks, while lay risk perceptions are "flawed or incomplete" (Wynne, 2002, p. 102). There is therefore some uncertainty as to whether expert risk assessment may be enhanced or weakened via reference to lay risk perceptions and their use of additional qualitative factors. Wynne (2002) asserts that "this reflects more than mere uncertainty in propositional claims about consequences" (p. 460).

2.12 Dread and Risk Consequence

The traditional assumption that people rationally evaluate risk as a cognitive function has been shown to be misleading, as "such cognitive evaluations have Affective consequences, and feeling states also exert a reciprocal influence on cognitive evaluations" (Loewenstein et al., 2001, p. 270). The idea that Affective reactions to risk are one of the fundamental drivers of risk perception originated with the first Psychometric Risk studies, which identified two main factors significant to risk perception, one of which was labelled 'Dread Risk' (Fischhoff et al., 1978; Slovic, 1987). This research has led to the view that fear may influence risk judgments, and that "people will make their [risk] decision based on the dread of a particular event, rather than based on the actual harm that may be inflicted" (Smith & Brooks, 2013, p. 55).

Schusterschitz, Schütz, and Wiedemann (2010) found that "the explanatory power of the Dread factor is strongly influenced by the severity of consequences" (p. 394), a sentiment echoed by Sjöberg (2006a), who asserts that the fundamental presumption of Psychometric risk that risky activities are important to risk attitudes is incorrect, and that

it is the risk consequences that are "much more important" (p. 12). Loewenstein et al. (2001) describe the relationship between consequence and dread as a product of what Sunstein (2002) refers to as probability neglect, stating that:

> as the probability of an aversive event passes the zero threshold, a consequence that was previously of no concern now becomes a source of worry. Subsequent increments in probability, however, have little additional emotional impact and, presumably for this reason, have little impact on choice. (p. 276)

The cognitive conception of risk, anchored in the engineering perspective, is based on a view of risk assessment by rational actors and their assessments of probability, whereas risk perception as a product of Affect appears to be primarily reliant on the *possibility* rather than *probability* of the consequences of risk events. Renn (2008) has proposed the rather literary title of 'Sword of Damocles' for risks falling into this particular class, based on the tale from Greek mythology, which illustrates the issue of the possibility versus the probability of catastrophic consequences, stating that "this risk class relates to risk sources that have a potential for very high damage and, at the same time, very low probability of occurrence" (p. 199).

Mythen and Walklate (2006) caution against this Affective distinction in the perception of risk, stating that "once we make the distinction between risk as possibility and risk as harm, the universalising language of the risk-society narrative comes unstuck" (p. 387). However, the concept of Psychometric Dread (specified as Affect) and its relationship to probability neglect may be more discrete than a simple neglect of probability in the face of severe consequences. Sjöberg (1999) for example, found that perceived risk is related to probability, while "demand for risk reduction was related mostly to the expected severity of consequences" (p. 129).

The literature makes clear that the conception of risk as probability and consequence is primarily a cognitive view of risk judgement. It also shows that the Affective influence on risk perception is recognised as being of great importance, while at the same time being poorly understood. Ropeik (2004) makes the point that any influence on risk perceptions that lead to risk misperceptions is a hazard that must be understood, quantified, and reduced like any physical hazard. Thus it is insufficient to advocate for the inclusion of the Psychometric Dread factor in the risk analysis process on the basis that Dread holds great explanatory power (Fischhoff et al., 1978; Slovic, 1987).

Not only is it unclear how such factors should be incorporated into "decision frameworks" (Gregory & Mendelsohn, 1993, p. 259; Merkhofer, 1987), the importance and significance of Dread risk to perceived risk is also unclear. Sjöberg (2000b) for example, states that a hazard may be defined as the risk generating activity itself, or as a consequence of such an activity depending on the way the risk is framed. This in turn has a bearing on how much Affect an activity elicits, the demand for mitigation, and expected severity of consequences. Palmer (1996) agrees that it is risk consequence that is of primary importance to perceived risk, and asserts that this may be "a biological adaptation since it is the severity of the consequences that, ultimately, defines how dangerous an event is" (p. 32).

In terms of the evolution of the Psychometric paradigm of risk perception since its inception, it is somewhat perplexing that 'severity of risk consequences' was not recognised earlier as the predominant concept driving the factor that came to be known as Dread risk. Perhaps the most incriminating evidence for this view comes from one of the seminal papers of Psychometric risk perception research, where the item Severity of Risk Consequence was shown to have the highest factor loading in the factor analysis of 'Dread' risk (Fischhoff et al., 1978).

Sjöberg (2003a), cites this finding as evidence to support a somewhat overhauled conception of what has come to be known as Dread risk, arguing that the empirical evidence in Psychometric risk research points to severe consequences as having the most explanatory power within the Dread risk factor, and showing that "emotional risk reactions were not significant" (p. 6). Sjöberg (2000a) has also criticised the focus of Psychometric researchers on "risky activities rather than risky events" (p. 291), and has cited this as a potential reason for a focus on Affect, rather than severe consequences. The estimation of risk consequence may therefore be dependent on whether a risk is presented as a hazardous activity, such as the use of nuclear energy, or as a risky event, for example, a nuclear reactor accident. The mental image of risky events are more accessible and are more easily visualised than risky activities, and this kind of visualisation or imagery "matters a great deal to people's reactions to risks" (Sunstein, 2002, p. 81).

In a study of the interpretation of high and low risk information, Viscusi (1997) found an asymmetry where individuals tended to interpret high risk information as more informative than low risk information, regardless of the information source. Sunstein (2002) argues that this alarmist bias can be accounted for by "emotional reactions to risk, and probability neglect" (p. 81), stating that concern over risks may be heightened, even for very low probability risks, if the risk is easily visualised. Sunstein (2002) also notes that there is some inherent difficulty in ascertaining whether it is probability neglect driving such behaviour. He argues that it is difficult to know whether "visualization makes the issue of probability less relevant or even irrelevant" (Sunstein, 2002, p. 82), or whether it is the availability heuristic leading the decision maker to substitute a question of statistical risk for one of ease of visualisation.

The difficulty in separating the mechanisms of the Affect Heuristic from the Availability Heuristic were evident, if not overtly noted, in the seminal studies on availability. For example, Lichtenstein, Slovic, Fischhoff, Layman, and Combs (1978) found that more

highly publicised causes of death were overestimated in terms of frequency, compared with the underestimation of those which were relatively underpublicised. However, Slovic et al. (2004) note that the more highly publicised causes of death "appear to be more Affectively charged, that is, more sensational, and this may account both for their prominence in the media and their relatively overestimated frequencies" (p. 7).

The literature suggests, therefore, that estimations of risk consequence may not only be related to framing effects, but may also be subject to complex interrelations between a range of heuristics and biases and estimations of probability that are influenced by cognitive and emotional stimuli. As Klaczynski (2001) notes, "judgments arrived at heuristically feel intuitively correct, but the basis for this feeling is often difficult to articulate" (p. 846).

Disentangling the emotional and cognitive impacts on risk probability and consequence judgements is far more complex than simply viewing risk-as-feelings, or Dread risk, as "an alternative description of the psychological processes underlying decision making" (Loewenstein et al., 2001, p. 271). Risk consequence estimation is vulnerable to a range of common factors that influence intuitively constructed risk narratives, especially the vividness of imagined risk impacts, which in turn impact probability assessments (Hughes, Kitzinger, & Murdock, 2006; Kahan, Hoffman, & Braman, 2009; Loewenstein et al., 2001).

Although the vividness with which risk consequences may be imagined may be dependent on emotional reactions, Loewenstein et al. (2001) assert that "cognitive assessments of risk… tend to depend on more objective features… such as… assessments of outcome severity" (p. 271). The overall picture to be drawn from the literature is that the perception of risk is seldom based on a rational cognitive process. Rather, it is the product of a complex interplay between estimations of harm and probability, emotion and

cognition, between thoughts and feelings, coloured by framing effects, heuristics, and biases.

2.13 Conclusion

A review of the literature on risk perception and the research surrounding it provides an account of the attempts to understand and quantify human behaviour in response to risk. The literature provides a history of the effort to understand the predictably irrational nature of human decision making. The body of research shows the extent to which the modern world is uncontrollable and unmasks the pervasive illusion that future events are predictable and manageable, and that risk judgements are logical and objective.

The intention of this chapter was to offer a contextual foundation for risk perception in general, and the Psychometric Theory of Risk specifically. In addition, the purpose of the chapter was to provide justification for the study's Research Questions and methodology, to address the gaps in the current understanding of perceived risk, and to demonstrate how these relate to the Psychometric Theory of Risk perception. This review began by discussing the nature of risk and the fundamental subjectivity of the concept. Major theories of risk perception were examined in terms of their   ationalization and main criticisms, before turning to perception, cognitive psychology and theories of decision making.

The complex interplay between emotion, cognitive heuristics and the impact of framing effects on risk judgements were then outlined, leading the discussion to a discussion of these influences on perceived risk, assessments of probability and consequence. References were made throughout the literature review to the relationship of the concepts to Psychometric Dread. This discussion highlighted a specific gap in the literature relating to the accuracy of the widely accepted conception of Psychometric Dread risk, and its efficacy and appropriateness as predictor of perceived risk.

The overall picture drawn from the literature is that the perception of risk is seldom based only on a rational cognitive process. Rather, it is the product of a complex interplay between estimations of harm and probability, emotion and cognition, between thoughts and feelings which are coloured by individual context and experience as illustrated by framing effects, heuristics and biases. The literature suggests that estimations of risk consequence are inextricably linked with these complex interrelations and influenced by cognitive and emotional stimuli, which in turn impact on estimations of probability and overall perceptions of risk.

The literature highlights the resulting subjectivity of risk perception, especially in regards to intuitive interpretations of risk, and the value-laden construction of risk perception categories. A major issue that emerges from the risk perception literature therefore, is the difficulty in determining how the subjectivity of risk perception influences the overall risk assessment process.

Several key theories have been proposed to explain the findings of risk perception research, including the Heuristics and Biases approach, the Psychometric Theory of Risk, the Cultural Theory of Risk, and the Social Amplification of Risk Framework. Each of these approaches has received fair criticism for their shortcomings, however, and none of them account fully for the major findings of risk perception research. The literature indicates that humans are not rational optimisers, but rather are heavily reliant on biases, emotions, expectation, misconceptions and conformity in order to make risk judgements. It is clear from a review of the relevant literature that an understanding of decision making is inextricably linked to an accurate conception of risk judgement.

The method by which perceptions are interpreted and ascribed meaning is critical to the decision making process, and therefore essential to providing a clearer view of the nuances of risk assessment. However, despite various concepts such as Utility Maximisation and the Satisficing Heuristic coming to dominate the literature at different

times, Decision Theory in general has been found to have limited descriptive validity, failing in many cases to explain and predict behaviour.

When heuristics and biases were first considered within the context of risk perception, it raised the question of how much of the assessment of risk is reliant on subjective and intuitive subconscious reactions. Despite much evidence in the literature for cognitive heuristics and their potential impact on risk judgements, some researchers have felt that research into emotional or Affective reactions to risk, may reveal more about how perceptions of risk are formed. The view that eventually emerged from research into emotional Affect was initially one of a divergence of emotional reactions and cognitive assessments of risk. The reality, however, appears to be far more complex.

Despite emotional processes now being widely conceived as the major governing factor in risk perception, the literature suggests a complex interrelationship between the engineering-centric view of risk as consequence and probability, and the dual aspects of emotional reactions and cognitive risk assessments. The evaluability of risk judgement has been shown to be closely associated with Affective reactions, and these reactions may trump the consideration of more justifiable factors and heighten avoidance of risk consequences. Framing effects reported in the literature highlight this issue, showing that divergences from the ideal of rationality not only influence preferences in decision making, but also in perception. The Affective framing of risk influences consequence perception and alters the value of risk probabilities in the mind of the perceiver.

The literature also makes clear that the conception of risk as probability and consequence is primarily a cognitive and rationalistic view of risk judgement. The Affective influence on risk perception, although recognised as being of great importance, is at the same time poorly understood. For example, it is unclear how much of what is commonly referred to as Affect is based on emotion, and how much is based on attitude or evaluation. Other complexities associated with risk judgement also emerge from the literature. For

example, estimating an accurate consequence value ideally requires some historical data from which to infer the potential magnitude of similar future events. Judgements of consequence values, however, are not constant, as they vary over time and place, and even between individuals.

Another key issue that emerges from the literature is that risks with a very low probability of occurring and a very large consequence value are particularly difficult to assess. The Psychometric Dread factor is frequently cited as having great explanatory power, especially in this area. This view is primarily driven by a conception of Psychometric Dread as a quantification of emotional Affect; however, as a basis for research on Affect, the importance of Dread as an explanatory factor in perceived risk raises some issues.

A major gap that emerges from the literature is whether the explanatory power of the Psychometric Dread risk factor is strongly influenced by the severity of consequences, and that emotion is of comparatively minor importance. Thus it may be concluded that it is insufficient to advocate for the inclusion of the Psychometric Dread factor in the risk analysis process on the basis that Dread (specified as emotional Affect) holds great explanatory power. In order to provide a greater understanding of the development of the Psychometric Theory of Risk and the history of the Dread factor, the following chapter will provide an examination of this theory which underpins this study. The chapter explores the development, triumphs, and its criticisms of the Psychometric Theory of Risk, and provides a contextual exploration of the concept that has come to be known in risk perception research as Dread.

CHAPTER 3: THEORY SUPPORTING THE STUDY

3.1 Introduction

The previous chapter provided a contextual foundation for the study and offered justification for the Research Questions through a discussion of the definition and nature of risk and the fundamental aspects of perception. This chapter highlights the significant findings in Psychometric risk perception research, as well as outlining the criticisms of the approach. The chapter also provides a deeper understanding of the Psychometric Paradigm, Dread risk and the association with Affect. The chapter traces risk perception research to the development of the Psychometric Risk Paradigm, and details the significance of the approach to concepts of consequence, Dread and Affect. The discussion leads to criticisms of the Psychometric Paradigm, and of Dread risk specifically, highlighting the identified gap in the knowledge.

3.2 The Birth of Risk Perception Research

Research into the perception of risk is inherently difficult to draw a boundary around. It has been characterised by research that is "eclectic in its epistemological roots" (Breakwell, 2007, p. 41). Studies into the perception of risk began in the 1970s and 1980s in response to the concerns of policymakers over increasing public anxiety surrounding the impact of new technologies on the environment, particularly nuclear power (Pidgeon, Simmons, & Henwood, 2006). Although the main drivers behind the early research into risk perception had their basis in public policy issues, the research objectives were primarily theoretical and empirical (Pidgeon & Gregory, 2004).

Taylor-Gooby & Zinn (2006) suggest that the urgency of policymakers over the question of public risk perception was great, and the task of addressing the issue was given to Chauncey Starr, a leading electrical engineer and expert in nuclear energy, turned academic. Starr, who had previously worked as president of the Atomic Division of Rockwell International, completed the seminal study by analysing public responses to

risk using a quantitative methodology to provide decision makers with a "functional answer" (Starr, 1969, p. 1233) to the question of how safe the technology would need to be to gain widespread acceptance among the public.

Starr (1969) used what has become known as a *revealed preference* approach by equating the perceived benefit of the risks with percent of income spent on the hazard and approached the problem by comparing the risks associated with nuclear power with the publicly accepted conventional power plant risks. He suggested that the expected gains in addition to the lower risks associated with the nuclear power option, which he estimated to be 1 in 200 compared to 1 in 40 for conventional power risks, would equate to a high level of public support and acceptance of nuclear power (Starr, 1969). Along with this assessment, Starr (1969) also provided some general guidelines for decision makers to guide them in assessing public perceptions of risk.

True to his engineering background, Starr (1969) expressed his findings in a very specific statistical terms, stating that the public would be willing "to accept 'voluntary' risks roughly 1,000 times greater than 'involuntary' risks" (p. 1237). Starr (1969) also found a tendency for the public to use the risk of death as a psychological yardstick, and that risk acceptability appeared to be "crudely proportional to the third power" (p. 1237) to the expected benefits. Although somewhat optimistic in hindsight, Starr's (1969) findings offered social and cognitive psychologists "the possibility of an empirical understanding of some of the judgements and beliefs underlying this highly visible and complex social and public policy issue" (Pidgeon et al., 2006, p. 96).

This initial study paved the way for sociology and psychology researchers to move to the fore in the study of risk perception, and in doing so they shifted the research away from technical issues towards "questions of acceptability and the prediction of public response" (Taylor-Gooby & Zinn, 2006b, p. 26). From the engineering perspective, the management of risk was predominantly a technical issue "of calculation and public

acceptance" (Taylor-Gooby & Zinn, 2006b, p. 27), whereas for behavioural economists and cognitive psychologists, the problem was rooted in decision-making. This shift from a technical approach to a cognitive and behavioural approach resulted in the framing of risk perception research within either a cognitive scientific or a sociocultural context. Thus the cultural and psychological methodologies came to dominate the study of risk perception, a situation which persisted from the mid-1970s to the mid-1990s "with relatively little interaction between the two" (Pidgeon et al., 2006, p. 96).

Cognitive psychologists, meanwhile, had been developing another influential stream of research as early as 1948 in the examination of gambling and risky choices (Cohen & Hansel, 1956; Friedman & Savage, 1948; Simon, 1956). Using a model of rational action, behavioural economists and cognitive psychologists "examined how people deviate from theoretical assumptions" (Taylor-Gooby & Zinn, 2006b, p. 27). The research in this area came to dominate the early studies into the perception of risk, primarily in the form of the Heuristic and Biases approach pioneered by Amos Tversky and Daniel Kahneman (Tversky & Kahneman, 1973, 1974, 1981). They proposed several mental short-cuts or Heuristics such as Availability, Representativeness, and Anchoring and Adjustment, which lead to systematic biases in the estimation of probabilities (Kahneman, Slovic, & Tversky, 1982).

Einhorn and Hogarth (1981) argued, however, that the Heuristics and Biases approach was limited by its roots in Bayesian decision theory and restricted in its conceptualisation of risk as subjective probability; however, the approach would lay the groundwork for another influential theory stemming from the cognitive psychological tradition which would come to dominate the research domain. Although borrowing the Heuristics and Biases interpretation of lay peoples "irrationality in the face of true risks" (Pidgeon et al., 2006, p. 96), this new approach "promised to give access to the understanding of public risk preferences which was urgently needed by politicians and other decision-makers"

(Taylor-Gooby & Zinn, 2006b, p. 29). It was on this premise in a climate of urgency that the Psychometric Paradigm of risk perception originated.

3.3 The Psychometric Paradigm of Risk Perception

Following the work of Starr (1969) and Tversky and Kahneman (1973), the Psychometric Paradigm was rapidly developed by researchers at the University of Oregon's *Decision Research Group*, with the aim of establishing stable risk perception factors that could inform policy makers on public risk attitudes (Fischhoff, Slovic, Litchtenstein, Read, & Combs, 1978; Slovic, Fischhoff, & Lichtenstein, 1982). The Psychometric Paradigm was first proposed in 1978 in a paper reporting the results of a study in which participants rated their perception of the risks associated with a range of 30 hazardous activities (Fischhoff et al., 1978). The activities ranged from unfamiliar and involuntary risks, such as nuclear power, to voluntary risks with which participants would be far more familiar, such as bicycle riding (Fischhoff et al., 1978).

A range of hazard characteristics were proposed to account for risk perceptions, and participants in the study rated the hazardousness of each of the activities in relation to these characteristics (Fischhoff et al., 1978). The proposed hazard characteristics were determined by using an approach developed in Personality Theory, where the hazards were evaluated against a series of characteristics proposed to influence risk perception (Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978). The characteristics included voluntary choice in exposure to the risk; the immediacy of fatal effect; personal knowledge of the risk; the extent to which the risks were known to science; personal control over the level of risk exposure; the newness and novelty of the risk; whether the risk was considered chronic, killing one person at a time, or catastrophic, killing many at once; whether the risk was considered to be common and was thought about calmly, or whether the risk was one that people dread; and the severity of the risk consequences (Lichtenstein et al., 1978).

Whilst Starr's (1969) approach was to examine perceived risk through revealed preferences, the Psychometric Paradigm employed standardised questionnaires to elicit expressed preferences (Fischhoff et al., 1978). The aim of the Psychometric Paradigm was to quantify and model the factors and interrelationships that influence individual risk perceptions "in order to illuminate the responses of individuals and their societies to the hazards that confront them" (Slovic, 2001, p. xxiii). Researchers quickly became aware of apparent differences between expert and lay perceptions of the same hazards.

Psychometric Paradigm researchers asserted that the "conceptual models of reality people construct… differ from those based on expert knowledge" (Taylor-Gooby & Zinn, 2006b, p. 27) and viewed lay perceptions of risk as being faulty and a result of general human cognitive limitations (Slovic, Fischhoff, & Lichtenstein, 1977). This assumption stemmed from concepts of Bounded Rationality (Simon, 1957) and the Heuristics and Biases approach, which proposed that "people rely on a limited number of heuristic principles which reduce the complex tasks of assessing probabilities and predicting values to simpler judgemental operations" (Tversky & Kahneman, 1974, p. 1124). The assumption also stemmed from a study by Slovic, Fischhoff, & Lichtenstein (1979), who found that the assessments of a relatively small sample of experts were in better agreement with known risks than were assessments of laypeople.

Experts, unlike laypeople, were assumed to base their decision making on the rational ideal proposed by economists, psychologists, and Decision Theory researchers (Taylor-Gooby & Zinn, 2006a), despite evidence that experts were subject to the same biases as laypeople (Tversky & Kahneman, 1974). It was asserted that if a Positivistic solution existed, it was obscured by confounding cultural and political influences (Wynne, 1982). The Positivistic approach taken by the Psychometric Paradigm frequently meant that failures in risk management were attributed to human fallibility in judgement and

decision making, leading to flawed risk management recommendations (Taylor-Gooby & Zinn, 2006a).

Sociologists however, rejected of Positivistic science, arguing that the approach was enmeshed in cultural and political conceptions of power and authority (Wynne, 1982). Despite evidence indicating that risk perception was more complex than the approach allowed for (Tversky & Kahneman, 1974), the assertion of Psychometric risk researchers of the reality of the divide between lay and expert risk judgements persisted until the early 2000s (Rowe & Wright, 2001), and messy ideas of confounding sociological influences were largely ignored. The runaway success of the Psychometric Paradigm also meant that other shortcomings at the foundation of the Theory were overlooked.

Breakwell (2007) explains that the Psychometric risk tradition typically uses data from a large number of participants to establish any significant structure in risk perception. Although this may be true for many subsequent studies, the early studies from which the Psychometric Paradigm was established employed relatively small samples to determine the foundational elements of the approach. For example, the study by Lichtenstein et al. (1978) from which many of the risk characteristics of the Psychometric Paradigm were determined consisted of two groups of subjects comprising of 111 for the first group and 77 subjects for the second. Likewise, the seminal study by Fischhoff et al. (1978) in which the Psychometric Paradigm was first proposed employed a sample of 76 participants.

Despite these shortcomings in its foundation, it is widely accepted that the Psychometric risk approach allows for a wide range of analytic techniques, such as assessing the mean profiles of hazards or Psychometric Risk factor items (Fischhoff et al., 1978; Slovic, 1987). Breakwell (2007) asserts that the most striking conclusion to emerge from these seminal studies "stemmed from subjecting the ratings of the characteristics of hazards to a factor analysis" (p. 31). Through factor analysis, the Psychometric theory proposed two

unrelated factors which accounted well for the variability in the correlations. The first factor comprised of uncontrollable, new, involuntary, poorly known and delayed consequences while the second factor encompassed certain to be fatal, dreaded, and catastrophic (Fischhoff et al., 1978).

This initial Psychometric risk study by Fischhoff et al. (1978) paved the way for many further studies in which the methodology of the Psychometric Paradigm was extended by sampling different populations, employing different risk characteristics and surveying different hazards. One of the first of these expansions to the initial work of Fischhoff et al. (1978) was published by Slovic, Fischhoff, and Lichtenstein (1980) who extended the original research to include a range of 90 hazards and 18 risk characteristics. Their results showed a three factor solution comprising of Dread, Familiarity, and the number of people exposed, which differed from the two-dimensional structure obtained by Fischhoff et al. (1978).

According to Breakwell (2007), the major difference between Fischhoff et al.'s (1978) study and Slovic et al.'s (1980) research was that the risk characteristics (or items) relating to voluntary choice in and personal control were no longer linked to novelty and knowledge of the risk, but to dread and the severity of risk consequence. The two primary dimensions of Slovic et al.'s (1980) three factor solution found in their expanded study "has become the benchmark" (Breakwell, 2007, p. 34) for much of the Psychometric risk perception research that has followed (Slovic, 1987, 1992; Slovic et al., 1980; Slovic, Fischhoff, & Lichtenstein, 1981, 1985, 1986). Other researchers who have closely replicated Slovic et al.'s (1980) procedures have found similar two and three factor solutions (Breakwell, 2007; Renn & Rohrmann, 2000).

However there has not always been agreement with Slovic et al.'s (1980) factor structures or labelling of the two principal factors. Fife-Schaw and Rowe (1996), for example, found a two factor solution in their Psychometric risk study of public perceptions of food

hazards, which they labelled as *severity* and *awareness*. Although a different factor structure to Slovic et al.'s (1980) three factor solution, Fife-Shaw and Rowe's (1996) two factors of severity and awareness may arguably mirror Slovic et al.'s (1980) two primary factors of Dread and Knowledge in all but semantics. Breakwell (2007) asserts that any departures from Slovic et al.'s (1980) factor structure in subsequent studies may simply be a product of differences in participants, hazards or characteristics used.

Since being introduced by Slovic et al. (1980), the Dread factor has been widely regarded as the most important factor to emerge from the Psychometric Paradigm of risk perception (Taylor-Gooby & Zinn, 2006a). Sjöberg (2006a) explains that the implication of the early research that risk perception was strongly determined by Novelty and Dread was a product of its apparent explanation for strong negative reactions to nuclear technology, and thus "similar conclusions were drawn about other kinds of more or less hazardous technologies" (p. 4).

The Novelty and Dread version of the Psychometric Paradigm became the most commonly used model, and suggested that risk perception was driven by several qualitative characteristics in addition to the engineering-centric view of risk as a product of probability and consequence (Pidgeon & Gregory, 2004). Risk perceptions were understood to be "richer and more complex than expert conceptions" (Pidgeon & Gregory, 2004, p. 97), and to include factors such as fear, voluntariness, equity and catastrophic potential (Slovic, 1998; Wynne, 1996).

An expanded version of the Psychometric Paradigm of risk perception appeared in the early 1990s, suggesting that Social Trust was another influential factor in risk perception (Slovic, Flynn, & Layman, 1991). In addition to the conception of perceived risk as Novelty and Dread, the Social Trust factor implied that public reactions to hazardous technologies relied on the degree of public trust that was invested in the authorities responsible for risk management (Sjöberg, 2006a, p. 5). In continuing the exploration of

risk perception using the Psychometric Paradigm, researchers began to assert that the role of emotion (or Affect) in risk judgements was among the key questions in the research domain (Breakwell, 2007).

By the early 2000s, Affect and feelings about risk were widely considered to be central to the understanding of perceived risk (Loewenstein, Weber, Hsee, & Welch, 2001) which furthered research into Affective reactions to risk. This led to the development of an Affect version of the Psychometric Paradigm and the proposal of an Affect Heuristic (Finucane, Alhakami, Slovic, & Johnson, 2000; Peters & Slovic, 1996; Rottenstreich & Hsee, 2001; Slovic, Finucane, Peters, & MacGregor, 2002, 2004, 2007; Slovic, Peters, Finucane, & MacGregor, 2005).

Sjöberg (2006a) asserts that the strong evidence for "a correlation between attitudes and perceived risk" (p. 5) found in Affect Heuristic research (Finucane et al., 2000; Slovic et al., 2007), together with the traditional conception of the Dread factor as driven by emotion rather than severity of risk consequence, has resulted in widespread support for the idea that emotion plays a significant role in risk perception. Sjöberg (2006b) however, argues that confusion has arisen from the broadening of the meaning of Affect to include the concept of Attitude, and resulted in the findings of Affect Heuristic research being linked to the concept of Dread.

3.4 Criticisms of the Psychometric Paradigm

Starr's (1969) seminal study of risk perception paved the way for the development of new approaches to research of risk perception and the Psychometric Paradigm's promise of providing a more accurate picture of public risk perceptions to policy makers was, in part, based on the criticisms Starr's (1969) approach attracted. Starr's (1969) critics cited problems with the way his approach interpreted acceptable and accepted risks as being equivalent, the study's focus on lethal outcomes as the sole consequence measure and the

use of quantitative pecuniary measures that theoretically derived revealed preferences of risks and hazards (Taylor-Gooby & Zinn, 2006a).

Researchers of the Psychometric Paradigm sought to improve upon Starr's (1969) approach by eliciting expressed preferences through direct questioning. One of the criticisms of the expressed preference method is ironically based on a central finding of the Psychometric Theory of risk; the assumption that laypeople generally have flawed perceptions of risk. Breakwell (2007) however, argues that the risks studied are often not fully understood by anyone, and that the Psychometric approach simply captures an "appreciation of the risk that [participants] have at the moment of the study and in a way that they can articulate at that time" (p. 41).

The debate regarding lay and expert risk perceptions relies somewhat on the Positivist assumption of expert objectivity and rationality, a view that was called into question by Wynne (1982) early in the development of Psychometric risk research. Taylor-Gooby and Zinn (2006) note that the "dismantling of Positivistic accounts of science and their… impact on risk problems [has] strengthened the view that citizens' understanding of risk has an equivalent validity and rationality to that of the accredited experts" (p. 34). Despite Wynne's (1982) early criticism of the Positivistic view of expert objectivity in risk assessment, the received wisdom that expert assessments are more veridical than those of laypeople has persisted (Cole & Withey, 1981; Sandman, Weinstein, & Klotz, 1987; Siegrist, Keller, Kastenholz, Frey, & Wiek, 2007; Slovic, 1999; Wright & Bolger, 1992). Rowe and Wright (2001) assert that the initial research findings supporting this view (Slovic et al., 1979) and many that followed are based on weak evidence.

Sjöberg (2006a) notes that Slovic et al.'s (1979) study surveyed only 15 experts, and argues that "their claim to expertise is very dubious" (p. 11). Rowe and Wright (2001) echo this sentiment, arguing that the early studies "made little attempt to ensure that experimental tasks posed to experts were… appropriately matched to… expertise" (p.

354). They also assert that the question of whether differences between expert and lay risk perceptions exist, or whether expert risk judgements are more veridical than lay judgements cannot be ascertained from the body of research due to extensive methodological issues (Rowe & Wright, 2001).

Sjöberg (2006a) cautions that expert risk perceptions are much like those of laypeople in structure, and that "experts make much lower risk judgments of a technology whenever their professional role involves a responsibility for handling that very technology, but not otherwise" (p. 7). One received message to come from the lay/expert debate within Psychometric risk research, is that perceived risk is an interpretation of reality that encompasses far more than simply probability and consequence as espoused by the technical-statistical approach (Taylor-Gooby & Zinn, 2006a).

Wilkinson (2001) argues that there is a disconnect between the perception of risk measured in Psychometric research and the reality of actual responses to risk. Other critics argue that there is little recognition of the impact of feelings, values and knowledge, and that these contexts must be elucidated before Psychometric risk research findings can be generalised (Taylor-Gooby & Zinn, 2006a). This issue is compounded by the neglect of differences between individual risk perceptions, as the Psychometric Paradigm is traditionally based on aggregate data.

A significant debate surrounds the original methodology of the Psychometric Paradigm and its use of group (or aggregate) data based on mean ratings, neglecting the influence of individual differences in risk perceptions. According to Breakwell (2007), Psychometric risk researchers tend to use aggregated data, reducing the three dimensional conception of risk data (figure 3.1) to a two dimensional conception (figure 3.2).
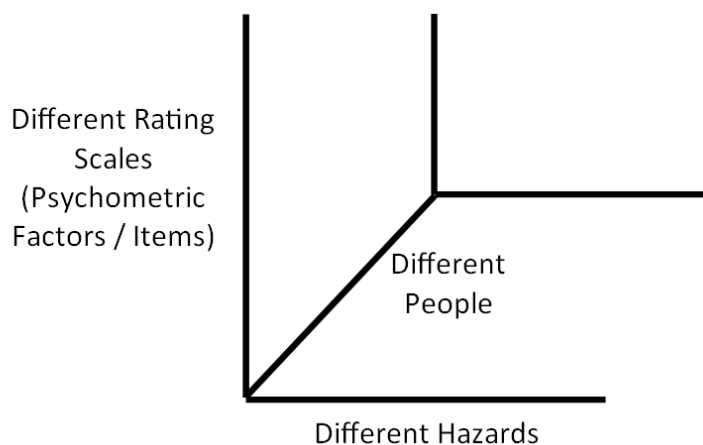
Figure 3.1   Three dimensional conception of risk data (adapted from Breakwell, 2007)
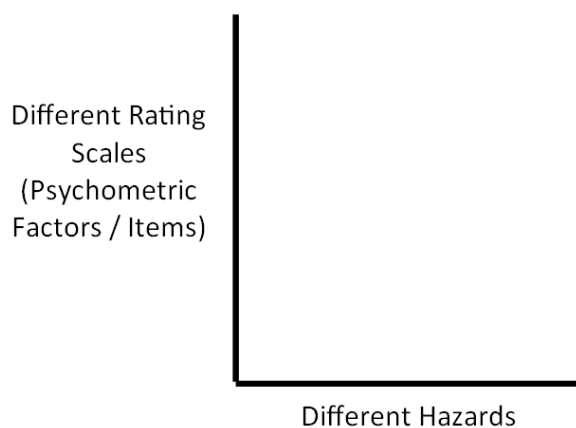
Figure 3.2   Two dimensional conception of risk data (adapted from Breakwell, 2007)

The traditional use of Principal Components Factor Analysis (PCA) in the Paradigm has been criticised as being somewhat unsuitable to explore social and cultural framing of risks (Langford et al., 1999; Willis, DeKay, Fischhoff, & Morgan, 2005). Siegrist, Keller, and Kiers (2005) used a three-way principal component analysis (based on the three dimensional model of risk data) to determine whether the two dimensional model neglected individual differences in risk perception. The analysis revealed that individuals differ in their perception of different hazards, especially in terms of how unobservable or

old hazards are perceived as unknowable, unpredictable and dreaded (Siegrist et al., 2005). Gardner and Gould (1989) had previously performed an individual difference analysis using a probability sample to study six hazards and three Psychometric risk factors (Catastrophic, Dread, and Known to Science). These approaches were in contrast to the traditional mean score analysis, as in Slovic's (1987) oft cited study.

Sjöberg (2006a) asserts that the aggregate data methodology artificially inflates the amount of variance in perceived risk that the traditional model accounts for, which he cites as one of the main reasons that the Psychometric Paradigm was initially viewed as "common sense and… readily accepted as giving a correct analysis of perceived risk and related attitudes" (p. 5). He argues that "means… have much less random error than individual values and therefore can be expected to be more readily accounted for than individual values… " (Sjöberg, 2006a, p. 5). Breakwell (2007), however, argues that these two approaches actually answer two different questions, maintaining that "the Slovic [1987] approach analyses why people on average judge technologies differently [while] the Gardner and Gould [1989] approach analyses why different people judge the same technologies differently" (p. 46).

The techno-statistical view of risk generally involves a calculation using the probability or likelihood of the risk and an estimation of the consequence or impact, should the risk eventuate. The former is closely related to perceived risk and the concept of probability neglect (Sunstein, 2002, 2003). Sjöberg (1999) however, asserts that attitudes such as demand for risk mitigation are largely related to the severity of risk consequences, and that the strongest correlations between perceived risk and mitigation relate to fatal risks. The Psychometric Paradigm's basis in the judged frequency of potentially fatal events (Lichtenstein et al., 1978) has resulted in a tradition of using fatality as an index of risk. However, the question of to whom the lethal consequences may apply relates to another criticism of the Psychometric approach; that of personal versus general risks.

There tends to be a clear separation between the way individuals perceive risks to themselves as opposed to those impacting on others (Sjöberg & Drottz, 1987). This difference between the perception of risks as general or personal is related to Weinstein's (1980) proposed *Optimism bias*, where personal risks are viewed with unrealistic positivity. Risks are also generally perceived to be lower when framed in personal or voluntary terms, than they are when framed in general or involuntary terms (Sjöberg, 2003a). In addition, personal risk taking has been shown to be unrelated to estimates of risk probability (McKenna & Horswill, 2006).

Essentially, there is a separation "between the level of risk perceived and the willingness to take the risk… [and] risk-taking [is] not mediated by some cognitive mechanism which reduces the perceived risk involved" (Breakwell, 1996, p. 51). The root of this criticism of the Psychometric risk tradition is that "hazards and hazardous activities are mixed" (Breakwell, 2007, p. 51), impersonalised, and not easily interpreted as voluntary or involuntary activities, resulting in framing-dependent hazards. Sjöberg (2006a) summarises the argument succinctly, stating that "the psychometric tradition got a wrong start by studying the type of risk least relevant for policy issues" (p. 6).

3.5 Criticisms of Dread Risk

The Psychometric Dread risk factor has long been held to be the main determiner of risk perception and one of the most robust predictors of perceived risk for a wide range of hazards (Bouyer, Bagdassarian, Chaabanne, & Mullet, 2001; Conrad, 1980; Fischhoff et al., 1978; Jenkin, 2006; von Winterfeldt, John, & Borcherding, 1981). More recent work has refined the concept of Dread risk as the emotional factor of Psychometric risk perception research, principly in light of research highlighting the importance of the Affect Heuristic to percieved risk (see Finucane et al., 2000; Peters & Slovic, 1996; Rottenstreich & Hsee, 2001; Slovic et al., 2002, 2004, 2007; Slovic et al., 2005).

Since Starr's (1969) influential study, risk research has revealed perceived risk to be the product of complex psychological processes, eclipsing the initial rationalistic view of how risks are perceived. Much of the success in the field of risk perception research may be attributed to the Psychometric Paradigm, but despite this, the approach has been keenly criticised for failing to take into account the significance of fundamental methodological issues.

The view that Psychometric Dread risk is a major determinant of perceived risk may be disputed on methodological grounds based on aggregated versus individual data analysis (Langford et al., 1999; Marris, Langford, Saunderson, & O' Riordan, 1997; Willis et al., 2005); although this criticism may in turn be contested on the basis that the methodology employed in the study of risk perception is dependent on the question which the research is attempting to answer (Breakwell, 2007). Even the protracted debate regarding the validity of differences between expert an lay perceptions of risk may be surmised as a dispute concerned with the pros and cons of scientific Positivism (Taylor-Gooby & Zinn, 2006a).

Many of these criticisms such as those relating to the nature of the hazards used, the questions asked about those hazards, the participants used and the data analysis approach may all be viewed as overly simplistic, as the initial Psychometric risk studies "were conducted in full appreciation of their methodological limitations" (Breakwell, 2007, p. 42). According to Breakwell (2007), many critiques of the Psychometric Paradigm "often merely represent clashes of worldviews, battles between paradigms" (p. 42), and argues that it is important to evaluate the Psychometric Theory of risk in terms of "the system of basic assumptions that guide work in [the] tradition" (p. 42).

There is a problematic issue however, that emerges from the foundation of the Psychometric Paradigm of risk with repercussion for risk management, communication and policy; that of whether the prevailing interpretation of Dread risk as a measure of

risk-as-feelings is a valid view. The critical point here is the link between Dread and risk consequence. In Fischhoff et al.'s (1978) seminal study, their first factor was labelled Severe; in Slovic et al.'s (1980) subsequent expansion of the work, they labelled the equivalent factor as Dread.

Slovic et al.'s (1980) Dread factor was found to be linked to control over the risk, and was made up of items (or characteristics) such as dreaded, catastrophic, hard to prevent, fatal, inequitable, threatening to future generations, not easily reduced, increasing and involuntary. Sjöberg (2006b) argues that Slovic et al.'s (1980) Dread factor is a heterogeneous assortment of risk characteristics dominated by items related to severe consequences, containing only one item relating to emotion. He asserts that the 'Dread' label is, at best, a misnomer, and at worst, may have "unwanted policy implications" (Sjöberg, 2006b, p. 101).

It may also be argued that the dominance of severe consequences and the link to Dread found in many Psychometric risk studies may be a by-product of the Psychometric Paradigm's epistemological roots. Many of the characteristics used in the tradition are based on Lichtenstein et al.'s (1978) study of the judged frequency of lethal events, which arguably represent the most severe of consequences. It is thus unsurprising that subsequent Psychometric risk studies have identified several contextual elements related to the perceived severity of risk consequence, such as the expected number of fatalities and the catastrophic risk potential (Jungermann & Slovic, 1993; Renn, 1983). Severe consequences have also been shown to be related to estimations of probability, as demonstrated by von Winterfeldt et al. (1981), who found that low probability/high consequence risks are perceived as having a greater likelihood than more probable risks with lower consequences.

Interestingly, consequence characteristics of risk have become embedded within the Dread factor, a concept that has since become inextricably linked to the role of emotion

in risk judgement. The association of the Dread risk concept with emotional or instinctive reactions to risk through the widening the meaning of Affect (Sjöberg, 2006a) has caused some risk researchers to marvel that the importance of Affect was not recognised earlier, given the initial recognition of the importance of Dread risk. This bridging of Dread and Affect has led to the view that *fear* is the major determinant in risk judgments and that "people will make their [risk] decision based on the dread of a particular event, rather than based on the actual harm that may be inflicted" (Smith & Brooks, 2013, p. 55). However, this widely held view has more recently been called into question.

Schusterschitz, Schütz, and Wiedemann (2010) found that "the explanatory power of the Dread factor is strongly influenced by the Severity of Consequences" (p. 394), an interpretation previously advocated by Sjöberg (2006a), who asserts that "a close look at the definition of Dread shows that it is measured wholly, or mostly, with non-emotional components which can be best summarised as measuring the perceived severity of consequences" (p. 7). In clarification of this criticism, he states that "this finding does not imply that emotions are not important in risk perception, only that the evidence for their importance is lacking in the Psychometric Paradigm" (Sjöberg, 2006a, p. 7).

Sjöberg's (2006b) view of the Dread factor is bolstered by the results reported in Fischhoff et al.'s (1978) seminal paper, where the Severity of Risk Consequence item was found to have the highest factor loading of all of the Dread factor items. Palmer (1996) agrees with the interpretation that risk consequence is of primary importance to perceived risk, theorising that the primal response that Dread risk captures may be attributed to an evolutionary instinct that provides an intuitive definition of potential danger.

Although it may be argued that the role of Affect should have been recognised earlier given the success of Dread as a determiner of risk perception, the nature of Dread risk as Affect or consequence remains under debate. The same argument could be made for the

Severity of Risk Consequences as having gone unrecognised as the predominant characteristic of Dread risk. Sjöberg's (2006b) assertion that the Dread factor is a heterogeneous blend of different risk characteristics, rather than a quantitative measure of Affective risk reactions, is supported by Pidgeon et al. (2006) who argue that many of the Dread characteristics tap into concerns unrelated to Affect. This view is supported by Schusterschitz et al. (2010), who found that "the explanatory power of the Dread factor is strongly influenced by the Severity of Consequences" (p. 394).

However, Slovic and Peters (2006) assert that "evidence of risk as feelings was present in early studies of risk perception [and] those studies showed that feelings of Dread were the major determiner of public perception and acceptance of risk for a wide range of hazards" (pp. 322-323). This highlights the need for an investigation of the Affective relationship to Dread risk characteristics, as these dimensions "may have a relationship to emotional processes but they are not emotional *per se* and their emotional significance remains to be documented" (Sjöberg, 2003b, p. 109). This demonstrates the gap in the knowledge. Whether the prevailing interpretation of Dread risk as a measure of risk-as-feelings is a valid view, or whether Dread risk is a measure of severe consequences is a question of Affect.

3.6 Conclusion

This chapter discussed the significant findings in Psychometric risk perception research as well as outlining the criticisms of the approach, providing a deeper understanding of the Psychometric Paradigm, Dread risk and the association with Affect. Research into the perception of risk is inherently difficult to draw a boundary around, with roots in many disciplines. Many schools of thought contributed to the initial studies which paved the way for sociology and psychology researchers to move to the fore in the study of risk perception. Much of the success in the field of risk perception research may be attributed to the Psychometric Paradigm, and to Dread risk in particular.

Research has refined the concept of Dread risk to an emotional factor, principly in light of research stressing the importance of the Affect Heuristic to perceived risk (Finucane et al., 2000; Slovic et al., 2002, 2007; Slovic et al., 2005). However, there is debate over the nature of Dread risk, which has implications for the way in which Psychometric risk findings are interpreted. The assertion of Dread as Affect (Slovic & Peters, 2006) is in contrast to a conception of Dread as severe consequences (Sjöberg, 2003b), and reveals the gap in the knowledge this study sought to investigate.

The methodology used to address this gap in the knowledge is detailed in the following chapter, which explains how the research problem was approached and describes the reasoning behind the choice of methods used. The chapter discusses the sample population and sampling strategy used in the study and outlines the reasoning behind the approaches taken. The study design is discussed, showing how each of the approaches taken were justified. The materials, methods and procedures used in the collection and analysis are detailed, providing an overview of how the methodology was applied to the research problem. The methodological limitations are discussed, outlining how they were approached and how they impact the study results. The chapter summarises the methods used to elicit and measure the Affective reaction to risk, and the approach taken to establish the Affective association with estimations of risk consequence.

CHAPTER 4: METHODOLOGY

4.1 Introduction

The problem of the nature of Psychometric Dread risk and its relationship to the perception and estimation of risk consequence is a complex one. The problem was characterised through a review of the literature and the theory supporting the study, as well as through establishment of the research problem and Research Questions. The study required a methodology that would address the Research Questions adequately and thoroughly, and in a way that would not rely on any previous assumptions about the nature of Psychometric Dread risk. This chapter explains how this goal was attained, how the established research problem was approached, and describes the reasoning behind the choice of methods used.

The discussion begins with an explanation of the sampling strategy that was employed, and how the selection of this strategy was intended to maximise the reliability of the results. The reasoning behind a three phase approach to the study is also discussed, and how the selection of this approach was consistent with the aim of establishing an accurate understanding of the nature of Dread risk, and its relationship to the estimation of risk consequence. The methods and procedures used in the collection of data on the perceptions of hazards via Dread risk and severity of risk consequence are described, as are the approaches taken to analyse the data. It is noted that the research methodology was not devoid of limitations. The manner in which each of the identified limitations were addressed is discussed, together with their impact on the overall study.

From the review of the literature, it was established that one of the most significant aspects in understanding the nature of Psychometric Dread risk is firmly anchored in the concept of Affect and its impact on risk consequence perception. This chapter explains the methods used to elicit and measure the Affective reaction to risk, and the approach taken to establish the Affective association with estimations of risk consequence. The

methods used to gain a clearer understanding of the nature of Psychometric Dread risk are also discussed, and it is shown how the study sought to establish internal and external validity through the use of appropriate sampling, data analysis, and comparison with previous work in the area of Psychometric risk perception research.

4.2 Participants

It was established early in the study that the determination of an appropriate target population and sample size would be essential in obtaining significant and valid results from which confident conclusions could be drawn. By the very nature of the investigation, obtaining data from a sample population that would be as representative as possible would require an inventive approach if the study were not to suffer from the limitations of previous Psychometric risk research. These past studies often relied largely on the perspectives of small groups of respondents sampled for convenience rather than representativeness.

The Psychometric Theory of Risk posits that the perceptions that drive risk judgements are generalisable. According to Birnbaum (1999), the "basis for generalisation is similarity of an experiment to the domain of intended generalisation" (p. 245). As this study employed Psychometric Risk elements in the research instruments, it was determined that a general population of respondents would be sampled with as few restrictions as possible. It was clear that in order to confidently assert that the results obtained could be generalised to wider populations, then no specific demographic restrictions could be placed on the populace from which the samples were drawn. It was reasoned that using traditional methods such as the recruitment of undergraduate university students to complete the research instruments, would be insufficient if the study outcomes were to contribute new knowledge to the body of research on Psychometric risk and risk perception.

The solution came in the form of online crowdsourcing, defined as "the practice of obtaining needed services… by soliciting contributions from a large group of people… especially from the online community" (Merriam-Webster, n.d.). Participants were sourced via Amazon Mechanical Turk, an online service which crowd-sources tasks that "require human intelligence to complete" (Paolacci, Chandler, & Ipeirotis, 2010, p. 411). This service is increasingly being embraced as a feasible alternative for the collection of data, allowing fast, anonymous recruitment of participants (Paolacci et al., 2010). In a demographic study of 1000 Amazon Mechanical Turk users, Paolacci et al. (2010) received responses from 66 different countries, and respondents were shown to be "at least as representative... as traditional subject pools" (p. 414).

Using this method, the study attracted participants from 28 countries including Canada, India, Egypt, Indonesia, Jamaica, Koli, Romania, Sri Lanka, United Arab Emirates, Argentina, Australia, Ghana, Guadalupe, Mexico, New Zealand, Pakistan, Russia, Germany, Kenya, Macedonia, Panama, Serbia, South Korea, Haiti, Mauritius, Poland, the United Kingdom, and the United States of America. The majority of participants were based in the USA or India. Participants ranged in age from 18 to 71. This method provided a solution to obtaining a suitably large and diverse sample of respondents. It also provided tools to reduce any potential biases in the data set, such as overrepresentation of a particular demographic, by allowing for a range of pre-screening and demographic restrictions to be restricted or open.

However, it was recognised that the use of this method of participant recruitment might result in simple non-random self-selection if participants were able to choose which survey to complete. As a result, the research instruments were made available one at a time, and no indication of the differences between them were made apparent in the descriptions. The method was thus justified as providing the best solution to the general population problem. The method also had the advantage of involving respondents who

would likely have a greater commitment to the subject being studied, and who would potentially afford greater thought and insight to their responses.

Further consideration of the sampling strategy then led to the issue of how best to determine an appropriate representative sample size from a population with no definite boundaries. To overcome this limitation, it was reasoned that a representative sample size could be established from the results of Phases One and Two using statistical Power Analysis. Such a method of determining the sample size required for a significant chance of detecting the minimum value of interest (Kraemer & Thiemann, 1987) could then inform the required sample size of the third Phase of the study, where the methodology of the first two Phases could be replicated.

In order to satisfy the requirements for calculating a sample size in this way, several values had to be estimated. These estimations were not arbitrary, but based on the results of the Phase One and Two data analysis. It was reasoned that if Affect were associated with risk perceptions, then Affective responses would be expected to be significantly different from the neutral responses. This difference was used as the critical effect size in the Power Analysis for sample size, informing the study of what probability to assign to maximize the chance of detecting a significant result (Kraemer & Thiemann, 1987). As a result, the first two study Phases employed a total sample size of N=200. Based on the results of the Power Analysis, the third study Phase total sample size was N=1638.

4.3 Research Design

The Psychometric Theory of Risk falls within the positivist, objectivist paradigm of risk and "has produced valuable insights into risk perception and decision making (Zinn & Taylor-Gooby, 2006b). Positivism makes the assumption of a set of universal laws that underlie social interactions (Wardlow, 1989), and that these laws were "understandable

through empirical investigation" (Kim, 2003, p. 11). Popkewitz (1980) outlines five fundamental assumptions of positivistic research, which include:

1. Researchers are able to understand social interactions in the same way that the properties of the physical world can be examined and understood.

2. Theory is fundamental tool for inferring and describing behaviour and phenomena that is generalisable across settings.

3. Study participants are assumed to have an independent existence from the researcher.

4. Knowledge is formalised through theory.

5. Theorised knowledge is "tested by the quantification of observations and by the use of statistical analyses" (Kim, 2003, p. 10).

According to Kim (2003), "the taxonomy of positivism should be considered the method-of-choice relative to interpretive and critical science because of its ability to uphold best the validity of findings and generalisability of results" (p. 9). Given that the Psychometric theory falls within the positivist, objectivist paradigm of risk, a quantitative methodology was developed with a positivist research approach.

The study design was conceived as a three Phase process. The first Phase of the study involved surveying two cohorts of respondents using a Psychometric Dread risk research instrument. One cohort would respond to a neutral worded survey, while the other cohort would respond to a survey designed to elicit an Affective response. The neutral and Affective data collected would then be analysed using descriptive statistical analysis, Independent Samples *t*-tests, Factor Analysis, and Multidimensional Scaling. The analysis was expected to also result in neutral and Affective Dread risk spatial maps which would be compared with each other, and with previous Psychometric Risk studies (figure 4.1).
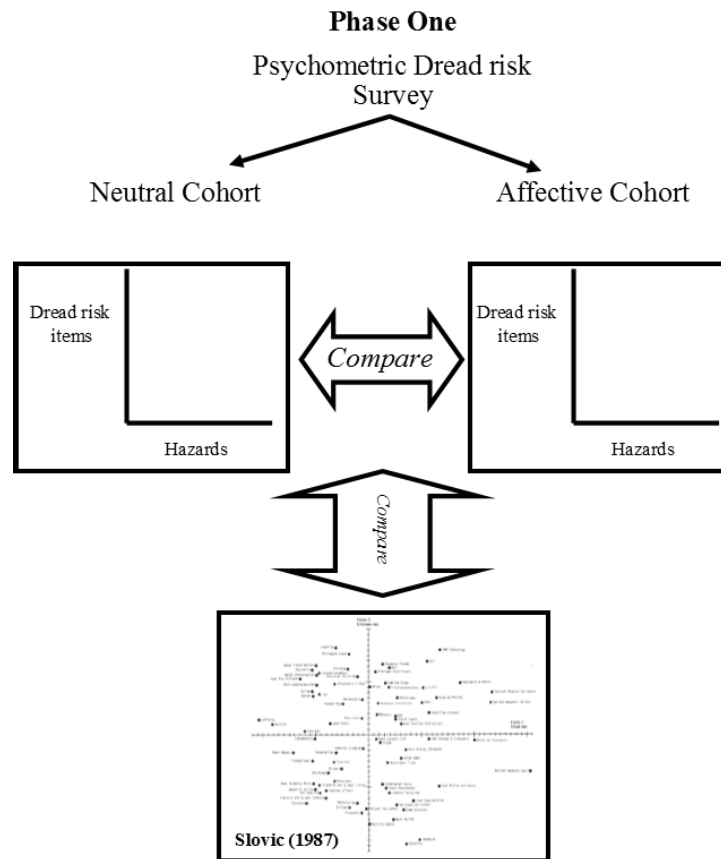
Figure 4.1.   Phase One study design.

The second Phase of the study involved a neutral-worded and an Affective-worded Risk Consequence Task. In this survey, respondents were asked to estimate the seriousness of the risk consequences associated with the six hazards used in Phase One. The collated data was analysed and compared with the Phase One data using several statistical measures including descriptive statistics, Independent Samples *t*-tests, multiple regression analysis and reliability analysis (figure 4.2).
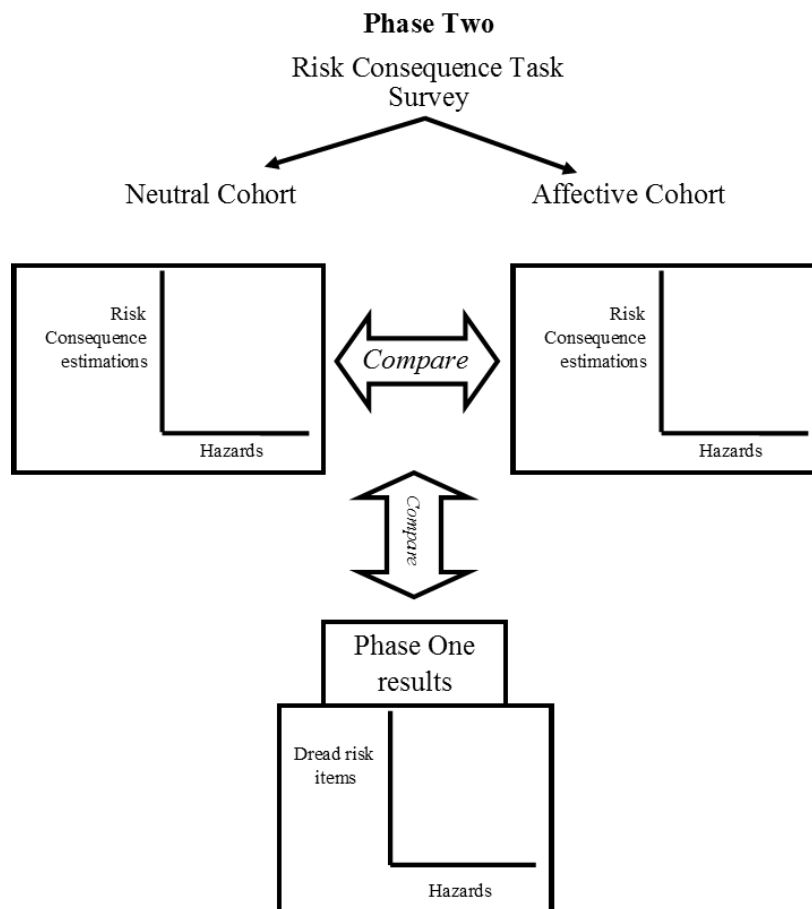
Figure 4.2.   Phase Two study design.

Phase Three largely replicated the procedure of Phases One and Two, with some modifications to address the identified limitations in the first two Phases. The third Phase recruited a larger sample size than the first two Phases, and enlisted four separate groups of participants rather than two. The Phase Three Risk Consequence surveys also included questions asking respondent's to estimate of the amount of harm and benefit associated with each hazard.

The need to confirm that Affect had actually been manipulated was addressed by examining whether the Phase Three Affective cohort displayed a greater inverse risk-benefit association compared with the neutral cohort (Slovic, Finucane, Peters, and MacGregor, 2002). This provided Phase Three of the study with an indicator that a

greater level of Affect had been elicited in the Affective cohort than the neutral cohort. In addition, the Risk Consequence Task included Affective framing statements for each hazard. The data analysis for Phase Three included descriptive statistics, Independent Samples *t*-tests, Multidimensional Scaling, and reliability analysis (figure 4.3).
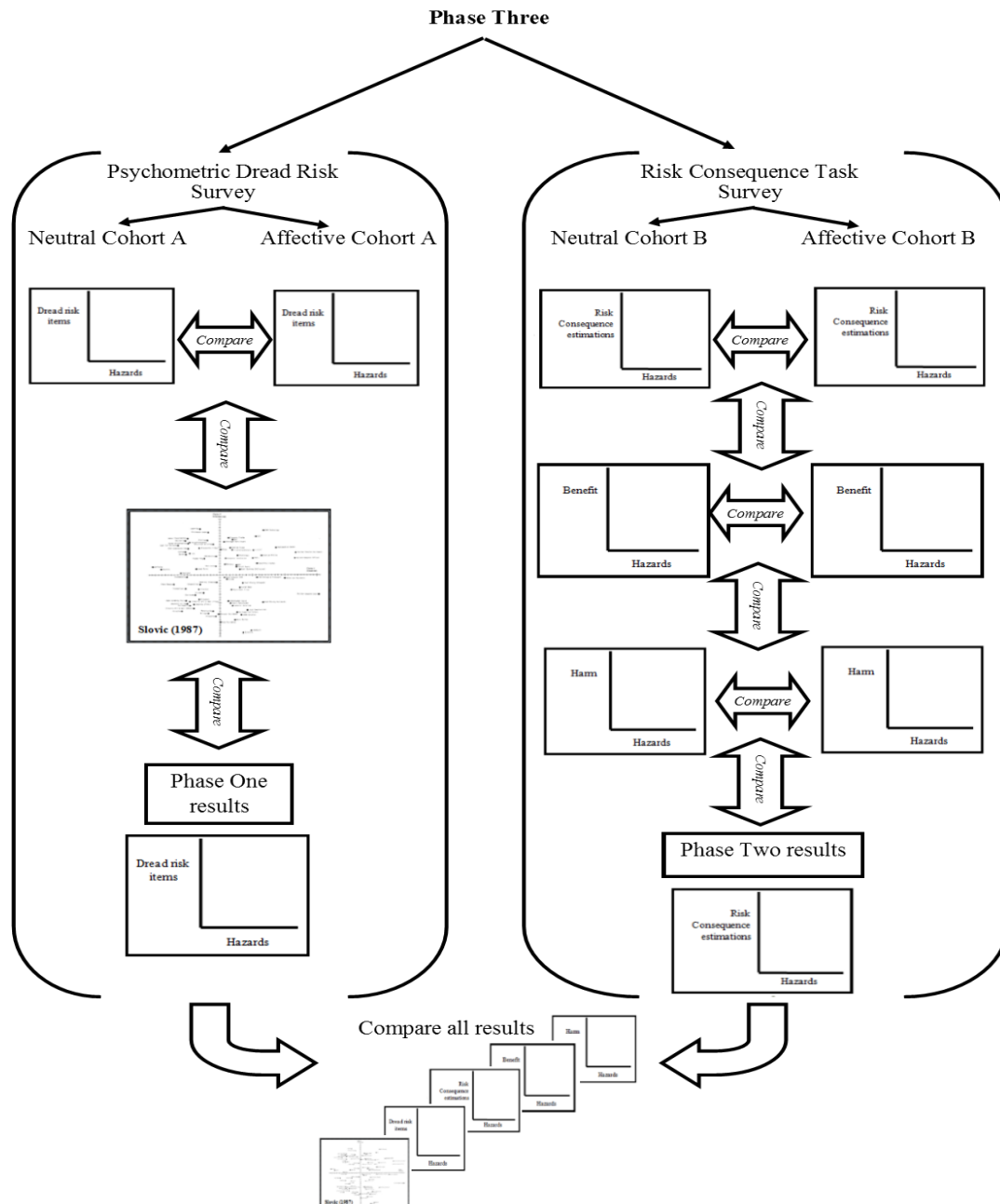
Figure 4.3.   Phase Three study design.

4.4 Research Instruments

In order to build upon established theory, the initial conception of the research instruments were as a series of surveys based on the Dread aspect of Psychometric risk used within a between-subjects framework. According to Trumbo (1996), Psychometric risk research has shown that there are several important dimensions to risk perception, particularly Dread and Knowledge. As Dread risk is commonly viewed as the emotional factor, it was determined that the study would focus on the Dread risk factor alone. The study would also draw on previous Psychometric risk research by focusing on six different hazards. The locations of these hazards within the Dread spectrum were established via reference to Slovic's (1987, p. 282) spatial representation of 81 hazards, chosen due to their dispersion across the Dread risk axis (figure 4.4).
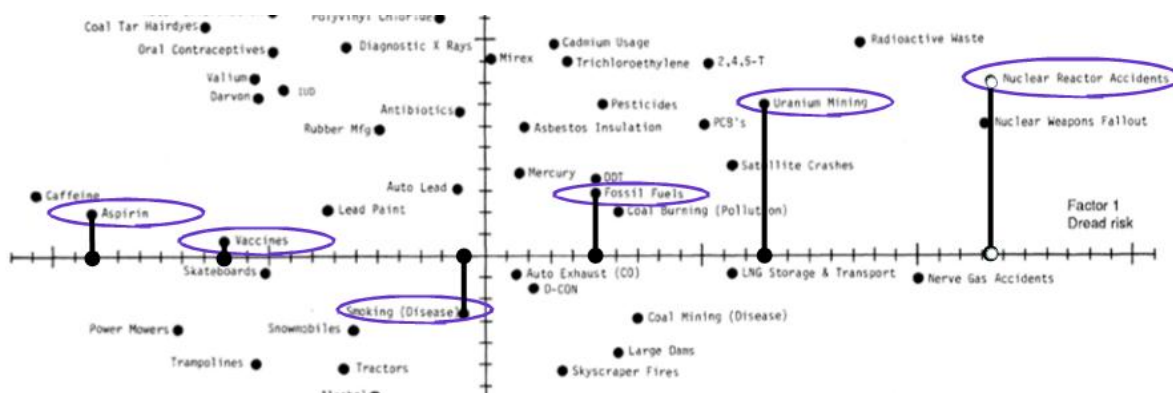
Figure 4.4.   Psychometric Dread risk locations of six hazards (adapted from Slovic, 1987, p. 282).

The Psychometric Dread risk research instruments (Appendix A) utilised the set of ten Psychometric Dread risk factor items identified by Slovic (1987), upon which to base questions regarding the six different hazards (table 4.1).

Table 4.1

Dread factor items used in the research instruments

Dread Factor Items	
(Slovic, 1987)	
1. Uncontrollable	6. Future generations
2. Dread	7. Not easily reduced
3. Consequences Fatal	8. Risk increasing
4. Not Equitable	9. Involuntary
5. Catastrophic	10. Global Catastrophic

In order for the study to maintain an accurate context of Dread risk, it was determined that all ten of Slovic's (1987) Dread risk factor items would be used in the research instruments. The reasons for this were twofold. First, all ten Dread factor items were deemed necessary in order for a valid assessment of the potential Affect associations to be made. Second, in order to ascertain the level of reliability and validity of the collected data, a method consistent with that used by Slovic (1987) was considered essential. However, the conception of Dread risk attained from the review of the literature highlighted the heterogeneous nature of the ten items making up the factor, and some delineation of emotional and severity of consequence items had to be made.

It was reasoned that perceptions of the six hazards would be driven by some combination of the Dread risk characteristics. For this reason, the Dread risk factor items were theoretically categorised into emotional and severity of consequence items. The categorisation of the severity of consequence items was based on whether the item could conceivably be used to rate the severity of a risk consequence using a unit of magnitude. The decision to split the Dread item from the rest of the Dread factor was based on semantics, an approach identical to that used by L. Sjöberg (personal communication, October 28, 2011) in his investigations into the Dread risk factor (Sjöberg, 2006b).

In addition to the separation of emotional and severity of consequence Dread risk items, a third aspect to the Dread risk factor emerged from this process. This third aspect was made up of the items Uncontrollable, Not Equitable, and Involuntary (table 4.2).

Table 4.2.
Split of the Dread Factor items

Original Dread Factor Items (Slovic, 1987)	**Severity of Consequence Items**	**Emotional Items**	**Other Items**
Uncontrollable			*Uncontrollable*
Dread		*Dread*	
Consequences Fatal	*Consequences Fatal*		
Not Equitable			*Not Equitable*
Catastrophic	*Catastrophic*		
Future generations	*Future generations*		
Not easily reduced	*Not easily reduced*		
Risk increasing	*Risk increasing*		
Involuntary			*Involuntary*
Global Catastrophic	*Global Catastrophic*		

With this determination of the character of the Psychometric Dread risk factor to be used in the study, along with the simplification of its heterogeneous nature into three logical aspects, the next stage was to develop the research instruments and determine how they would be employed in each of the study's three Phases.

The data collection instruments for the study comprised of a Psychometric Dread risk research instrument and a simple Risk Consequence Task. The Psychometric Dread risk instrument utilised the ten Dread risk factor items identified by Slovic (1987) for use in the first and third Phases of the study. The ten Dread risk questions were worded around each of the six hazards, resulting in 60 Psychometric Dread risk questions (Figure 4.5).
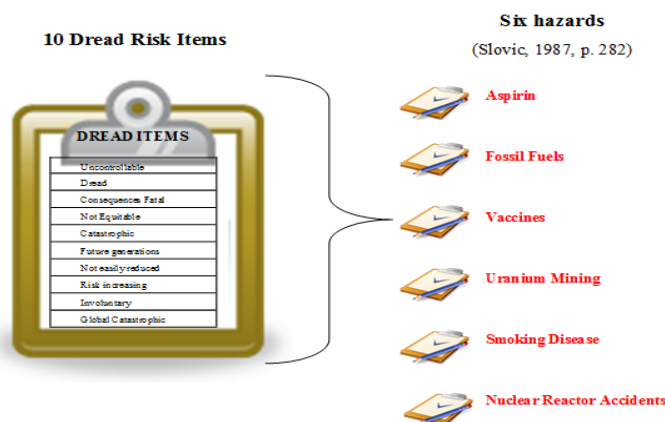
Figure 4.5.   Psychometric Risk survey format.

This instrument was then refined into two versions; a neutral-worded version and an Affective-worded version, based on words selected from the Affective Norms for English Words (ANEW) list (Bradley & Lang, 2010). The Affective Norms for English Words (ANEW) list is produced by the University of Florida and provides a "set of normative emotional ratings for a large number of words in the English language" (Bradley & Lang, 2010, p. 2). The ANEW list is essentially a set of "verbal materials that had been rated" (Bradley & Lang, 2010, p. 2) in terms of pleasure (happy/unhappy), arousal (calm/excited), and dominance (control/in-control). The wording chosen for the Psychometric research instruments was required to be either emotionally provocative or emotionally neutral, and were selected for their potential impact on perceptions of risk consequences.

This process involved the comparison of the wording of the Psychometric Dread risk questions used by Slovic (1987) with alternative words found in the ANEW list (Bradley & Lang, 2010). The wording used in Slovic's (1987) version of the ten Psychometric Dread risk questions were examined, and any words that had mean ANEW valences that were very high (positive words) or very low (negative words) were identified. These were replaced with neutral words of an average valence from the ANEW list (Bradley & Lang, 2010), resulting in a 60 question neutral Psychometric Dread risk research instrument in

which the wording was Affectively neutral, and therefore less likely to influence hazard perceptions via emotional influence.

The next step in the development of the research instruments was to produce an Affectively worded version of the Psychometric Dread risk survey. The survey was developed by reviewing the newly produced neutral-worded instrument against the ANEW list (Bradley & Lang, 2010) and identifying words which could be replaced with negative Affective words for the Affective version of the instrument. The final result was two 60 question Psychometric Dread risk surveys, one with neutral wording, and one with negative Affective wording.

In order to replicate the method in which Slovic's (1987) survey asked participants to respond to the questions, a seven-point Likert scale was used. As with previous Psychometric risk studies (Fischhoff, Slovic, Litchtenstein, Read, & Combs, 1978; Slovic, 1987; Slovic, Malmfors, Mertz, Neil, & Purchase, 1997; Trumbo, 1996), the category labels for the Psychometric risk instruments were located at the extremes (1 and 7), and were altered from question to question, depending on which hazards and risk characteristics were being referred to.

The process of selecting neutral and Affective words was repeated for the creation of the simple Risk Consequence Task instruments utilised in Phases Two and Three of the study. The seven-point Likert scale of the Risk Consequence Task instruments employed the term 'serious' as the basis for the category labels. The term 'serious' has a mean ANEW valence of 5.08 (Bradley & Lang, 2010), making it a word of relatively neutral emotional arousal. This ensured that any potential influence of the category label wording on respondents' estimations of risk consequences was controlled and consistent. In addition, neutral cohort were asked what they thought about the hazards while the Affective cohort were asked how they felt.

The neutrally and Affectively worded Risk Consequence Task instruments (Appendix B) produced for Phase Two required respondents to simply estimate the severity of the consequences of each of the same six hazards used in the Psychometric Dread risk surveys. The Phase Three Risk Consequence Task survey included questions relating to perceptions of harm and benefit. Respondents were asked to estimate the potential amount of harm caused by the hazard, as well as perceptions of benefit in addition to the severity of risk consequence.

In addition, each hazard was introduced with a simple framing statement which highlighted either the negative or positive aspects of each risk. The negative aspects of the six hazards were presented in the Affective version of the instrument, and the positive aspects were highlighted for the neutrally worded version of the instrument. These modifications were made to the Phase Three Risk Consequence Task research instruments after the analysis of the Phase One and Two results, in order to further explore the relationship between Dread, Affect and consequence independently of the Psychometric approach. The framing statements were included to further elicit an Affective reaction to the six hazards to better assess the role Affect might play in the estimation of risk consequence, and its relationship to the concept of Dread.

4.5 Data Collection

The research instruments for the three study Phases were developed into online versions using the using Qualtrics software (Qualtrics, Provo, UT, 2014). The Amazon Mechanical Turk service (Amazon.com, 2014) was used to recruit participants, who were then redirected to the Qualtrics online surveys. Phases One and Two of the study were executed simultaneously, and involved two independent cohorts in a between-subjects design. The first cohort (n=100) completed the neutral Psychometric Dread risk survey and the neutral Risk Consequence Task, while the second cohort (n=100) completed the Affective versions of the same research instruments.

The participants recruited using the Amazon Mechanical Turk service via the link from the Amazon Mechanical Turk website to the online surveys. They were provided with an electronic participant information sheet (Appendix C) and consent document (Appendix D) upon volunteering to participate in the study. Using Paolacci et al.'s, (2010, p. 412) assessment of average Amazon Mechanical Turk task earnings as a guide, respondents were offered US$0.30 per completed survey. This approach proved to be a successful estimate in Phases One and Two, and generated N=222 responses within one week. Once participants had completed the survey, they were paid for their participation through the Amazon Mechanical Turk system. Once the initial Phase One and Two quota of N=200 participants was exceeded, the survey was closed and the data was downloaded into a spreadsheet program in preparation for cleansing.

Phase Three of the study replicated the research instruments from Phases One and Two, but with some improvements. In Phase Three, four independent cohorts of respondents were used, rather than the two cohorts used in Phases One and Two, employing independent cohorts of respondents for each of the Psychometric Dread risk and Risk Consequence Task surveys. Based on a two-tailed a-priori Power Analysis which was conducted at the end of Phases One and Two, a sample size of n=481 for each of the four cohorts in Phase Three was required to achieve 80% statistical Power, yielding a total sample size target of N=1924. The final number of valid responses was N=1638. These consisted of neutral (n=370) and Affective (n=401) cohorts for the Psychometric Dread risk survey, as well as a neutral (n=434) and Affective (n=433) cohorts for the Risk Consequence estimation survey.

4.6 Data Analysis

The data from Phases One and Two were collated into a spreadsheet and analysed using the SPSS Statistics package version 21 (IBM Corp., Armonk, NY). The Phase One data was analysed first by way of descriptive statistics, Independent Samples *t*-tests, Multidimensional Scaling Analysis and Factor Analysis. The variables under measurement included the ten Dread risk characteristics as well as the average overall dread risk perception for each hazard. In addition, estimations of the severity of risk consequence, harm and benefit were measured. Each of these variables were measured for the neutral and Affective cohorts. Each variable was measured on a seven-point Likert scale.

The descriptive statistical analysis provided an assessment of the mean risk perceptions and the variability among the surveyed cohorts. The Independent Samples *t*-tests provided a method of assessing whether any differences between the risk perceptions of the Affective and neutral cohorts were statistically significant. The Multidimensional Scaling Analysis was used to compare the data with previous Psychometric studies, thereby allowing for an assessment of the external validity of the results. This measure also provided an additional method of comparison of the neutral and Affective results. Factor analysis was used as a method of exploring the Psychometric Dread risk factor, and identifying the constructs that arose from the ten Dread factor items, and how these constructs related to Affect, Dread, and severity of risk consequence. Upon completion of the Phase One data analysis, the results of Phase Two were assessed.

The analysis of the Phase Two data involved descriptive statistical analysis, Independent Samples *t*-tests, and Multiple Regression analysis. In order to compare Psychometric risk perceptions and estimations of risk consequence, a measure of multiple correlation was obtained using the standard Multiple Regression analysis model. This analysis allowed for an assessment of the degree of association between the responses to the ten Dread factor items form Phase One and the neutral and Affective responses to the Risk

Consequence Task from Phase Two. The Phase two data analysis also included a determination of the sample size required for Phase Three via the use of statistical Power Analysis. The results obtained from the analysis of the Phase One and Two data allowed for any limitations to be identified and addressed before the initiation of the third and final Phase of the Study.

Phase Three of the study was largely designed to replicate the analysis of Phases One and Two, with the aim of either confirming or refuting the results found in the initial Phases using a more robust sample size and with appropriate modifications to the methodology. The first two study Phases also indicated which statistical measures yielded the most significant results related to answering the Research Questions. Phase Three therefore applied many of the same statistical measures as Phases One and Two. These included descriptive data analysis, Independent Samples t-tests, Multidimensional Scaling and Factor Analysis. Each of the study Phases also included assessments as to the validity and reliability of the results, determined through Cronbach's Alpha Coefficient, and comparison of the results between the Three Phases. A comparison of the results obtained with the previous Psychometric work on which the study was based (Slovic, 1987) also allowed for a measure of external validity to be obtained.

4.7 Reliability and Validity

Validity may be defined as the careful use of sampling, instrumentation and statistical analysis of the data (Cohen, Manion, & Morrison, 2007, p. 112) to accurately measure what is intended to be measured. In order to demonstrate internal validity, the study needed to provide evidence that it was the measured variables that were contributing to the results and not extraneous variables (Graziano & Raulin, 2004, p. 138). Consistency in instrumentation was maintained so that changes in measurement methods would not be a factor in weakening internal validity. As the study involved comparison of the responses in a between-groups design, functional equivalence of the groups was maintained so that any differences in risk judgements would more likely be a product of

response to the variables, reducing the potential for bias in this area. Finally, participants were unaware that the results obtained were to be compared with another group, or to which group they belonged, mitigating self-selection bias.

Reliability may be defined as "dependability, consistency, and replicability over time, over instruments, and over groups of respondents" (Cohen et al., 2007, p. 146). In order to determine the reliability of the results, several measures were used, including comparison of results within the study and with previous research, as well as the use of Cronbach's alpha coefficient, which provides "a unique estimate of the reliability of a given test" (Gliem & Gliem, 2003, p. 84).

The test yields an alpha coefficient between 0 (unreliable) and 1 (perfectly reliable) (Cohen et al., 2007, p. 506), and was used as a measure of the internal consistency and reliability of the data. The Multidimensional Scaling Analysis was compared with the results of Slovic's (1987) Psychometric study of 81 hazards to determine the reliability and external validity of the results obtained. This method also provided a measure of the reliability and validity of the results through triangulation of the spatial maps obtained in Phases One and Three with each other and Slovic's (1987) results.

4.8 Limitations of the Methodology

The following is a summary of the limitations of the methodology. An issue that was identified early in the conception of the research project was that the theory underpinning the study placed very few restrictions on the way risks are perceived. As the target population was defined as a 'general population', the boundaries were unclear. It was recognised that if the study were not to suffer from the limitations of previous Psychometric risk research, which often relied largely on the perspectives of small groups of respondents sampled for convenience rather than representativeness, then a more robust methodology would be required. This limitation was addressed using statistical

Power Analysis which determined an appropriate sample size for Phase Three from the general population of Amazon Mechanical Turk users based on the initial data collected in Phases One and Two. The use of Amazon Mechanical Turk for recruitment of participants raised the question of whether using such a method may introduce a degree of self-selection bias. It was recognised that the use of this method of participant recruitment might result in simple non-random self-selection if participants were able to choose which survey to complete.

As a result, the research instruments were made available one at a time, and no indication of the differences between them were made apparent in the descriptions. The method was thus justified as providing the best solution to collecting an appropriate number of responses from a sufficiently diverse population. It was also considered that there was a potential for inconsistencies in the logic used to ascribe meaning (semantics) to the neutral and Affective words, given that the target population was sourced globally, with participants likely to have come from diverse cultural and linguistic backgrounds. Although it was anticipated that the use of words from the ANEW list (Bradley & Lang, 2010) would provide a level of consistency in interpretation, the potential remained for differences in word interpretation to influence reported perceptions of risk.

This limitation was considered to be present, but somewhat mitigated by the increase in the sample size in Phase Three, which indicated remarkably similar results to those found in the first two Phases of the study. The influence of individual concentration on the survey as it was completed was also identified as a potential limitation in Phase one and Two. As a result, the Phase Three subjects were asked a concentration check question to mitigate concentration loss during completion of the research instruments. Any incorrect answers to a simple question (for example, how many days in one week) were eliminated from the data set.

4.9 Conclusion

The review of the literature highlighted that Psychometric Dread risk is largely considered to be centred around the concept of Affect. The focus of this Thesis was to understand the impact of Affect on Dread risk characteristics and risk consequence perception. A methodology was sought that could provide an avenue to make such an assessment.

This chapter explained the methods used to elicit and measure the Affective relationship to Dread risk characteristics, and the approach taken to establish the Affective association with estimations of risk consequence. The chapter also demonstrated how the study sought to establish internal and external validity through the use of appropriate sampling, data analysis, and comparison with previous work in the area of Psychometric risk perception research.

The following chapter describes the results and data analysis of the first Phase of the study, which was an assessment of the nature of Psychometric Dread risk. The relationship between Affect and risk perception via Psychometric Dread risk characteristics was the focus of Phase One. The first Phase of the study assessed Dread risk in its purported role as Affect, while also providing an assessment of the factor without this assumption.

CHAPTER 5: PHASE ONE

5.1 Introduction

The previous chapter demonstrated how the methodology was conceived and designed in order to meet the aims and objectives of the study and to develop a response to the Research Questions. This chapter details the implementation of the first study Phase, including the design, procedure and data analysis. This Phase involved participants completing either a neutral-worded or an Affective-worded Psychometric risk survey in a between-subjects design. The analyses of data using various statistical measures are presented, together with a summary of the results. The limitations identified in this initial Phase are also outlined, together with improvements for the second and third Phases of the study. This chapter concludes with a summary of the Phase One design, implementation, and outcomes.

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5.2 Phase One Sample

Participants for the study (N=200) were sourced via Amazon Mechanical Turk, an online service which crowd-sources tasks that "require human intelligence to complete" (Paolacci, Chandler, & Ipeirotis, 2010, p. 411). This Phase of the study attracted respondents from eleven countries, including Canada, China, Egypt, Germany, Hungary, India, Israel, Italy, Philippines, Taiwan, United Kingdom, and the United States of America. Participants ranged in age from 18 to 67 years old.

5.3 Phase One Design

The between-subjects design of Phase One required that two separate research instruments be developed for the two cohorts. These consisted of neutral-worded and Affective-worded Psychometric Dread risk surveys (Appendix A). The neutral and Affective cohorts were independent, and responses were gathered on two different occasions. Care was taken to ensure that one participant could not complete both surveys.

The Dread risk perceptions of the two cohorts were then compared through statistical analysis. The results were recorded and the limitations of the phase noted.

5.3.1 Phase One Research Instruments

The study's aim to assess Affective associations with Dread risk characteristics meant that the instruments focused on the items making up the Dread risk factor identified by Slovic (1987), while ignoring the Knowledge risk factor. The Psychometric risk surveys referred to six different hazards which have been found in previous work to be located across the Dread risk spectrum, ranging from low Dread to high Dread. The locations of Aspirin, vaccines, smoking, fossil fuels, uranium mining and nuclear reactor accidents within the Dread risk spectrum were established via reference to Slovic's (1987, p. 282) spatial representation of 81 hazards.

The Phase One Psychometric risk research instruments utilised a set of ten Dread risk factor items (or characteristics) identified by Slovic (1987) upon which the questions regarding the six different hazards were based. The ten Dread risk questions were worded around each of the six hazards, resulting in 60 Psychometric Dread risk questions. This instrument was then refined into two versions; a neutral-worded version and an Affective-worded version, based on words selected from the Affective Norms for English Words (ANEW) list (Bradley & Lang, 2010).

The ANEW list is a set of "verbal materials that have been rated" (Bradley & Lang, 2010) in terms of their emotional valence (happy/unhappy), arousal (calm/excited), and dominance (control/in-control). The wording chosen for the Psychometric research instruments was intended to either elicit negative Affect or to be emotionally neutral, and were selected for their potential impact on perceptions of risk consequences. Using the ANEW list, the difference between the neutral and Affective emotional valences of word choices for each Dread risk item could be assessed and selected accordingly.

5.3.2 Phase One Procedure

Using a between-subjects design, two independent cohorts of Phase One respondents were surveyed (N=200). The first cohort (n=100) completed the Affective-worded Psychometric instrument, while the second cohort (n=100) completed the neutral-worded version of the same instrument. Participants were sourced from the Amazon Mechanical Turk service and were able to complete the research instrument created with Qualtrics online survey software. Participants were directed to the Qualtrics survey via the Amazon Turk service.

Respondents rated their perceptions of ten Psychometric Dread risk characteristics for six different hazards. As with previous Psychometric risk studies (Fischhoff, Slovic, Litchtenstein, Read, & Combs, 1978; Slovic, 1987; Slovic, Malmfors, Mertz, Neil, & Purchase, 1997; Trumbo, 1999), responses most closely representing respondents' risk judgements were recorded on a seven-point Likert scale.

5.4 Phase One Data Analysis

Analysis of the data collected during Phase One employed several statistical measures to describe the data, compare the groups of respondents, and determine any association of Affect with Dread risk characteristics. The results of the completed surveys were first collated and subjected to an initial data cleanse. In order to ensure accuracy and validity of the data, each individual's results were inspected for completeness and any obvious errors. Data based on descriptive statistics were generated from a small sample of respondents to estimate the average time taken to complete the instruments. Any respondent completing the survey in a very short time was eliminated from the data. Of 222 responses, 22 were rejected. The main reasons for response rejection were incomplete surveys or invalid responses (such as responses with only 7's or 1's for all questions).

5.4.1 Descriptive Analysis

Once the data had been cleansed, the distributions of all data sets were tested for normality using the Kolmogorov-Smirnov statistic with a Lilliefors significance level. This first step was essential, as the outcome would have a direct impact on the type and power of the statistical tests that could subsequently be applied. A subset of thirty simple random samples of the neutral and Affective data sets was generated using the Statistics Package for the Social Sciences (SPSS).

The distribution of these samples were then tested for normality using the Kolmogorov-Smirnov statistic with a Lilliefors significance level, and through inspection of the normality plots and histograms (Coakes, Steed, & Ong, 2010, p. 41). The results of these tests indicated that the data were normally distributed ($p>.05$) for all hazards except the Affective responses to the Vaccine hazard. However, inspection of the histograms and normality plots associated with the Vaccine hazard indicated that the assumption of normality had not been violated (table 5.1).

Table 5.1

Kolmogorov-Smirnoff statistic for each neutral and Affective hazard data

Hazard	Affect (p)	Neutral (p)
Aspirin	.144	.2
Vaccines	.012	.2
Smoking	.2	.2
Fossil Fuels	.2	.2
Uranium Mining	.2	.2
Nuclear Reactor Accidents	.2	.2

Confirmation of the assumption that the data were normally distributed provided justification for the use of parametric statistical tests. Parametric tests "make assumptions about the wider population" (Cohen, Manion, & Morrison, 2007, p. 318), and allow the comparison of sub-populations within the wider population.

Measures of central tendency were then calculated via the mean and the standard deviations to test for variability. The overall mean of the neutral Psychometric Dread risk scale was calculated to be $M=4.49$ ($SD=1.66$). The Affective data had a mean of $M=4.43$ ($SD=1.86$). The mean and standard deviation was then calculated for each hazard on all questions/Dread items for the neutral research instrument (table 5.2).

Table 5.2

Descriptive statistics for the neutral instrument by hazard and Dread item

	Aspirin		Vaccines		Smoking		Fossil Fuels		Uranium Mining		Nuclear Accidents	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Uncontrollable	3.6	1.80	3.96	1.55	3.90	1.73	4.52	1.56	4.9	1.64	4.96	1.63
Dread	3.57	1.57	3.62	1.53	4.86	1.64	4.45	1.46	4.75	1.53	5.34	1.41
Consequences Fatal	3.93	1.65	3.86	1.42	5.64	1.24	4.88	1.35	5.42	1.25	5.90	1.29
Not Equitable	4.12	1.61	4.48	1.50	4.63	1.53	4.42	1.57	4.61	1.40	4.46	1.66
Catastrophic	3.56	1.75	3.86	1.54	4.72	1.54	4.67	1.32	5.06	1.46	5.68	1.29
Future generations	3.83	1.69	4.24	1.47	4.92	1.55	4.91	1.42	5.22	1.52	5.66	1.36
Not easily reduced	3.54	1.64	3.86	1.50	4.50	1.58	4.7	1.47	4.87	1.58	5.41	1.46
Risk increasing	4.37	1.22	4.12	1.30	5.14	1.40	5.2	1.24	4.93	1.42	5.30	1.31
Involuntary	2.98	1.37	3.0	1.25	2.88	1.35	3.9	1.65	3.73	1.57	4.33	1.89
Global Catastrophic	3.26	1.64	3.86	1.55	4.40	1.51	5.08	1.32	5.30	1.26	5.51	1.43

The results for the neutral Psychometric instrument showed the Dread item Involuntary to consistently have the lowest mean all hazards, suggesting that perceptions of voluntary choice were relatively positive, although fossil fuel, uranium mining and nuclear reactor accident hazards were seen as less voluntary. Smoking, uranium mining and nuclear reactor accidents were all previewed to have fatal consequences. Neutral Dread item means generally increased overall from low Dread hazards such as Aspirin and vaccines

to the high Dread hazards, uranium mining and nuclear reactor accidents. The two hazards located closest to the centre of the Dread risk spectrum were smoking and fossil fuels.

The standard deviation was also calculated for each neutral Dread item in each hazard to determine the amount of variance in the risk perceptions. The greatest variations in risk perceptions were found in the Dread item Uncontrollable for the hazards Aspirin, vaccination, smoking and uranium mining and in Involuntary for the fossil fuel and nuclear reactor accident hazards. This indicated less agreement over these characteristics of the risks. The Dread items which demonstrated the most uniform perceptions of risk were Risk Increasing for Aspirin and fossil fuels, Consequences Fatal for smoking, uranium mining and nuclear reactor accidents, and Involuntary for the vaccination hazard. The means and standard deviations were then calculated for each hazard on all Dread items for the Affective research instrument (table 5.3).

Table 5.3

Descriptive statistics for the Affective instrument by hazard and Dread item

	Aspirin		Vaccines		Smoking		Fossil Fuels		Uranium Mining		Nuclear Accidents	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Uncontrollable	3.18	2.06	3.61	1.88	3.51	1.97	4.61	1.82	5.16	1.59	5.22	1.64
Dread	3.34	1.69	3.16	1.77	4.79	1.66	4.02	1.76	4.70	1.67	5.32	1.49
Consequences Fatal	3.32	1.76	3.11	1.69	5.38	1.44	4.33	1.78	5.02	1.62	5.95	1.38
Not Equitable	4.26	1.58	4.33	1.78	4.81	1.64	4.12	1.74	4.74	1.75	4.60	1.70
Catastrophic	3.23	1.88	3.24	1.96	4.55	1.91	4.39	1.61	5.40	1.37	5.70	1.45
Future generations	3.91	1.80	4.15	1.75	4.86	1.77	4.83	1.65	5.45	1.43	5.84	1.49
Not easily reduced	3.33	1.75	3.62	1.80	4.52	1.76	4.79	1.55	5.03	1.65	5.47	1.43
Risk increasing	4.32	1.36	3.82	1.57	5.23	1.44	5.34	1.26	4.98	1.35	5.18	1.46
Involuntary	3.13	1.55	3.75	1.77	4.88	1.81	4.12	1.93	3.98	2.03	4.24	2.28
Global Catastrophic	3.26	1.72	3.81	1.74	4.48	1.80	5.20	1.39	5.17	1.51	5.58	1.42

The results for the Affective Psychometric instrument indicated that Aspirin and fossil fuel hazards were associated with increasing risk, while vaccination was not seen as an equitable hazard. The consequences smoking hazard and nuclear reactor accidents were perceived as being Fatal, and concern for Future Generations in regards to uranium mining was evident. Examination of the lowest means indicated perception of choice in exposure to Aspirin, uranium mining and nuclear reactor accidents. Vaccines were not perceived to have Fatal Consequences and smoking was seen as a controllable risk. Dread was found to be of least concern to fossil fuels. For each hazard, the standard deviation was also calculated for each Dread item for the Affective cohort in order to determine the amount of variance in the risk perceptions.

The Dread items demonstrating the greatest variations in risk perception were Uncontrollable for Aspirin and smoking, Involuntary for fossil fuels, uranium mining and nuclear reactor accidents, and Not Equitable for the vaccination hazard. The most uniform perceptions of risk were found in the Dread risk item Risk Increasing for all hazards except fossil fuels and uranium mining, for which Consequences Fatal was found to have the lowest standard deviation. A summary table of the mean Psychometric Dread Risk perceptions for each hazard was then constructed (table 5.4)

Table 5.4

Summary of neutral and Affective Descriptives by hazard and Dread item

	Neutral		Affective	
	Mean	**SD**	**Mean**	**SD**
Aspirin	3.68	1.59	3.53	1.72
Vaccines	3.89	1.46	3.66	1.77
Smoking	4.76	1.51	4.5	1.72
Fossil Fuels	4.67	1.44	4.58	1.65
Uranium Mining	4.88	1.46	4.96	1.6
Nuclear Accidents	5.26	1.47	5.31	1.57

The mean Affective and neutral Dread risk responses were then plotted graphically to visualise any differences between neutral and Affective perceptions for each hazard (figure 5.1).
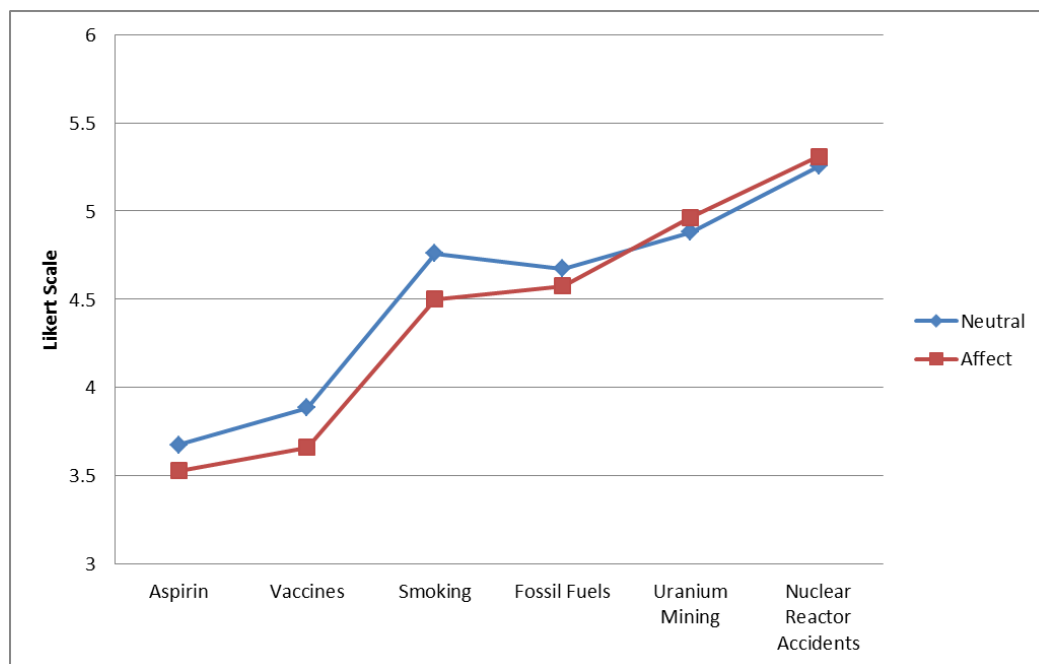
Figure 5.1. Mean neutral and Affective Dread risk perceptions of each hazard.

Compared with the neutral responses, the results showed lower mean Affective Dread risk perceptions for the four lower Dread hazards, but marginally higher mean Affective responses for uranium mining and nuclear reactor accidents.

5.4.2 Independent Samples *t*-test

In order to ascertain the significance of the differences in the mean perceptions of Dread risk characteristics, an independent samples *t*-test was conducted. The *t*-test is a robust parametric measure ideal for between-subjects studies (Coakes et al., 2010). The purpose of the test was to determine whether the differences between the mean neutral and Affective responses to each hazard were statistically significant.

In addition to requiring a between-subjects study design, the independent samples *t*-test relies on the assumption that the two surveyed cohorts are drawn from population with equal variances, determined via the Levene test for equality of variances (Coakes et al., 2010). The results of the Levene's test for equality of variances indicated that for each

hazard, the *t*-test should be interpreted with equal variances assumed (*p*>.05). The results of the independent samples *t*-test on the overall mean Dread risk factor for each hazard indicated that none of the mean Affective Dread risk responses to the six hazards were significantly different to the mean neutral Dread risk perceptions.

In order to more closely examine the individual characteristics making up the Dread risk factor, a second one-tailed independent samples *t*-test was performed on the mean Dread factor items for each hazard, as opposed to the overall Dread risk factor mean. Initial analysis revealed that equal variances could be assumed for the significant results, as indicated by Levene's test for equality of variances (*p*>.05).

The results indicated statistically significant medium to strong differences between some neutral and Affective items for some hazards. The Consequences Fatal item was found to be significantly different for the Affective compared to neutral mean responses for Aspirin (t(174) = 2.36, *p*=.04, *d*=.36), vaccines (t(174) = 3.18, *p*=.02, *d*=.48), and fossil fuels (t(174) = 2.32, *p*=.04, *d*=.35). Affective responses to Involuntary was also found to be significantly different to the neutral responses for the vaccination hazard (t(174) = -3.27, *p*=0.2, *d*=.49), as was the Catastrophic item (t(174) = 2.34, *p*=.04, *d*=.35). This indicated that Affect was associated with Fatal, Catastrophic and Involuntary Dread risk characteristics.

5.4.3 Multidimensional Scaling Analysis

It was anticipated that the Multidimensional Scaling Analysis (MDS) would produce low-dimensional plots, or spatial maps, of the neutral and Affective Dread risk data. The neutral and Affective spatial maps would be compared with one another, as well as with the low-dimensional plots produced by previous Psychometric studies. This would indicate whether Affect was associated with the locations of the hazards within the Dread risk spectrum.

The MDS was completed in two stages. First, the Psychometric data was analysed via Multivariate Analysis of Variance using a multi-factor design, which allowed for the exploration of several variables without artificially inflating the significance level (Hand & Taylor, 1987). Next, the Psychometric data was transformed using multidimensional scaling to perform an ordination of the data, placing it in a low-dimensional coordinate system (Johnson & Wichern, 2002). The resulting spatial map demonstrated the Psychometric Dread risk locations of the six neutral and Affective risk hazards in a single Dread dimension (figure 5.2).
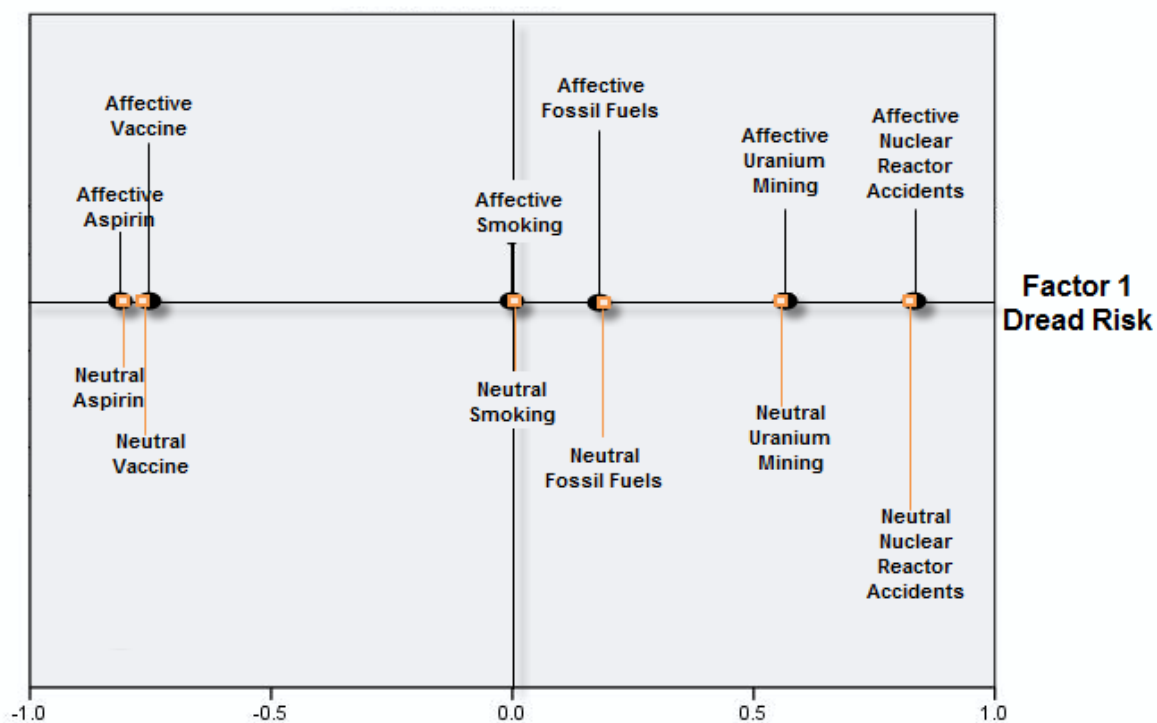
Figure 5.2.   Neutral and Affective hazard locations within the Dread spectrum.

When the spatial maps of the neutral and Affective data sets were overlayed, it was anticipated that id Affect were associated with Dread risk perceptions, the Affective locations would be shifted towards higher Dread locations in comparison to the neutral locations. However, where vaccines, uranium mining and nuclear reactor accidents demonstrated slightly higher Dread locations, Aspirin, smoking and fossil fuels occupied

slightly lower Dread locations in the Affective condition compared with the neutral (figure 5.3).

	Aspirin	Vaccines	Smoking	Fossil Fuels	Uranium Mining	Nuclear Reactor Accidents
Phase One Neutral Dread Locations	-19.6	-12.8	-1	6.2	10.2	17
Phase One Affective Dread Locations	-17.4	-15.2	-0.8	4.2	12	17.2
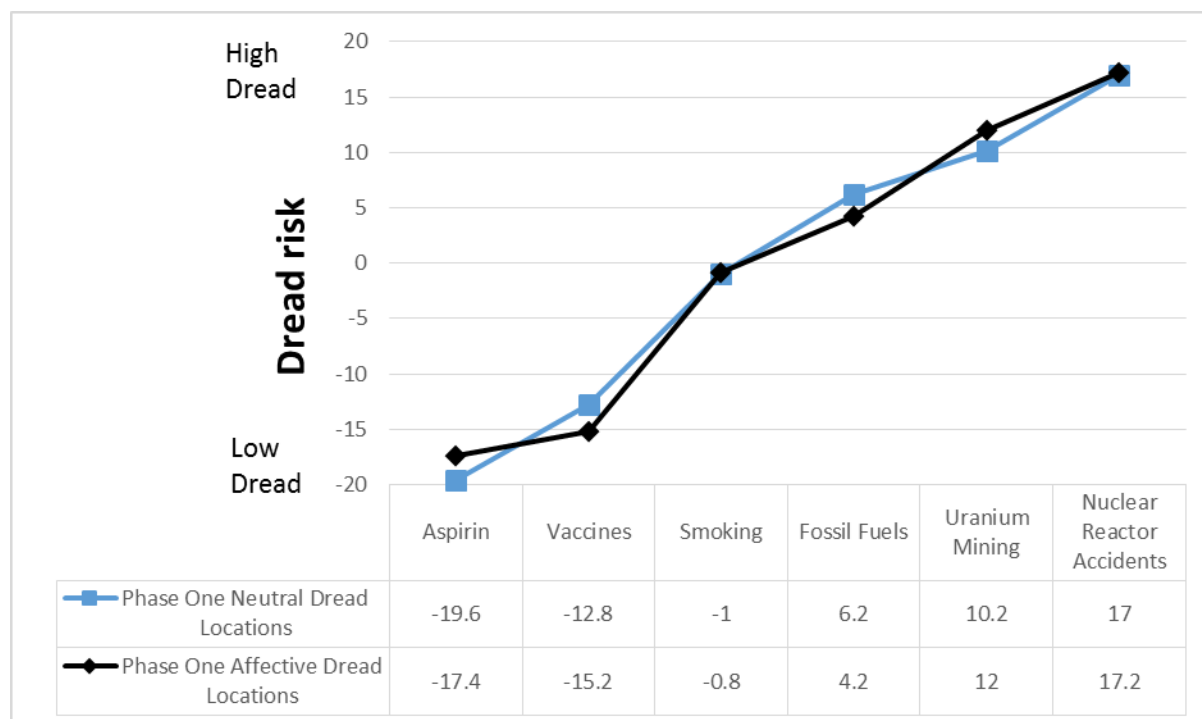
Figure 5.3. Low-dimensional spatial locations of the six hazards.

The resulting low-dimensional plot was then compared with Slovic's (1987, p. 282) spatial map from which the study's six hazards arose (figure 5.4).
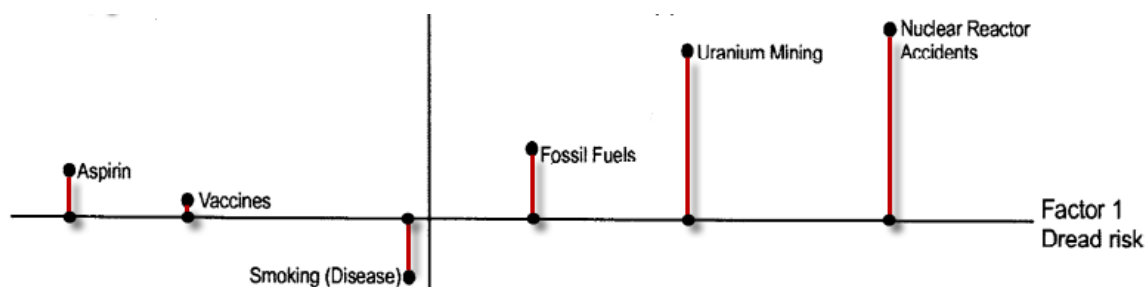
Figure 5.4. Slovic's locations of six hazards within the Dread spectrum (adapted from Slovic, 1987, p. 282).

In order to compare Slovic's (1987) Dread risk locations of the six hazards with the spatial maps produced in the Phase One MDS, the relative locations of each hazard along the Dread factor was determined by dividing the Dread axis of the Phase One spatial map into the same 20-point increments and then identifying the relative locations of each hazard on each map. The locations of the six hazards on both of the spatial maps were recorded and graphically plotted to highlight any similarities or differences (figure 5.5).

	Aspirin	Vaccines	Smoking	Fossil Fuels	Uranium Mining	Nuclear Reactor Accidents
Phase One Neutral Dread Locations	-19.6	-12.8	-1	6.2	10.2	17
Slovic's (1987) Dread Locations	-18.5	-12	-1	5	13	23
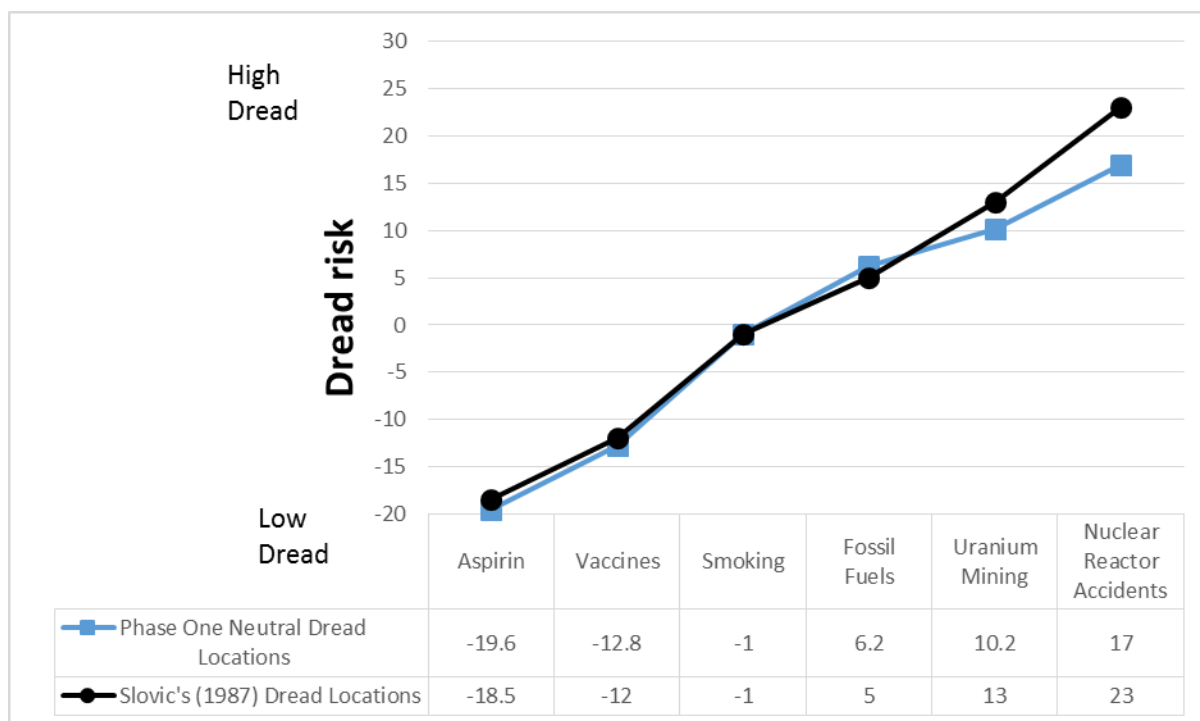
Figure 5.5. Spatial locations of hazards from Phase One MDS compared with Slovic (1987).

The results showed the neutral Dread risk perceptions of smoking occupied the same locations reported by Slovic (1987), whereas the Aspirin, vaccines and fossil fuel hazards were located in slightly higher Dread risk locations. Larger differences were found for uranium mining nuclear reactor accidents which location lower Dread risk locations than that which was reported by Slovic (1987). These differences could be accounted for by the shift in risk perceptions over time. Overall, the results indicated that the locations of

the six hazards were consistent with the Dread risk locations identified by Slovic (1987). These results indicated that Affect was not associated with Dread risk as an overall factor, and the validity was supported by the findings of Slovic (1987).

5.4.4 Factor Analysis

Factor Analysis was performed to determine whether the ten Dread factor items were "tapping into the same construct" (Coakes et al., 2010, p. 133). This would indicate which risk characteristics were dominant in the Dread risk factor. An initial exploratory Factor Analysis was completed fist. Initially, the factorability of the ten Dread items for the neutral condition was examined. All ten Dread items correlated at least .3 with another item, signifying sound factorability.

The Kaiser-Meyer-Olkin measure of sampling adequacy was $> .6$ for all hazards, and Bartlett's test of sphericity was significant for Aspirin (χ^2 (45)=402.82, $p<.05$), vaccines (χ^2 (45)=267.30, $p<.05$), smoking (χ^2 (45)=208.40, $p<.05$), fossil fuels (χ^2 (45)=337.12, $p<.05$), uranium mining (χ^2 (45)=328.57, $p<.05$), and nuclear reactor accidents (χ^2 (45)=342.28, $p<.05$). The diagonals of the anti-image correlation matrix were largely $>.5$, supporting the inclusion of each of the ten Dread items in the Factor Analysis. Finally, the communalities were largely $>.3$, further confirming a large common variance among the items. Supported by these overall indicators, Factor Analysis was conducted with all ten neutral Dread items for the neutral hazards.

The initial eigenvalues indicated that the first factor explained approximately 50% of the variance for each hazard, and the remaining factors accounted for approximately 10% of the variance. Solutions were examined using oblimin rotations of the factor loading matrix, as the ten Dread items are considered to measure a single construct and a high correlation of factors was expected (Coakes et al., 2010, p. 142). A summary table of factor loadings $>.75$ was constructed for the neutral condition. The intention of this

summary was to draw attention to the Dread items which explained the greatest amount of the variance observed in the extracted primary factors (table 5.5).

Table 5.5

Primary Neutral explanatory factor loadings for Dread items by hazard

Neutral Condition Hazard	Dread Item	Factor Loading	Communality
Aspirin	*Global Catastrophic*	.87	.73
	Catastrophic	.87	.72
Vaccines	*Global Catastrophic*	.83	.65
	Consequences Fatal	.79	.72
	Catastrophic	.78	.65
Smoking*	*Global Catastrophic*	.79	.78
Fossil Fuels	*Catastrophic*	.86	.75
	Consequences Fatal	.83	.76
	Future Generations	.78	.65
Uranium Mining	*Catastrophic*	.83	.68
	Risk Increasing	.80	.69
	Not Easily Reduced	.79	.62
Nuclear Reactor Accidents*	*Catastrophic*	.82	.69
	Global Catastrophic	.76	.54

Note. Factor loadings < .75 are suppressed
* no rotation

Overall, the analysis of the primary factor indicated that of the ten Dread factor items used, the items Global Catastrophic and Catastrophic explained the greatest variance in neutral risk perceptions of the six hazards in the primary factors.

Further statistical Factor Analysis was then performed on each of the ten Dread factor items for each of the six hazards in the Affective condition. In testing the assumptions of the Factor Analysis for each hazard, all ten Dread items correlated at least .3 with another item, suggesting sound factorability.

The Kaiser-Meyer-Olkin measure of sampling adequacy was >.6, and Bartlett's test of sphericity was significant for Aspirin (χ^2 (45)=523.27, $p<.05$), vaccines, (χ^2 (45)=438.81, $p<.05$), smoking, (χ^2 (45)=263.81, $p<.05$), fossil fuels, (χ^2 (45)=300.05, $p<.05$), uranium mining (χ^2 (45)=333.71, $p<.05$), and nuclear reactor accidents (χ^2 (45)=283.41, $p<.05$).

The diagonals of the anti-image correlation matrix were almost all over .5, supporting the inclusion of each of the ten Dread items in the Factor Analysis, and the communalities were almost entirely above .3. Supported by these overall indicators, a principle components Factor Analysis was employed using oblimin rotations of the factor loading matrix, to examine all ten Affective Dread items for each hazard. A summary table of the factor loadings >.75 was constructed in order to highlight those Dread items with the greatest potential for driving perceptions of risk for the Affective condition (table 5.6).

Table 5.6

Primary Affective explanatory factor loadings for Dread items by hazard

Affective Condition Hazard	Dread Item	Factor Loading	Communality
Aspirin	*Dread*	.93	.81
	Catastrophic	.82	.83
Vaccines	*Catastrophic*	.84	.77
	Dread	.83	.76
Smoking	*Consequences Fatal*	.82	.63
	Risk Increasing	.80	.59
Fossil Fuels	*Catastrophic*	.82	.77
	Global Catastrophic	.78	.69
Uranium Mining	*Consequences Fatal*	.92	.78
	Dread	.92	.76
	Catastrophic	.82	.67
Nuclear Reactor Accidents	*Catastrophic*	.87	.78
	Dread	.82	.58
	Consequences Fatal	.81	.64

Note. Factor loadings < .75 are suppressed

Overall, these analyses of the primary Affective factors indicated that the items Catastrophic and Consequences Fatal explained the highest percentage of the variance in Affective risk perceptions of five of the six hazards in the primary factors, with the Dread item holding explanatory power in the two lowest and highest Dread risk spectrum hazards. This indicated that Affect had some association with the Dread item, however, severe consequences still dominated the factor.

Upon completion of the initial exploratory Factor Analysis of the Dread items for each hazard in the neutral and Affective conditions, a Factor Analysis was performed as an exploratory data reduction technique to determine whether the mean of the ten Dread factor items across the six hazards were demonstrating related constructs. This Analysis would inform the study of which Dread factor items the data suggested were most likely responsible for driving overall perceptions of risk across the Dread spectrum in the neutral and Affective conditions.

The individual Dread item scores were first averaged across the six hazards for the neutral and the Affective Psychometric data. The factorability of the ten mean Dread items for the neutral condition was examined. All ten Dread items correlated at least .3 with another item, indicating sound factorability, and the diagonals of the anti-image correlation matrix were all >.5, supporting the inclusion of all ten Dread items in the Factor Analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was >.6, and Bartlett's test of sphericity was significant for (χ^2 (45)=374.42, $p<.05$). A factor scree plot was created to ascertain the number of factors to be extracted using Kaiser's criterion which asserts that factors should be extracted until their eigenvalues fall below 1 (Bahr, 1999) (figure 5.6).

Figure 5.6.   Neutral scree plot of eigenvalues with Kaiser's Criterion of > 1.

The Factor Analysis resulted in the extraction of three neutral factors. The initial eigenvalues indicated that the first factor explained 45% of the variance, the second factor accounted for 12%, and the third factor explained 10% of the variance. Solutions were examined using oblimin rotations of the factor loading matrix. A summary table of the factor loadings was then constructed for the neutral condition (table 5.7).

Table 5.7

All neutral explanatory factor loadings for Dread items by hazard

Dread Item	Factor 1 Loading	Factor 2 Loading	Factor 3 Loading	Communality
Catastrophic	.82			.65
Risk Increasing	.78			.61
Global Catastrophic	.76			.63
Not Easily Reduced	.75		.44	.58
Consequences Fatal	.71			.57
Future Generations	.7			.52
Dread	.59			.41
Voluntary	.34			.17
Control	.46	.69		.37
Equity		.34		.27

The results showed that all items had primary loadings over .5, with the exception of Voluntary and Control. The results indicated that items making up the theorised 'severity of consequence' factor (see Chapter 4, section 4.4) explained a greater amount of variance in the neutral Dread risk perceptions of the six hazards than did the 'emotional' (Dread) item, or Voluntary, Control, or Equity items. The communalities revealed the proportion of variation in each Dread item that was explained by the three factors. The results again indicated that items making up the 'severity of consequence' factor explained a greater proportion of the variation than did the 'emotional' (Dread) item, or Voluntary, Control, or Equity items.

Overall, the analyses of the primary factor indicated that of the ten Dread factor items, Catastrophic, Risk Increasing, Global Catastrophic, Not Easily Reduced, Consequences Fatal and Future Generations met the internal consistency criterion of a factor loading >.7 (Salkind, 2006, p. 58). This indicated that these were the Psychometric Dread risk characteristics that were driving perceptions of risk in the neutral condition. The second

and third factors failed to meet this criterion, or the criteria for retaining factors proposed by O'Rourke, Hatcher and Stepanski (2005, pp. 449-454) where, in addition to having an eigenvalue >1 and accounting for more than 10% of the variance, a minimum of three items are required to establish a factor.

The factorability of the ten Dread items for the Affective condition was examined. All ten Dread items correlated at least .3 with another item, indicating sound factorability and the diagonals of the anti-image correlation matrix were all >.5, supporting the inclusion of all ten Dread items in the Factor Analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was >.6, and Bartlett's test of sphericity was significant for (χ^2 (45)=374.42, $p<.05$). A factor scree plot was created to ascertain the number of factors to be extracted using Kaiser's criterion which asserts that factors should be extracted until their eigenvalues fall below 1 (Bahr, 1999) (figure 5.7).

Figure 5.7.   Affective scree plot of eigenvalues with Kaiser's Criterion of > 1.

A Factor Analysis using oblimin rotations resulted in the extraction of two Affective factors. The initial eigenvalues indicated that the first factor explained 55% of the variance in Affective risk perceptions, and the second factor accounted for 12%. A summary table of the Affective factor loadings was constructed (table 5.8).

Table 5.8

All Affective explanatory factor loadings for Dread items by hazard

Dread Item	Factor 1 Loading	Factor 2 Loading	Communality
Catastrophic	.89		.8
Consequences Fatal	.85		.72
Not Easily Reduced	.81		.63
Global Catastrophic	.77		.67
Dread	.72		.59
Risk Increasing	.71		.51
Future Generations	.71	.44	.59
Control	.65	-.36	.51
Voluntary	.48	.45	.33
Equity	.45		.32

The analysis revealed that the items making up factor one with loadings >.7 were identical to those items identified in the neutral Factor Analysis, but with the addition of the Dread item. The analysis also showed that only the items Catastrophic and Consequences Fatal had communalities explaining more than 70% of the proportion of variation.

Factor one and two met O'Rourke, Hatcher and Stepanski's (2005, pp. 449-454) criteria, where the factor must have eigenvalues greater than one for each item, account for more than 10% of the variance, and contain a minimum of three items. The analyses of the

primary factor indicated that of the ten Dread factor items, seven items met the internal consistency criterion of a factor loading >.7 (Salkind, 2006, p. 58). These were Catastrophic, Consequences Fatal, Not Easily Reduced, Global Catastrophic, Dread, Risk Increasing and Future Generations. This indicated that these were the primary Psychometric Dread risk items that were driving perceptions of risk in the Affective condition.

In order to create predictor variables for use in the Phase Two analysis, the primary neutral and Affective factors extracted in the Factor Analysis were labeled. Using Neill's (1994) proposed method for labeling factors, the top one or two items were used to form a factor label. Factors two and three were disregarded, given their failure to achieve the criterion proposed by O'Rourke, Hatcher and Stepanski (2005, pp. 449-454). The items with factor loadings of >.7 were included in a factor which was labeled *Neutral Severity of Consequences*.

The label was given due to the factor's inclusion of the same items theorised in the 'severity of consequences' factor from the Dread split analysis. Items with factor loadings of >.7 in the Affective condition were grouped as a factor and labeled *Dread Severity of Consequences*. The composition of the Affective factor was identical to the *Neutral Severity of Consequences* factor, with the exception of the inclusion of the *Dread* item in the Affective version. The items in factor two did not meet the criterion of achieving factor loadings in excess of .7, and this factor was discarded.

Finally, composite scales that balanced the Psychometric items appropriately according to their influence on risk perceptions were created. Unit-weighted z-scores of the *Dread Severity of Consequences* and *Neutral Severity of Consequences* factors were used to from stable measures of the underlying items. This provided a linear composite of the component variables, and resulted in weighted neutral and Affective scales, where items with larger standard deviations had greater weighting. These composite scales were used

in the Phase Two data analysis as predictor variables for the multiple regression analysis to indicate the degree of association between Psychometric Dread risk and risk consequence estimations.

5.5 Reliability and Validity

A reliability analysis was conducted using Cronbach's Alpha Coefficient, a statistical measure which, according to Gliem and Gliem (2003), provides "a unique estimate of the reliability of a given test" (p. 84). Reliability may be defined as "dependability, consistency, and replicability over time, over instruments, and over groups of respondents" (Cohen et al., 2007, p. 146). The original Psychometric ten item Dread scale was found to be highly reliable in the neutral condition (α=.85) and in the Affective condition (α=.89). The reliability of the ten item Dread scale for each of the six hazards was then examined, and the results again indicated that the scales were highly reliable in both the neutral and Affective conditions (α >.7) (table 5.9).

Table 5.9

Cronbach's Alpha Coefficient for neutral and Affective Dread

Hazard	Neutral scale α	Affective scale α
Aspirin	.88	.87
Vaccines	.78	.84
Smoking	.73	.74
Fossil Fuels	.79	.76
Uranium Mining	.78	.78
Nuclear Reactor Accidents	.81	.79

Validity may be defined as the careful use of sampling, instrumentation and statistical analysis of the data (Cohen et al., 2007), providing evidence that it is the measured variables that are contributing to significant results and not extraneous variables (Graziano & Raulin, 2004). The Psychometric research instrument used in Phase One is

widely regarded as a robust and valid measure of perceived risk (Slovic, 1987), and the ten Dread factor items used in Phase One are related to the defined theory and concepts of the Psychometric Paradigm. This approach provided the study with construct validity. All 10 of Slovic's (1987) Dread factor items were included in the research instruments, supporting translational content validity.

Comparison of the multidimensional scaling results with Slovic's (1987) work also provided a measure of external validity. When the Phase One spatial maps were compared with Slovic's (1987, p. 282) findings, each of the six hazards were located in remarkably similar locations, supporting confidence in the external validity of the Multidimensional Scaling Analysis results and the integrity of the data. In terms of the subjective assessment that is face validity however, the Phase One results suggested that the Dread risk factor overall may not be a reliable measure of Affective reactions to risk, as is suggested in the literature (Finucane, Alhakami, Slovic, & Johnson, 2000; Loewenstein, Weber, Hsee, & Welch, 2001; Peters & Slovic, 1996; Slovic, Finucane, Peters, & MacGregor, 2007; Visschers & Siegrist, 2008), but Affect may be associated with some characteristics of the factor.

5.6 Phase One Limitations and Improvements

Several limitations of the study were identified in Phase One. The issue of detecting respondents who had selected their answers via random selection on the Likert scale was identified as a limitation of the Phase One methodology. It was conceived that an improvement to the methodology would be to include 'integrity' questions in the body of the survey, where only one answer is correct (for example, by asking how many days are in one week?). Respondents who incorrectly answered an integrity question would be eliminated from the data set. Another issue was that although it was assumed that the Affective wording would be sufficient to induce Affect, the lack of any evidence to confirm that Affect had actually been manipulated was also identified as a limitation.

The results of the Phase One analysis indicated that Affect was of minor importance to overall Dread risk perceptions of the six hazards. However, the Phase One methodology offered no confirmation that the Affective survey had elicited more Affect than the neutral survey. In order to improve upon this limitation, a method of confirming Affective manipulation was required. It was conceived that a solution to this issue my lie in the inverse relationship between risk and benefit observed in risk perception research (Alhakami & Slovic, 2006; Finucane et al., 2000; Gardner & Gould, 1989; Gregory & Mendelsohn, 1993).

The research suggests that the inverse relationship of perception of risk and benefit may be explained by way of the influence of Affect on risk judgements. This view is supported by the work of Finucane et al. (2000), who suggested that "perceived risk and benefit are linked via some sort of Affective commonality" (p. 14). It was conceived that by increasing the likelihood that Affect would play a role in the responses of participants in the Affective cohort via the use of Affective wording and framing, a greater inverse risk-benefit association would be observed.

This would provide the study with an indicator that a greater level of Affect had been elicited in the Affective cohort than the neutral cohort. It was decided therefore, to include questions relating to the perceived benefit and harm of each hazard in Phase Three of the study. If an increase in perceived benefit and a decrease in perceived harm was observed in the Affective cohort compared with the neutral cohort, this would provide evidence that greater Affect had been elicited in the Affective condition and therefore support any conclusions made regarding the role of Affect.

5.7 Conclusion

Phase One of the study took the shape of a between-subjects design, which consisted of neutral-worded and Affective-worded surveys which focused on the Psychometric Dread risk factor (Slovic, 1987). The surveys centered around six different hazards which were located across the Dread risk spectrum, ranging from low Dread to high Dread. Two independent cohorts of respondents were surveyed (N=200). The first cohort completed an Affective-worded Psychometric risk perception instrument, while the second cohort completed the neutral-worded version of the same instrument. Responses most closely representing respondents' risk judgements were recorded on a seven-point Likert Scale.

Analysis of the data collected during Phase One required that several statistical measures be utilised to describe the data, compare the groups of respondents, and determine the impact of Affect on risk perceptions and Dread risk characteristics. The statistical tests used included descriptive analysis, Independent Samples t-tests, Multidimensional Scaling, Factor Analysis, and Cronbach's Alpha Coefficient.

The overall mean of the neutral Psychometric Dread risk scale was calculated to be M=4.49 (SD=1.66). The Affective instrument had a mean of M=4.43 (SD= 1.86). Initially, this result appeared to indicate that the Affective research instrument had not elicited more Dread as one would expect, but rather revealed a lower mean Dread response. When the mean Dread risk factor was examined for each hazard, the results indicated that the Affective responses had lower mean ratings than the neutral responses for all hazards except uranium mining and nuclear reactor accidents. However, the differences between the mean Affective and neutral Dread risk responses for each hazard were not found to be statistically significant when examined using the Independent Samples t-test. Comparison of the neutral and Affective spatial maps created in the Phase One Multidimensional Scaling Analysis also indicated that the Affective wording appeared to have no association with the Dread spectrum spatial locations of the hazards.

When the means and standard deviations were calculated for each hazard individually, it was found that the item Consequences Fatal had the greatest mean for the majority of hazards in the neutral condition. This indicated that when Affect was not being manipulated, it was the fatal consequences of risks that generally elicited the most concern. In the Affective condition, Aspirin and fossil fuel hazards were associated with increasing risk, while vaccination was not seen as an equitable hazard. The consequences smoking hazard and nuclear reactor accidents were perceived as being Fatal, and concern for Future Generations in regards to uranium mining was evident.

The Factor Analysis suggested that a distinct factor driven largely by severity of consequence characteristics was underlying the perception of risk for both the Affective and neutral conditions. As per the conceived 'Dread factor split' (see Chapter 4), this indicated that severe consequence items formed the primary construct responsible for the risk perception of the six hazards. The Affective factor revealed the same items as a related construct, but with some influence from the Dread (or 'emotional') item. The results of the Independent Samples *t*-test on the individual Dread risk factor items also indicated that Affect had some impact on particular risk characteristics associated with risk consequence in some hazards. The Independent Samples *t*-test also suggested statistically significant differences between the neutral and Affective Consequences Fatal and Catastrophic items for three of the six hazards.

Taken together, these results suggested that Dread as a Psychometric item was associated with, Affect, a finding supported by previous Psychometric risk studies (see Finucane et al., 2000; Loewenstein et al., 2001; Peters & Slovic, 1996; Slovic et al., 2007; Visschers & Siegrist, 2008). However, severity of risk consequence items dominated the Dread risk factor overall. The results also suggested that the Affective association with Dread risk characteristics was minor in the overall Affective perceptions of the hazards, a finding consistent with Sjöberg's (2006), assertion that "when tested empirically, emotions by themselves play a minor role." (p. 106).

In summary, the Phase One results suggested that although the Dread item appeared to be associated with Affect, there was no significant difference between the responses of the two groups. There was some indication that the Affect Heuristic may influence the perception particular risks in very specific ways associated with severe and fatal consequences, however the emotional aspect of the Dread risk factor did not appear to be influencing risk perceptions to the degree suggested in the literature. The next Phase of the study involved assessing the impact of Affect on estimations of risk consequence and the relationship of these two concepts to Dread risk. Although the findings of the first Phase appeared to indicate that Dread risk is primarily a measure of perceptions of severity of risk consequence, the aim of the second Phase was to assess whether this finding would remain consistent with the Phase Two data.

CHAPTER 6: PHASE TWO

6.1 Introduction

This chapter details the design, procedure and data analysis of Phase Two of the study. This Phase involved participants completing either a neutral-worded or an Affective-worded Risk Consequence Task in a between-subjects design. The results of the various statistical measures are presented and the identified limitations are also outlined together with improvements for the third Phase of the study. The chapter concludes with a summary of the Phase Two design, implementation, and outcomes.

6.2 Phase Two Sample

The same participants sourced via Amazon Mechanical Turk who completed the Phase One neutral and Affective research instruments also completed the Phase Two instruments (N=200). Participants were sourced via Amazon Mechanical Turk from eleven countries and ranged in age from 18 to 67 years old. The respondents who completed the neutral Phase One instrument also completed the neutral Phase Two instrument. Likewise, the Phase One and Two Affective instruments were completed by the same second group (table 6.1).

Table 6.1

Summary of research instrument distribution.

	Cohort One	Cohort Two
Phase 1 Affective worded Psychometric instrument	X	
Phase 1 Neutral worded Psychometric instrument		X
Phase 2 Affective Worded Risk Assessment Task	X	
Phase 2 Neutral Worded Risk Assessment Task		X

N=200

6.3 Phase Two Design

As with the first Phase of the study, Phase Two maintained the tradition of Psychometric risk research by employing a positivist research approach together with a quantitative methodology. Phase Two was executed as a between-subjects study involving a neutral-worded and an Affective-worded Risk Consequence Task (Appendix B). This Phase involved respondents estimating the seriousness of the risks associated with the six hazards used in Phase One.

The research instruments were again created using the Qualtrics online survey software, with participants being directed to the survey via the Amazon Mechanical Turk service. The collated data was cleansed and then analysed using several statistical measures. These included descriptive statistics, Independent Samples t-tests, multiple regression analysis and Cronbach's Alpha.

6.3.1 Phase Two Research Instruments

The between-subjects design of the Phase Two required that two research instruments be developed. These consisted of a neutral-worded and an Affective-worded simple Risk Consequence Task survey (Appendix B) based on words selected from the Affective Norms for English Words (ANEW) list (Bradley & Lang, 2010). Using the emotional valence ratings of the ANEW list, wording was chosen for the neutral and Affective risk consequence instruments to be either emotionally provocative or emotionally neutral.

The instruments used a seven-point Likert scale with the term 'serious' as the basis for the category labels. The term 'serious' has a mean ANEW valence of 5.08 (Bradley & Lang, 2010) making it a word of relatively neutral emotional arousal. Such neutrality deemed necessary to avoid any potential influence of the category label wording on respondents' estimations of risk consequences, and to ensure consistency. The Risk

Consequence Task required respondents to estimate the severity of the consequences of each of the six hazards used in the Phase One.

6.3.2 Phase Two Procedure

The procedure for Phase Two was modeled closely on the procedure for Phase One of the study. Using a between-subjects design, two cohorts of Phase Two respondents were surveyed (N=200). The first cohort (n=100) completed the neutral version of a simple risk consequence task, while the second cohort (n=100) completed the Affective-worded task. Responses most closely representing respondents' consequence estimations were recorded on the seven-point Likert scale.

6.4 Phase Two Data Analysis

The initial stages of the second Phase data analysis utilised a similar range of statistical tests to those employed in Phase One. These tests included descriptive statistics, Independent Samples t-tests and multiple regression analysis on the neutral and Affective versions of the consequence estimation task data.

6.4.1 Descriptive Statistics

Once the data had been cleansed, the distribution of the Phase Two data sets were tested for normality using the Kolmogorov-Smirnov statistic with a Lilliefors significance level, and through inspection of the normality plots and histograms (Coakes, Steed, & Ong, 2010), determining the type and power of the statistical tests that could be applied. These tests indicated that both neutral and Affective data sets were normally distributed ($p>$ .05), providing justification for the use of parametric statistical tests. Measures of central tendency were first calculated via the mean, and the standard deviation was used to test for variability. The tests were performed for each of the six hazards, for both the neutral data and the Affective data (table 6.2).

Table 6.2

Phase Two descriptive statistics calculated for each hazard

	Neutral		Affective	
	Mean	**SD**	**Mean**	**SD**
Aspirin	4.04	1.74	4.16	1.86
Vaccines	4.24	1.51	3.98	1.73
Smoking	5.41	1.31	5.55	1.23
Fossil Fuels	5.0	1.21	5.23	1.45
Uranium Mining	5.33	1.27	5.66	1.42
Nuclear Accidents	5.91	1.1	6.12	1.19

The mean for each hazard in the neutral condition indicated that the perception of the severity of risk consequence increased in general agreement with the locations of the six hazards in the Dread spectrum, with the exception of the smoking hazard. Neutral perceptions of the severity of risk consequence ranged from Aspirin as the lowest severity to nuclear reactor accidents as having the most severe consequences. The standard deviation was used to measure "the typical difference between each value and the mean" (Burdess, 1994, p. 50), indicating the amount of variation in opinion for each hazard. Variations in the perception of neutral risk consequence were greatest for Aspirin, but became more uniform as the perception of the severity of risk consequence increased. Nuclear reactor accidents presented the most uniform neutral perception of risk consequence.

The mean for each hazard in the Affective condition indicated that the perception of the severity of risk consequence also increased in general agreement with the six Dread spectrum locations. Although vaccines rather than Aspirin was the hazard perceived as least severe, smoking was again perceived as having the most severe consequences. Affective perceptions of the severity of risk consequence ranged from vaccines as the lowest severity to nuclear reactor accidents as the most severe. The data from the

Affectively worded risk consequence task showed that the perception of the severity of consequence had increased in the Affective condition in all hazards, with the exception of vaccines.

The standard deviation was also used to measure the amount of variation in opinion for each hazard for the Affective cohort. As with the neutral survey responses, variation in the perception of Affective risk consequence was greatest for Aspirin, but most uniform for nuclear reactor accidents. The Affective perception of risk consequence was consistently more varied for each hazard than the neutral perception, with the exception of the smoking hazard.

6.4.2 Independent Samples *t*-test

In order to determine whether the difference between the mean neutral and mean Affective responses to each Risk Consequence Task was significant, an Independent Samples *t*-test was used. The results of the Levene's test for equality of variances indicated that for each hazard, the *t*-test should be interpreted with equal variances assumed ($p>0.05$), with the exception of fossil fuels ($p=.049$), where equal variances would not be assumed. The results of the two-tailed *t*-test indicated that there were no significant differences in the mean perceptions of the severity of risk consequence between the neutral and Affectively influenced cohorts for any of the hazards ($p > .05$).

6.4.3 Multiple Regression Analysis

In order to ascertain the degree of association between the ten Dread factor items and the neutral and Affective responses to the Risk Consequence Task, a measure of multiple correlation was obtained using the standard multiple regression analysis model. The analysis would indicate how much variability in estimations of risk consequence could be accounted for by Psychometric Dread. The criterion or dependent variable describing the subject of measurement for this multiple regression analysis was the means of the neutral

and Affective risk consequence estimations. Responses to the Psychometric Dread risk items were assessed against the risk consequence estimations for each hazard.

The results of the multiple regression analysis for the neutral cohort indicated that Consequences Fatal was the Dread risk characteristic that most significantly predicted the neutral consequence estimations of Aspirin, vaccines, smoking, fossil fuels and uranium mining. Catastrophic was identified as the Dread characteristic that most significantly predicted the neutral risk perceptions of nuclear reactor accidents. However, when Affect was manipulated via the use of Affective wording, Risk Increasing and Catastrophic were the Dread risk characteristics which most significantly predicted perceptions of Aspirin and vaccine risk respectively. For the remaining Dread risk hazards, the analysis indicated that Consequences Fatal most significantly predicted the Affective risk perceptions. Overall, this result showed that the dominance of severe consequence characteristics in the Dread risk factor was not significantly related to Affect (table 6.3).

Table 6.3

Multiple Regression analysis of Dread and risk consequence

Condition	Hazard	R^2	F	*p*	Dread Item	β	*p*
Neutral	Aspirin	.69	18.31	.01	*Consequences Fatal*	.31	.01
					Voluntary	.24	.01
	Vaccines	.56	11.34	.01	*Consequences Fatal*	.39	.01
					Dread	.23	.01
					Future Generations	.28	.01
	Smoking	.41	5.55	.01	*Consequences Fatal*	.42	.01
					Risk Increasing	.26	.02
	Fossil Fuels	.41	5.43	.01	*Consequences Fatal*	.35	.02
					Not Easily Reduced	.32	.01
					Global Catastrophic	.26	.04
	Uranium Mining	.57	10.36	.01	*Consequences Fatal*	.34	.01
	Nuclear Accidents	.62	12.69	.01	*Catastrophic*	.33	.01
					Future Generations	.29	.01
Affective	Aspirin	.56	9.46	.01	*Risk Increasing*	.19	.04
	Vaccines	.48	6.85	.01	*Catastrophic*	.47	.01
					Not Easily Reduced	-.35	.01
					Voluntary	.25	.01
	Smoking	.53	8.52	.001	*Consequences Fatal*	.48	.01
					Not Easily Reduced	.28	.01
					Control	-.34	.01
	Fossil Fuels	.49	7.18	.01	*Consequences Fatal*	-.26	.04
					Catastrophic	.33	.01
					Future Generations	.23	.05
					Risk Increasing	.46	.01
	Uranium Mining	.4	5.07	.01	*Consequences Fatal*	.32	.04
					Future Generations	.27	.02
	Nuclear Accidents	.62	12.47	.01	*Consequences Fatal*	.25	.01
					Future Generations	.34	.01

The next analysis was conducted using the Affective and neutral composite scales created in the Phase One factor analysis as predictor variables, while the neutral and Affective risk consequence estimation data were used as dependent variables. Neutral estimations of risk consequence were analysed via the neutral composite factor and the mean Dread

risk factor, while Affective estimations of risk consequence were analysed using the Affective equivalents. For comparison, the means of the neutral and Affective Psychometric ten item Dread risk responses from Phase One were also examined against the neutral and Affective responses to the risk consequence task (table 6.4).

Table 6.4

Multiple Regression analysis of Composite Scales and consequence

	Neutral Severity of Risk Consequence Composite	Neutral Psychometric 10 item Dread risk Factor	Dread Severity of Risk Consequence Composite	Affective Psychometric 10 item Dread risk Factor
R^2	.54	.42	.5	.47
F	103.49	63.82	84.89	74.85
p	.01	.01	.01	.01
β	.74	.65	.71	.69
p	.01	.01	.01	.01

The results of the analysis indicated that 54% of the variance in the surveyed risk perceptions was explained by the weighted composite Neutral Severity of Consequences factor extracted in Phase One (R^2=.54, $F(1,88)$=103.49, $p<.05$). The results also indicated that this factor significantly predicted perceptions of the severity of risk consequences (β=.74, $p<.05$).

The explanatory power of the Neutral Severity of Consequences factor was also shown to be greater than the explanatory power of the neutral version of the original ten item Psychometric Dread risk factor. The original neutral Dread factor explained only 42% of the variance in perception of risk consequence (R^2=.42, $F(1,88)$=63.82, $p<.05$) and did not predict perceptions of the severity of risk consequences (β=.65, $p<.05$) as well as the composite Neutral Severity of Consequences factor.

The results of the multiple regression analysis on the Affective composite scale indicated that 50% of the variance in the surveyed risk perceptions was explained by the Dread Severity of Consequences factor (R^2=.5, F(1,84)=84.89, p<.05) when the factor items had been combined into a weighted composite scale. The factor also significantly predicted Affective perceptions of the severity of risk consequences (β=.71, p<.05). As with the neutral factors, the Affective-worded Psychometric Dread risk factor was shown to explain less of the variance in the Affective perceptions of risk consequences than did the Dread Severity of Consequences composite scale (R^2 =.47, F(1,84)=74.85, p<.05). The Affective-worded version of the original Dread factor explained 47% of the variance in Affective perceptions of risk consequence, and did not predict Affective perceptions of the severity of risk consequences as well as the Neutral Severity of Consequences composite scale (β=.69, p<.05).

The next multiple regression analysis focused on the two factors (rather than the composite scales) derived from the factor analysis in Phase One (see Chapter 5, section 5.6.4). Once again, analysis was conducted for the neutral responses and Affective responses separately. For both the neutral and Affective cohorts, mean estimations of risk consequence were used as the dependent variables, together with the Neutral Severity of Consequences and Dread Severity of Consequences factors extracted in the Phase One factor analysis as predictor variables (table 6.5).

Table 6.5

Multiple Regression analysis of Consequence factors and consequence

	Neutral Severity of Risk Consequence Factor	Neutral Psychometric 10 item Dread risk Factor	Dread Severity of Risk Consequence Factor	Affective Psychometric 10 item Dread risk Factor
R^2	.53	.42	.49	.47
F	97.57	63.82	79.54	74.85
p	.01	.01	.01	.01
β	.73	.65	.7	.69
p	.01	.01	.01	.01

The results indicated that the Neutral Severity of Risk Consequence factor and the Dread Severity of Risk Consequence factor explained only marginally less of the variance in perceptions of risk consequences than did the weighted composite scales derived from the two factors. The Neutral Severity of Risk Consequence factor explained 53% of the variability (R^2=.53, F(1,88)=97.57, *p*<.05), and significantly predicted perceptions of risk consequences (β=.73, *p*<.05). Similarly, in the Affective condition, the Dread Severity of Risk Consequence factor explained 49% of the variance (R^2=.49, F(1,84)=79.54, *p*<.05), and significantly predicted Affective perceptions of risk consequences (β=.7, *p*<.05).

As with the results of the multiple regression analysis on the composite scales, this analysis indicated that the Neutral Severity of Risk Consequence and the Dread Severity of Risk Consequence factors were better predictors, and explained a greater amount of the variance than either the neutral or the Affective versions of the ten item Psychometric Dread risk factor. The multiple regression analysis between the Phase One and Phase Two data also indicated that the Dread Severity of Consequences factor explained less of the variance in Affective risk perceptions than the Neutral Severity of Consequences factor. The major difference in the composition of the two extracted factors was the inclusion of the Dread item in the Dread Severity of Consequences factor.

Overall, the results indicated that the dominance of severity of risk consequence items in the Dread factor meant that this dimension was a better predictor of consequences for the neutral and Affective cohorts, and that inclusion of the Dread item reduced predictive power. These results support the conception of Dread risk as severe consequences, rather than a factor strongly associated with Affect.

6.5 Reliability and Validity

The Affective and neutral Phase Two data was examined using Cronbach's Alpha Coefficient in order to determine the level of reliability of the risk estimation scales, yielding an alpha coefficient between 0 (unreliable) and 1 (perfectly reliable) (Cohen, Manion, & Morrison, 2007). Alpha Coefficients were calculated for both the Affective and neutral Risk estimation scales. The results indicated an acceptable level of reliability for both the neutral (α=.62) and the Affective scales (α=.68), although the scales consisted on only 6 items each, which is likely to have reduced the Alpha.

6.6 Phase Two Limitations and Improvements

A major limitation for the first two Phases of the study was the low statistical power (P=.2) based on the sample size used. In order to detect any significant influence of Affect on estimations of risk consequences, a larger sample would be required for Phase Three. The Psychometric paradigm places few demographic restrictions on the perception of risk, creating difficulties in establishing an appropriate and representative sample size. This limitation was overcome by establishing the sample size for Phase Three using a post-hoc statistical Power Analysis on the data from Phases One and Two. Power Analysis is a statistical method that determines the sample size required for a significant chance of detecting the minimum value of interest (Kraemer & Thiemann, 1987).

A two-tailed post-hoc Power Analysis was conducted using G*Power statistical software (Faul, Erdfelder, Lang, & Buchner, 2007) to determine the achieved power in Phases One

and Two. An effect size was calculated based on the difference between neutral and Affective responses found in Phases One and Two. The resulting effect sizes were averaged for a total effect size (ρ=0.127). Based on this measurement, the achieved power for Phases One and Two was P=.25. This result indicated that the sample size needed to be increased for Phase Three in order to detect a statistically significant result. A two-tailed a priori Power Analysis was then conducted to compute the required sample size for Phase Three, based on the calculated effect size. As per convention, statistical Power was set at 80% (Araujo & Froyland, 2007) and Alpha set to .05. The results indicated that a sample size of n=481 for each of the four groups would be required to achieve 80% statistical Power in Phase Three, yielding a total sample size of N=1924.

It was also determined that the lack of any significant difference indicated by the *t*-test between the neutral and Affective estimations of risk consequence in Phase Two could conceivably be a result of a low statistical power. This issue would be rectified in Phase Three using the Power Analysis calculations for an increased sample size. However, the result of no significant differences between neutral and Affective estimations of risk consequence also raised the question of whether or not it could be argued that Affect had indeed been manipulated at all. Therefore additional questions relating to the harm and benefit of each hazard would be included in the Risk Consequence Task for Phase Three, together with 'framing' statements to increase the likelihood that Affect would play a role in the responses of participants. Using this improved methodology, it was anticipated that a greater inverse risk-benefit association would be observed in the Affective condition, indicating that a greater level of Affect had been elicited in the Affective cohort than the neutral cohort.

Another limitation that was identified was the possibility of linguistic variations in the way respondents ascribed meaning to the terminology used in the surveys. Given that the surveys were intended to manipulate Affective reactions to some degree, the large number of participants sourced from countries with a primary language other than

English raised some concerns. To ascertain whether linguistic variations had any impact on the responses, it was decided that an independent samples *t*-test would be performed in Phase Three between the neutral and Affective responses of native-English speakers and non-native English speakers.

6.7 Conclusion

Phase Two was executed as a between-subjects study involving a neutral-worded and an Affective-worded risk consequence estimation survey where respondents (N=200) estimated the seriousness of the risks associated with the six hazards used in Phase One. The initial descriptive statistics from the Phase Two data indicated that variations in the perception of neutral and Affective risk consequence were greatest at the low end of the Dread Risk spectrum, but became more uniform as the hazard locations (and severity of risk consequence) increased.

Mean Affective risk consequence estimations were generally ranked higher than neutral risk consequence estimations, although the difference was not found to be statistically significant when examined using an independent samples *t*-test. This finding supported the Phase One *t*-test results, which also indicated no significant difference between neutral and Affective risk perceptions.

The results of the multiple regression analysis indicated that the severity of risk consequence items Consequences Fatal and Catastrophic most significantly predicted neutral risk perceptions. When Affect was manipulated, Risk Increasing and Catastrophic most significantly predicted perceptions at the lower end of the Dread risk spectrum. However, for the remaining medium to high Dread risk hazards, the analysis indicated that Consequences Fatal most significantly predicted the Affective risk perceptions.

The analysis conducted using the Affective and neutral composite scales and factors from Phase One indicated that Neutral Severity of Consequences explained the greatest amount of the variance in the surveyed risk perceptions, and that the Neutral Severity of Consequences factor significantly predicted risk consequence estimations. The original Psychometric Dread risk factor was shown to explain less of the variance in both neutral and Affective perceptions of risk consequences than did the Severity of Consequences factors and composite scales formed in Phase One. These results may be taken to suggest that risk characteristics relating to severity of consequences were generally better predictors of perceived risk in both the Affective and neutral conditions than the original Dread risk factor. However, the delineation between risk characteristics was unclear, and the association with Affect was difficult to assess. In considering these results, it was decided that multiple regression analysis did not provide a great deal of additional value in responding to the Research Questions, and this statistical test was not used in Phase Three.

Overall, the results suggested that although manipulation of Affect through emotive wording may have induced minor modifications to risk consequence estimations, Dread risk characteristics relating to the severity of risk consequence still held the most explanatory power for consequence estimations, whether Affect was manipulated or not.

In order to address the limitation of poor statistical Power, an increased sample size would be introduced in Phase Three to increase the statistical Power of the tests, and raise the probability of detecting any significant differences between neutral and Affective estimations of risk consequence. The inclusion of questions relating estimations of harm and benefit in the Phase Three risk consequence task would provide confirmation that increased negative Affect was being induced via the risk-benefit relationship.

The next chapter details Phase Three of the study which combined and replicated Phases One and Two with improvements to the methodology. As the findings of the first and

second Phases of the study appeared to be in agreement in indicating that Dread risk is primarily a measure of severity of risk consequence, the aim of the Third Phase was to determine whether these findings would remain consistent with the more rigorous and robust Phase Three methodology.

CHAPTER 7: PHASE THREE

7.1 Introduction

This chapter details the design, procedure and data analysis of Phase Three of the Study. The third Phase involved participants completing either a neutral-worded or an Affective-worded Psychometric risk survey, as well as a neutral-worded or an Affective-worded risk consequence survey, in a between subjects design. The analysis of various statistical measures are presented, together with an summary of the results. This chapter concludes with a summary of the Phase Three design, implementation, and outcomes.

7.2 Phase Three Sample

Participants for the study were sourced via Amazon Mechanical Turk and attracted respondents from 28 countries, including Canada, India, Egypt, Indonesia, Jamaica, Koli, Romania, Sri Lanka, United Arab Emirates, Argentina, Australia, Ghana, Guadalupe, Mexico, New Zealand, Pakistan, Russia, Germany, Kenya, Macedonia, Panama, Serbia, South Korea, Haiti, Mauritius, Poland, the United Kingdom, and the United States of America. Participants ranged in age from 18 to 71. Based on a two-tailed a-priori Power Analysis which was conducted at the end of Phases One and Two, a sample size of n=481 for each of the four cohorts in Phase Three was required to achieve 80% statistical Power, yielding a total sample size target of N=1924.

7.3 Phase Three Design

The between-subjects design of Phase Three required four research instruments be developed for Phases One and Two. Four different groups of participants completed the four research instruments (N=1638). These consisted of a neutral-worded (n=370) and an Affective-worded (n=401) Psychometric Dread risk survey (Appendix A), as well as a neutral-worded (n=434) and an Affective-worded (n=433) Risk Consequence estimation survey (Appendix B). As with Phase One of the study, the Psychometric risk surveys focused solely on the Dread Risk factor, identified by Slovic (1987).

In addition to estimations of the seriousness of the risk consequences associated with each of the six hazards, the Phase Three Risk Consequence surveys also included questions asking respondents to estimate the harm and benefit of each hazard. In addition, each hazard was introduced with a simple framing statement which highlighted either the negative or positive aspects of each risk. The negative aspects of the six hazards were presented in the Affective version of the Risk Consequence instrument, and the positive aspects were highlighted for the neutrally worded version. The framing statements were included to further elicit an Affective reaction to the six hazards to better assess the role Affect might play in the estimation of risk consequence and its relationship to the concept of Dread.

The analysis of the Psychometric Dread Risk factor largely mirrored the Phase One data analysis, while the analysis of the Phase Three Risk Consequence Task data followed the Phase Two analysis but with the additional examination of estimations of harm and benefit. All four of the surveys were centered around six different hazards which are located across the Dread risk spectrum, ranging from low Dread to high Dread. The locations of these hazards within the Dread spectrum were established via reference to Slovic's (1987) spatial representation of 81 hazards, and formed the basis for both of the Phase Three Psychometric Risk research instruments, and the Phase Three Risk Consequence Task surveys.

7.3.1 Phase Three Research Instruments

The Phase Three Psychometric Risk research instruments utilised the same set of ten Psychometric Dread Risk factor items used in Phase One. The ten Dread Risk questions were then worded around each of the six hazards, resulting in 60 Psychometric Dread Risk questions. As with Phase One of the study, this instrument was then refined into two versions; a neutral-worded version and an Affective-worded version, based on words selected from the Affective Norms for English Words (ANEW) list (Bradley & Lang, 2010). The wording chosen for the Psychometric research instruments was intended to

either elicit negative Affect or to be emotionally neutral, and were selected for their potential impact on perceptions of risk consequences.

To mirror Phase Two of the study, the Phase Three between-subjects design required that two Risk Consequence Task research instruments be developed. These consisted of neutral-worded and Affective-worded simple risk consequence surveys, but differed to the Phase Two surveys, in that questions relating to the harm and benefit for each of the six hazards were also included. The Phase Three Risk Consequence Task instruments were then refined into two versions; a neutral-worded version and an Affective-worded version, based on words selected from the Affective Norms for English Words (ANEW) list (Bradley & Lang, 2010). Using the emotional valence ratings of the ANEW list, wording was chosen for the neutral and Affective Risk Consequence instruments to either elicit negative Affect or to be emotionally neutral

Analysis of the data collected during Phase Three required that several statistical measures be utilised to describe the data, compare the groups of respondents, and determine the impact of Affect on risk perceptions and estimations of risk consequence and harm. The initial stages of the Phase Three data analysis utilised a similar range of statistical tests to those employed in Phases One and Two. These included using descriptive statistics, Independent Samples t-tests, multiple regression analysis, Multidimensional Scaling, and reliability analysis.

Using a between-subjects design, four independent cohorts of Phase Three respondents were surveyed (N=1638). The first cohort completed the Affective-worded Psychometric instrument, while the second cohort completed the neutral worded version of the same instrument. A third and fourth cohort completed the neutral version of a Risk Consequence Task and the Affective-worded task respectively. Participants were again sourced from the Amazon Mechanical Turk service, and were able to complete the research instrument online.

The Phase Three Psychometric Dread risk surveys required respondents to rate their responses to ten Psychometric Dread risk items for six different hazards. As with previous Psychometric risk studies (Fischhoff, Slovic, Litchtenstein, Read, & Combs, 1978; Slovic, 1987; Slovic, Malmfors, Mertz, Neil, & Purchase, 1997; Trumbo, 1999), responses most closely representing respondents' risk judgements were recorded on a seven-point Likert scale. The Phase Three Risk Consequence Task surveys required respondents to rate the seriousness of the consequences and harm of the six hazards, as well as indicating the harm and benefit. Responses most closely representing respondents' consequence, harm, and dread estimations were also recorded on a seven-point Likert scale.

The results of the four completed surveys were then collated and subject to an initial data cleanse. Of the total N=1924 participants surveyed, 286 surveys were discarded based on several factors. Each of the Phase Three research instruments included a 'concentration check' question to eliminate those respondents who were likely to be simply clicking though the questions without reading them. For example, one of the concentration check questions was "How many days in a week?", for which any response other than seven was discarded. Any respondents completing one of the surveys at an unlikely speed were also discarded, as were incomplete surveys and any responses containing only one number (for example, responses where all questions were rated as 7 or as 1) were also eliminated from the data sets.

7.4 Phase Three Data Analysis

Analysis of the data collected during Phase Three required that several statistical measures be utilised to describe the data, compare the groups of respondents, and determine the association of Affect with risk perceptions and estimations of risk consequence and harm. The initial stages of the Phase Three data analysis utilised a similar range of statistical tests to those employed in Phases One and Two. These

included using descriptive statistics, Independent Samples *t*-tests, Multidimensional Scaling, and reliability analysis.

7.4.1 Descriptive Statistics

Once the data had been cleansed, the distribution of all Phase Three data sets were tested for normality using the Kolmogorov-Smirnov statistic with a Lilliefors significance level, and through inspection of the normality plots and histograms (Coakes, Steed, & Ong, 2010, p. 41). This would determine the type and power of the statistical tests that could subsequently be applied. The distribution of the data was calculated via the mean across the six hazards. These tests indicated that all data sets were normally distributed ($p > .05$). Confirmation that the data were normally distributed provided justification for the use of parametric statistical tests, which allow assumptions to be made regarding the wider population from which the samples came, as well as comparisons of sub-populations within the wider population. (Cohen, Manion, & Morrison, 2007, p. 318).

An initial descriptive investigation was then conducted for the Psychometric data for which a neutral cohort (n=370) and an Affective cohort (n=401) of respondents rated their perceptions of risk according to the ten Psychometric Dread risk items for each of the six hazards. Measures of central tendency were calculated via the mean, and the standard deviation was used to test for variability. The mean and standard deviation was calculated for each hazard on all Dread items for the neutral research instrument (table 7.1).

Table 7.1

Neutral descriptive statistics by hazard and Dread item

	Aspirin		Vaccines		Smoking		Fossil Fuels		Uranium Mining		Nuclear Accidents	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Uncontrollable	2.39	1.80	3.22	1.87	2.84	2.07	4.71	1.75	4.81	2.01	5.39	1.82
Dread	2.6	1.78	2.55	1.66	4.51	2.15	3.46	1.82	4.5	1.95	5.0	1.99
Consequences Fatal	3.24	1.72	3.04	1.68	6.04	1.1	3.95	1.77	5.56	1.49	6.14	1.31
Not Equitable	4.05	1.93	4.11	1.93	4.89	1.94	4.06	1.94	4.53	1.92	4.85	2.04
Catastrophic	2.71	1.8	2.9	1.77	4.8	1.88	4.55	1.84	5.36	1.62	6.02	1.43
Future generations	3.18	2.01	3.62	1.96	5.37	1.73	5.44	1.57	5.61	1.39	6.17	1.23
Not easily reduced	2.68	1.86	3.29	1.85	4.02	2.23	4.8	1.59	4.93	1.86	5.62	1.6
Risk increasing	4.04	1.29	3.58	1.77	5.06	1.5	5.11	1.44	4.9	1.39	5.01	1.69
Involuntary	2.49	1.8	3.21	1.92	2.72	1.99	4.92	1.68	4.9	1.88	5.55	1.62
Global Catastrophic	2.46	1.81	3.4	1.86	4.52	1.97	5.45	1.52	5.34	1.53	5.91	1.30

The mean and standard deviation was then calculated for each hazard on all Dread items for the Affective Psychometric Risk research instrument (table 7.2).

Table 7.2

Affective descriptive statistics by hazard and Dread item

	Aspirin		Vaccines		Smoking		Fossil Fuels		Uranium Mining		Nuclear Accidents	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Uncontrollable	2.5	1.91	3.15	1.85	2.98	2.0	4.91	1.8	5.19	1.87	5.61	1.69
Dread	2.45	1.74	2.52	1.66	4.5	2.11	3.36	1.84	4.53	2.01	5.03	1.95
Consequences Fatal	2.93	1.63	2.91	1.68	6.00	1.13	3.89	1.78	5.32	1.65	6.0	1.45
Not Equitable	3.98	1.94	4.84	1.84	4.66	1.87	3.79	1.97	4.41	1.97	4.52	2.01
Catastrophic	2.39	1.78	2.67	1.69	4.8	1.94	4.32	1.82	5.22	1.67	5.96	1.51
Future generations	3.32	1.98	3.8	1.91	5.41	1.63	5.45	1.67	5.68	1.47	6.23	1.20
Not easily reduced	2.7	1.87	3.27	1.73	3.96	2.11	4.89	1.66	4.95	1.86	5.68	1.53
Risk increasing	3.99	1.22	3.7	1.58	4.86	1.59	5.2	1.56	4.82	1.38	4.86	1.76
Involuntary	3.02	1.88	3.54	1.9	3.21	2.06	5.03	1.7	5.41	1.63	5.69	1.53
Global Catastrophic	2.65	1.88	3.58	1.83	4.49	1.82	5.69	1.45	5.12	1.71	5.47	1.57

A summary table of the mean Psychometric Dread Risk perceptions for each hazard was then constructed for comparison with the findings from the Risk Consequence Task (table 7.3).

Table 7.3

Summary of descriptive statistics by hazard and Dread item.

	Neutral		Affective	
	Mean	SD	Mean	SD
Aspirin	2.98	1.78	2.99	1.78
Vaccines	3.29	1.83	3.39	1.76
Smoking	4.47	1.86	4.48	1.82
Fossil Fuels	4.64	1.69	4.65	1.72
Uranium Mining	5.04	1.7	5.06	1.72
Nuclear Accidents	5.56	1.6	5.5	1.62

The results of the descriptive data analysis for the Phase Three neutral Psychometric instrument indicated that concern over the effect of nuclear reactor accidents on future generations elicited the greatest average perception of risk, while the Aspirin hazard was demonstrated to be of least concern, especially in relation to the Psychometric Dread Risk item Uncontrollable. The standard deviation was also calculated for each neutral Dread item in each hazard to determine the amount of variance in the risk perceptions. The hazards demonstrating the greatest variation in risk perceptions was demonstrated to be smoking, especially in the Dread factor items Not Easily Reduced, Dread, and Uncontrollable. The hazards which demonstrated the most uniform perceptions of risk were the Fatal Consequences of smoking, and the effect of nuclear reactor accidents on Future Generations.

The results for the Affective Psychometric instrument indicated that nuclear reactor accidents had the largest means for the majority of the Dread factor items, whereas the Aspirin hazard had the lowest average perception of risk. The standard deviation was also calculated for each Dread item in each hazard for the Affectively worded research instrument, in order to determine the amount of variance in the risk perceptions. The hazard demonstrating the greatest variation in risk perceptions was smoking, largely associated with the Dread factor items Dread, Not Easily Reduced, and Involuntary, while the most uniform perception of risk was found to be associated with Consequences Fatal for the smoking Hazard.

As with the Phase One descriptive data analysis results, the mean Affective and neutral responses were plotted to ascertain the overall shift in the risk perceptions from neutral to Affective for each hazard (figure 7.1).
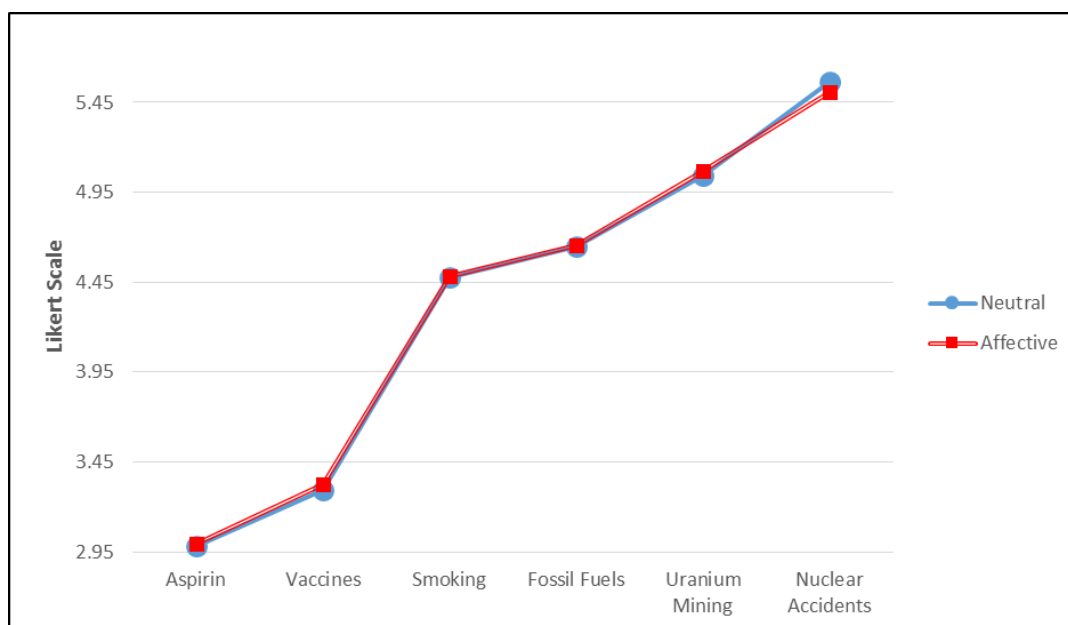
Figure 7.1.   Mean neutral and Affective Psychometric risk perceptions of each hazard.

The results demonstrated little difference between the mean neutral and Affective responses to the Psychometric Dread Risk surveys, with only slightly higher mean Affective risk perceptions for the five lower Dread hazards. However, as with the Phase One results, it was the neutral perceptions of nuclear reactor accidents which were perceived to be slightly higher than the Affective responses.

As with Phase Two, the next stage of data analysis began with initial descriptive statistics of the data for the Risk Consequence Task, for which a neutral cohort (n=434) and an Affective cohort (n=433) of respondents rated their perceptions of the severity of risk consequence, harm and benefit for each of the six hazards. Measures of central tendency were calculated via the mean, and the standard deviation was used to test for variability. The tests were first performed for each of the six hazards for both the neutral and the Affective severity of risk consequence data (table 7.4).

Table 7.4

Summary of descriptive statistics for risk consequence for each hazard.

| | Neutral | | Affective | |
	Mean	SD	Mean	SD
Aspirin	3.41	1.74	4.3	1.63
Vaccines	3.69	1.66	3.91	1.8
Smoking	6.0	1.12	6.2	1.1
Fossil Fuels	4.24	1.69	5.29	1.4
Uranium Mining	4.73	1.63	5.04	1.54
Nuclear Accidents	5.2	1.62	5.71	1.34

The mean for each hazard in the neutral condition indicated that the perception of the severity of risk consequence increased in general agreement with the locations of the six hazards in the Dread spectrum, with the exception of the smoking hazard, for which the highest mean rating of risk severity was found. Determined by the Standard Deviation, smoking also demonstrated the least variation in risk perception, whereas Aspirin demonstrated the greatest. Variations in the perception of neutral risk consequence were more uniform for the remainder of the hazards.

The hazard with the highest mean rating in the Affective condition was smoking, which again demonstrated the least variation in risk perception. Vaccination was once more perceived as the posing the least risk, but with the greatest variation in risk perception. Each of the hazards in the Affective condition for the estimation of risk consequence were rated as having a greater mean severity of risk consequence than in the neutral condition. The Affective cohort also demonstrated less variation among risk perceptions than the neutral cohort for all hazards except vaccination.

Descriptive statistics were then calculated for the neutral and Affective estimations for harm for each of the six hazards (table 7.5).

Table 7.5

Summary of descriptive statistics for severity of risk harm for each hazard.

	Neutral		Affective	
	Mean	**SD**	**Mean**	**SD**
Aspirin	3.32	1.67	4.09	1.78
Vaccines	3.4	1.63	3.55	1.86
Smoking	6.1	1.09	6.2	1.05
Fossil Fuels	4.07	1.74	5.03	1.45
Uranium Mining	4.57	1.62	4.78	1.65
Nuclear Accidents	4.8	1.74	5.51	1.51

The mean for each hazard in the neutral condition indicated that the perception of the severity of risk harm once more increased in general agreement with the locations of the six hazards in the Dread spectrum, with the exception of the smoking hazard, for which the highest mean rating of risk severity was found. The Standard Deviation also indicated that smoking demonstrated the least variation in estimation of risk harm, whereas fossil fuels and nuclear reactor accidents demonstrated the greatest. Variations in the perception of neutral risk harm were more uniform for the remainder of the hazards.

The hazard with the highest mean rating of risk harm in the Affective condition was smoking, which again demonstrated the least variation in risk perception. vaccination was once more perceived as the posing the least harm. Each of the hazards in the Affective condition for the estimation of risk harm were rated as having a greater mean severity of risk consequence than in the neutral condition. The Affective cohort demonstrated greater variation among perceptions of risk harm for the two lower Dread Risk hazards (namely Aspirin and vaccination), but demonstrated either similar or less variation than the neutral cohort for all other hazards. Finally, descriptive statistics were calculated for the neutral and Affective estimations of benefit for each of the six hazards (table 7.6).

Table 7.6

Summary of descriptive statistics for estimations of benefit for each hazard.

	Neutral		Affective	
	Mean	SD	Mean	SD
Aspirin	5.19	1.31	4.32	1.56
Vaccines	5.22	1.49	5.02	1.63
Smoking	2.32	1.79	2.14	1.75
Fossil Fuels	5.05	1.46	4.25	1.68
Uranium Mining	4.22	1.57	4.1	1.61
Nuclear Accidents	4.86	1.69	4.14	1.85

The mean for each hazard in the neutral condition indicated that the perceptions of benefit did not increase in general agreement with the locations of the six hazards on the Psychometric Dread Risk spectrum. The Standard Deviation indicated that Aspirin demonstrated the least variation in perceptions of benefit, whereas smoking demonstrated the least agreement. The hazard with the highest mean rating of benefit in the Affective condition was vaccines while smoking demonstrated the lowest. Perceptions of benefit were most uniform for Aspirin and the least agreement was found for nuclear reactor accidents.

Each of the hazards in the Affective condition were rated as having a lower mean benefit than in the neutral condition. When the perceptions of benefit and harm were plotted graphically, it became clear that the Affective cohort had perceived the harms to be greater and the benefits to be lower for each of the six hazards (figure 7.3) compared with the neutral cohort (figure 7.2).
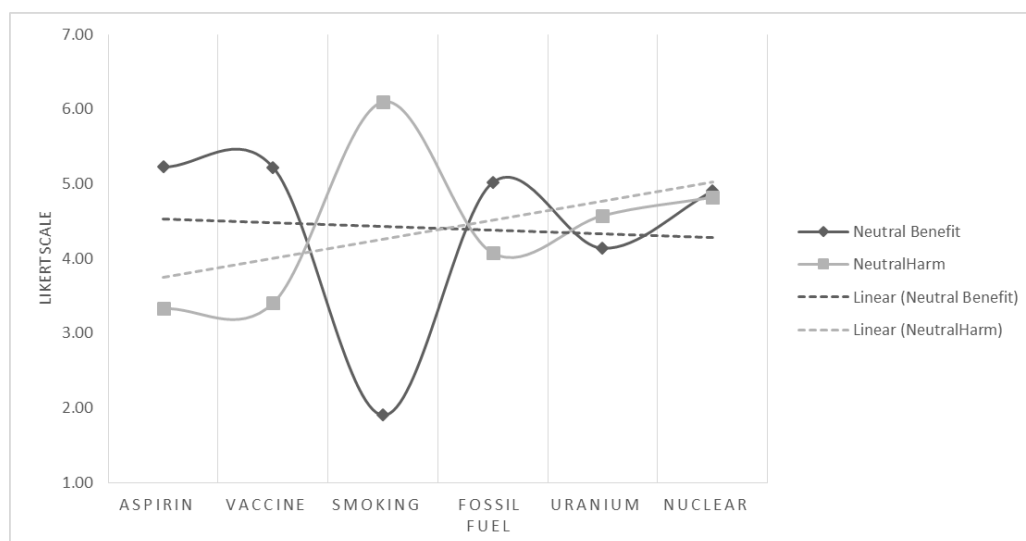
Figure 7.2. Mean neutral perceptions of benefit and harm for each hazard.
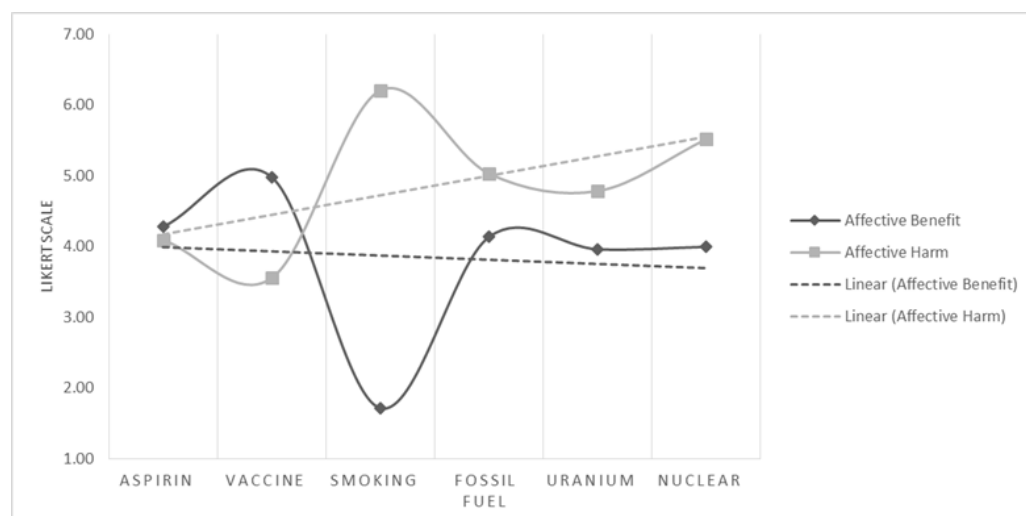
Figure 7.3. Mean Affective perceptions of benefit and harm for each hazard.

Finucane et al. (2000) suggests that "perceived risk and benefit are linked via some sort of Affective commonality" (p. 14) and the result that the inverse relationship of risk and benefit was evident indicated that the Affective wording and framing of the hazards had influenced Affective feelings.

7.4.2 Independent Samples *t*-test

The next stage of the Phase Three data analysis employed the independent samples *t*-test to determine whether the difference between the mean neutral and mean Affective Psychometric Dread Risk responses to each hazard in the results were significant. In addition to requiring a between-subjects study design, the independent groups *t*-test relies on the assumption that the two surveyed cohorts are drawn from population with equal variances, determined via the Levene test for equality of variances (Coakes et al., 2010, p. 75). The results of the Levene's test for equality of variances indicated that for each hazard, the *t*-test should be interpreted with equal variances assumed ($p>.05$), except for the Aspirin Hazard ($p<.05$). For this Hazard, a modified version of the *t*-test called Welch's *t*-test was used (Allen & Bennett, 2012), as the assumption of homogeneity of variance could not be assumed.

As with the Phase One *t*-test, a positive relationship between neutral and Affective responses to equivalent hazards was expected, requiring a one-tailed significance to be calculated for the independent samples *t*-test on the overall mean Psychometric Dread Risk response for each hazard (Argyrous, 1996). The results demonstrated no significant difference between the mean neutral and Affective responses for any of the six hazards.

A second independent samples *t*-test was then performed on the mean responses to each Dread factor item for each hazard to compare the neutral responses with those of the Affective worded survey. Given the expectation of a direction of the difference (that is, an increase in the perception of risk in the Affective results), a one-tailed significance was calculated (Argyrous, 1996). The analysis showed that equal variances could be assumed for some, but not all of the Dread factor items. The Welch's *t*-test was used for those Dread Factor items where the assumption of homogeneity of variance was violated.

The results indicated statistically significant differences between the neutral and Affective items for each of the six hazards. The *t*-test showed that the amount of personal choice (specified as the Dread risk item Involuntary) in exposure to the four of the six hazards were significantly different. The Affective cohort for Aspirin (*M*=3.02, *SD*=1.88) indicated perceptions of risk marginally higher than the neutral cohort (*M* = 2.48, *SD*=1.8), *t*(769) = -3.99, *p* < .001, one tailed, *d* = -.3.

The Affective cohort for vaccines (*M*=3.54, *SD*=1.92) indicated perceptions of risk marginally higher for the Involuntary Dread item than the neutral cohort (*M* = 3.21, *SD* = 1.9), *t*(769) = -2.42, *p* < .005, one tailed, *d* = -.28. The Affective cohort for smoking (*M*=3.2, *SD*=2.05) indicated perceptions of risk marginally higher for the Involuntary Dread item than the neutral cohort (*M* = 2.72, *SD* = 1.99), *t*(769) = -3.34, *p* < .001, one tailed, *d* = -.26. The Affective cohort for uranium mining (*M*= .4, *SD*=1.63) also demonstrated perceptions of risk marginally higher for the Involuntary Dread item than the neutral cohort (*M* = 4.89, *SD* = 1.88), *t*(733) = -4.0, *p* < .001, one tailed, *d* = -.29.

Also significant were the Affective responses to fossil fuels (*M*=5.68, *SD*=1.45), which demonstrated marginally higher perceptions of risk than the neutral cohort (*M* = 5.45, *SD* = 1.52) for the Global Catastrophic item, *t*(769) = -2.22, *p* < .02, one tailed, *d* = -.16, as well as the Affective responses to uranium mining for the Uncontrolable item (*M* = 5.19, *SD* = 1.86) compared to the neutral responses (*M* = 4.8, *SD* = 2.01), *t*(750) = -2.75, *p* < .003, one tailed, *d* = -.2. Finally, the Affective responses to nuclear reactor accidents (*M*=5.61, *SD*=1.69), demonstrated marginally higher perceptions of risk than the neutral cohort (*M* = 5.38, *SD* = 1.81) for the Uncontrolable Dread item, *t*(752) = -1.79, *p* < .03, one tailed, *d* = -.17.

An independent samples *t*-test was then performed on the responses to the risk consequence task, in order to determine whether the difference between the mean neutral and mean Affective responses to each consequence task was significant. The results of

the Levene's test for equality of variances indicated that the *t*-test should be interpreted with equal variances assumed ($p > 0.05$), with the exception of Aspirin ($p = .02$), fossil fuels ($p < .01$) and nuclear reactor accidents ($p < .01$), where equal variances could not be assumed. For those hazards where the assumption of homogeneity of variance was violated, the Welch's *t*-test was used. Given the expectation of a direction of the difference (that is, an increase in the perceived seriousness of consequences in the Affective results), a one-tailed significance was calculated for the independent samples *t*-test (Argyrous, 1996, p. 221) (table 7.7).

Table 7.7

Summary of Phase Three t-test results.

Hazard	Neutral	Affect	t	p (1-tail)	d
Aspirin	$M = 3.41$ $SD = 1.74$	$M = 4.3$ $SD = 1.63$	$t(861) = -7.81$	$< .001$	-.52
Vaccines	$M = 3.69$ $SD = 1.66$	$M = 3.91$ $SD = 1.8$	$t(865) = -1.85$	$=.032$	-.013
Smoking	$M = 6.0$ $SD = 1.12$	$M = 6.2$ $SD = 1.08$	$t(865) = -2.58$	$= .005$	-.25
Fossil Fuels	$M = 4.24$ $SD = 1.69$	$M = 5.29$ $SD = 1.41$	$t(865) = -9.92$	$< .001$	-.67
Uranium Mining	$M = 4.73$ $SD = 1.63$	$M = 5.04$ $SD = 1.54$	$t(865) = -2.88$	$= .002$	-.19
Nuclear Reactor Accidents	$M = 5.2$ $SD = 1.62$	$M = 5.71$ $SD = 1.33$	$t(836) = -5.04$	$< .001$	-.34

The results indicated significant differences between the neutral and Affective risk perceptions for each hazard. Effect sizes (*d*) ranged from large for the fossil fuel hazard, medium for Aspirin, moderate for nuclear reactor accidents, and small for the remainder of the hazards. This result indicated that an association with Affect for estimations of severe consequences.

Finally, to ascertain whether linguistic variations in the way participants ascribed meaning to the terminology used in the surveys had any significant influence on the responses, two further independent samples t-tests were performed. These were performed by splitting the cohorts between those from native and non-native English speaking countries.

The responses from the neutral and Affective cohorts from native English speaking countries were examined first. The results of the Levene's test for equality of variances indicated that the t-test should be interpreted with equal variances assumed ($p > 0.05$), with the exception of the Vaccine ($p = .001$) and Uranium Mining ($p = .041$) hazards, where equal variances were not assumed. The results demonstrated no significant differences between the mean neutral and Affective perceptions of any of the six hazards.

The responses from the neutral and Affective cohorts from non-native English speaking countries were examined next. The results of the Levene's test for equality of variances indicated that the t-test should be interpreted with equal variances assumed ($p > 0.05$), for all hazards. The results demonstrated no significant differences between the mean neutral and Affective perceptions of any of the six hazards, with one exception. This exception was found in the Affective responses to Vaccines ($M=4.05$, $SD=1.15$) which were significantly different to the neutral responses ($M=3.57$, $SD=1.23$) for the respondents from non-native English speaking countries, $t(351) = 3.69$, $p < .001$, two tailed.

7.4.3 Multidimensional Scaling Analysis

To mirror the Phase One analysis of the Psychometric research data, the Phase Three results was also subjected to multidimensional scaling "to quantify and map risk perceptions" (Lazo, Kinnell, & Fisher, 2000, p. 180). This multidimensional scaling process would produce low-dimensional plots of the neutral and Affective Psychometric Dread risk data. The neutral and Affective spatial maps would be compared with one

another, as well as with the low-dimensional plots produced by previous Psychometric studies.

The multidimensional scaling analysis was completed by transforming the Psychometric results for both neutral and Affective cohorts to perform an ordination of the data, placing each hazard in a low-dimensional coordinate system (Johnson & Wichern, 2002). The resulting spatial map demonstrated the Psychometric Dread risk locations of the six neutral and Affective risk hazards in a single Dread dimension. When the spatial maps of the neutral and Affective data sets were overlayed, very little difference between the neutral and Affective Dread risk locations for the six hazards were demonstrated, consistent with the findings of the Phase One multidimensional scaling analysis (figure 7.4).
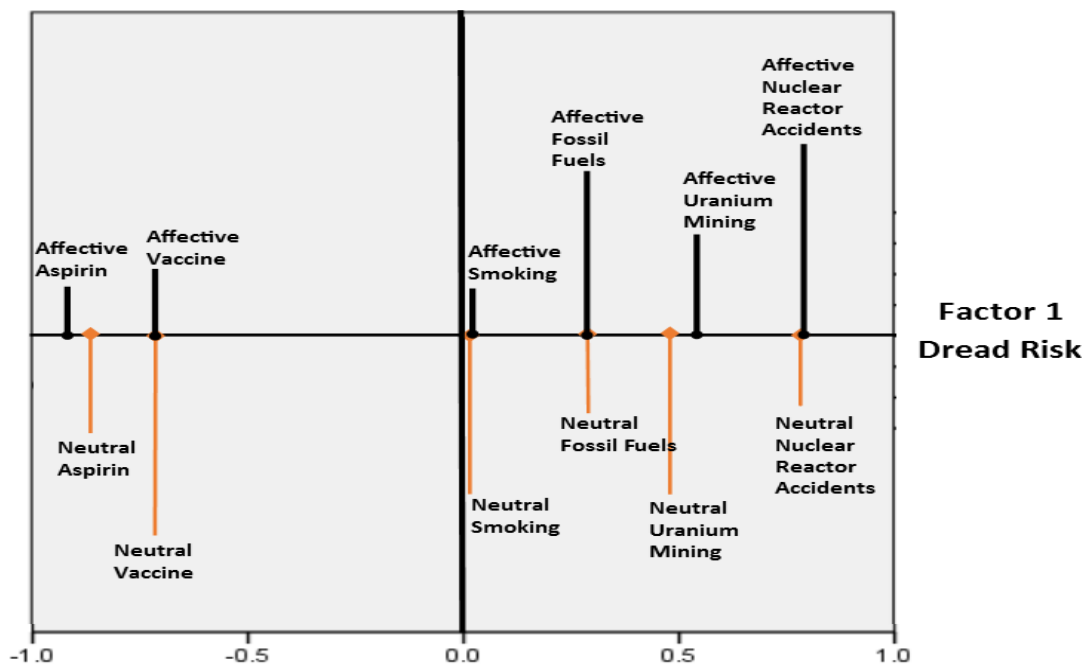
Figure 7.4.   Locations of the six neutral and Affective hazards within the Dread spectrum for Phase Three.

Examination of the neutral and Affective Multidimensional Scaling distance measures showed remarkably similar results between the two surveyed cohorts (figure 7.5).

	Aspirin	Vaccines	Smoking	Fossil Fuels	Uranium Mining	Nuclear Reactor Accidents
Phase Three Neutral Dread Locations	-17.4	-14.2	0.4	5.8	9.6	15.6
Phase Three Affective Dread Locations	-18.5	-14.2	0.4	5.6	10.6	15.6
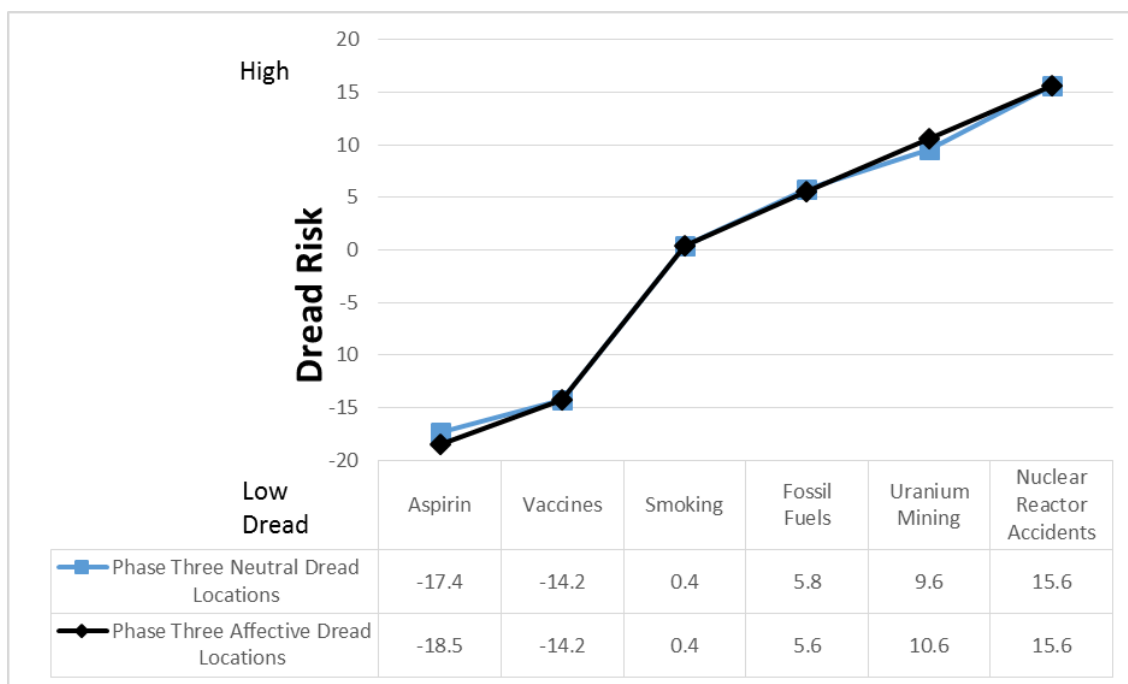
Figure 7.5. Low-dimensional spatial locations of six neutral and Affective hazards from the Phase Three MDS.

The resulting low-dimensional spatial locations from the Phase Three neutral data analysis were then compared with Slovic's (1987) spatial map from which the study's six hazards arose. The locations of the six hazards on both of the spatial maps were recorded and plotted graphically to highlight any similarities or differences (figure 7.6).
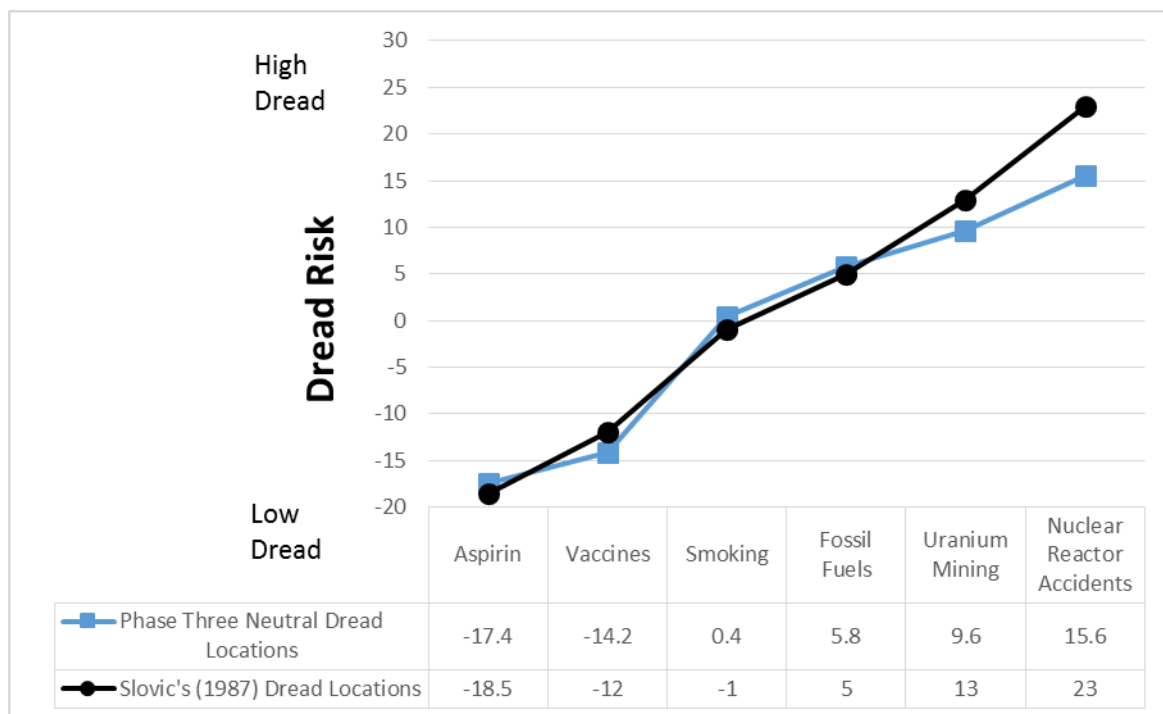
Figure 7.6.   Comparison of Slovic (1987) and Phase Three MDS.

The plot indicated that the Phase Three results were generally consistent with the locations identified by Slovic (1987) and were consistent with the findings of Phase One, showing that the Aspirin, smoking, and fossil fuel hazards occupied slightly higher Dread locations than those reported by Slovic (1987), whereas the vaccine, uranium mining, and nuclear reactor accident hazards occupied lower Dread risk locations (figure 7.7).
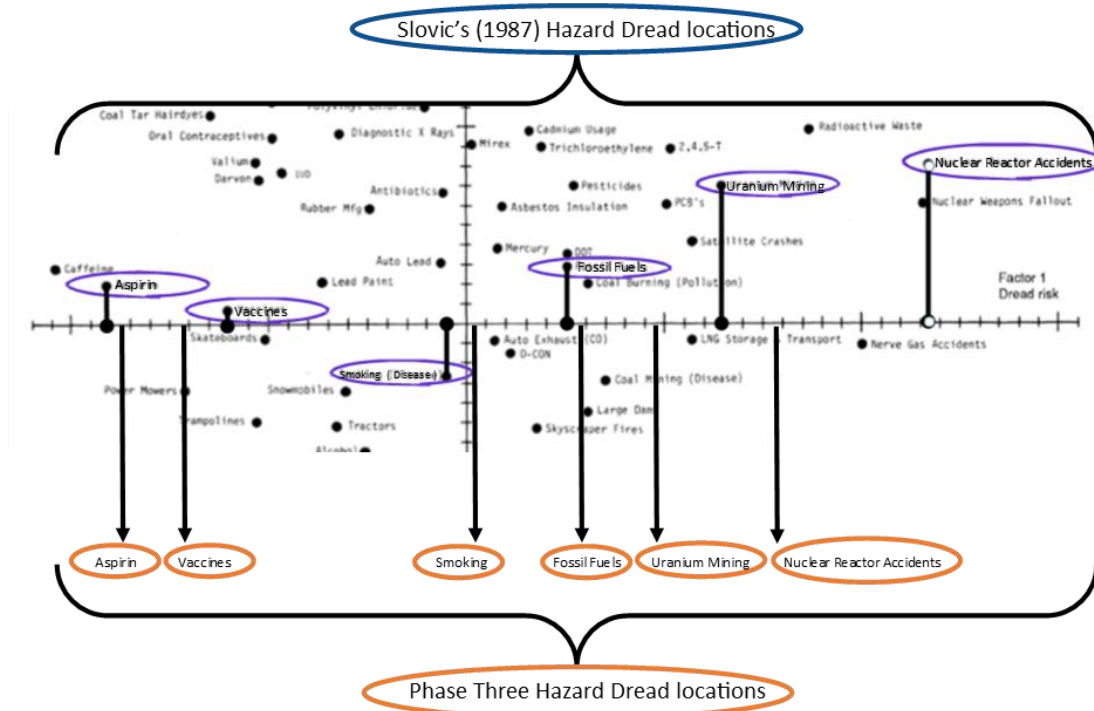
Figure 7.7. Dread locations of hazards from the Phase Three MDS and Slovic (1987).

7.4.1 Factor Analysis

A Factor Analysis was performed next as an exploratory data reduction technique to determine whether the ten Dread factor items from the Phase Three results were "tapping into the same construct" (Coakes et al., 2010, p. 133). First, the factorability of the ten Dread items for the neutral condition was examined. The majority of the correlations for the ten Dread items for Phase Three correlated at least .3 with another item, indicating the data were suitable for Factor Analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was > .6 for all hazards, and Bartlett's test of sphericity was significant for Aspirin (χ^2 (45) = 2011.76, p < .05), vaccines (χ^2 (45) = 1902.04, p < .05), smoking (χ^2 (45) = 1278.16, p < .05), fossil fuels (χ^2 (45) = 1770.33, p < .05), uranium mining (χ^2 (45) = 1823.22, p < .05), and nuclear reactor accidents (χ^2 (45) = 1471.98, p < .05).

The diagonals of the anti-image correlation matrix were all > .5, supporting the inclusion of each of the ten Dread items in the Factor Analysis. Finally, the majority of the communalities were well above > .3, further confirming a large common variance among the items. However, the Dread factor item Not Equitable was demonstrated to have communalities < .3 for the Aspirin, smoking, fossil fuel, and uranium mining hazards, indicating that very little of the variance of Not Equitable was explained in the analysis for these hazards. The Not Equitable item was also demonstrated to have a low communality (=.3) for the vaccine hazard. However, for the nuclear reactor accident hazard, the Dread factor item Not Equitable was shown to have the highest communality (=.3). Supported by these overall indicators, Factor Analysis was conducted with all ten neutral Dread items for the neutral hazards.

The initial eigen values indicated that the first factor explained 53% of the variance for Aspirin, 52% for vaccines, 40% for smoking, 46% for fossil fuels, 48% for uranium mining, and 45% for nuclear reactor accidents. The remaining factors for each hazard accounted for 15% or less of the variance. Solutions were examined using oblimin rotations of the factor loading matrix, as the ten Dread items are considered to measure a single construct, and a high correlation of factors was expected (Coakes et al., 2010, p. 142). A summary table of factor loadings > .75 for Phase Three was constructed for the neutral condition. The intention of this summary was to draw attention to the Dread items which explained the greatest amount of the variance observed in the extracted primary factors (table 7.8).

Table 7.8

Primary Neutral explanatory factor loadings for Dread items by hazard

Neutral Condition Hazard	Dread Item	Factor Loading	Communality
Aspirin	*Risk Increasing*	.84	.55
	Consequences Fatal	.77	.66
Vaccines	*Consequences Fatal*	.85	.72
	Risk Increasing	.85	.61
	Global Catastrophic	.84	.69
	Catastrophic	.83	.75
Smoking	*Catastrophic*	.81	.66
	Global Catastrophic	.79	.66
Fossil Fuels	*Involuntary*	.84	.63
	Uncontrollable	.83	.62
	Global Catastrophic	.78	.68
Uranium Mining	*Consequences Fatal*	.91	.74
	Catastrophic	.9	.79
	Dread	.82	.6
Nuclear Reactor Accidents	*Consequences Fatal*	.88	.69
	Catastrophic	.85	.69
	Dread	.77	.56

Note. Factor loadings < .75 are suppressed

Overall, the analysis of the primary factor in the neutral condition indicated that of the ten Dread factor items used, the item Catastrophic explained the greatest variance in neutral risk perceptions for the uranium mining, vaccines, and smoking hazards. The Dread factor item Consequences Fatal explained the greatest variance in neutral risk perceptions for the hazards nuclear reactor accidents and Aspirin, whereas Global Catastrophic explained the greatest variance in neutral risk perceptions for fossil fuels.

A Factor Analysis was then performed on each of the ten Dread factor items for each of the six hazards in the Affective condition. For the Affective Factor Analysis, the factorability of the ten Dread items for each hazard in the was examined. In testing the assumptions of the Factor Analysis for each hazard, all ten Dread items correlated at least .3 with another item, suggesting sound factorability.

The Kaiser-Meyer-Olkin measure of sampling adequacy was > .6, and Bartlett's test of sphericity was significant for Aspirin (χ^2 (45) = 1851.95, $p < .05$), vaccines, (χ^2 (45) = 1571.81, $p < .05$), smoking, (χ^2 (45) = 1150.91, $p < .05$), fossil fuels, (χ^2 (45) = 1405.82, $p < .05$), uranium mining (χ^2 (45) = 1542.13, $p < .05$), and nuclear reactor accidents (χ^2 (45) = 1254.53, $p < .05$).

The diagonals of the anti-image correlation matrix were all > .5 for each hazard, supporting the inclusion of each of the ten Dread items in the Factor Analysis, and the communalities were almost entirely above .3. Supported by these overall indicators, a principle components Factor Analysis was employed using oblimin rotations of the factor loading matrix to examine all ten Affective Dread items for each hazard. A summary table of the factor loadings > .75 was constructed in order to highlight those Dread items with the greatest potential for driving perceptions of risk for the Affective condition (table 7.9).

Table 7.9

Primary Affective explanatory factor loadings for Dread items by hazard

Affective Condition Hazard	Dread Item	Factor Loading	Communality
Aspirin	*Catastrophic*	.89	.82
	Consequences Fatal	.81	.69
	Future Generations	.79	.54
	Global Catastrophic	.77	.62
	Dread	.75	.73
Vaccines	*Catastrophic*	.84	.77
	Dread	.83	.76
	Consequences Fatal	.83	.63
Smoking	*Catastrophic*	.79	.67
	Consequences Fatal	.79	.58
Fossil Fuels	*Uncontrollable*	.78	.59
	Involuntary	.75	.55
Uranium Mining	*Catastrophic*	.84	.74
	Consequences Fatal	.76	.73
Nuclear Reactor Accidents	*Catastrophic*	.83	.68
	Consequences Fatal	.81	.64
	Dread	.76	.58

Note. Factor loadings < .75 are suppressed

Overall, the analysis of the primary Affective factor for each hazard indicated that the Dread risk item Catastrophic explained the highest percentage of the variance in Affective risk perceptions for the six hazards in the primary factors, with the exception of the Fossil Fuel hazard, for which Uncontrollable explained the highest percentage of variance. Similar to the Phase One results, the item Dread held explanatory power in the two lowest and the highest Dread Risk spectrum hazards, being Aspirin, vaccines, and nuclear reactor accidents respectively.

To mirror the exploratory Factor Analysis completed in Phase One of the study, a second Factor Analysis was performed as an exploratory data reduction technique to determine whether the mean of the ten Dread factor items across the six hazards were demonstrating related constructs. This would inform the study of whether the Dread factor items the

data suggested were most likely responsible for driving overall risk perceptions in Phase One would hold true with the larger sample size used in Phase Three.

The mean Dread item scores for each Dread Factor item were first calculated across the six hazards for the neutral and the neutral Psychometric data. The factorability of the ten mean Dread items for the neutral condition was then examined. The majority of the neutral Dread items correlated at least .3 with another item, indicating sound factorability and the diagonals of the anti-image correlation matrix were all > .5, supporting the inclusion of all ten Dread items in the Factor Analysis. The Kaiser-Meyer-Olkin measure of sampling adequacy was > .6, and Bartlett's test of sphericity was significant for (χ^2 (45) = 2345.55, p < .05). A factor scree plot was created to ascertain the number of factors to be extracted using Kaiser's criterion which asserts that factors should be extracted until their eigenvalues fall below 1 (Bahr, 1999) (figure 7.8).

Figure 7.8.   Neutral scree plot of eigenvalues with Kaiser's Criterion of > 1

The Factor Analysis resulted in the extraction of two neutral factors, rather than the three factor solution found in Phase One. The initial eigenvalues indicated that the first factor explained 58% of the variance, while the second factor accounted for 13%. Solutions were examined using oblimin rotations of the factor loading matrix. A summary table of the factor loadings was then constructed for the neutral condition (table 7.10).

Table 7.10

All Neutral explanatory factor loadings for Dread items by hazard

Dread Item	Factor 1 Loading	Factor 2 Loading	Communality
Catastrophic	.92		.82
Risk Increasing	.84		.68
Global Catastrophic	.84		.74
Not Easily Reduced	.45	.59	.83
Consequences Fatal	.9		.74
Future Generations	.45	.59	.83
Dread	.77		.72
Involuntary		.91	.76
Uncontrollable		.94	.79
Equity		.31	.2

The results showed that all Psychometric Dread Factor items had primary loadings > .5, with the exception of Not Easily Reduced and Future Generations. As with the Phase One results, the analysis indicated that items measuring the severity of risk consequence explained a greater amount of variance in the neutral Psychometric Dread Risk perceptions of the six hazards than did the emotional Dread item, or Voluntary, Uncontrollable, or Not Equitable items. The communalities revealed the proportion of variation in each Dread Factor item that was explained by the two factors, and indicated that items measuring the severity of risk consequences explained a greater proportion of the variation than did the emotional Dread item, or Voluntary, Uncontrollable, or Not

Equitable items, with the exception of the Not Easily Reduced and Future Generations items, which loaded on the second factor.

Overall, the analyses of the primary factor in the neutral condition indicated that of the ten Dread factor items, Catastrophic, Risk Increasing, Global Catastrophic, Consequences Fatal and Dread met the internal consistency criterion of a factor loading > .7 (Salkind, 2006, p. 58). The second factor also met the same criterion for Voluntary and Uncontrolable. This indicated that these two factors were the Psychometric Dread risk items that were driving perceptions of risk in the neutral condition. However, it should be noted that the second factor did not meet the criteria for retaining factors proposed by O'Rourke, Hatcher and Stepanski (2005, pp. 449-454) where, in addition to having an eigenvalues >1 and accounting for more than 10% of the variance, a minimum of three items are required to establish a factor. As with Phase One, Neill's (1994) proposed method for labeling factors was again used to form factor labels for factors one and two. The items with factor loadings of > .7 included in factor one and two, could conceivably be labeled *Neutral Catastrophic Consequence* and *Neutral Voluntary Control* respectively.

The next stage of the Phase Three Factor Analysis began with an assessment of the factorability of the ten mean Dread items for the Affective condition of Phase Three. The results showed that all ten Dread items correlated at least .3 with another item, indicating sound factorability. The Kaiser-Meyer-Olkin measure of sampling adequacy was > .6, and Bartlett's test of sphericity was significant for (χ^2 (45) = 2149.63, p < .05). A factor scree plot was created to ascertain the number of factors to be extracted using Kaiser's criterion which asserts that factors should be extracted until their eigenvalues fall below 1 (Bahr, 1999) (figure 7.9).
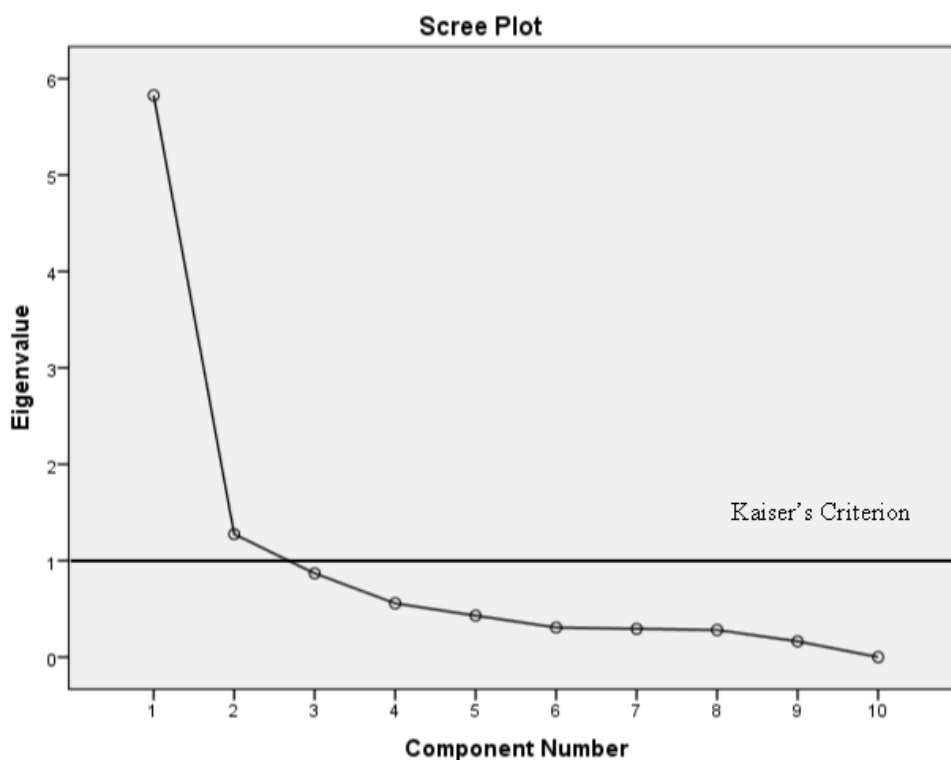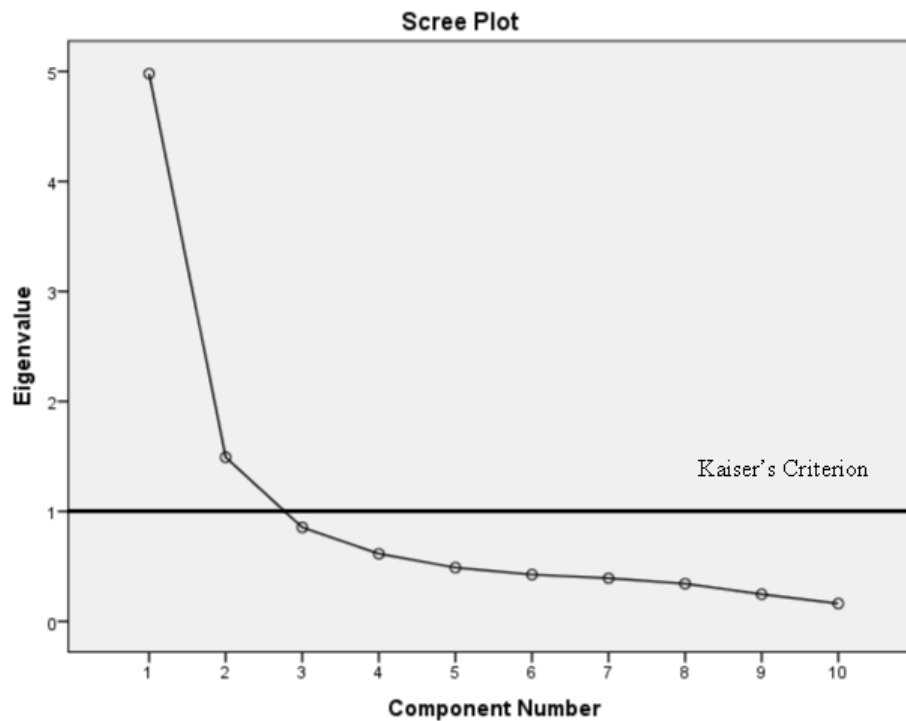
Figure 7.9.   Affective scree plot of eigenvalues with Kaiser's Criterion of > 1.

The Factor Analysis using oblimin rotations resulted in the extraction of two Affective factors. The initial eigenvalues indicated that the first factor explained 50% of the variance in Affective risk perceptions, and the second factor accounted for 15%. A summary table of the Affective factor loadings was constructed (table 7.11).

Table 7.11

All Affective explanatory factor loadings for Dread items by hazard

Dread Item	Factor 1 Loading	Factor 2 Loading	Communality
Catastrophic	.91		.84
Consequences Fatal	.89		.77
Not Easily Reduced	.38	.59	.66
Global Catastrophic	.78		.62
Dread	.8		.69
Risk Increasing	.76		.66
Future Generations	.79		.58
Uncontrollable		.84	.7
Involuntary		.9	.71
Equity		.4	.25

The analysis revealed that the items making up Factor one with loadings > .7 were very similar to those items identified in the neutral data set, but with the loss of the Dread Factor item Not Easily Reduced. Factors one and two met O'Rourke, Hatcher and Stepanski's (2005, pp. 449-454) criteria, where the factor must have eigenvalues greater than one for each item, and account for more than 10% of the variance, however, as with the neutral results for Phase Three, only factor one contained a minimum of three items. As with the neutral cohort, the Affective results indicated that it was the items Uncontrollable and Involuntary that loaded on the second factor.

The analyses of the primary factor indicated that of the ten Dread factor items, six items met the internal consistency criterion of a factor loading > .7 (Salkind, 2006). These were Catastrophic, Consequences Fatal, Global Catastrophic, Dread, Risk Increasing and Future Generations. These results indicated that these Psychometric Dread risk items were driving perceptions of risk in the Affective condition. As with the neutral Factor

Analysis results, only being two items loaded on the second factor, although the factor loadings of these two items were high (> .7), and explained > 10% of the variance.

Again, using Neill's (1994) proposed method for labeling factors, the factor one and two items with factor loadings of >.7 were tentatively labeled *Affective Catastrophic Consequence* and *Affective Voluntary Control* respectively. In contrast to the results of the Phase One Factor Analysis, the Psychometric risk item *Dread* was present in the primary factor for both the neutral and Affective conditions. However, the influence of Dread on the risk perceptions of participants from the neutral cohort was less than that of the Affective cohort.

7.5 Reliability and Validity

Validity may be defined as providing evidence that it is the measured variables that are contributing to significant results and not extraneous variables (Graziano & Raulin, 2004). The primary variable under investigation in this study was Affect. The results indicating an inverse relationship of perception of risk and benefit in the Affective results compared with the neutral indicated that the Affective wording and framing of the hazards had influenced Affective feelings. Finucane et al. (2000) suggests that "perceived risk and benefit are linked via some sort of Affective commonality" (p. 14), and this finding provides a measure of validity to the results of the study.

This finding is also supported by the *t*-test results between respondents from non-native and native English speaking countries. The results showed no significant difference between neutral and Affective risk perceptions for respondents from either the non-native or the native English speaking countries (with the exception of vaccine perceptions among non-native English speakers). This supported the view that Affective manipulation had not failed due to linguistic variations in the way respondents ascribed meaning to the terminology used in the surveys.

The Psychometric Dread research instrument used in the study (Slovic, 1987) is widely regarded as a robust and valid measure of perceived risk. It was found in this study to be highly reliable in the neutral condition (α=.85) and in the Affective condition (α=.89). Use of this instrument provided the study with construct validity. All ten of Slovic's (1987) Dread factor items were included in the research instruments, supporting translational content validity.

Comparison of the multidimensional scaling results with Slovic's (1987) work also provided a measure of external validity. When the Phase Three spatial maps were compared with Slovic's (1987) findings, each of the six hazards were located in remarkably similar locations, supporting confidence in the external validity of the Multidimensional Scaling Analysis results and the integrity of the data.

7.6 Conclusion

Phase Three of the study was designed with a between-subjects methodology consisting of neutral-worded and Affective-worded surveys focusing on the Psychometric Dread Risk factor (Slovic, 1987). The surveys centered around six different hazards which are located across the Dread risk spectrum, ranging from low Dread to high Dread. Four independent cohorts of respondents were surveyed (N=1638). The first cohort (n=401) completed an Affective-worded Psychometric Risk perception instrument, while the second cohort (n=370) completed the neutral worded version of the same instrument. Phase Three also included a third (n=434) and a fourth cohort (n=433) completing neutral-worded and Affective-worded Risk Consequence estimation surveys, respectively. Responses most closely representing respondents' risk perceptions and estimations of consequence, harm and benefit were recorded on a seven-point Likert Scale.

The results of the Phase Three descriptive data analysis suggested that the hazard that elicited the greatest and most uniform perception of risk, was the impact of nuclear

reactor accidents on Future Generations for both the neutral and the Affective cohorts. By contrast, an inability to control exposure to Aspirin was perceived as posing the least risk for the neutral cohort, while the Affective cohort rated the Dread item as being of the least concern in regards to the Aspirin hazard.

The Fatal Consequences of smoking produced the most uniform perceptions of risk for both the neutral and Affective cohorts, together with the impact of nuclear reactor accidents on Future Generations. The hazards of smoking, however, proved to be a more polarized issue, with much less agreement in relation to reducing exposure, the level of personal control, voluntary exposure, and dread.

The neutral and Affective cohorts were both found to perceive nuclear reactor accidents as posing the greatest risk, with the least variation in opinion, while Aspirin was perceived as posing the least risk. The hazard with the least amount of agreement for both cohorts, in terms of perception of the risk, was smoking. When respondents were asked to rate the seriousness of the consequences of each hazard, both the neutral and Affective cohorts perceived smoking as being the most serious, with the least variation in opinion. The neutral cohort, however, perceived Aspirin as having the least serious consequences, while the Affective cohort held the same view of the risks associated with vaccination.

Overall, the Affective cohort demonstrated less variation in perceptions of the seriousness of the consequences of the six hazards compared with the neutral cohort. When asked to rate how harmful each hazard was perceived to be, the neutral and Affective cohorts were once again in agreement with the view that smoking posed the greatest risk. The hazard perceived to create the least harm was demonstrated to be Aspirin for the neutral cohort, but the Affective cohort saw vaccination as posing the least risk. Both of these hazards were also demonstrated to have the most variation in opinion.

The hazard with the highest mean rating of benefit in the Affective condition was vaccines while smoking demonstrated the lowest. Perceptions of benefit were most uniform for Aspirin and the least agreement was found for nuclear reactor accidents. Each of the hazards in the Affective condition were rated as having a lower mean benefit than in the neutral condition. When the perceptions of benefit and harm were plotted graphically, it became clear that the Affective cohort had perceived the harms to be greater and the benefits to be lower for each of the six hazards compared with the neutral cohort. This result indicated that Affect has been influenced in the Affective cohort.

The Independent Samples *t*-test on the Psychometric Dread risk survey data showed no significant difference between neutral and Affective perceptions of the six hazards overall, but indicated significant differences on several of the hazards for some Dread factor items. There was a significant difference found between neutral and Affective perceptions of voluntary exposure to the risks of Aspirin, vaccines, smoking and uranium mining. The Affective cohort's perception of the Global Catastrophic consequences of the use of fossil fuels was also demonstrated to be significantly greater than that of the neutral cohort, as was the Affective cohort's perception of a lack of personal control over the risks of nuclear reactor accidents. These results suggested that Affect, via the use of Affective wording, had influenced perceptions of voluntary control over the risks and evidence of the Affective wording significantly influencing perception of the severity of risk consequences was found only for the Global Catastrophic consequences of the use of fossil fuels.

A significant difference was found, however, between neutral and Affective perceptions of the consequences of the six hazards in the Risk Consequence Task data, with the effects of this difference being most pronounced for the fossil fuel, Aspirin, and nuclear reactor accident hazards. These findings taken together, suggested that Affect had influenced judgements of consequence severity, but that this influence was dependent on certain aspects of the risk, which were inferred from the Dread risk results to be the

perception of how much personal control can be exerted over exposure to a risk, and the degree to which risk exposure is voluntary.

The Multidimensional Scaling (MDS) analysis indicated that the locations of the six hazards obtained from the Phase Three Psychometric Dread risk data were consistent with the results of the Phase One MDS, as well as being in agreement with the findings of Slovic (1987). This finding demonstrated both internal and external validity of the results obtained. Factor Analysis of the neutral Psychometric Risk data indicated that the greatest amount of variance was explained by Catastrophic Consequences for the uranium mining, vaccination and smoking hazards, while Fatal Consequences explained the greatest amount of variance in perceptions of the nuclear reactor accident and Aspirin hazards. Global Catastrophic was identified as explaining the greatest amount of variance in risk perceptions of fossil fuels. When Affect was manipulated, however, the Factor Analysis identified Catastrophic Consequences as the Dread Factor item explaining the greatest variance for all hazards except fossil fuels, for which Uncontrolable was found.

As component correlations were moderately related, indicating the presence of a second-order model, a two factor solution was examined for both the neutral and Affective data. The primary neutral factor was largely driven by the severity of risk consequence items, and although the Dread item was identified as loading on the primary factor, it held the lowest value of the explanatory factor loadings. The explanatory factor loadings on the secondary factor were shown to be Involuntary and Uncontrolable. Similar findings were shown for the Affective cohort, where the only notable difference to the neutral results was the loss of the Dread Factor item Not Easily Reduced from the primary factor, and the gain of the item Future Generations.

The findings of the Factor Analysis indicated that Affect had very little association with the Psychometric Dread Risk items holding the greatest explanatory power in the perception of the six hazards. The indication that the Psychometric Dread Risk items

Involuntary and Uncontrolable formed a second factor was noteworthy, as the results of the Independent Samples *t*-test suggested it was largely within these characteristics that the significant differences between neutral and Affective risk perceptions lay. The results also suggested that it was the severity of risk consequence Dread factor items that held the most explanatory power of the risk perceptions of the six hazards.

After having completed and analysis of the three study Phases, the results were considered in light of the relevant literature. The proceeding chapter discusses the interpretations of the results and the limitations of the study. The findings are discussed in response to the Research Questions and exceptions and alternate explanations are examined. The chapter then summaries the implications and significance of the findings before outlining the study's limitations.

CHAPTER 8: INTERPRETATIONS AND LIMITATIONS

8.1 Introduction

The previous chapter detailed the analysis of the main Phase of the study, whereas this chapter offers an interpretation of those results. The response to the Research Questions suggests that Psychometric Dread risk should not be thought of solely as a measurement of Dread or fear, nor as consequence severity alone. Previous Psychometric risk perception research has shown Dread risk to be the most robust predictor of perceived risk, and it is a widely held view that Dread is chiefly governed by emotional processes.

However, it may be inferred from the results that the aspects of perceived risk, which the Dread factor captures, are not principally governed by emotional processes. The discussion in this chapter reveals a more complex process, where concepts of voluntary choice and control are significantly related to emotional stimuli and form a separate construct from risk consequence. It also shows that the framing of risk consequences is associated with Affect, and how this may relate to concepts of choice and control. The final section of this chapter discusses the limitations of the research and how they impact the interpretation of results.

8.2 Response to the Research Questions

The Research Questions were based on the problem identified by Sjöberg (2006a), who asserts that the strong evidence for "a correlation between attitudes and perceived risk" (p. 5) found in Affect Heuristic research (Finucane, Alhakami, Slovic, & Johnson, 2000; Slovic, Finucane, Peters, & MacGregor, 2007), together with the traditional conception of the Dread factor as driven by emotion, has arisen from the broadening of the meaning of Affect to include the concept of Attitude. This view has resulted in widespread support for the idea that emotion plays a significant role in risk perception and Affect being linked to the concept of Dread (Sjöberg, 2006b). Such an assertion highlighted the need for clarification on the question of how Affect is associated with the Dread factor's risk

characteristics. However, Sjöberg (2006b) also raises a related issue, arguing that Slovic et al.'s (1980) Dread factor is a heterogeneous assortment of risk characteristics dominated by items related to severe consequences. This related issue suggested that the question of how Affect is associated with risk consequence estimations should be investigated in tandem with Dread risk. Thus the Research Questions were framed as: *how is Affect associated with the Dread factor's risk characteristics?* and *how is Affect associated with risk consequence?*

In response to the first Research Question *how is Affect associated with the Dread factor's risk characteristics?* it may be inferred from the results that although perceptions of voluntary exposure and control over risk are significantly associated with Affect, it is the risk consequence characteristics of the Dread factor which are dominant and largely unrelated to emotional Affect. This finding is supported by Pidgeon, Simmons, and Henwood (2006) who argue that many of the Dread characteristics tap into concerns unrelated to Affect. The Factor Analysis showed that Dread as a risk characteristic was of minor importance to overall Dread risk factor perceptions and the *t*-test showed that Affect was primarily associated with Involuntary and Uncontrolable risk characteristics.

It may therefore be inferred from the results that Affect is significantly associated with risk characteristics related to voluntary choice and control, but is not significantly associated with perceptions of consequence severity or dread. In this view, concepts of choice and control are the emotional risk characteristics within the Psychometric Dread risk factor, and these concepts form a separate construct from consequence severity or dread feelings. This view is evidenced by the *t*-test results and the two factor solution found in the Factor Analysis.

Such an interpretation is supported by Sjöberg (2006a), who asserts that "a close look at the definition of Dread shows that it is measured wholly, or mostly, with non-emotional components which can be best summarised as measuring the perceived severity of consequences" (p. 7). This view is also supported by Schusterschitz, Schütz, and

Wiedemann (2010), who found that "the explanatory power of the Dread factor is strongly influenced by the Severity of Consequences" (p. 394). This is not to suggest however, that Affect has no influence on estimations of risk consequence, only that the association is not significant to severe consequence risk characteristics. The significance of Dread as Affect is based on the importance of choice and control. The Psychometric Dread factor may therefore be considered as a combination of two separate constructs: cognitive estimations of risk consequence, and emotionally sensitive perceptions of choice and control.

The second Research Question, *how is Affect associated with risk consequence?* may be addressed by suggesting that in general, consequence perceptions are not significantly influenced by Affect, although this may depend on risk framing. This interpretation is supported by the lack of significant difference in the *t*-test results between neutral and Affective perceptions of the Dread risk consequence characteristics. However, indications of some association between Affect and consequence perception were found in the significant differences in the *t*-test results between neutral and Affective perceptions of consequence severity in the Risk Consequence Task.

The lack of significant difference for the consequence items of the Dread risk factor compared with the Risk Consequence Task results may be attributed to the effects of risk framing. Tversky and Kahneman (1981) demonstrated the impact of Affectively framing risks, finding that "framing influences the experience of consequences" (p. 458). In the Psychometric Dread risk instrument, hazards were framed in terms of specific characteristics. By contrast, the Risk Consequence Task was framed in less specific terms but were framed with negative or positive statements about each hazard, potentially resulting in perceptions of the hazards as impersonalised and not easily interpreted as voluntary or involuntary, creating frame-dependent estimations of risk consequence.

From this line of argument, it may be inferred that the lack of specific risk characteristics on which to base risk judgement results in the Affective associations becoming more pronounced. Jenkin (2006) supports this view, asserting that the framing of risks in a way that is not specific is "more likely to increase anxiety without increasing awareness" (p. 5). This view is also supported by Hamilton, Adolphs, and Nerlich (2007) and Zajonc (1980), who underscore how linguistic assessments impact precognitive Affective impressions of risk based on good/bad or like/dislike. It may be inferred from these results that without adequate framing of risk consequence in terms of its characteristics, judgement is deferred to Affective impressions; however, when risk characteristics are made explicit, Affect is shown to be primarily associated with perceptions of voluntary choice and personal control.

8.3 Discussion

The interpretation of the results was based on the most significant findings of the study as they relate to the literature. It was concluded that consequence severity risk characteristics dominate the Dread risk factor, and the factor is not significantly related to emotional Affect. This interpretation not only provides a clearer view of the Dread risk factor, but also a greater understanding of the role of Affect in the way in which risks are perceived, and how risk judgements are made.

8.3.1 Interpretations of the Findings

The significant results led to several related interpretations that were supported by the literature. The first interpretation was that Dread risk is primarily a measure of the severity of consequence, while the second inference was that Affect is related to perceptions of voluntary choice in exposure to a risk and personal control, but not dread or severity of consequence characteristics. It was also inferred from the results that Dread risk is largely a measure of two distinct constructs, including estimations of risk consequence and perceptions of voluntary choice and personal control.

The view that Dread risk is primarily a measure of the severity of risk consequence was based on several findings supported in the literature. The study results indicated that the neutral and Affective cohorts in the descriptive analysis were in agreement as to the riskiness of each of the six hazards, and no significant differences were found in the *t*-test between overall neutral and Affective Dread risk perceptions. Comparison of the Multidimensional Scaling analysis conducted in Phases One and Three confirmed this interpretation, and Factor Analysis showed risk consequence characteristics as a primary construct. This suggests a conception of Dread risk as a measurement of risk consequence perceptions which are largely uninfluenced by Affect.

Despite a widespread view of Dread risk as the emotional factor (see Finucane et al., 2000; Peters & Slovic, 1996; Rottenstreich & Hsee, 2001; Slovic, Finucane, Peters, & MacGregor, 2002, 2004; Slovic et al., 2007; Slovic, Peters, Finucane, & MacGregor, 2005), it may be inferred from the these results that Dread risk is not primarily a measure of risk-as-feelings. This interpretation is supported by Fischhoff et al.'s (1978) seminal Psychometric risk study, at which time the Dread factor was labelled *Severe* due to the dominance of consequence severity in the factor. It was not until Slovic et al.'s (1980) subsequent expansion of the work that the equivalent factor was labelled as *Dread*. Sjöberg (2006b) has been a vocal proponent of the view that the Dread risk factor is a heterogeneous assortment of risk characteristics dominated by items related to severe consequences rather than emotion, and this interpretation supports this view.

The second major inference of the study is that Affect is associated with perceptions of voluntary choice and personal control, but not with dread or consequence characteristics. The study found a significant difference in the *t*-test results between neutral and Affective perceptions relating to voluntary exposure to the risks of Aspirin, Vaccines and Smoking and a lack of personal control over the risks of Uranium Mining and Nuclear Reactor Accidents. From this it was inferred that Affect is largely associated with perceptions of voluntary control. The literature suggests that there tends to be a clear separation between

the way individuals perceive risks to themselves as opposed to those impacting on others (Sjöberg & Drottz, 1987) and Starr (1969) asserts that there is a significant difference between acceptance of voluntary versus involuntary risks. The interpretation of this study that Affect is associated with risk perceptions of voluntary choice and control offers an explanation as to the mechanisms behind risk acceptance.

The literature suggests that Affect may be considered as feelings of like or dislike for a particular activity (Alhakami & Slovic, 2006), and it may be inferred from the results of this study that it is these impressions that are associated with the amount of personal control and choice over a risk. The difference between the perception of risks as general or personal is related to Weinstein's (1980) proposed *optimism bias*, where personal risks are viewed with unrealistic positivity. It may thus be surmised that positive Affect or optimism regarding a hazardous activity is associated with the perception of how personal the risk is, a concept directly related to ideas of control and choice. This interpretation is supported by Nickerson (1998), who refers to Confirmation Bias in which individuals unconsciously gather selective information and give undue consideration to "evidence that supports one's position while neglecting to gather, or [discount], evidence that would tell against it" (p. 175).

The study results also indicated that choice and control characteristics were independent of the characteristics of severe consequences. The smoking hazard elicited the largest variation in mean perception, especially in regards to the Uncontrolable and Involuntary characteristics. It may be inferred from this result that although smokers and non-smokers have a similar perception of the risk consequence, Affect impacts perceptions of choice and control over exposure. The ways in which these perceptions may be influenced is indicated in the literature, which shows that the choice to smoke is largely influenced by attitude (Slovic, 2000) and suggests Confirmation Bias, or selective case building (Nickerson, 1998). Although there were large variations in the perceptions of choice and control for this hazard, perceptions of smoking were also demonstrated to have the least

variation in opinion in regards to the Fatal Consequences of the risk. Respondents perceived the smoking hazard as a voluntary and controllable risk on par with Aspirin consumption, while also perceiving it to be as fatal as nuclear reactor accidents. It may be inferred from this result that the severe consequences of some hazards may be acknowledged and perceived similarly, while differing Affective perceptions associated with choice and control will influence risk acceptance.

The view that voluntary control is a significant construct to overall Dread risk perceptions is supported by the finding that smoking was perceived to be the most severe and harmful risk on average, when respondents were asked about severity of consequence or harm alone. From this it was inferred that the role of Affect in overall Dread risk perceptions is largely limited to an association with voluntary choice and personal control characteristics within the factor. This view is supported by Lupton and Tulloch (2002), who assert that voluntary risk taking is a form of emotional engagement associated with control. It may be further inferred that the association of voluntary control with Affect, or feelings of like or dislike for a hazard, may be related to the personal nature of particular risks.

The third major interpretation that Dread risk is largely a product of the two distinct constructs of consequence estimation and perceptions of choice and control, was based on several findings and is supported by the literature. The results showed a two factor solution in the Factor Analysis, with a primary factor comprised primarily of severity of consequence items. The secondary factor was made up of the voluntary and control items, albeit not quite meeting O'Rourke, Hatcher and Stepanski's (2005) Factor Analysis criterion. From this result, it was surmised that the Psychometric Dread risk factor is a measure of the two distinct constructs of risk consequence estimations and perceptions of voluntary choice and personal control. This interpretation is supported by Fischhoff et al. (1978), who found this factor to be "associated with severity of consequences and, to a lesser extent, with common/dread" (p. 137).

The separation of voluntary control from consequence was also supported by the findings in relation to the smoking hazard which showed that Affect and perceptions of voluntary control do not necessarily impact perceptions of consequence severity. Although the severity of risk consequences may be a point of agreement and be perceived similarly, differing Affective perceptions associated with choice and control may influence risk acceptance. This finding is supported in the literature, which suggests that there is a separation "between the level of risk perceived and the willingness to take the risk" (Breakwell, 1996, p. 51).

For example, post 9/11, many Americans who feared flying chose to drive personal vehicles instead, due to the threat of further terrorist activity targeted at the airline industry. As a result, the number of fatal traffic accidents in the United States increased for a period of 12 months after the terrorist attacks on September 11, 2001, when compared with the previous five years of data (Gigerenzer, 2006). The apparently fear-provoked increase in motor vehicle fatalities may be ascribed to the perception of greater control and choice in the risk outcome of driving a personal vehicle, when compared with airline travel. Although still linking risk acceptance to Affect, this interpretation offers are more refined perspective through reference to perceptions of choice and control.

8.3.2 Exceptions and Alternate Explanations

The study also revealed results to which alternate interpretations to those outlined above might be attributed. For example, a significant difference was found in the t-test between neutral and Affective perceptions of the consequences of the six hazards in the Risk Consequence Task. This indicated that Affect was associated with risk consequence estimations. One interpretation of this result would be to infer that Affect is associated with risk consequence judgements, resulting in a view in conflict with the Psychometric results. However, risk consequence judgements are shown in the literature to be associated with control, the perception of which is a "major factor in determining risk consequence value" (Rowe, 1988, p. 135). This interpretation offers some reconciliation

with the main assertions of this Thesis by viewing concepts of choice and control as inextricably linked to estimations of consequence severity, just as Affect is an integral part of overall risk perception.

In this instance, participants were not asked to consider specific aspects of risk consequence, such as fatality, but simply to rate the seriousness of the risk consequences. Many different risk characteristics may have been considered by different participants in estimating the seriousness of a risk. It may also be argued that, compared with the Phase Two results which indicated no Affective association with consequence estimation, the framing statements used in the Risk Consequence Task for Phase Three (Appendix B) were the most likely reason behind the difference. The neutral framing statements highlighted the benefits of the hazards or downplayed the consequences, while the Affective framing statements emphasised the negative aspects. Taylor-Gooby and Zinn (2006) assert that this type of Affective priming provides a frame of reference through Affective experience, and that any assessment is necessarily subject to context and framing. This interpretation suggests that the context within which a risk is framed has a greater association with Affect than the content of a risk message.

Also indicating an association between Affect and risk consequence were the results of the Factor Analysis. Although the primary factor to emerge was dominated by severity of consequence risk characteristics, the Dread item was found to load on this primary factor. Factor Analysis of the Affective results showed the Dread item to load slightly higher on the primary factor than for the neutral cohort. It is most reasonable to infer from this result that Affect is associated with worry or dread of a hazard, and that dread feelings are part of the mental construct dominated by severe consequences. An alternate explanation however, is that worry, concern or dread feelings are not significantly related to perceptions of risk consequence. This interpretation is in agreement with Sjöberg (2006b), who found the emotional aspects of the Dread risk factor to be of minor importance to perceived risk compared with severe consequences. A third consideration

is that worry, concern or dread feelings may be associated with severe consequences, but this characteristic of risk perception is not a significant driver behind severity of consequences construct.

Another finding suggesting alternate interpretations, was the significant difference found in the *t*-test on Global Catastrophic between neutral and Affective perceptions of the fossil fuel hazard. This finding may be interpreted as suggesting that risk consequence characteristics are associated with Affect for particular hazards. However, significant differences for the remaining hazards were related to Involuntary and Uncontrolable. From this, it may be inferred that the globally catastrophic consequences of fossil fuel use and climate change represent a risk that is both Involuntary and Uncontrolable, resulting in an association of Affect with risk consequence estimation. Sunstein (2004) suggests that when risk consequences conjure vivid mental impressions, they tend to produce visceral Affective reactions. From these findings, it might be further suggested that risks perceived as highly Involuntary and Uncontrolable also produce visceral Affective reactions related to estimations of catastrophic risk.

Also supporting this view were the responses for the fossil fuel hazard, which showed higher mean Affective risk perceptions compared with the neutral cohort for Involuntary, Uncontrolable and Global Catastrophic, while Dread and other consequence severity items were lower. An alternate interpretation of the Global Catastrophe finding is that consequence perceptions may be influenced by Affect if the magnitude and severity of the risk is large enough, such as with climate change risks. Slovic et al. (2007), assert that in some circumstances, the magnitude of a risk consequence conveys little meaning and may not be evaluable, and it may be argued that the estimation large magnitude consequences is mediated by Affective impressions, including perceptions of choice and control.

Comparison of the Multidimensional Scaling Analysis results of the study with those of Slovic (1987, p. 282) indicated general agreement, but with some exceptions. The Dread risk perception of uranium mining and nuclear reactor accident hazards has were lower in the study results than those reported by Slovic (9187). These differences could be accounted for by the shift in risk perceptions over time. Nuclear energy is no longer a new and unfamiliar technology and the mining of uranium is understood to be related. Such an interpretation is supported by Sjöberg and Drottz- Sjöberg (2009) who found the perception of nuclear waste to be neither perceived as new or "particularly dreaded" (p. 90).

The risk context of nuclear energy during Slovic's (1987) investigation was also significantly different to the present. For example, the Chernobyl nuclear reactor accident occurred the year before Slovic's (1987) findings were published, which could conceivably account for increased Dread risk perceptions for nuclear reactor accidents and uranium mining in Slovic's (1987) study. Likewise, the knowledge of the consequences of fossil fuel use on climate change has also increased in the last 28 years, and the slightly increased perceptions of Dread risk (or consequence) for the fossil fuel hazard may be interpreted as a reflection of this. Such an interpretation is also supported by Sjöberg and Drottz-Sjöberg (2009), who questioned whether concern over the Greenhouse effect was "replacing nuclear fear" (p. 290). This study would suggest a response in the affirmative.

8.3.3 Implications, Significance and Relationships to Previous Work

Risk research is immensely significant to risk governance and policy development. Because of the high level of uncertainty and limited knowledge surrounding decisions, "the need for certain knowledge is enormous" (Zinn & Taylor-Gooby, 2006b). Questions surrounding public acceptance of technologies and risky decision making are immensely important to risk management and policy development. As Psychometric risk research has "often being primarily concerned with issues of risk communication" (Taylor-Gooby

& Zinn, 2006a, p. 398), it follows that the outcomes of this research would also have implications in this area. The interpretation of an association of Affect with concepts of voluntary and control has implications for the Psychometric risk contribution to risk management and communication.

Risk assessment is a necessary precursor to risk management. Understanding risk perception contributes to effective risk assessment, as the human factor is frequently important to determining the likelihood and consequences of a hazard (Breakwell, 2007). Psychometric risk research provides insights into the way in which risks are perceived, which has implications for understanding behaviour in response to risk issues, as "one cannot predict how people will respond to an issue without knowing how they perceive it" (Fischhoff, 1985, p. 90). In terms of risk management, operationalisation of this finding might take the form of greater and more frequent stakeholder consultation and involvement to promote perceptions of control and voluntary, thereby influencing Affective associations with the risk issue.

The outcomes of this study may also result in considerable advantage to the risk communication effort. It has long been recognised that "risk communication would benefit from a shift in attention from message construction to audience analysis" (Marris, Langford, & O'Riordan, 1998, p. 646). The finding in this study that Dread risk is chiefly governed by estimations of severe consequences rather than emotional considerations may influence how the judgements of risk communication audiences are interpreted.

One of the key questions impacting risk communication is "what systematic departures from rationality can be identified" (Viscusi, 1997, p. 1659). If Dread risk is viewed as a measure of irrational emotional response to risk, then it may be inferred that Dread risk may inform the degree of irrational perception. However, the view of Dread risk offered in this Thesis infers a limited role of Affect in Dread risk perceptions, offering a different perspective in the interpretation of risk judgement rationality. Sjöberg (2007) asserts that

risk communication based on the "notion of the primacy of a primitive initial emotional reaction" (p. 223) will likely fail, and the outcomes of this study potentially offer a more refined perspective on Dread risk and the role of Affect relating to perceptions of voluntary and control in risk judgements.

This view that the Affective association with voluntary control is of importance to risk perception is also relevant to policy formulation and an awareness of the impact of different risk judgements is "of intense practical significance" (Viscusi, 1997, p. 1658). In this domain, Kahlor, Dunwoody, Griffin, and Neuwirth (2006) highlight a need for greater research into impersonal rather than personal risk in order to meet the needs of policy issues. The interpretation of this Thesis that concepts of personal choice and control are associated with emotions may offer potential avenues of policy research, as investigations in this area consistently "measure public opinions…but struggle to understand the basis for those opinions" (Viscusi, 1997, p. 1658). It is also significant that the interpretation of results offers implications for understanding risk acceptance in relation to choice, control and Affect, potentially offering insights into "how the behavior and responses of actors are to be understood" (Taylor-Gooby & Zinn, 2006a, p. 407).

Several findings of the study were found to replicate the outcomes of previous Psychometric risk studies. The Multidimensional Scaling Analysis results were in good agreement with the spatial locations of the same hazards in Slovic's (1987) original work, with the exception of some shifts in perceptions of uranium mining and nuclear technology over time. The Factor Analysis results were also noteworthy, as the finding of severe consequences to be dominant was in good agreement with both the seminal work of Fischhoff et al. (1978), as well as the later findings of Sjöberg (2006b). The finding in the results of a secondary factor relating to voluntary choice and personal control is also supported by the literature. When Slovic, Fischhoff, and Lichtenstein (1980) found a three factor solution differing from the two-dimensional structure obtained by Fischhoff et al. (1978), items relating to voluntary choice and personal control were no longer

linked to novelty and knowledge of the risk, but to Dread and the severity of risk consequence (Breakwell, 2007). From this it might be surmised that voluntary control may require a place as a distinct construct from the established factors.

The findings also showed the Psychometric Dread risk factor to be largely dominated by items related to the severity of risk consequence, a finding supported by Schusterschitz et al. (2010) who asserts that "the explanatory power of the Dread factor is strongly influenced by the Severity of Consequences" (p. 394). This interpretation was previously advocated by Sjöberg (2006a), who asserts that "a close look at the definition of Dread shows that it is measured wholly, or mostly, with non-emotional components which can be best summarised as measuring the perceived severity of consequences" (p. 7). In agreement with Sjöberg's (2006b) view of the Dread factor, the study findings are also supported by the results reported in Fischhoff et al.'s (1978) seminal paper, where the Severity of Risk Consequence item was found to have the highest factor loading of all of the Dread factor items.

8.4 Limitations

The study was limited by a number of factors which may be broadly summarised as those inherent to the Psychometric risk methodology, those anticipated in the study design and those encountered during the course of research. Limitations inherent to the Psychometric risk approach were largely adopted in the study and regarded as acceptable. Limitations that were anticipated were acknowledged and accounted for in the study design where possible, as were those encountered during the course of the research.

Breakwell (2007) asserts that the Psychometric risk approach can only capture an "appreciation of the risk that [participants] have at the moment of the study and in a way that they can articulate at that time" (p. 41). Although this risk 'snapshot' is the basis for all Psychometric risk research and is an arguably adequate one, this limitation should nevertheless be taken into consideration. It may be necessary to accept that the relative

pre-eminence of Affect and of Consequence may truly be a matter of timing, context and audience, and be heavily frame-dependent.

The Psychometric risk approach has also been criticised for the use of aggregate data, which gives "much less random error than individual values" (Sjöberg, 2006a, p. 5). It was therefore deemed essential that the results of this Thesis be interpreted in the context of "why people on average judge technologies differently" rather than "why different people judge the same technologies differently" (Breakwell, 2007, p. 46). The Psychometric risk tradition has also been criticised for the mixing of hazards and hazardous activities in the research instruments (Breakwell, 2007). The hazards chosen for the research contained in this Thesis were subject to this limitation; for example, smoking is a hazardous activity, whereas a nuclear reactor accident is a hazard.

There is some debate over the representativeness of samples of participants crowdsourced via Amazon Mechanical Turk (MTurk), and this was identified as a potential limitation of the study in the initial stages. However, the typical demographic of an MTurk sample was not anticipated to contain sub-populations that would invalidate the subject of measurement in the study (Paolacci, Chandler, & Ipeirotis, 2010). This assumption was justified by the Multidimensional Scaling Analysis results which showed Dread risk perceptions to be in general agreement with those reported by Slovic (1987).

It was also considered that there was a potential for inconsistencies in the logic used to ascribe meaning (semantics) to the neutral and negative words. Although it was anticipated that the use of words from the ANEW list (Bradley & Lang, 2010) would provide a level of consistency in interpretation, the potential remained for differences in word interpretation to influence reported perceptions of risk.

Several limitations of the study were identified as the first two study Phases progressed. As the target population was defined as having few demographic boundaries, it was

recognised that a larger sample size would be needed to maximize the chance of detecting a significant result. Statistical Power Analysis was performed on the data gathered in Phases One and Two to provide an optimal sample size for Phase Three. When the data cleanse was performed on the Phase One and Two data, it became apparent by that concentration levels on the accuracy of expressed preferences. This limitation was accounted for by the introduction of 'concentration check' questions in the Phase Three research instruments, where only one answer was correct. Any incorrect responses to this question were discarded from the data analysis.

A major limitation that was identified in Phases One and Two was the need to confirm that the emotional wording used in the study had actually manipulated perceptions of risk via negative Affect. The solution to this issue, it was reasoned, lay in the inverse relationship between risk and benefit observed in previous risk perception research (Alhakami & Slovic, 2006; Finucane et al., 2000; Gardner & Gould, 1989; Gregory & Mendelsohn, 1993). The view that the inverse relationship of risk and benefit is due to the influence of Affect on risk judgements is supported by the work of Finucane et al. (2000) who suggested that "perceived risk and benefit are linked via some sort of affective commonality" (p. 14). Questions relating to the perceived benefit and harm of each hazard were introduced in Phase Three of the study to ascertain whether an increase in perceived benefit and a decrease in perceived harm would be observed in the Affective cohort compared with the neutral cohort. This mitigated the limitation by providing evidence of whether greater Affect had been elicited in the Affective condition or not.

8.5 Conclusion

The received message from the results of this study is that Psychometric Dread is a misleading label for a group of items which relate to two constructs: emotional risk responses based on choice and control, and cognitive risk estimations based on the severity of risk consequences. Affect is chiefly associated with voluntary control, but also with the framed risk context. The implications of the outcomes of the study are

significant to the research and practical levels of risk governance. It offers a view of how risks are assessed in terms of risk consequence estimations, perceptions of personal choice and control, and the subtle associations of Affect with the risk characteristics of the Psychometric Dread risk factor. The next chapter will conclude the Thesis by discussing how the empirical findings of the study converge in response to the Research Questions. The theoretical and policy implications of the results are also discussed together with recommendations for future research. The chapter concludes with closing remarks on the significance and contribution of the study's outcomes to the risk domain.

CHAPTER 9: RECOMENDATIONS AND CONCLUSION

9.1 Introduction

This study set out to explore the concept of Dread risk in terms of Affect and consequence estimation. The study has identified a relationship between risk consequence, voluntary control and Affect in Dread risk perceptions. The general theoretical literature on risk and specifically in the context of Psychometric risk perception, leaves several vital questions relating to Dread risk and Affect unanswered. This study sought to respond to two of these questions:

1. *How is Affect associated with the Dread factor's risk characteristics?*

2. *How is Affect associated with risk consequence?*

This chapter will provide a synthesis of the empirical findings of the study, and show how these converge in response to the Research Questions. The theoretical and policy implications of the research outcomes are also discussed, demonstrating how the findings of the study may influence further understanding and application of knowledge in the risk domain. The chapter concludes with recommendations for future investigations and closing remarks on the significance and contribution of the research.

9.2 Empirical Findings

The main empirical findings are chapter specific and were summarised within the respective empirical chapters five, six, and seven. This section will synthesise the empirical findings in response to the study's Research Questions, *how is Affect associated with the Dread factor's risk characteristics?* and *how is Affect associated with risk consequence?*

Responses to the Research Questions were based on several interpretations of the empirical findings. The first interpretation was that perceptions of voluntary exposure and control over risk are significantly associated with Affect. The empirical findings

underpinning this interpretation included the finding that the neutral and Affective cohorts had significantly different perceptions of either voluntary or control for all but one of the hazards. These risk characteristics were shown to form a separate construct from the remainder of the Dread risk factor items in the Factor Analysis. These result was interpreted as indicating that the Psychometric Dread risk factor is comprised of two separate constructs related to cognitive estimations of risk consequence and emotionally sensitive perceptions of choice and control.

The second interpretation was that the Dread risk factor is largely dominated by risk consequence characteristics. This view was based on the findings that risk consequence characteristics were dominant in the primary factor to emerge from the Factor Analysis and the Dread risk item was of minor importance to overall Dread risk factor perceptions. The third interpretation to shape the response to the Research Questions was that the risk consequence characteristics of the Dread factor are largely unassociated with Affect. The results showed that there were no significant differences between most of the neutral and Affective perceptions of Dread risk consequence characteristics or the Dread item, indicating little association with Affect. This interpretation is not to suggest that Affect has no influence at all on perceptions of risk consequence or on Dread risk, but only that the influence is not greatly significant to the constructs under measurement.

The fourth interpretation significant to the response to the Research Questions was that risk framing may influence Affective perceptions of risk consequences. Indications of some association between Affect and consequence perception were found in the significant difference between neutral and Affective perceptions of consequence severity in the Risk Consequence Task. This result was in contrast to the lack of evidence for an Affective association to risk consequence characteristics found in the Dread risk results. As the major difference between the two research instruments was the specificity with which the risk consequences were framed, an inference based on the literature was made that a lack of specific risk characteristics on which to base risk judgements may result in

the Affective association becoming more pronounced. It was inferred that without adequate framing of risk characteristics, judgement is deferred to Affective impressions based, at least in part, on available information. However, when risk characteristics are made explicit, Affect is shown to be primarily associated with perceptions of voluntary choice and personal control.

The above synthesis of the empirical findings of the study show how these interpretations converge in response to the Research Questions as follows:

- *how is Affect associated with the Dread factor's risk characteristics?*

The association of Affect with the Dread risk factor's risk characteristics is chiefly limited to a construct related to perceptions of voluntary and control, and Affect is largely unrelated to the remaining Dread risk items.

- *how is Affect associated with risk consequence?*

The association of Affect with perceptions of risk consequence is dependent on the characteristics of the risk. When risk characteristics are explicit, perceptions of severe consequences are not generally associated with Affect. Affective associations are largely limited to voluntary and control, which become important to perceptions of risk consequences when they are not framed with reference to specific risk characteristics.

9.3 Theoretical Implications

The implications of the research findings indicate that revisiting the Psychometric Theory of Risk and the role of Affect may be worthwhile. This Thesis forwards an understanding of the role of Affect in perceived risk, and offers some insight into the elements which make Dread risk successful. The Dread risk factor is widely regarded as the most important factor to emerge from the Psychometric Paradigm of risk perception (Taylor-Gooby & Zinn, 2006b) and the role of Affect in risk judgements was identified early on as being among the key questions in the research domain (Breakwell, 2007). However,

Sjöberg (2006b) argues that confusion has arisen from the broadening of the meaning of Affect to include the concept of Attitude, and this has resulted in the findings of Affect Heuristic research being linked to the Psychometric concept of Dread risk.

It is however noted from the results of this study that the association between Affect and Dread risk is not entirely unjustified. Among the heterogeneous assortment of Dread risk items, it is the voluntary and control characteristics which are associated with Affect. Sjöberg (2003) has previously highlighted the need for an investigation of the Affective relationship to Dread risk items, stating that these "dimensions may have a relationship to emotional processes but they are not emotional *per se* and their emotional significance remains to be documented" (p. 109). In this way, the results of this study offer some insight into the emotional processes behind Dread risk characteristics, and are significant to Psychometric risk research.

Sjöberg (2006b) also asserts that the Dread factor is a heterogeneous blend of different risk characteristics, rather than a quantitative measure of Affective risk reactions. The outcomes of this study show that this view is also not unjustified, indicating that Dread risk is dominated by severe consequences. Schusterschitz, Schütz, and Wiedemann (2010) found that "the explanatory power of the Dread factor is strongly influenced by the Severity of Consequences" (p. 394), an interpretation previously advocated by Sjöberg (2006a), who asserts that "a close look at the definition of Dread shows that it is measured wholly, or mostly, with non-emotional components which can be best summarised as measuring the perceived severity of consequences" (p. 7).

However, the outcomes of this research are also in agreement with the early findings that perceptions of Dread risk are associated with Affect (Fischhoff, Slovic, Litchtenstein, Read, & Combs, 1978; Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1980), although the findings limit the association to perceptions of voluntary and control. The assertion of Pidgeon, Simmons, and Henwood (2006) that many of the Dread risk factor's

characteristics tap into concerns unrelated to Affect is not unfounded, nor is the view that Dread is related to Affect, however the results of this research reveal a more subtle and complex relationship between feelings, choice, control and consequences that is of value to the understanding of risk perception and risk acceptance.

The research finding that Affective associations with perceptions of risk consequence are linked to the characteristics with which risks are framed also has significant implications for the Psychometric Theory of Risk. The view that Affective reactions are inextricably linked to linguistic meanings of risk provides the Psychometric paradigm of risk with a vehicle for assessing risk perceptions. The Psychometric paradigm attempts to explain risk perception through expressed preferences (Fischhoff et al., 1978; Slovic, Fischhoff, & Lichtenstein, 1985), and the context and content of the language used to elicit those preferences is important.

The finding of the study that the specificity of the terms with which risk characteristics are communicated is of greater importance to Affect than the emotional tone, suggests that Affect may be more strongly related to the context than to the content of the risk message. The importance of language to Affect and perceptions of risk is also significant to the Psychometric Theory of Risk in the respect that Dread is a misleading label for a consequence dominated factor. Sjöberg (2007) asserts that as a factor in the Psychometric paradigm, Dread is somewhat of a misnomer, and that the bulk of the explanatory power of Dread risk is "carried by the non-emotional content of the Dread factor" (Sjöberg, 2007, p. 2). The study results confirm this observation, finding that Affect was not associated with the dominance of consequence risk characteristics in the factor.

9.4 Policy Implications

Risk research is ultimately concerned with questions about "the kind of world we would like to live in, and the technical developments we wish to support, or the risks we are willing to take" (Zinn & Taylor-Gooby, 2006a). As such, the implication of any risk research has significant implications for risk governance and policy development. The implications of the research outcomes are best understood in the context of the theoretical framework from which the study arose.

In this context, Psychometric risk research provides insights into the way in which risks are perceived, which has implications for understanding behaviour in response to risk issues, as "one cannot predict how people will respond to an issue without knowing how they perceive it" (Fischhoff, 1985, p. 90). The Psychometric Dread factor is regarded as the main determiner of risk perception and much of the success in the field of risk perception research may be attributed to the Psychometric Paradigm (Bouyer, Bagdassarian, Chaabanne, & Mullet, 2001; Breakwell, 2007; Conrad, 1980; Fischhoff et al., 1978; Jenkin, 2006; von Winterfeldt, John, & Borcherding, 1981).

Other work has refined the concept of Dread risk to an emotional factor, principly in light of research stressing the importance of the Affect Heuristic to percieved risk (see Finucane, Alhakami, Slovic, & Johnson, 2000; Peters & Slovic, 1996; Rottenstreich & Hsee, 2001; Slovic, Finucane, Peters, & MacGregor, 2002, 2004, 2007; Slovic, Peters, Finucane, & MacGregor, 2005).

However, evidence from several studies, including Palmer (1996), Sjöberg (2006b), Schusterschitz et al. (2010) and this Thesis indicate that the Dread risk factor is largely comprised on non-emotional items dominated by consequence characteristics. The findings of this Thesis also document the significance of Affect to Dread risk characteristics, thereby clarifying some "questionable assumptions and overly strong generalizations have been made" (Sjöberg, 2003a, p. 109) regarding the Dread risk factor.

The theoretical arguments for this justification suggest that it is insufficient to advocate for the inclusion of the Psychometric Dread factor in risk governance processes on the basis of Dread risk as Affect. For example, the Standards Australia HB 167:2006 Security Risk Management handbook asserts that "many aspects of risk management are highly subjective and are greatly influenced by the perceptions of information providers, analysts, and users of the products of security risk management" (Standards Australia, 2006, p. 20).

The guide defines Dread as "the level of fear… of an event occurring [which] elevates perceptions of the risk beyond reasonable norms" (Standards Australia, 2006, p. 20), and gives the example of the perceived risk of airline travel in response to the threat of terrorism. The results of this study however, offer a more refined conception of the Affective influence on Dread risk characteristics, providing greater clarity on risk judgements and acceptance. For example, instead of an example of fear increasing risk perceptions beyond the norm, the increase in motor vehicle fatalities in the 12 months post 9/11 in the United States (Gigerenzer, 2006) may be ascribed to the perception of greater control and choice in the risk outcome of driving a personal vehicle, when compared with airline travel.

The study outcomes are also significant to risk communication and are related to one of the key questions impacting the area, which is "what systematic departures from rationality can be identified" (Viscusi, 1997, p. 1659). The finding in this study that Dread risk is chiefly governed by estimations of severe consequences rather than emotional considerations may influence the understanding of how the judgements of risk communication audiences are expressed. If Dread risk is viewed as a measure of irrational emotional response to risk, then it may be inferred that Dread risk informs the degree to which risk perception is "beyond reasonable norms" (Standards Australia, 2006, p. 20).

However, Sjöberg (2007) asserts that risk communication based on the "notion of the primacy of a primitive initial emotional reaction" (p. 223) will likely fail, and the outcomes of this study offer a more refined perspective of Dread and Affect relating to perceptions of voluntary and control. Risk communication practitioners may benefit from the results which show that that it is perceptions of voluntary control which are sensitive to Affect and may influence risk perceptions beyond the norm. It may also be inferred from that results that if perceptions of risk consequences are considered to be beyond reasonable norms, then the risk message may be enhanced through ensuring that risk characteristics are made clear, with care taken to address issues of voluntary and choice.

An awareness of the impact of different risk judgements is also "of intense practical significance" (Viscusi, 1997, p. 1658) to policy development. The interpretation of this Thesis that concepts of personal choice and control are associated with emotions may offer potential avenues of policy research, as investigations in this area consistently "measure public opinions…but struggle to understand the basis for those opinions" (Viscusi, 1997, p. 1658). Of significance to policy development are the implications of the study outcomes to understanding risk acceptance in relation to choice, control and Affect, potentially offering insights into "how the behavior and responses of actors are to be understood" (Taylor-Gooby & Zinn, 2006a p. 407).

9.5 Recommendations

The scale of the debate over the relationship of Affect to Dread risk characteristics and the dominance of severe consequences in the factor is therefore multifaceted. In order to generate a robust theoretical framework around these concepts that will lead to achievable risk governance strategies, further investigation into the role of Affect in perceptions of voluntary control related risk characteristics is recommended. Exploring the following, as future research strategies, will facilitate the attainment of this goal:

- *Investigation of other potential risk characteristics related to the voluntary control construct*: research into other risk characteristics related to the voluntary control construct would allow exploration of the extent of the factor and its association with Affect. Outcomes may be significant to Psychometric risk research and risk governance.

- *Investigation of the specificity of risk framing and the association with Affect*: research into the context of risk messages versus the content, and how this impacts risk perception and Affective reactions may have outcomes particularly significant to the field of risk communication.

- *Investigation of whether Affect and attribute substitution play a role in risk perceptions when information is specific versus non-specific*: research in this area would show which other risk attributes are substituted for cognitive considerations when risk characteristics are and are not specified, and whether there is an association with Affect. Outcomes may also be significant to Psychometric risk and risk governance research.

These future research directions would build on the findings of the current study, and allow further assessment of the way in which Affect and concepts of personal choice and voluntary control impact risk perceptions and behaviour. Such a direction in future research would promote the development of a more robust view of the ways in which Affect is associated with different risk characteristics, and further dispel some of the misconceptions of Psychometric risk factors.

9.6 Conclusion

The most important statement that can be made in regards to the research outcomes is that Dread risk as Affect is largely limited to concepts of control and choice, and that these concepts form a construct distinct from unemotional assessments of severe consequences. The way in which fear influences risk perceptions and acceptance is related to the ability to anticipate future events, and to judge the implications of those events. Risk perception invariably originates from an individual perspective, giving rise to concern over how the risk of the hazard impacts *me*. From an evolutionary perspective, it is most logical for emotion to influence perceptions of how much control and choice one has over an anticipated negative outcome.

Consideration of control and choice in the face of risk influences risk behaviour and is associated with an Affective impetus for action, an innate human impulse for mitigation of those risks which are perceived as being responsive to one's control and choice. There is arguably little evolutionary point in an Affective association with risk consequences that are unrelated to voluntary choice and personal control. If there is the potential for a choice in exposure and control over a risk, it follows that an emotional impetus to carry out mitigation strategies is an excellent survival trait. The fight or flight response refers to the emotional impulse to either run away from or confront a threat; to choose retreat or exercise some form of control. Control and choice are therefore arguably more fundamental considerations to the Affective impact on the perception of risk, than the concept of Affect as a fear response.

Just as the fear of a harmless spider may cause a fight or flight response despite the knowledge of negligible consequences, activities with severe consequences such as smoking are routinely indulged in by some individuals. Thus an Affective association with concepts of choice and control is a far more satisfactory explanation for many risk behaviours than the conception of Affect as Dread risk. Simply because a risk is dreaded does also not infer that this relates to estimations of consequence severity or that

consequence severity is related to Affect. The label of the Dread risk factor is therefore a misleading representation of its two main characteristics of consequence and voluntary control. The overall view of this Thesis that the emotional response to risk is frame dependent and related to concepts of *action*, such as voluntary and control, offers a tangible link between the biases of subjective human perception and the objective reality of risk behaviour.

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APPENDIX A: PSYCHOMETRIC DREAD RISK SURVEY

Phase One Neutral Psychometric Dread Risk Survey

This research instrument used ten Psychometric Dread Risk items and posed them as questions concerning six hazards:
   a) Aspirin
   b) Vaccination
   c) Smoking
   d) Fossil fuels
   e) Uranium mining
   f) Nuclear reactor accidents

The following questions were asked separately for each hazard (x), but have been condensed here.

Thinking of the risks associated with (x), please answer the following questions:

Do you think that this is the kind of risk where the consequences could be fatal?
(1 = No risk of fatality / 7 = High risk of fatality)

Is this the kind of risk you can learn to live with and rationally deliberate about, or one that you dread? (1 = Calmly deliberate / 7 = Dread)

Do you think this kind of risk has the potential to become a catastrophe?
(1 = Low potential / 7 = High potential)

Do you think that any risk that may be posed from (x) extends to future generations?
(1 = This generation only / 7 = Many generations to come)

How easy or difficult would it be for you to reduce any risk you might face from (x)?
(1 = Extremely easy / 7 = Extremely difficult)

Do you think the risks from (x) are increasing, decreasing, or staying the same?
(1 = Decreasing / 4 = Staying the same / 7 = Increasing)

Do you think this kind of risk has the potential to have a global catastrophic impact?
(1 = small local impact / 7 = global catastrophic impact)

How much control do you think you personally have over avoiding possible risks to yourself from (x)? (1 = Total control / 7 = No Control)

Do you think that all people are impacted by this risk equally, or are some people more at risk than others? (1 = Very equal / 7 = Not equal at all)

Do you think you have much choice over accepting any possible risks of (x)?
(1 = Completely my choice / 7 = No choice)

Phase One Affective Psychometric Dread Risk Survey

This research instrument used ten Psychometric Dread Risk items and posed them as questions concerning six hazards:

  a) Aspirin
  b) Vaccination
  c) Smoking
  d) Fossil fuels
  e) Uranium mining
  f) Nuclear reactor accidents

The following questions were asked separately for each hazard (x), but have been condensed here.

Thinking of the risks associated with (x), please answer the following questions:

Do you feel that this is the kind of risk where the consequences could result in death? (1 = No risk of death / 7 = High risk of death)

Is this the kind of risk you can learn to live with and rationally deliberate about, or one that you dread and are terrified of?   (1 = Calmly deliberate / 7 = Dread)

Do you feel this kind of risk has the potential to cause catastrophic death and destruction? (1 = Low potential / 7 = High potential)

Do you feel that any risk that may be posed from (x) extends to the babies, children and adults of future generations? (1 = This generation only / 7 = Many generations to come)

How easy or difficult would it be for you to reduce any danger you might face from (x)? (1 = Extremely easy / 7 = Extremely difficult)

Do you feel the dangers of (x) are increasing, decreasing, or staying the same? (1 = Decreasing / 4 = Staying the same / 7 = Increasing)

Do you feel the impact of this risk has the potential to be a very localised tragedy, or a global catastrophe that brings misery and grief to millions? (1 = very local impact / 7 = global catastrophic impact)

How much control do you feel you personally have over avoiding the possible dangers of (x)?   (1 = Total control / 7 = No Control)

Do you feel that all people are impacted equally by this risk, or do some people suffer more than others? (1 = Very equal / 7 = Not equal at all)

Do you feel you have much choice over accepting any possible risks from (x), such as [Affective example]? (1 = Completely my choice / 7 = No choice)

Phase Three Neutral Psychometric Dread Risk Survey

This research instrument used ten Psychometric Dread Risk items and posed them as questions concerning six hazards:

a) Aspirin
b) Vaccination
c) Smoking
d) Fossil fuels
e) Uranium mining
f) Nuclear reactor accidents

The following questions were asked separately for each hazard (x), but have been condensed here.

Think of the risks associated with (x). What comes to mind?
Now please answer the following questions:

Do you think that this is the kind of risk where the consequences could be fatal?
(1 = No risk of fatality / 7 = High risk of fatality)

Is this the kind of risk you can learn to live with and rationally deliberate about, or one that you dread?
(1 = Calmly deliberate / 7 = Dread)

Do you think this kind of risk has the potential to become a catastrophe?
(1 = Low potential / 7 = High potential)

Do you think that any risk that may be posed from (x) extends to future generations?
(1 = This generation only / 7 = Many generations to come)

How easy or difficult would it be for you to reduce any risk you might face from (x)?
(1 = Extremely easy / 7 = Extremely difficult)

Do you think the risks from (x) are increasing, decreasing, or staying the same?
(1 = Decreasing / 4 = Staying the same / 7 = Increasing)

Do you think this kind of risk has the potential to have a global catastrophic impact?
(1 = small local impact / 7 = global catastrophic impact)

How much control do you think you personally have over avoiding possible risks to yourself from (x)?
(1 = Total control / 7 = No Control)

Do you think that all people are impacted by this risk equally, or are some people more at risk than others?
(1 = Very equal / 7 = Not equal)

Do you think you have much choice over accepting any possible risks from (x)?
(1 = Completely my choice / 7 = No choice)

Phase Three Affective Psychometric Dread Risk Survey

This research instrument used ten Psychometric Dread Risk items and posed them as questions concerning six hazards:
   a) Aspirin
   b) Vaccination
   c) Smoking
   d) Fossil fuels
   e) Uranium mining
   f) Nuclear reactor accidents

The following questions were asked separately for each hazard (x), but have been condensed here.

Think of the risks associated with (x) What comes to mind?
Now please answer the following questions:

Do you feel that this is the kind of risk where the consequences could result in death?
(1 = No risk of death / 7 = High risk of death)

Is this the kind of risk you can learn to live with and rationally deliberate about, or one that you dread and are terrified of?
(1 = Calmly deliberate / 7 = Dread)

Do you feel this kind of risk has the potential to cause catastrophic death and destruction?
(1 = Low potential / 7 = High potential)

Do you feel that any risk that may be posed by (x) extends to the babies, children and adults of future generations?
(1 = This generation only / 7 = Many generations to come)

How easy or difficult would it be for you to reduce any danger you might face from (x)?
(1 = Extremely easy / 7 = Extremely difficult)

Do you feel the dangers of (x) are increasing, decreasing, or staying the same?
(1 = Decreasing / 4 = Staying the same / 7 = Increasing)

Do you feel the impact of this risk has the potential to be a very localized tragedy, or a global catastrophe that brings misery and grief to millions?
(1 = very local impact / 7 = global catastrophic impact)

How much control do you feel you personally have over avoiding the possible dangers of (x)?
(1 = Total control / 7 = No Control)

Do you feel that all people are impacted equally by this risk, or do some people suffer more than others?
(1 = Very equal / 7 = Not equal at all)

Do you feel you have much choice over accepting any possible risks from (x), such as [Affective example]?
(1 = Completely my choice / 7 = No choice)

APPENDIX B: RISK CONSEQUENCE TASK SURVEY

Phase One Neutral Risk Consequence Task

For each of the following questions, please select the number (1 to 7) that best represents your opinion.

Please indicate how severe you think the consequences associated with the risk of taking Aspirin are. (1 = Not Serious / 7 = Extremely Serious)

Please indicate how severe you think the consequences associated with the risk of Vaccination are. (1 = Not Serious / 7 = Extremely Serious)

Please indicate how severe you think the consequences associated with the risk of Smoking are. (1 = Not Serious / 7 = Extremely Serious)

Please indicate how severe you think the consequences associated with the risk of using Fossil Fuels are. (1 = Not Serious / 7 = Extremely Serious)

Please indicate how severe you think the consequences associated with the risk of Uranium Mining are. (1 = Not Serious / 7 = Extremely Serious)

Please indicate how severe you think the consequences associated with the risk of Nuclear Reactor accidents are. (1 = Not Serious / 7 = Extremely Serious)

Phase One Affective Risk Consequence Task

For each of the following questions, please select the number (1 to 7) that you feel best represents your opinion.

How severe do you feel the consequences of taking Aspirin could be, such as the danger of developing ulcers? (1 = Not Serious / 7 = Extremely Serious)

How severe do you feel the consequences of Vaccination could be, such as suffering distressing symptoms like fever and vomiting?(1 = Not Serious / 7 = Extremely Serious)

How severe do you feel the consequences of Smoking could be, such as developing cancer or heart disease? (1 = Not Serious / 7 = Extremely Serious)

How severe do you feel the consequences of using Fossil Fuels are, such as rising pollution and toxic waste? (1 = Not Serious / 7 = Extremely Serious)

How severe you feel the consequences of Uranium Mining are, such as the possibility of accidents during the transport of nuclear material? (1 = Not Serious / 7 = Extremely Serious)

How severe you feel the consequences of Nuclear Reactor Accidents are, such as the threat of radiation burns or developing cancer? (1 = Not Serious / 7 = Extremely Serious)

Phase Three Neutral Risk Consequence Task

This research instrument asked about three aspects of each of the six hazards:
1. Benefit
2. Harm
3. Consequence

Each of the hazards were preceded by a framing statement:

- *"Aspirin's benefits go far beyond the traditional treatment for aches and pains"*

- *"Doctors say side-effect fears obscure vaccination benefits"*

- *"Increasing obesity rate eliminates benefits from smoking cessation"*

- *"Fossil fuels: Efficient, cheap, and have storage advantages"*

- *"It is completely safe to consume fish, game and fruit from regions near operating uranium mines and mills."*

- *"Nuclear power can be harnessed safely"*

The following questions were asked separately for each hazard (x), but have been condensed here.

Please think of the risks associated with (x) what comes to mind?
Now please answer the following questions:

How much of a benefit do you think (x) is?
(1 = No benefit / 7 = Great benefit)

How much harm do you think is caused by (x)?
(1 = No harm / 7 = Great Harm)

How severe do you think the consequences associated with the risk of (x) are?
(1 = Not Serious / 7 = Extremely Serious)

Phase Three Affective Risk Consequence Task

This research instrument asked about three aspects of each of the six hazards:
4. Benefit
5. Harm
6. Consequence

Each of the hazards were preceded by an Affective framing statement and had differing Affective wording. The survey is reproduced in full here.

Please read the following statement, and answer the questions below.
"Daily Aspirin use could be more harm than good"

After reading the statement above, how much harm do you think the use of Aspirin causes?
(1 = No Harm / 7 = Great Harm)

How much Benefit do you think is associated with the use of Aspirin?
(1 = No Benefit / Great Benefit)

How severe do you feel the consequences of taking Aspirin could be, such as the danger of
developing ulcers?

Please read the following statement, and answer the questions below.
"Autism-vaccine fear confounds scientific community"

After reading the statement above, how much harm do you think Vaccination causes?
(1 = No Harm / 7 = Great Harm)

How much Benefit do you think is associated with Vaccination?
(1 = No Benefit / Great Benefit)

How severe do you feel the consequences of Vaccination could be, such as suffering distressing symptoms like fever and vomiting, or the anecdotal link to Autism?
(1 = Not Serious / 7 = Extremely Serious)

Please Read the following statement, and answer the questions below.
"Risk of early death from smoking more severe than thought ..."

After reading the statement above, how much harm do you think is caused by Smoking?
(1 = No Harm / 7 = Great Harm)

How much of a Benefit do you think Smoking may be?
(1 = No Benefit / 7 = Great Benefit)

How severe do you feel the consequences of Smoking could be, such as developing cancer or heart disease?
(1 = Not Serious / 7 = Extremely Serious)

Please Read the following statement, and answer the questions below.
"Governments Are Blind To Fossil Fuel Energy Risk"

After reading the statement above, how much harm do you think is caused by Fossil Fuel use?
(1 = No harm / 7 = Great Harm)

How much Benefit do you think is associated with the use of Fossil Fuels?
(1 = No Benefit / 7 = Great Benefit)

How severe do you feel the consequences of using Fossil Fuels are, such as rising pollution, polar melting, and toxic waste?
(1 = Not Serious / 7 = Extremely Serious)

Please read the following statement and answer the questions below.
"Greenland Has Melted So Much That We Can Mine It for Uranium Now"

After reading the statement above, how much harm do you think is caused by the mining of Uranium?
(1 = No harm / 7 = Great Harm)

How much of a benefit do you think the mining of Uranium is?
(1 = No benefit / 7 = Great benefit)

How severe you feel the consequences of Uranium Mining are, such as the possibility of accidents during the transport of nuclear material?
(1 = Not Serious / 7 = Extremely Serious)

Please read the following statement, and answer the question below.
"Scientists Warn of Extreme Risk: Greatest Short term Threat to Humanity is from Fukushima Nuclear Plant Fuel Pools"

After reading the statement above, how much harm do you think is caused by Nuclear reactors, and potential accidents?
(1 = No harm / 7 = Great Harm)

How much of a benefit do you think Nuclear Reactors are?
(1 = No benefit / 7 = Great benefit)

How severe you feel the consequences of Nuclear Reactor Accidents are, such as the threat of radiation burns or developing cancer?
(1 = Not Serious / 7 = Extremely Serious)

APPENDIX C: PARTICIPANT INFORMATION FORM

The following information was made available to participants on an introductory screen that displayed after participants clicked on the survey.

This study is about risk perception and how people estimate the impact of risks. People judge risks based on their perception, which is a rapid process of forming and testing ideas regarding what is being perceived.

The aim of the project is to examine the way that emotions influence our judgements of risk consequences. You are a potential participant as a user of Amazon Mechanical Turk. You will be asked to complete a simple survey. You may withdraw your participation at any stage. Participants in the study will receive [amount specified] per survey completed through Amazon Mechanical Turk.

The first survey involves indicating your opinion about certain risks. Remember, there are no right or wrong answers. We are interested in your opinion. You can indicate your opinion by selecting the number which best represents your opinion on a scale of 1 to 7. The survey is easy to complete, and all the questions ask you to simply rank your opinion by circling a number. The survey takes approximately [time specified] to complete, and no further participation in the study is required.

This research project is being undertaken as part of the requirements of a PhD at Edith Cowan University. Participation in the study is entirely voluntary and consent to participate may be revoked at any stage without condition. The information gathered about you by the investigator or obtained during the study will be held by the investigator in strict confidence. All the people who handle your information will adhere to traditional standards of confidentiality and will also comply with all relevant privacy legislation. In Australia this is the Privacy Act 1988. The Ethics Committee has obtained assurances from the investigator that the 'Information Privacy Principles' laid down in the Act will be met, and will oblige all involved to meet strict privacy standards. The Privacy Act does not apply overseas but there is equivalent binding legislation in force in the USA, the European Union and elsewhere. No reader will be able to identify individual participants in any publication, report, or presentation arising from this study.

APPENDIX D: PARTICIPANT CONSENT

The information on the following form was made available to participants. Participants were able to confirm their consent to participate in the study by clicking on and "Agree" button on the page which linked to the online survey site.

If you would like to participate in the study, please click on the "Agree" button below.

By pressing the agree button, I freely agree to participate in the above study. I have read and understood the Participant Information and I have access to a copy of it. I understand that I have the opportunity to ask questions about the study. I am aware that I am free to contact the researcher if I have any further questions. I understand that the study involves indicating my opinion on a set of statements in the online questionnaire. I am aware that I am free to withdraw from the study at any time.

I understand that the information I provide will only be used for the purposes of this research project. I am aware that the investigator of the study will adhere to usual standards of confidentiality in the collection and handling of any personal information and that the standards of the Privacy Act 1988 will apply to the way information is handled.

Agree   *Disagree*