Agathe Backer-Grøndahl
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Institute of Transport Economics
Norwegian Centre for Transport Research

Risk perception and transport – a literature review

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Summary:
The Institute of Transport Economics is conducting a project on perceived risk on various transport modes within the research program Risk and safety in the transport sector (RISIT), funded by the Research Council of Norway. In order to provide a sound theoretical and scientific basis for generating specific research questions, sub-projects, and surveys, relevant research literature within the field is reviewed in the present report. First, the dominating lines of research within the risk perception literature is presented, followed by new trends in the field, with a specific emphasis on risk perception in transport. Finally, we discuss the operationalisations of risk within empirical studies and challenges related to such operationalisations.

Sammendrag:
Innen Forskningsrådets RISIT-program har TØI et prosjekt om risikopersepsjon på ulike transportmidler. Som bakgrunn for utforming av spesifikke forskningsspørsmål, delprosjekter og spørreskjema har vi i denne rapporten gått igjennom relevant forskningslitteratur, for på den måten å ha et godt teoretisk vitenskapelig grunnlag for videre arbeid. I rapporten presenteres hovedlinjene innen risikopersepsjonsforskningen generelt. Videre presenteres forskning på risikopersepsjon i transport spesielt, samt ulike komponenter i risikobegrepet slik det brukes i risiko-persepsjonslitteraturen. Rapporten avsluttes med en diskusjon av operasjonalisering av risiko i empiriske risikopersepsjonsstudier og av utfordringene ved en slik operasjonalisering.

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Preface

The Institute of Transport Economics (TØI) is conducting a project on perceived risk on various transport modes. The project is funded through the research program Risk and safety in the transport sector (RISIT), hosted by the Research Council of Norway. In order to provide a sound theoretical and scientific basis for generating specific research questions, sub-projects, and surveys, it was valuable to review relevant research literature within the field. Thus, the present report aims at presenting dominating lines of research within the risk perception literature. The report particularly emphasises new trends in the field and literature concerning risk perception in transport.

Researchers at TØI Agathe Backer-Grøndahl and Aslak Fyhri have conducted the literature review and written the report. Truls Vaa (TØI) and Pål Ulleberg (TØI/UiO) have both contributed with theoretical and methodological perspectives and discussions. Fridulv Sagberg has been responsible for quality assurance, and Trude Rømming has edited and prepared the report for printing.

Oslo, March 2009
Institute of Transport Economics

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Contents

TØI rapport 1008/2009
Agathe Backer-Grøndahl og Aslak Fyhri
Oslo 2009, 40 sider

Sammendrag:

Risikopersepsjon og transport – en litteraturgjennomgang

Hensikten med denne rapporten har vært å lage en oversikt over de dominerende linjene i risikopersepsjonsforskningen ved å presentere forskningslitteratur på feltet. Spesielt har vi sett på nyere trender og litteratur som ligger i skjæringsfeltet "risikopersepsjon" og "transport". Litteraturgjennomgangen viser at det er to hovedlinjer i forskningen på risikopersepsjon – innen det psykometriske paradigmet er man først og fremst opptatt av å studere egenskaper ved de ulike risikokildene, mens man i en annen forskningslinje fokuserer på egenskaper ved personene som opplever risiko. I nyere forskning har man fokusert på følelser som en del av risikoopplevelsen, ved siden av det rent kognitive som tradisjonelt har dominert risikopersepsjonsforskningen. I forskningslitteraturen er det i svært liten grad diskutert hvordan risikobegrepet bør operasjonaliseres. Det er betimelig med en begrepsavklaring for å finne et risikobegrep som er teoretisk forankret samtidig som det er intuitivt og anvendbart for lekmannen.

Forskning på risikopersepsjon – to hovedlinjer

Risiko kan defineres som produktet av sannsynligheten for at noe (uheldig) skal inntreffe, og konsekvensene av det inntrufne. Dette er slik begrepet gjerne blir brukt blant fagfolk. I denne rapporten er det dog ikke "faktisk" risiko slik det blir brukt av profesjonelle som er av betydning, men risikopersepsjon. Risikopersepsjon viser til risiko slik det oppleves av vanlige folk, og går som forskningsfelt gjerne utover en streng rasjonell fortolkning av begrepet, til å inkludere kunnskap om de tanker og følelser folk knytter til risikoerfaringene.

En kan spore to hovedlinjer innen risikopersepsjonslitteraturen: Innen det psykometriske paradigmet er man først og fremst opptatt av å studere egenskaper knyttet til ulike potensielle farer eller risikokilder (risk hazards) og på denne måten si noe om hvilke risikokilder som blir oppfattet som å ha høyest risiko og hvilke egenskaper ved risikokildene som er bestemmende for folks vurdering av risiko. I en annen forskningslinje fokuseres det på egenskaper ved personene som opplever risikoen, og i hvilken grad slike personlige, sosiale, politiske og kulturelle egenskaper påvirker risikoopplevelse. Sagt på en annen måte ser man i det psykometriske paradigme på variasjon mellom ulike risikokilder og egenskaper ved disse, mens man i den andre hovedlinjen i dette feltet ser på variasjon i risikopersepsjon mellom mennesker, sosiale grupper og kulturer.

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Emosjon i risikopersepsjon

Risikopersepsjonsforskningen er nært knyttet til kognitiv beslutningsteori, og tradisjonelt har man i dette feltet gått ut i fra teori om rasjonelle aktører. Det har således vært fokus på de kognitive vurderinger folk gjør av ulike risikokilder. Nyere forskning bygger i større grad på teorier om emosjoner og affekt som viktige faktorer i beslutninger og vurderinger, og etter 2000 har det vært et fokus på affekt og emosjoner også i risikopersepsjonslitteraturen. I forbindelse med introduksjon av emosjoner og affekt som komponenter i måten folk vurderer risiko på, er en utfordring å fange opp slike emosjonelle komponenter

Risikopersepsjon i transport

Det har i den senere tid vært et økende fokus på risikopersepsjon i transport, og det har blitt foretatt noen studier av folks opplevelse av risiko eller utrygghet på reiser med ulike transportmidler. Funn fra slike studier tyder på at transportmidlene kan ordnes i to grupper når det gjelder opplevelse av utrygghet: private transportmidler og kollektivtransport. Folk opplever i større grad at de private transportmidlene er forbundet med risiko enn de kollektive transportmidlene. En begrensning med en del av disse studiene er at man ofte kun har spurt om risiko/utrygghet i forbindelse med å oppleve ulykker. Når man reiser med kollektivtransport er det sannsynligvis andre hendelser enn ulykker som gjør at man opplever utrygghet, for eksempel å bli utsatt for vold, ran, ubehagelige personer, trusler osv. Det har vist seg hensiktsmessig å skille mellom risiko for ulykker og risiko for ubehagelige hendelser i forbindelse med transport. Det er for eksempel funnet at folk som er utrygge for ubehagelige hendelser foretar atferdstilpasninger når de reiser med kollektivtransport, mens de som er utrygge for ulykker foretar atferdstilpasninger når de benytter private transportmidler. Gange er et unntak, da dette kan defineres som en privat reisemåte, samtidig som dette er en av de reisemåtene folk opplever som mest utrygg med tanke på ubehagelige hendelser.

Risikopersepsjon – diskusjon

Til tross for at det innen risikopersepsjonsfeltet er gjennomført en mengde empiriske studier, er det kun i svært liten grad diskutert hvordan risikobegrepet bør operasjonaliseres. En gjennomgang av litteraturen viser at det heller ikke er én måte å måle oppfattet risiko på. Et poeng med denne litteraturgjennomgangen var å etablere en tydeligere link mellom risikopersepsjonslitteraturen og et mer anvendt perspektiv på risikopersepsjon i transport.

Mye tyder på at ”risiko” ikke er et entydig begrep: ulike personer mener ulike ting med ”risiko”. I tillegg er det slik at ”risiko” oppfattes ulikt når det knyttes til ulike transportmidler. Med dette som utgangspunkt kan det hevdes at det ikke er hensiktsmessig å operasjonalisere opplevd risiko ved å bruke ordet ”risiko”. Dersom en bruker dette ordet vet en ikke hva folk tenker på – om det er sannsynligheten for at noe skal skje, konsekvensene av at noe skjer, hvor redde de er for at noe skal skje, eller lignende. Det er tidligere foreslått at ordet risiko bør

brukes da dette er mer eller mindre ”likt” på tvers av land og språk (risk, risque, risiko, osv.), men all den tid dette begrepet er mange-fasettert og det er variasjon mellom mennesker i hva man mener med det, er ikke dette et holdbart argument. Det kan derfor være hensiktsmessig å finne ett eller flere mer anvendbare begreper som er mer intuitive i forhold til ulykker og ubehagelige hendelser i transport. Denne litteraturgjennomgangen har vært et forsøk på å berede grunnen for en slik begrepsavklaring. I videre studier vil vi forfølge den forskingslinjen som har fokusert på emosjonelle faktorer i risikopersepsjon, og undersøke hvilke operasjonaliseringer (sannsynlighetsvurdering, utrygghet/bekymring eller ”risiko”) som har størst grad av sammenheng med faktiske atferdstilpasninger knyttet til transportmidler.

1 Introduction

It is essential both at political and individual levels to understand how people think about risk, what hazards are perceived as having high risk, and what people worry about. In particular, information about various hazards and their potential risks should be provided in a way that makes the public manage the risks in a reasonable way. That is, based on risk information, people should be able to make judgements that promote an adaptable way of living - without being overly worried or afraid about the riskiness of hazards, but at the same time reason about some risks and take precautions when necessary. In order to communicate risk in a way that will influence people's way of thinking about the hazards and risks, research on risk perception is essential. Risk perception research makes it possible to understand not only what hazards people perceive as risky, but also what aspects of the hazard "constitute" the risk, if perceived risk varies between individuals, what aspects of risk perception that influence behaviour etc. In addition to serving as basic information for risk communication, knowledge about people's perception of risk and its effect on behaviour is important with regard to implementation of safety and security precautions.

Moreover, knowledge about what hazards people believe are risky, as well as in what way hazards are perceived as risky, is important for ensuring peoples' well-being – physically as well as psychologically.

Risk perception research dates back to the start of the so-called "psychometric paradigm" in the late 1970's (Slovic 2000). Psychological research on decision making, heuristics and cognitive biases were especially influential in the early research on risk perception. Later, the field of risk perception research has propagated to other areas of social sciences, and both sociological and social anthropological, as well as psychological, perspectives on risk perception have been influential in the development of this research field (Boholm 1998; Sjöberg et al. 2004; Slovic 2000). While the research within the psychometric paradigm first and foremost has been focused on studying aspects of various risk hazards and in this way map what hazards are perceived as having high risk, social anthropological and sociological research have been preoccupied with studying variations in risk perception between cultures and individuals (Chauvin et al. 2007). Thus, roughly one can detect two lines of research, one focusing on aspects linked to the risk hazard, and one focusing on aspects linked to the risk perceiver (Bouyer et al. 2001).

The main aim of this literature review is to give an outline of the field of risk perception in general, and risk perception and transport in particular. More specifically, a short description of the dominating lines of research will be given, followed by a discussion of new trends within the field. As our point of departure is transport, research on risk perception – and worry – in the field of transport will be emphasised. One of the main reasons for conducting this literature review is to obtain knowledge about how to best operationalise "risk perception" in transport.

1.1 Methods

Literature search was conducted in Science Direct and ISI web of Science using variations of the following key words: risk perception/worry/ and transport/transport modes/traffic. Subsequently, more literature was obtained following relevant references. As the field of risk perception research is rather large, this is not meant to be an exhaustive literature review, rather to give an outline of the field.

1.2 Concepts

In science, *risk* is a statistical concept that denotes the product of probability of an incident and the consequence of that incident (Bjørnskau 2003). Although risk may be defined and measured in other ways, for instance as the probability of an incident given exposure to an activity, the "probability" and "consequence"-definition of risk is commonly agreed upon among experts.

In the present literature review, it is not risk as such - but *perceived risk* – that is of main interest. What is perceived risk, then?

Perceived risk is the risk people, both experts and lay people, perceive or experience0F0F[1]. Some studies suggest that while experts perceive risk more or less accurately, i.e., in accordance with the "objective" statistical definition of risk, lay people tend to emphasise other aspects as well (Slovic et al. 2000a). It has been suggested for instance, that perceived risk consists of three factors; cognitive (probability), emotional (worry), and consequences (Sjöberg 1993). Other studies have identified a number of various hazard characteristics assumed to influence risk perception (Fischoff et al. 2000). Questions like "what do people mean when they talk about risk?", "do experts and lay people perceive risk differently", and "what predicts risk perception" have guided the risk perception research, and will be in focus in the present report.

In the risk perception literature, *hazard* and *risk* are used interchangeably to denote the risk unit or activity. That is, risk is used both as a concrete unit or activity, and as the abstract concept that involves for instance probability, consequences, worry etc. In order to make a clear distinction between the two, the term *hazard* or *risk hazard* will be used to designate the activity or unit (i.e., transport mode, technology, riding a bike, etc.) that is associated with risk, while *risk* designate the intangible concept that exists in the minds of people, be that lay people or experts.

[1] Perceived risk may also be termed "subjective risk".

2 The psychometric paradigm

"…researchers have sought to discover what people mean when they say that something is 'risky', and to determine what factors underlie those perceptions."

Slovic, (2000)

One basic assumption within the psychometric paradigm is that lay people's perception of risk differs from experts' perception of risk (Brun 1991; Brun 1995; Slovic et al. 2000a; Slovic 2000). This has been tested empirically, and the results from such studies suggest that experts tend to perceive risk as annual deaths resulting from the risk in question, whereas various aspects influence lay peoples' perception of risk (Slovic et al. 2000a). Actually, this finding is the point of departure for much of the risk perception research, and the main question within the psychometric paradigm ha been: What is "risk" for lay people?

2.1 The psychometric model

In 1978, Fischoff, Slovic, Lichtenstein, Read and Combs published a study where risk perception and attitudes towards risks were measured by means of psychological scaling methods (Fischoff et al. 2000). The main aim of this study was to examine the usefulness of psychological questionnaire techniques for studying perceived risks. Perceived risk and benefits of a wide array of risk hazards were measured in two separate samples. In addition, all respondents were to rate each risk hazard on nine 7-point scales reflecting characteristics of the risk hazards hypothesised to influence perception of risk and benefits: was the risk *voluntary*, was the effect of the risk *immediate*, was the risk *known* – both to individual *persons* and to *science*, was the risk *controllable*, was it a *new* risk, was the risk *chronic* or *catastrophic*, was it *common* or *dreaded*, and to what degree was the *consequences severe*. In fact, it is the nine risk characteristic scales that have been the main focus of later research within the psychometric paradigm.

By means of principal component analysis (factor analysis), the nine risk characteristics were reduced to two factors: voluntariness, immediacy of effect, knowledge about risk, control, and newness loaded on factor one which was termed 'technological risk', whereas chronic-catastrophic, common-dread, and severity of consequences loaded on factor two which was termed 'severity'. These two factors were later renamed 'unknown risk' and 'dread'. Moreover, based on this factor analysis, all risks were placed in a factor space – a mental map of all the risk hazards were created based on their score on the two factor dimensions (e.g., nuclear power had a high score on "certain to be fatal, dread and catastrophic, and were also rated to be high on involuntariness, delayed effect, unknown, uncontrollable, and new).

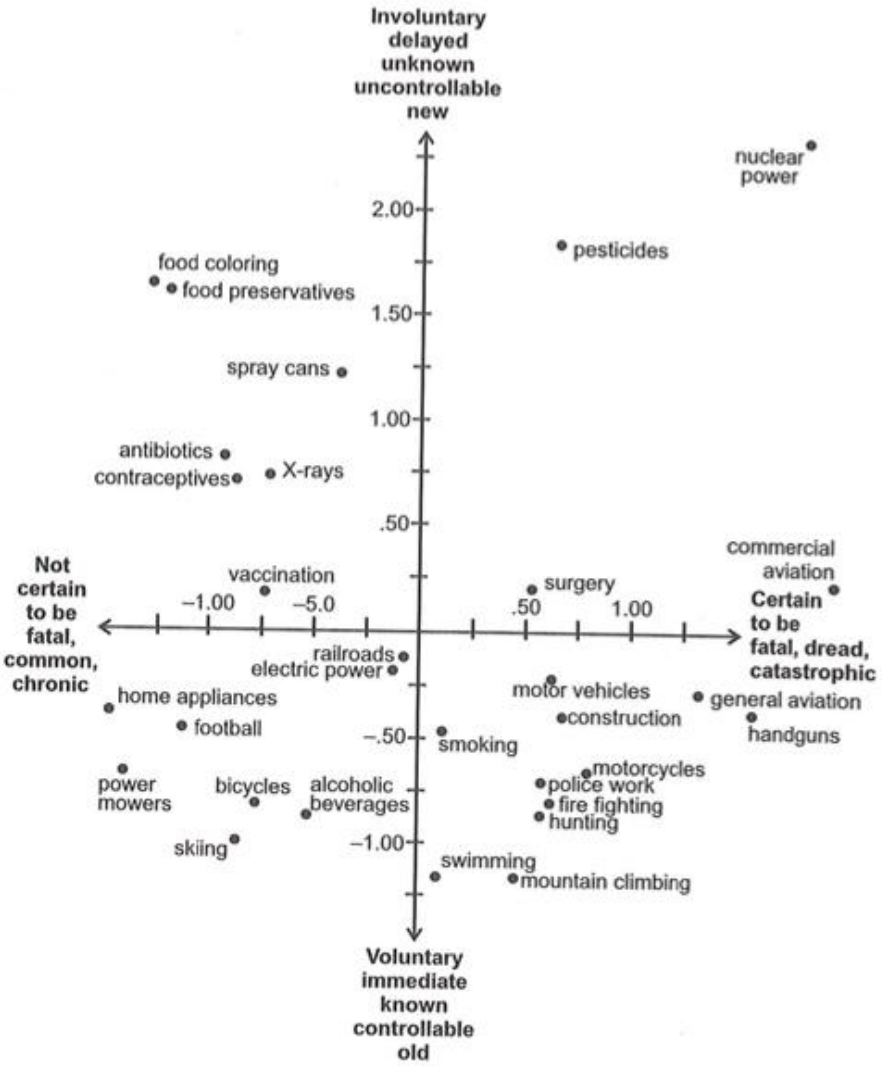

Figure 5.5 *Location of risk items within the two-factor space*

Figure 1. Map of risk items within the two factors dimension space (Fischoff et al. 2000).

Further on, the two factors were used to predict a) acceptable risk levels, and b) risk perception. In both multivariate regressions, the dependent variable (i.e., risk acceptance and risk perception) was regressed upon factor 1 and 2 as well as perceived benefit. Multiple R's of .76 and .67 were obtained, showing that 58 % of the variance in acceptable risk level was explained by perceived benefit, factor 1 and factor 2, whereas the same three predictor variables explained 45 % of the variance in perceived risk. Importantly, acceptable risk and risk perception was averaged across all risk hazards.

This mental map of risk hazards according to hazard characteristics has been known as the 'psychometric model', and the study by Fischoff et al. (1978) constitutes the beginning of the 'psychometric paradigm' (Sjöberg et al. 2004; Slovic 2000). In the realm of this, several studies have more or less replicated the two factor solution representing important risk characteristics.

Source: TOI report 1008/2009

Figure 2. Risk characteristics and risk factors: Factor 1 "Dread risk" and factor 2 "Unknown risk".

Slovic, Fischoff and Lichtenstein (2000b) emphasise that the two factor-solution demonstrated in the "first" study has proved well and been demonstrated across four different groups of lay and expert respondents (Slovic, Fischoff & Lichtenstein 1980 in Slovic et al. 2000a p. 142). However, the same authors found that extending the number of hazards (i.e., from 30 to 90) and risk characteristics (i.e., from 9 to 18) resulted in a three factor solution: Factor 1 'dread' (severity not controllable, dread, globally catastrophic, little preventive control, certain to be fatal, risks and benefits inequitable, catastrophic, threatens future generations, not easily reduced, risks increasing, involuntary, and affects me personally), factor 2 'familiarity' (not observable, unknown to those exposed, effects immediate, new, unknown to science), and factor 3 'number of people exposed' (many people exposed). Inspection of the characteristics loading on the different factors, reveal discrepancy between the first factor solution (Fischoff et al. 2000) and this three factor solution. For instance, while "involuntary" and "uncontrollable" loaded on the "technical risk" factor together with for instance "known" "new" and "delayed effect" in the former study, they later loaded on the "dread"-factor associated with severity of the risk. The conclusion seems to be that the "nature" of the dimensions of risk is influenced by what risk hazards and what characteristics are included in the analyses.

This notion was supported by findings in a study aimed at investigating the "cognitive map" of risk hazards within the single domain of rail transport (Kraus and Slovic 1988). 49 different rail situations were rated on 7 scales measuring voluntariness, knowledge, control, dreadedness, equity, catastrophic potential, and newness. The scales for all situations were subsequently analysed by means of factor analysis, in the same way as various risk hazards is analysed in the "traditional psychometric model". As with previous findings in the psychometric study, a two factor solution was found (Kraus & Slovic 1988). However, one particular discrepancy was found between this "local" set of hazards and the usual "global" set of hazards: 'Dread' was not as important as usually found in determining the structure of the hazards. Thus, factor 1 consisted of 'involuntary', 'uncontrollable', and 'unknown', whereas factor 2 consisted of 'catastrophic', 'new', and 'inequitable'. 'Dread 'loaded on both factors (Kraus & Slovic 1988).

Thus, although fairly consistent, the cognitive structuring of risks seems to be dependent on number of risk hazards, types of risk hazards and number of risk characteristics. Further on, another question that has been addressed in the literature is if the psychometric model is constant across cultures.

2.2 The psychometric model and cultural variations

Within the psychometric paradigm, attention has been given to potential variations between nations or cultures (Boholm 1998). One of the main aims in this respect has been to investigate potential differences between cultures when it comes to the qualitative hazard dimensions and their importance. Further, differences in *level* of risk perception of various hazards has also been the topic of several studies (Boholm 1998). An underlying assumption to be tested by this cross cultural comparisons of the psychometric model is that the structuring of risk is cognitively determined and similar across individuals and cultures. The alternative notion is that risk perception is determined by individual and cultural variations.

Replications of the study by Slovic et al. from 1980 (Slovic et al. 2000b) have been carried out in several countries, for instance Hungary, Norway and Poland (Boholm 1998; Teigen et al. 1988). In these studies, results from the country in question have been compared to the results from findings in the US. Results indicate for instance that levels of risk perception in Norway is clearly below similar risk ratings in USA, however above such ratings in Hungary (Teigen et al. 1988). Moreover, studies have been conducted in which the main aims was to carry out a cross-cultural comparison, that is, similar research designs, measures etc. have been applied in more or less similar samples in different nations (Boholm 1998).

Boholm (1998) has reviewed literature on risk perception from a comparative perspective, and one of her main findings is that, although there are minor variations, "hazards have in general been grouped together along certain common identified factors relating to 'dread' and 'knowledge'" (Boholm, 1998, p 143). However, according to Boholm, this is not evidence enough to conclude that the cognitive structuring of risk is universal.

Explanations of the differences in level of perceived risk, as well as differences in loadings of the factors, have focused upon conditions that differ between the

countries; e.g., size of the country, impact from the media and characteristics of the societies (Boholm 1998; Teigen et al. 1988).

2.3 What does the psychometric model tell us?

While the psychometric paradigm and the psychometric model have dominated the research on risk perception, it is essential to bear in mind what information about risk perception this perspective generates. First, the main objective of most studies within the psychometric paradigm is to create so called "personality profiles" of a wide array of risk hazards, i.e., *comparing* different risk hazards on a few underlying dimensions. Second, it is possible to investigate what underlying dimensions are important in different cultures. Third, *these dimensions* (the most important characteristics of all hazards) are used to predict for instance risk perception or acceptability of risk. However, it is capital that this relates to perception of risk averaged across *all the hazards* included. In other words, the information gained from such studies is:

- Comparison of different risk hazards on underlying hazard characteristics. This can be represented by a "mental map" or "personality profiles" of the hazards.
- How many, and what underlying dimensions (hazard characteristics) are important (e.g., Technological and Severity, Dread and Novelty)
- Explained variance in risk perception of several risk hazards predicted by the underlying dimensions/factors (i.e., the hazard characteristics)

Considering what knowledge and information the psychometric model generates also brings to the fore what it does *not* tell us. This has been the starting point for the critique of the psychometric paradigm, as well as the research trying to alleviate the problems that has been identified in the critique.

2.4 Critique of the psychometric paradigm

Although much, if not most, risk perception research has been conducted within the psychometric paradigm, this paradigm and in particular the psychometric model has been criticised on various points (Sjöberg 2002; Sjöberg 2000f; Sjöberg et al. 2004; Sjöberg 2003; Sjöberg 2006):

First, Sjöberg (2000a; 2004; 2006) discusses the dominating methodology used within the psychometric paradigm, and points out that with, according to Sjöberg, appropriate analysis the psychometric model would explain much less variance in risk perception than currently claimed. The two factors 'Dread' and 'Novelty' (the latter also named "Familiarity" or "Unknown risk") has been found to explain approximately 70 to 80 percent of the variance in the scales, when using factor analysis based on group means (Sjöberg 2000a). Moreover, studies suggest that these two factors account for approximately 60 to 70 percent of the variance in risk perception and/or risk acceptance when using aggregated analyses. Sjöberg (2000a) points out that it would be more appropriate using analyses based on raw data rather than group means. If raw data are used, explained variance in risk

perception decreases to approximately 20 to 30 percent, according to Sjöberg (2000a).

This is an important objection, supported by other risk perception researchers (see for instance Marris, 1998). However, as is the case with all scientific research, the research question should guide the choice of design and analysis, not vice versa. Within the psychometric paradigm the main has been to create "personality profiles" of the hazards, in order to end up with a few "traits" that best can explain people's perception of risk for these hazards. This can be seen as equivalent to using factor analysis to reduce possible personality traits of humans, e.g., the Big Five (Costa 1992), and to study what personality trait that best predicts e.g. academic achievement. However, in such an analysis it is the mean scores for each hazard (the aggregated data) that is the unit of analysis. This makes sense if the aim is to say something about different hazards and the "average person's" perception of risk based on the underlying dimensions of risk hazards. If the aim is to say something about how different individuals perceive risk, however, this is not the appropriate analyses. Rather, raw data should be used in order to investigate individual variations in the perception of risk. Moreover, separate analyses should be conducted on each risk hazard (Sjöberg 2002).

Second, Sjöberg (2004; 2006) discusses the assumption that lay people's perception of risk differs significantly from experts' risk perception. According to this perspective, experts' perception of risk is based on probability assessments and is quite similar to objective, statistical risk estimates. Lay people's risk perception, on the other hand, is believed to be more complex, with various hazard factors influencing. This notion has been suggested and empirically tested by Slovic, Fischoff, and Lichtenstein (2000a). Subsequently, this finding has been replicated and established as a scientific fact. However, Sjöberg (2004; 2006) claims that experts perceive risks more or less similarly to lay people, and that their risk perception can be explained by the 'psychometric model' just as well as lay peoples' risk perception. Moreover, empirical support for his claim was found in a study of experts' risk perception of nuclear waste; the results suggested that risk perception was related to qualitative risk characteristics (Sjöberg et al. 2004).

Third, Sjöberg (2004; 2006) argue that important factors and distinctions are neglected in the psychometric paradigm. Among these are:

- The distinction between personal and general risk
- The variable "tampering with nature"
- Affect (other than fear, for instance anger)
- Demand for risk mitigation

Marris, Langford, and O'Riordan (1998) summarise the main critiques of the psychometric paradigm as follows: 1) The 'psychometric model' can be viewed as an attempt to create so called "personality profiles" of the hazards. That is, the "qualitative characteristics" of the hazards are treated as inherent attributes of the hazard. However, these characteristics (e.g., knowledge about the hazard, control over the hazard, voluntariness, and dread potential) may just as well be constructs of the respondents. 2) Related to the first critique, it is pointed out that the psychometric paradigm does not discern between groups of people, except between experts and lay people. Thus, whereas the focus is on variation between the *hazards*, variations between individuals and groups are neglected within this paradigm. Moreover, this is related to the methodological discussion regarding aggregate versus individual raw data emphasised by Sjöberg (2000a; 2004; 2006). Cultural explanation of risk perception was developed within the social anthropological and sociological traditions, and has been suggested as one solution to the critiques of the psychometric paradigm.

2.5 In brief

The *psychometric paradigm* is a tradition of research in which the use of psychometric techniques (questions) are used to produce quantitative estimates of perceived risk. The *psychometric model* is a model that is based on a number of surveys where people have been asked to rate 90 risk hazards (the number varies between studies) on 18 (also varies) risk characteristics, and use these to predict their overall assessment of risk levels for the same hazards. According to the model these characteristics may be condensed into three high order factors: 1) familiarity, 2) dread, and 3) number of people exposed. The number of factors and their correct interpretation has been discussed, but the main picture seems to be fairly consistent over a range of studies using the same methodology. Although there are differences in terms of *level* of risk, the structure, or *profile* described in the model is found in several cross-cultural comparisons. The model has been criticized for using mean scores of risk perception, rather than individual estimates, and hence boosting explained variance. As the focus is on the general risk characteristics of the hazards, and not individual's perception, this critique may be refuted. Further, the model predicts that the only systematic difference in risk perception is between lay people's and experts, and several studies have supported this view. However, other studies have found that experts and lay people *do not* differ.

3 Variations between the "perceivers"

Whereas most research within the psychometric paradigm has focused on characteristics related to the risk, research has also been conducted aiming towards identifying differences between individuals, i.e., characteristics of the perceiver.

3.1 Cultural explanation of risk perception

Cultural theory of risk perception was first proposed by Douglas and Widavsky and later developed to quantitative measuring scales by Dake. The main concept of this theory is that social processes are underlying dimensions influencing people's risk perceptions. Importantly, proponents of the cultural theory of risk perception argue that risk perception is not only a matter of cognitive structures representing what hazard characteristics are salient in people's mind. Risk perception is also connected to worldviews, i.e., "deeply held beliefs and values regarding society, its functioning, and its potential fate" (Dake 1991). Consequently, people perceive risks according to their orienting dispositions, which build upon both personality and public policy preferences as well as social structure. More specifically, four cultural biases or world views are defined by strength of an individual's characteristic of social relations according to what is called "grid" and "group": Grid refers to respect for authorities, whereas group refers to membership in groups. Combining "grid" and "group", one is left with four cultural biases (Marris et al. 1998; Sjöberg 2003):

1. Hierarchy: high grid, high group
2. Egalitarians: low grid, high group
3. Fatalists: High grid, low group
4. Individualists: low group, low grid

By and large, the dimension discriminating between the cultural biases seems to be attitudes towards free market economy (Dake 1991). It is assumed that Hierarchists, Egalitarians, Fatalists, and Individualists have different views about what represents a risk hazard and societal concerns: Egalitarians are believed to perceive technological risk hazards as great as such hazards serve as a danger towards "the fragile environment just as it exploits the poor" (Dake 1991). Individualists and Hierarchists are assumed to be optimistic about new technologies. These assumptions were empirically tested and found support for in two American samples in 1981 and 1982 (Dake 1991). Note however, that the cultural biases here were correlated with *societal concerns* and *societal risk taking*

especially related to *technological* risks and *political issues*, for instance corruption and civil disobedience.

The cultural theory has been tested as an alternative to the psychometric paradigm as an explanation of risk perception. Sjöberg (2000a; 2003) points out that cultural theory has proven to explain only small proportions of variance in risk perception, i.e.., around 5 % in European samples, and 10 % in U.S. samples (Brenot et al. 1998). Moreover, Marris et al. (1998) found that the cultural theory explained far less of the variance in risk perceptions than the qualitative risk characteristics of the psychometric paradigm. One explanation for this comparative advantage of the psychometric model is the fact that the hazards characteristics in the psychometric model refer directly to risk hazards, whereas cultural bias measures are distal factors. Variables that are semantically close are also more prone to be highly correlated than distal variables.

3.2 Gender

Risk perception has been found to vary between males and females (Finucane et al. 2000b; Slovic 2000). The differences found suggest that males perceive risk as lower than females, and in particular that white males constitute a group who perceive risk as extremely low compared to non-white males and women in general (Finucane et al. 2000b). This "white male effect" is explained by socio-political factors.

In a short review, Gustafson (1998a) call for further investigation of gender differences in risk perception research. Summing up relevant research, Gustafson (1998b) discusses how quantitative research consistently has found gender differences in risk perception. These differences are most often small, and have to a large degree been left unexplained. In qualitative studies, however, one has focused on how males and females not only perceive the same risks differently, but also that they perceive different risks; whereas females tend be oriented towards health and environmental risks, males report to be more concerned about economic issues (Gustafson 1998c). Gustafson (1998d) emphasise that gender differences rarely are explained in the scientific literature. Moreover, he points out that to the degree explanations are offered, they are seldom related to theories of gender. Thus, Gustafson (1998) call for research taking gender structures as the point of departure for the explanation of gender differences in risk perception.

3.3 Personality

One basic assumption within personality psychology is that individual differences vary with personality. Personality can be defined as "the distinctive and characteristic patterns of thought, emotion and behaviour that define an individual's personal style of interacting with the physical and social environment" (Atkinson et al. 2000).

Recently, risk perception researchers have started to study personality as one factor that contributes to individual variations in risk perception (Backer-Grøndahl et al. 2008; Backer-Grøndahl et al. 2007a; Bouyer et al. 2001; Chauvin et al. 2007; Sjöberg 2003; Sjöberg and af Wåhlberg 2002). Generally, these

studies find that some personality constructs such as neuroticism (emotional stability) are linked to risk perception, but that correlations are moderate to weak.

Personality measures were for instance included in one study where the main objective was to study risk perception in relation to new age beliefs (Sjöberg & af Wåhlberg 2002). Neuroticism was the only personality trait that correlated significantly with perceived level of risk: A moderate positive correlation indicated that people who are high on neuroticism perceive risk to be high. Personality was further investigated in another study by Sjöberg (2003). The Five Factor Model of Personality was studied in relation to risk perception of various risk hazards, among them traffic accidents. Of the five personality traits measured, i.e., agreeableness, extraversion, emotional stability, openness, and conscientiousness, emotional stability was the only trait showing a persistent correlation with perceived risk across hazards. Correlations were negative, indicating that being more emotionally stable is related to low perceived risk. Although several significant correlation coefficients, the relationships between risk perception and emotional stability were rather low and did not exceed .20 (Sjöberg 2003).

Risk perception and personality was also investigated in a recent study in which both personality *factors* and personality *facets* were included as predictors of risk perception (Chauvin et al. 2007). Personality factors designate the five traits of the Big Five (extraversion, agreeableness, conscientiousness, emotional stability, and openness), whereas personality facets are at a more fine-grained level. For instance, the personality factor *extraversion* is made up of several facets, e.g., gregariousness, friendliness, assertiveness etc. (Chauvin et al. 2007). Personality was studied in relation to various risk hazard *factors* designated as “energy production”, “pollutants”, “sex, deviance, and addiction”, “weapons”, “common individual hazards”, “outdoor activities”, “medical care”, and “psychotropic drugs”. The results showed that different hazard factors were related to different personality factors and facets (Chauvin et al. 2007). In sum, all personality traits except openness were significantly related to risk perception of one or more hazard factor. Generally, personality facets explained significant variance over and above personality factors (Chauvin et al. 2007).

In a Norwegian study of risk perception in transport, extraversion and neuroticism was measured in relation to worry about accidents and worry about unpleasant incidents on various transport modes (Backer-Grøndahl et al. 2008). While extraversion showed no relationship with neither worry about accidents, nor worry about unpleasant incidents, support was found for the previous finding that neuroticism predicts worry. In particular, neuroticism was related to both worry about accidents and worry about unpleasant incidents. However, when including a measure of general worry about various safety and security issues in the regression analyses, the effect of neuroticism on worry about unpleasant incidents diminished. This suggests that the measures of general worry and neuroticism share variance in worry about unpleasant incidents. In the model of worry about accidents, neuroticism remained a significant predictor, even after the measure of general worry was included. This indicates that neuroticism measures something unique not accounted for by the GWI, and support the notion that worry about accidents in transport vary with this personality trait.

In the study by Backer-Grøndahl et al. (2008), worry was only measured in relation to two personality traits, i.e., neuroticism and extraversion. Locus of control items were included in the questionnaire, but did not show any bivariate correlation with worry. Moreover, as for the locus of control measure, data was only available for a part of the sample, and this construct was thus excluded from further analyses. It is also worth noting that due to an extensive questionnaire, personality traits were measured using only a few items. Further research should a) include more personality traits in relation to worry in transport (e.g., Big Five) and b) apply a standardised battery of personality items (e.g., Big Five Inventory).

3.4 In brief

Instead of studying the characteristics related to the risk, as is done within the psychometric paradigm, it is possible to identify differences between individuals, i.e., characteristics of the perceiver. The *cultural theory* of risk perception outlines four "ways of life" or biases according to the terms "grid" and "group". Each way of life corresponds to a specific social structure and a particular outlook on risk. Grid refers to respect for authorities, whereas group refers to membership in groups, thus producing the four biases: Hierarchical, Individualist, Egalitarian, and Fatalist. Studies have shown that the cultural theory explains less variance in risk perception than the psychometric model. Although a number of studies have found consistent differences between males and females in risk perception, there are no attempts at using *gender theories* to explain this phenomenon. A few studies have looked at differences in risk perception according to personality traits. In sum these studies find a positive, but week, correlation between neuroticism and risk perception. It should be noted that explanations of risk perception according to gender and personality are not necessarily in opposition to a psychometric model, but can rather be seen as supplementary to this approach.

4 Cognition or emotion? Feelings in risk perception

"The best policy, then, would be one that involves mitigating real risks and irrational fears"

Loewenstein et al. (2001)

The consistent finding within the psychometric paradigm that 'Dread' is one of the most important dimensions/characteristics of risk hazards, implies that "risk" involves some sort of affect or feelings, in this case in the form of fear of the hazard. This has inspired researchers to investigate the affective (or even emotional) components of risk perception.

Within the field of decision research there is an increasing understanding of the importance of the concept of affect. According to Zajonc (1980), all perceptions contain some degree of affect, and affective reactions are often the first to occur when people encounter a given stimulus. Affective judgements occur automatically and function as a guide for information processing tasks. Damasio, having studied people with some specific types of brain damage, argued that the presence of somatic markers was crucial for effective information processing (Damasio 1994). Somatic markers can be positive, beacons for incentive, or negative, alarms for avoidance. An image of a future situation will thus be associated with a somatic marker of either positive or negative value, and the person will be either alarmed or rewarded accordingly when the image occurs in consciousness (Damasio 1994).

The term affect heuristic has been employed to characterize situations where people use such readily available representations, rather than making rational calculated decisions (Finucane et al. 2000a; Slovic et al. 2004; Slovic et al. 2005b; Slovic et al. 2007; Slovic et al. 2005a; Slovic and Peters 2006). Several studies have showed that perceived risk and perceived benefit are negatively correlated (in Finucane et al. 2000a; McDaniels et al. 1997; Slovic et al. 1991). This has been suggested as an argument for people's judgement of risk and benefit being guided by their general affective evaluation of a given hazard (situation, activity).

In order to test this, two studies were conducted. In one study people (54 students) were asked to evaluate risk/benefit of 23 items, either with or without time pressure. The idea behind this was that time pressure would lead to more affective and less rational decisions concerning the hazards. The results of the study indicated that the negative correlations between risk and benefit were larger in the time pressure situation, than in the non-time pressure situation. This was interpreted as evidence for the use of affect in decision making processes in situations where cognitive processing is difficult.

In the second study perceived risk or perceived benefit was manipulated, and 219 students were asked to evaluate three technologies (natural gas/nuclear power/food preservatives) before and after the manipulation. The manipulation involved giving textual descriptions with four conditions (high risk; low risk; high benefit; low benefit). The results indicated that 50% of the subjects changed their perceptions of the manipulated aspect (e.g., increased risk) in the predicted direction. The affective model predicts that for these subjects, perception of the *non-manipulated variable* would change in the *opposite* direction (i.e., elevated perceived risk leads to lowered perceived benefit). The results showed that 34 percent of the subjects that had changed their perceptions of the manipulated variable did in fact change their perception of the non-manipulated aspect in the direction predicted. This is used as evidence for an affect heuristic operating to change people's perception, e.g., in conditions where only information on one dimension is available.

However, it should be noted that for most of the subjects the affect model *did not work*. 31% did not change their mind on the non-manipulated dimension, and 23% changed in the opposite direction than predicted (i.e., elevated risk lead to elevated benefit). Thus, it might be suggested that the proposed effect only is a result of random variations of pre- end post-manipulation scores.

Building upon ideas of affect in risk perception, Loewenstein et al. (2001) review relevant literature on cognition, emotion, and risk, and propose the "risk-as-feelings hypothesis". They point to the fact that most research on decision making (under risk) is studied from a consequentialistic perspective, in which decisions are made based on assessments of potential consequences. This perspective is dominated by a cognitive approach to decision making. However, several theories of affect have been proposed within psychological studies on decision making, such as Damasios somatic marker hypothesis and Slovic's affect heuristic (Loewenstein et al. 2001). Loewenstein et al. (2001) emphasise however, that these theories of affect in decision making deal with *anticipated* emotion, that is, emotions that are "expected to be experienced in the future" (p 268). The risk as feelings-hypothesis, however, deals with *anticipatory* emotions, that is, feelings/emotions/affect that are intuitively experienced immediately in connection with risks or uncertainties. Moreover, within this risk-as-feelings-hypothesis, it is emphasised that cognitive and emotional responses to risk can be divergent, i.e., have different effect on decision making. Finally, when divergent effects occur, it is hypothesised that 'feelings', rather than 'cognition', will drive behaviour (Loewenstein et al. 2001). Thus, anticipated emotions have an effect upon cognitive evaluations which in turn have an effect on behaviour, whereas anticipatory emotions have a direct effect on behaviour. The "risk as feelings" perspective is presented graphically in figure 3.

The difference between anticipated and anticipatory emotions can be applied to the field of transport in the following way: When thinking about a trip one is about to make and possible risks that can occur on this trip, one is imagining all possible outcomes of the decisions that are made, including the emotional reactions (anticipated emotions). This situation can be said to be equivalent to the strategic level in a driver behaviour model (Allen et al. 1971). However, when experiencing a feeling connected to a risk during a trip (i.e., at the tactical or operational level), one is more likely to be experiencing anticipatory emotions. The difference between risk experienced at strategic and tactical level was

attempted tested in a study by Backer-Grøndahl et al. (2007a). Risk experienced at a strategic level (i.e., anticipated emotions) was measured by means of a web based survey that participants responded to at home/work, whereas risk experienced at a tactical level (i.e., anticipatory emotions) was measured by means of interviewing travellers on the metro and by stopping people who were bicycling. Perceived risk at strategic and tactical levels were subsequently compared. The results showed that perceived risk was higher at the strategic level than at the tactical level (Backer-Grøndahl et al. 2007a).

The risk-as-feelings model uses the term 'behaviour' as the resultant of cognitive evaluations and feelings. It should be noted that most of the empirical basis for the model is actually on research connected with decision making processes. Thus it could be argued that the model does not necessary say much about risk perception influence in situations where the behaviour is of an immediate and automated nature. Further, the model does not aim at saying anything about the relationship between anticipatory and anticipated emotions, e.g., whether people are able to predict their own feelings in the future.

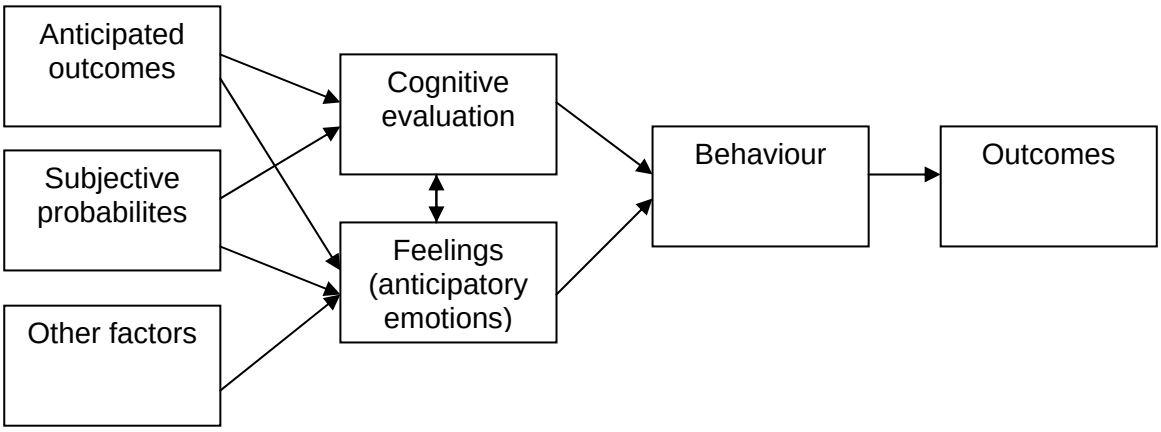

Figure 3. Risk as feelings perspective. Loewenstein et al. 2001, p 270

Moen (2008) builds upon the "risk-as-feelings hypothesis" and applies what she calls the "risk-as-feelings framework" in her doctoral thesis on perception of transport risks (Moen 2008). In her model, assessed consequences of an accident were used as 'anticipatory outcomes', whereas probability assessment was 'subjective probability'. 'Cognitive evaluation' was measured by means of general risk assessment (i.e., how risky do you think….), and the measure of 'feelings' consisted of worry, thinking about the risk and stigma (negative associations). Finally, risk behaviour was replaced by risk priority, with the presumption that "if people report their priorities truthfully this would reflect actual behaviour" (Moen 2008). The outcome-variable in this study was demand for risk mitigation.

Moen (2008) found that the model was able to explain 22 percent of the variance in behaviour (safety priority) and 52 percent of the variance in the outcome variable (demand for risk mitigation). Importantly, feelings was the strongest predictor of behaviour, and also considerably stronger than general risk assessment on the outcome variable. Moreover, assessed consequences were more important in the prediction of feelings than general risk assessment, whereas

probability was more important in the prediction of general risk assessment than in the prediction of feelings. Finally, Moen (2008) found a negative relation between general risk perception and safety priority, that is, the higher perception of risk, the less you prioritize safety. On the other hand, the relation between feelings and safety priority was positive: the more you worry and think about the possibility of an accident, and the more negative association you have with the transport mode in question, the more you prioritize safety. Thus, according to Moen (2008), support was found for the "risk-as-feelings framework"; cognitive and emotional evaluations of risk had divergent effects upon behaviour, and "feelings" was the strongest predictor of behaviour.

On a more general note, the divergent effects of cognitive and emotional aspects of risk perception upon behaviour highlight how important it is to be aware of what aspects of risk perception one is measuring.

4.1 Worry and risk perception

Worry has also been studied in risk perception, and it has been suggested that this construct is somewhat related to the *emotional* component in perception of risk (Sjöberg 1998). However, worry has also been defined as the *cognitive* component of anxiety (Macgregor 1991), and hence there is some disagreement as to whether worry denotes a cognitive or an emotional construct. Compared to "probability assessment", which clearly is an important aspect of risk perception and taps the cognitive feature of the concept, worry denotes something "emotional".

MacGregor (1991) investigated worry over various life concerns, including some technological risks such as nuclear power and nuclear waste disposal. Two surveys were conducted and the Three Mile Island accident (a reactor accident) happened in between the two surveys. MagGregor (1991) found that worry for nuclear power related risks increased from survey one to survey two. Moreover, MacGregor (1991) investigated correlations between worry and controllability. The correlation between worry and controllability was mediated by a third variable; degree of personal investment: For high personal investment items, there was a strong positive correlation between worry and controllability. That is, life concerns or risks that were perceived as controllable were also those that people worried most about. However, this was only true for items that were defined as high on personal investment, i.e., risks or concerns that required daily consideration. As for items defined as low personal investment, i.e., situations/concerns that occur only situationally, the correlation between worry and controllability was negative. Thus, people worried more about events that they thought they did not have control over. Moreover, MacGregor (1991) found that the correlation between worry and coping was dependent on controllability: people reported to cope with the situations they worried about, however only for situations they perceived as controllable. As to situations that were perceived as having low controllability, there was no correlation between worry and coping.

Whereas MacGregor studied worry for some technological risks, Sjöberg (1998) addresses the *relationship* between worry and risk perception in particular. In two studies, a measure of general worry based on 12 items was investigated in relation to various hazards and risk perception related to these hazards. The results

indicate that worry is only moderately related to risk perception – both with regard to general risk and specific measures of worry tailored to certain risk hazards. However, Sjöberg (1998) suggests that worry may be more relevant to so called sensory hazards (exemplified by thunderstorms in the article), whereas the cognitive aspects of risk may be more relevant to more abstract hazards (exemplified by traffic accidents in the article). The reasoning is that people have a day-to-day experience with traffic which inhibits a strong experiential feeling, whereas the infrequent occurrence of thunderstorms creates a strong sensory experience.

Even though Sjöberg (1998) emphasises that the correlation between worry and risk perception is weak, he acknowledges the consistent statistical significant association between the two. Moreover, he discusses several aspects of worry in relation to risk perception that deserves further investigation, among them worry as a stable personality trait versus more situational worry and the respective associations with risk perception. In particular, Sjöberg (1998) requests further investigation of the relative influence of worry and risk perception on behaviour.

4.2 Fear of crime and risk perception

Even though studies about fear of crime and public perceptions of crime risk has a strong tradition within criminology, there have been few attempts at cross-overs with the more general (psychological and sociological) risk perception literature (Jackson 2006). For instance, researchers in the 1960's looked at discrepancies between perceived levels of crime and actual risk (people tended to overestimate risk). Later studies changed away from the rationality issue, and treated fear of crime as a legitimate problem in itself. For instance, the British Home Office uses fear of crime as a performance indicator, thus focussing their resources into high profile interventions which have more of a public reassurance function than a crime preventive function (Jackson 2006). In a discussion of the concepts involved ("fear" and "crime") Jackson (2006) argues that the most used concept for fear, namely "worry", might be too strong or give the wrong valour to the emotions people actually experience related to crime (e.g. anger, concern or the more neutral "awareness"). Using gradients of worry, on the other hand might lead to an impression of it being normal to be worried. Further, Jackson argues that the measure rather than tapping into the number of times people are exposed to fearful situations, might tap into the number of times people "hold a vivid image of the risk of crime" (Jackson 2006, page 256). And finally, people's response to the question of fear or worry, may be more of a general assessment of general social tendencies than a measure of their own subjective vulnerability to crime. Three models for understanding fear of crime are proposed:

- the worry of crime model ((Jackson 2004) based on (Ferraro and Lagrange 1987))
- the risk as feelings model (Loewenstein et al. 2001)
- the risk as image perspective (Damasio, 1994)

Further, the social amplification of risk framework (SARF) is suggested as a promising avenue for analysing where people get their sense of crime as a

problem, or indeed any other risk factor. This framework focuses its attention on the communication processes involved in risk perception, and postulates that media functions as primary amplifiers of perceptions of risk. However, as a testable model or theory this framework is of rather limited value (af Wåhlberg 2001), as there are no falsifiable hypotheses to be derived from it.

4.3 In brief

A core element in the psychometric paradigm has been the role affect, emotion, and stigma play in influencing risk perception. A major finding that spurred this focus was that people sometimes use what is termed an *affect heuristic* to evaluate information. This heuristic is a usually useful shortcut for thinking, but may lead to inaccurate judgments in some situations - in which case it becomes a cognitive bias. Based on Damasio's somatic marker hypothesis, the *risk as feelings* hypothesis postulate that "feelings of risk" will have a stronger influence on behaviour than cognitive appraisals. The concept of *worry* has sometimes been put up as the emotional counterpart to the rather rational 'risk perception', although it might be argued that both terms contain both cognitive and emotional elements. Within the *fear of crime* tradition the concept of worry has been used quite frequently although some researchers debate its validity on methodological grounds.

5 Risk perception and transport

Recent numbers reported by the Norwegian Directorate for Civil Protection and Emergency Planning, suggest that a high percentage of the Norwegian public regards it as "very likely" or "likely" that big accidents within the domain of public transport will happen in the next 5 to 10 years (Direktoratet for samfunnssikkerhet og beredskap 2007). In addition to perception of big accidents, perception of risk for accidents in private transport as well as worry about unpleasant situations on various transport modes may have effect upon travel behaviour and mode choice. With the aim of investigating risk perception of various transport modes, as well as the association between risk perception and travel behaviour, risk perception research has propagated to the transport domain in the last 10 years.

5.1 Risk perception in transport and the psychometric paradigm

As discussed in chapter 2, the main objective within the psychometric paradigm has been to create so called "personality profiles" of risk hazards, and the two dimensions Dread and Novelty are assumed to be the two most important dimensions (table 2.1). By placing different risk hazard in this two-dimensional mental map, it is possible to compare the different hazards according to their "Dread"- and "Novelty-potential". Included in the various risk hazards typically investigated in such studies are some transport modes, for instance motorcycles, motor vehicles, bicycles, railroads, jumbo jets and general aviation (Slovic et al. 2000b). Of these, the risk associated with motor vehicles and motorcycles are more "known" than the risks associated with bicycles, general aviation, railroads, and jumbo jets. However, they are all on the "known" side of the dimension "unknown – known". Moreover, jumbo jet is the only transport mode that is situated on the "dread" side of the dimension "dread – not dread". Of the remaining transport modes, risks associated with motor vehicles, railroads, and general aviation are more dreaded than bicycles (Slovic et al. 2000a). However, the "personality profiles" of risk hazards are probably dependent on how many and what other risk characteristics are asked about (Slovic et al. 2000a). This is for instance evident when comparing the "mental maps" from Fischoff et al.'s (2000) study from 1978 with Slovic et al.'s (2000) study from 1980. In the former, general aviation is on the far end on the "dread"-dimension, rated as certain to be fatal, dreaded, and catastrophic. On the "dread" side of this dimension is also motorcycles and motor vehicles, both of which are situated on the "not dread" side in the study from 1980 (Fischoff et al. 2000; Slovic et al. 2000b). The point is that there is a discrepancy between the two studies with regard to the situations of the various transport modes in the two-dimensional hazard map. This discrepancy is most likely due to the fact that there are differences in how many hazards and hazard characteristics (dimensions) that are

included in the studies. Thus, it is of interest to investigate the underlying dimensions in relation to different transport modes only.

This was done in a study by Alm & Lindberg (2000) in which they investigated different aspects of risk perception on seven different transport modes in a convenience sample of 100 respondents. The transport modes were car, taxi, city bus, regional bus, train, ferry, and aeroplane. Hazard characteristics were control of accident probability, control of the consequences of an accident, risk of dying, dread, knowledge, and exposure. The results showed that car was rated as significantly higher than the other transport modes on control of accident probability, control of consequences of an accident, knowledge about the risk, and exposure. Plane was rated significantly higher than the other transport modes on risk of dying and dread, more or less in line with previous findings (Slovic et al. 2000b). Discrepancies from previous studies are explained by the fact that Alm and Lindberg (2000) only included transport modes, and that different labels of the transport modes were used, e.g., motor vehicles versus car.

Moreover, Alm and Lindberg (2000) investigated the relationship between the hazard characteristics and risk perception on the various transport modes by means of stepwise multiple regressions for each transport mode. Multiple R's were quite low and varied between .25 (taxi) and .60 (regional bus), indicating that proposed risk characteristics together explain between 6.5 % and 36 % of the variance in risk perception. Generally, control of probability of accident risk, risk of dying, and exposure was the most important predictors (Alm and Lindberg 2000). Knowledge did not contribute to the explained variance in risk perception on any of the transport modes.

To sum up, despite some discrepancies, the rating of transport modes on different risk characteristics seems to be quite intuitive: Planes and aviation seem to be more dreaded and have higher potential of risk for dying than the other transport modes. Moreover, car is typically rated high on control of accident probability, control of consequences, and knowledge, which suggest that people perceive this transport mode as something familiar. However, little variance in risk perception is explained by these factors. Moreover, it is capital to note that these analyses tell us about variations in risk perception linked to the various risk hazards, not to the perceiver.

5.2 Risk perception in transport and "the cultural theory"

A variation of the cultural theory of risk perception was empirically tested in a Norwegian study by Oltedal and Rundmo (2007). The point of departure was the cultural theory of risk perception. However, empirical investigations have proven it difficult to designate an individual as belonging to only one cultural bias/world view. Moreover, it has been suggested that several of the cultural theory items are similar to items measuring personality traits. In the study by Oltedal and Rundmo (2007), cluster analyses were conducted based on three personality traits and seven measures of culture. Four clusters were identified: Individuals in cluster 1 were characterised by high levels of anxiety, excitement seeking and individualism, and low scores on egalitarianism and fatalism (Oltedal and Rundmo 2007). Individuals in cluster 2 were characterised as trustful, with low scores on hierarchy, individualism and fatalism, whereas cluster 3 individuals

scored low on excitement seeking and high on hierarchy and egalitarianism. They were also highly personally involved in transport safety issues. Individuals in cluster 4 were emotionally stable. They scored high on fatalism, and low on trust.

The main objective of this study was to investigate variations in risk perception between the different clusters. Generally, members in cluster 1 and 2 rated risk probabilities, consequences and worry lower than members in cluster 3 and 4 (Oltedal & Rundmo 2007). Differences in risk perception within each group were also evident: Plane was for instance rated as the most lethal transport mode, followed by motorcycle, whereas taxi and bicycle were rated as least lethal. The authors argue that the results support the cultural theory in the assumption that different clusters of people perceive risks differently. However, the clusters are not based on the world views previously tested, and similarities between clusters were also found (Oltedal & Rundmo 2007).

5.3 Risk perception across various means of transport

Within the transport domain, comparison of risk perception on various transport modes has gained interest. Bjørnskau (2004) investigated people's perceived safety when travelling with plane, train, boat, bus, car, MC, bicycle, and as pedestrian. This was investigated by asking respondents "*How safe do you think it is to travel by means of (airplane, train, ship, bus, car, motorcycle, bicycle, or walking)? Do you think it is: a) very safe, b) safe, c) a little unsafe, d) very unsafe, e) unable to answer (do not know)*". Two more or less similar studies were conducted in June 2000 (Aftenposten 29.6.2000) and September 2003 (Bjørnskau 2004). Samples of 600 and 1000 respondents were obtained in 2000 and 2003 respectively, and both samples were representative of the Norwegian population.

The results from the study conducted in 2003 show that people think it is safer to travel with public transport than private transport (Bjørnskau 2004). In particular, motorcycle was perceived as the least safe transport mode, followed by bicycle and walking. Generally, men reported to be safer than women.

In addition, perceived safety on the different transport modes in 2000 and 2003 was compared (Bjørnskau 2004). The percentage reporting that the transport mode in question was "very safe" and "safe" had increased significantly for all transport modes except plane1F1F[2]. In particular train was perceived as surprisingly unsafe in 2000, which *may* be explained by several train accidents in Norway the preceding months (Åsta January 4th, Lillestrøm April 5th, and the accident on the train in Southern Norway June 17th) (Bjørnskau 2004). These accidents were covered extensively in the Norwgian mass media, and although there is some disagreement as to how much media coverage influences risk perception, it is commonly accepted that such information does have an effect.

One limitation of this study is that perceived safety is not linked to a specific type of incidents (e.g., accidents or unpleasant incidents). Thus, when respondents perceive a transport mode as unsafe, one can not be sure about what factors potentially make this transport mode unsafe. The general tendency that public

[2] Comparisons were only made for plane, train, boat, bus and car as these were the means of transport included in the survey from 2000.

transport was perceived as safer than private transport modes, and in particular motorcycles, indicate that people think about "accidents" when answering this question. However, the researchers also found that young women tended to perceive some public transport modes as more unsafe than other groups (Bjørnskau 2004). One likely interpretation of this finding, is that young women feel unsafe on these transport modes because of the possibility of being exposed to unpleasant incidents (violence, robbery, unpleasant people etc), rather than accidents. Thus, improvements of this kind of study would be obtained by reframing the questions, and specify situations and accidents that may contribute to feelings of being unsafe and unsecure.

The Norwegian public's risk perception on various transport means was also investigated in a study by Moen & Rundmo (2006). By means of factor analyses, the authors found that perceived transport risks fell into two main categories: public and private means of transport. Moreover, several regression analyses were performed in order to investigate what variables explained most variance in risk perception. Thus, probability of experiencing an injury, worry about injury, and consequences were tested as predictors of "risk perception" operationalised as "*how big do you think the risk is when using the following transport modes? Plane, train, bus etc*…". The models were estimated in relation to both public and private transport. Worry and probability was significant predictors of risk perception on public transport, whereas risk perception on private transport was predicted by consequences as well (Moen and Rundmo 2006). Worry was the most important predictor, followed by probability and consequence. When splitting the sample according to gender, the authors found a difference in importance of predictors: Whereas worry was found to be the most important predictor of risk perception on public transport both among males and females, risk perception on private transport was first and foremost predicted by *probability* among males and by *worry* among females. This study indicates that "worry" is an important factor in risk perception.

Perceived risk was in this study measured in relation to experiencing an injury, and fatal consequences – both of which are related to "accidents" rather than "unpleasant incidents" (e.g., violence, threats etc.). Consequently, potential differences between risk perception and worry about accidents on one hand and unpleasant incidents on the other hand, are not investigated here. However, the difference between worry about accidents and worry about unpleasant incidents has been acknowledged in more recent studies on risk perception in transport (Alm & Lindberg 2000; Alm and Lindberg 2002; Alm and Lindberg 2004; Backer-Grøndahl et al. 2007a; Backer-Grøndahl et al. 2007b)

5.4 Perceived risk and worry about unpleasant incidents in transport

In three studies, Alm & Lindberg (2000; 2002; 2004) studied people's risk perception on various transport modes. The tree studies differed in some respects, but one main objective in all three studies was to discern between accidents and unpleasant incidents.

The results from the first study indicated that it is of importance to distinguish between perceived accident risk and perceived risk for being exposed to violence

(Alm & Lindberg 2000). Whereas car, taxi, and aeroplane were associated with high accident risk and low risk for experiencing violence, the opposite was true for city bus, train and ferry.

Another purpose of this project was to investigate worry and feelings of being unsafe on various "travel-related" places, for instance railway stations and parking lots (Alm & Lindberg 2000). The point was to investigate how people perceive the "whole journey". This is perhaps particularly important in relation to risk of violence or of being threatened. The results showed that people reported to experience worry and feelings of being unsafe most frequently when *walking* to the transport mode in question, followed by being at the *bus stop*. Respondents were least worried at the ferry terminal and at the airport (Alm & Lindberg 2000).

The distinction between perceived accident risk and perceived risk for violence were supported in the second study (Alm & Lindberg 2002). Again, car was the transport mode participants rated highest on accident risk, whereas the other – public – transport modes were rated highest on risk for unpleasant situations, violence and threats. Moreover, the same pattern was detected for *worry* about accidents, unpleasant incidents, violence, and threats.

In this study, a second objective was to examine attitudes to the various transport modes (Alm & Lindberg 2002). Respondents were by far most positive towards cars, followed by commuter train, metro, regional bus, and city bus2F2F[3]. One hypothesis put forward by the authors is that perceived attractiveness is influenced more by perceived risk for and worry about being threatened and exposed to violence, than perceived accident risk.

These main findings were more or less replicated in the third study conducted in Gothenburg (Alm & Lindberg 2004). Respondents perceived higher accident risk when travelling with car than public transport modes, while they perceived higher risk of and worry more about being threatened and exposed to violence on travels with public transport than with car. Moreover, respondents held more positive attitudes towards car than the other transport modes.

Respondents were also asked how often they avoided travelling with the various transport modes, and what factors contributed to that decision (Alm & Lindberg 2004). 45 % reported that they avoided travelling with tram during nights to or in specific areas. This finding suggests that perceived risk or worry may have an influence on behaviour.

Alm and Lindberg (2000; 2002; 2004) have made a noteworthy contribution to the investigation of worry in the transport domain in that they distinguish between risk perception of different situations, as well as between risk perception and worry. However, all three studies are based on small convenience samples (N=58, 59 and 100), making generalisations problematic.

Backer-Grøndahl et al. (2008) investigated the difference between worrying about accidents and worrying about unpleasant incidents, e.g., threats, violence and sexual harassments, when travelling with nine different transport modes in a large

[3] Attitudes were also measured as "attitudes towards travelling with car/train etc.". The overall trend was similar; people were most positive towards car. There was however, minor discrepancies with regard to the ranking of the other modes.

sample. The results showed that people report to worry more about accidents than unpleasant incidents on private transport modes, and more about unpleasant incidents than accidents when travelling with public transport. This was further confirmed when investigating the two types of worry as predictors of behavioural adaptations: worry about accidents was more important than worry about unpleasant incidents in predicting behavioural adaptations on private means of transport, whereas the opposite was true for public transport modes. Thus, this study indicates that it is of importance to discern between worry about accidents and worry about unpleasant incidents when investigating risk perception in transport.

5.5 How accurately do people perceive risk in transport?

In one of the few internationally published studies investigating risk perception across transport modes, the Norwegian public's perception of risk was compared with the statistically estimated risk (i.e., annual fatality risk) for each transport mode (Elvik and Bjornskau 2005). In this study, risk perception was operationalised as perception of safety, and respondents were asked: *How safe do you think it is to travel by means of (airplane, train, ship, bus, car, motorcycle, bicycle, or walking)? Do you think it is: a) very safe, b) safe, c) a little unsafe, d) very unsafe, e) unable to answer (do not know)*3F3F[4]. In order to compare perceived risk with statistical risk, four scales were developed for the "perceived risk" measure converting the ordinal categories to numerical scales. Three of the scales ranged from a) 1 to 100, b) 1 to 4 and c) 0.01 to 10. The fourth scale was an estimate of the odds of unsafe to safe. All four scales reflecting perceived risk for each transport mode were correlated with the statistically estimated risk of annual fatalities on that transport mode. Strong correlations were found between all "perceived risk" scales and differences in actual fatality risk across modes of transport. Thus, these results suggest that the Norwegian public perceives risk rather accurately. In particular, motorcycles are correctly perceived as the riskiest transport mode, whereas car, bus, ship, railway and aviation are perceived more or less accurately as less risky. As to bicycling and walking, there is a discrepancy between perceived and statistical risk; cycling is perceived as somewhat riskier than walking, whereas the opposite is true for statistical risk. Moreover, both transport forms are perceived as less risky than the estimated actual risk (Elvik & Bjornskau 2005). One limitation of this study, is that one cannot be sure of what respondents think about when they are asked "how safe do you think it is to travel by means of…..?". In Elvik & Bjørnskau's (2005) study, it is assumed that respondents think about safety in relation to accidents4F4F[5]. However, it is likely that people think about security issues such as being exposed to violence, threats, unpleasant people etc., when thinking about risk and worry on some means of transport – especially public transport modes.

[4] Data on perceived risk was obtained in the study by Bjørnskau (2004) described under chapter 5.2

[5] In Norwegian, the word "sikkerhet/" and the related "trygghet" is used to designate both "safety" and "security". Thus, when using the word "sikker" or "trygg" in a questionniare one does not discern between safety and security issues.

Comparison of perceived and actual risks across transport modes was also investigated in a British study in which the main objective was to study risk perception and utility of various safety improving measures on the rail network (Thomas et al. 2006). In this study, people did not rank the risks as accurate as reported in the study by Elvik and Bjørnskau (2005). For instance, car was ranked as having the highest risk, while it actually is motorcycles. Moreover, bus/coach was perceived as having rather high risk, and was ranked more or less similar as motorcycles. In fact, bus/coach is, according to the estimates applied in the study, the least risky transport mode (Thomas et al. 2006).

5.6 Other approaches to risk perception in transport

The previous chapters have been concerned with approaches aimed at describing risk perception in transport *in a broad sense,* i.e., across a range of travel modes. These approaches are all concerned with trying to explain the components of risk perception, or to describe how it is shaped – the purpose can be said to be one of *taxonomy*. As mentioned, few studies have actually attempted at predicting behaviour based on these approaches. If we narrow the perspective from general transport users to *car drivers* there exists a whole body of literature describing different *driver behaviour models.* One important common feature of these models is the central role of *motivation* as a key element in the model description. The most prominent of these is Wilde's (Wilde 1994) *target risk theory* (more commonly known as risk homeostasis theory). All of these models predict that the driver's behaviour is motivated by the goal of achieving a certain outcome related to risk level. For Wilde's model this outcome is a targeted risk level that differs between individuals, but that is fairly static within society as a whole. By weighting potential risk benefits, risk costs, safety benefits and safety costs the individual seeks to achieve risk homeostasis at a level that by definition > 0. In another well established model, Näätänen and Summala's *zero risk theory* (Summala 1988), the desired outcome is zero risk, i.e., drivers monitor risks, adapt their behaviour and pace their driving speeds according to a perception where the level of risk of an accident is experienced as zero. It might seem a bit intriguing that there is so little common ground of research between transport related risk perception research and driver behaviour models, as both areas of research deals with experienced risk. An important difference between the driver behaviour models and the risk perception models, and a potential explanation, has to do with *methodology*: Risk perception models are mostly based on survey methods and people's self expressed behaviour (if any behaviour measures at all), whereas driver behaviour models first and foremost are theoretical models based on direct behavioural measures or indirect measures (accident rates). In an attempt at assessing three different approaches to risk perception (the psychometric paradigm, social amplification of risk and The Basic Risk Perception Model) for their scientific value, af Wåhlberg (2001) concludes that one of the most important common features is that all approaches rely on the surveys as data collection methods.

Driver behaviour models on the other hand, have as their ultimate goal to explain *why accidents happen, or do not happen.* They do this by describing how aspects of people's risk perception manifest in various types of behaviour, which again leads to variations in accident levels (or preferably risk levels). In other words, the

risk perception component in such a model is only inferred, it is never measured. Sometimes it is inferred based on behavioural measures (most often speeding), and sometimes it is inferred based on accidents (most often following the introduction of a safety measure). One problem with this, is that the proposed mechanisms (target feelings of risk etc.) are quite far away conceptually from what is empirically measured. Consequently, what would be considered the best scientific method from a road safety perspective, i.e., to measure effects of safety measures by looking at changes in accident risk, is not necessarily the best method from a theoretical perspective.

One thing that is apparent both in the risk perception field of research and the driver behaviour field of research is the growing attention to the importance of involving the concept of affect (or emotions) into the explanations. Within risk perception research this can be said to date from the introduction of the affect heuristic in 2000 (Finucane et al. 2000a). In some of the driver behaviour models emotional aspects have been a natural inherent part of the described mechanisms, but only recently has there been made any attempts at including emotions as a guiding principle for actions in such a model, through the introduction of the Risk Monitoring Model (Vaa 2003). At present this model is of a rather theoretical nature, and is yet to be tested empirically.

5.7 In brief

Even if a number of transport modes have been included among the original hazards in the original psychometric studies of risk, these studies do not fully tap the differences between different modes of transport in terms of their 'psychometric profiles'. When looking at risk perception with a particular focus on transport, there are two distinctions that turns out to be of special relevance: the distinction between "unintentional events" (accidents) and "intentional events" (crime, terror etc), and the distinction between public and private modes of transport. Further, it seems like 'worry' rather than 'probability' predicts individual risk perception of different transport modes. As opposed to studies from the 60s, studies of risk perception in transport, as recent studies from other sectors, indicate that people give quite good estimations of differences in risk levels. When it comes to the specific issue of *driver behaviour*, this field of research has been dominated by other traditions than the psychometric paradigm. An important distinction between driver behaviour models and the general risk perception research is that the former *assumes* the existence of some intervening variable, e.g "target level of risk", without directly measuring it, whereas the latter actually measures these kinds of variables without paying too much attention to the resulting behaviour.

6 Discussion and final comments

"There are clearly multiple conceptions of risk"

Slovic and Weber (2002)

6.1 Operationalisation of "risk perception"

When dealing with abstract concepts such as "risk perception" in empirical studies, one of the most important steps in the process is to transform the abstract and intangible concept (i.e., risk perception) into something observable. In order to "observe" risk perception, it is capital to make risk perception something observable. This is the process of operationlisation, or making an operational definition.

In the field of risk perception research, there seems to be no uniform agreement on how to operationalise "risk perception". In table 2 in the appendices we have listed most of the empirical studies that is referred to in this report and specified the operationalisation of risk perception in each study. Inspection of these measurements used to tap risk perception shows that most often respondents are asked more or less explicitly about "perceived risk", e.g., "How do you evaluate the risk of X5F5F[6]" or "How much risk do you think is associated with X?". Even though some of these studies are similar in the sense that they ask about "risk", variations are found with regard to specification of what kind of risk X is associated with, i.e., "risk of dying", "risk of experiencing an accident", "risk of an injury" etc.

Further on, variations are also evident with regard to risk target, i.e., for whom X is a risk, for instance "oneself", "friends and family" or "for the society". Studies have shown differences in risk perception level dependent on specification of risk target, with lower levels of risk perception when asked about "personal risk", and higher levels when asked about "general risk" (Moen & Rundmo 2006; Sjöberg 2000a). This tendency to rate risks as lower for oneself than for others is termed *risk denial*. However, this tendency could also be seen in the light of phenomena such as *parental concern* etc. For instance, a number of studies looking at people's experience of their local environment find that people are more concerned for their children in traffic than for themselves (Hjorthol et al. 1989; Kolbenstvedt 1998).

In addition, studies have operationalised perceived risk as for instance probability (of dying, of experiencing an accident, an injury etc.), worry, consequences of a potential risk etc. In these studies, risk perception is operationalised as something assumed to be important in lay people's understanding of "risk".

[6] X designates the risk hazard in question, i.e., an activity (driving a car) or a unit (cars).

Finally, the *rating* of the degree of risk, probability, worry etc. also differs between studies. Whereas Likert scales (5, 7 or 9-point scales) are the most frequent used ratings scales, other means of rating has been used as well: For instance scales from 0 – 100 (Slovic et al. 2000a; Teigen et al. 1988), and more advanced methods like asking the respondents to physically order several hazards according to their degree of riskiness, and subsequently give them "numbers" of riskiness (Fischoff et al. 2000). One possible disadvantage of this latter method of rating risk is that it demands a great deal of attention and use of cognitive abilities by the respondents. It should therefore only be applied in study settings in which respondents are highly motivated. Less demanding, more direct, ways of rating risks are preferred in large survey studies in which a high response rate is desired and it is assumed that respondents reply in a "satisfying" not "optimal" way (Krosnick 1999).

Surprisingly few of the studies in the field of risk perception, *discuss* how to operationalise risk perception. One exception is Sjöberg's brief discussion in a note on the methodology of risk perception research (Sjöberg 2000e). In this note, Sjöberg suggest that "It would be interesting to know what are the most common ways of operationalizing "risk perception" in applied work, and what the basis is for choosing one approach or another.". The present attempt at mapping the various ways risk perception has been operationalised in empirical studies, suggest that there is no uniform way of measuring risk perception. However, it is not obvious that risk perception *should* be operationalised in the same way across studies. Although similar operationalisations would make comparisons of results easier, one has to consider the field and risk hazard in question. That is, the operationalisation should be tailored to the risk hazard in question.

In his note on methodological challenges in risk perception research, Sjöberg (2000d) discusses whether one should ask explicitly about "risk" or measure risk perception by means of more subtle ways, e.g., "feelings of safety" or "worry". Sjöberg (2000c) argues that "risk" is a better operationalisation, as this word is more or less similar across cultures and languages (i.e., risk, risiko, risque, etc.) and consequently facilitates international understanding and comparability, whereas for instance "concern" and "worry" is more difficult to translate to other languages "without losing some of its essential meaning, or without adding some new meanings" (Sjöberg 2000b). Be that as it may, comparability should not go before a sound operationalisation of the relevance of the concept one intends to study. The problem with "risk" is that most lay people do not have an intuitive understanding of what this is – which of course has been one of the main themes in risk perception research. However, if risk is something abstract and not intuitive for people, it is not likely that perception of "risk" will influence their behaviour. "Concern" or "worry" etc. are concepts most people probably have an intuitive understanding of – these concepts are everyday language and therefore more ecological valid operationalisations of risk perception. Because people have an intuitive understanding of these concepts, asking about them is in one way a more direct way of asking about risks, than actually asking explicitly about "risk".

One problem is of course whether or not these other operationalisations of risks actually are part of the "risk concept". A few studies have investigated the relationship between worry and risk, but the results are diverging (Baron et al. 2000; Moen & Rundmo 2006; Sjöberg 1998). Whereas Sjöberg (1998) has found weak to moderate relationships between worry and risk, Moen and Rundmo

(2006) found worry to be the better predictor of "risk" compared to for instance probability and consequences. It is important to note however, that in Sjöberg's (1998) study, worry was measured as general worry, i.e., an index of 12 questions concerning how often the respondents had experienced various kinds of worry in the last 5 years. Thus the "worry"-measure in Sjöberg's study is intended as a predictor of risk perception, not an operationalisation of the concept – and should not be treated as such.

Moreover, Brun (1995) discusses individual variations in perception of risk and what different people understand by risk. The discussion is mainly linked to the scientific definition of risk, and deals with probability, consequences and a combination of the two as components of the risk concept. Brun (1995) refers to a study by Drottz-Sjöberg in which subjects were asked what they mean by the term "risk". 46 percent answered that "risk is mainly a question of the probability of an event", whereas 22 percent believed that risk "is mainly a question of the consequences of an event" and 22 percent agreed that "risk is a combination of probability and consequence". Finally, 26 percent said that the meaning of risk has to do with "the nature of the event"6F6F[7]. In a similar study, conducted by Brun, only 3 percent said that risk referred exclusively to probability or uncertainty, whereas 35 percent focused on consequences. In this study, 63 percent agreed that risk was a combination of probability and consequences. Thus, the two studies referred to points in somewhat diverse directions with regard to what people mean by "risk". Importantly though, in the latter study a short introduction was given in which different perspectives on risk was explained. This may have influenced the subjects, e.g., if the introduction mentioned that the scientific definition is "probability x consequences", this may be an explanation why a majority in this study said that risk is a combination of the two components.

Notwithstanding the above mentioned problems, one essential issue only implicitly discussed in the research literature is that of measuring a "riskconstruct" that is important in the sense that it influences behaviour, wellness or welfare of people. In order to be of applied value, the constructs of interest should have an effect on people, e.g., on behaviour, attitudes, or wellness. Results from a study on perceived probability of an accident and worry when travelling by metro and bicycle, showed that worry had a stronger correlation with behavioural adaptation than perceived probability. Thus, this study suggested that worry is more important in relation to behaviour than probability (Backer-Grøndahl et al. 2007a).

6.2 Final comments

The main aims of conducting this literature review was to a) give a short outline of the dominating lines of research within the risk perception literature with emphasis on the transport domain, b) study to what degree and how researchers have dealt with operationalisation of "risk perception", and c) use this literature review as a background for making relevant research questions and sound operationalisations of perception of transport risks that is 1) linked to the theories

[7] The percentage does not sum up to 100 as respondents could choose more than one alternative.

within the field and 2) of applied value (i.e., an ecological valid operationalisation).

The literature review indicates that there is little explicit discussion of operationalisation of risk perception in the literature, and that there are various ways to measure this construct.

We will pursue the line of research focusing on emotional aspects of risk perception. Moreover, we will investigate how to best capture the risk elements that is important for people when it comes to transportation and risk for accidents and unpleasant incidents.

7 References

af Wåhlberg, A. 2001. The theoretical features of some current approaches to risk perception. *Journal of Risk Research*, 4, (3) 237-250

Allen, T.M., Lunenfeld, H., & Alexander, G.J. 1971. Driver information needs. *Highway Research Records*, 366, 102-115

Alm, C. & Lindberg, E. 2000, *Perceived risk, feelings of safety and worry associated with different travel modes: pilot study*, Kommunikationsforskningsberedningen, Stockholm, 2000:7.

Alm, C. & Lindberg, E. 2002, *Upplevd trygghet vid resor med kollektiva transportmedel*, Väg- och transportforskningsinstitutet, Linköping, Sverige, VTI meddelande 919.

Alm, C. & Lindberg, E. 2004, *Betydelsen av upplevda risker och känslor av otrygghet vid resor med kollektivtrafik*, Väg- och transportforskningsinstitutet, Linköping, Sweden.

Atkinson, R.L., Atkinson, R.C., Smith, E.E., Bem, D.J., & Nolen-Hoeksema, S. 2000. *Hilgard's introduction to psychology*, Thirteenth ed. Orlando, Hartcourt College Publishers.

Backer-Grøndahl, A., Amundsen, A. H., Fyhri, A., & Ulleberg, P. 2007a, *Trygt eller truende? Opplevelse av risiko på reisen*, Transportøkonomisk institutt, Oslo, 913/2007.

Backer-Grøndahl, A., Amundsen, A. H., Fyhri, A., & Ulleberg, P. 2007b, *Trygt eller truende? Opplevelse av utrygghet på ulike transportmidler*, Transportøkonomisk institutt, Oslo.

Backer-Grøndahl, A., Fyhri, A., & Ulleberg, P. Accidents and Incidents: Worry in transport and prediction of travel behaviour. 2008.
Ref Type: Unpublished Work

Baron, J., Hershey, J.C., & Kunreuther, H. 2000. Determinants of priority for risk reduction: The role of Worry. *Risk Analysis*, 20, (4) 413-427

Bjørnskau, T. 2003, *Risiko i trafikken 2001-2002*, Transportøkonomisk institutt, Oslo, 694/2003.

Bjørnskau, T. 2004, *Trygghet i transport. Oppfatninger av trygghet ved bruk av ulike transportmidler*, Transportøkonomisk institutt, Oslo, 702/2004.

Boholm, Å. 1998. Comparative studies of risk perception: A reveiw of twenty years of research. *Journal of Risk Research*, 1, (2) 135-163

Bouyer, M., Bagdassarian, S., Chaabanne, S., & Mullet, E. 2001. Personality correlates of risk perception. *Risk Analysis*, 21, (3) 457-465

Brenot, J., Bonnefous, S., & Marris, C. 1998. Testing the Cultural Theory of Risk in France. *Risk Analysis*, 18, (6) 729-739

Brun, W. 1995. *Subjective conceptions of uncertainty and risk.*

Brun, W. 1991. Opplever vi trafikken som farlig? Trafikkrisiko sett i lys av kognitiv bedømmingspsykologi. *Tidsskrift for samfunnsforskning*, 32, 417-430

Chauvin, B., Hermand, D., & Mullet, E. 2007. Risk perception and personality facets. *Risk Analysis*, 27, (1) 171-185

Costa, P.T. 1992. *Revised NEO Personality Inventory (NEO PI-R) and NEO Five-Factor Inventory (NEO-FFI): professional manual* Odessa, Fla., Psychological Assessment Resources, Inc.

Dake, K. 1991. Orienting dispositions in the perception of risk. An analysis of contemporary worldviews and cultural biases. *Journal of Cross-Cultural Psychology*, 22, (1) 61-82

Damasio, A.R. 1994. *Descartes' Error: Emotion, Reason and the Human Brain* New York, G.P. Putnam's & sons.

Direktoratet for samfunnssikkerhet og beredskap 2007, *Nasjonalt beredskapsbarometer*.

Elvik, R. & Bjornskau, T. 2005. How accurately does the public perceive differences in transport risks? An exploratory analysis of scales representing perceived risk. *Accident Analysis and Prevention*, 37, (6) 1005-1011

Ferraro, K.F. & Lagrange, R. 1987. The Measurement of Fear of Crime. *Sociological Inquiry*, 57, (1) 70-101

Finucane, M.L., Alhakami, A., Slovic, P., & Johnson, S.M. 2000a. The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making*, 13, (1) 1-17

Finucane, M.L., Slovic, P., Mertz, C.K., Flynn, J., & Satterfield, T.A. 2000b. Gender, race, and perceived risk: the 'white male' effect. *Health Risk & Society*, 2, (2) 159-172

Fischoff, B., Slovic, P., Lichtenstein, S., Read, S., & Combs, B. 2000, "How safe is safe enough? A psychometric study of attitudes toward technological risks and benefits," *In The perception of risk*, P. Slovic, ed., London: Earthscan Publications Ltd, pp. 80-103.

Gustafson, P.E. 1998b. Gender Differences in Risk Perception: Theoretical and Methodological Perspectives. *Risk Analysis*, 18, (6) 805-811

Gustafson, P.E. 1998a. Gender Differences in Risk Perception: Theoretical and Methodological Perspectives. *Risk Analysis*, 18, (6) 805-811

Gustafson, P.E. 1998c. Gender Differences in Risk Perception: Theoretical and Methodological Perspectives. *Risk Analysis*, 18, (6) 805-811

Gustafson, P.E. 1998d. Gender Differences in Risk Perception: Theoretical and Methodological Perspectives. *Risk Analysis*, 18, (6) 805-811

Hjorthol, R., Kolbenstvedt, M., & Stangeby, I. 1989, *Barn, trafikk og miljø - intervjuer med 3-10 åringers foreldre i Vålerenga/Gamlebyen i Oslo*, Transportøkonomisk institutt, Oslo, 908/89.

Jackson, J. 2004. Experience and expression - Social and cultural significance in the fear of crime. *British Journal of Criminology*, 44, (6) 946-966

Jackson, J. 2006. Introducing fear of crime to risk research. *Risk Analysis*, 26, (1) 253-264

Kolbenstvedt, M. 1998, *Miljøkonsekvenser av hovedvegomlegging Oslo Øst. Oppsummering av studier 1987-1996*, Transportøkonomisk institutt, Oslo, 405/98.

Kraus, N.N. & Slovic, P. 1988. Taxonomic analysis of perceived risk: Modeling individual and group perceptions within homogeneous hazard domains. *Risk Analysis*, 8, (3) 435-455

Krosnick, J.A. 1999. Survey research. *Annual Reviews in Psychology*, 50, 537-567

Loewenstein, G.F., Weber, E.U., Hsee, C.K., & Welch, N. 2001. Risk as feelings. *Psychological Bulletin*, 127, (2) 267-286

Macgregor, D. 1991. Worry over technological activities and life concerns. *Risk Analysis*, 11, (2) 315-324

Marris, C., Langford, I.H., & O'Riordan, T. 1998. A quantitative test of the cultural theory of risk perceptions: comparison with the psychometric paradigm. *Risk Analysis*, 18, (5) 635-647

McDaniels, T.L., Axelrod, L.J., Cavanagh, N.S., & Slovic, P. 1997. Perception of ecological risk to water environments. *Risk Analysis*, 17, (3) 341-352

Moen, B.E. 2008. *Risk perception, priority of safety, and demand for risk mitigation in transport.*

Moen, B.E. & Rundmo, T. 2006. Perception of transport risk in the Norwegian public. *Risk Management*, 8, 43-60

Oltedal, S. & Rundmo, T. 2007. Using cluster analysis to test the cultural theory of risk perception. *Transportation Research Part F-Traffic Psychology and Behaviour*, 10, (3) 254-262

Sjöberg, L. 1998. Worry and risk perception. *Risk Analysis*, 18, (1) 85-93

Sjöberg, L. 93 A.D., Uro och riskuppfatning, *In FRN/ Riskkollegiets Symposium*.

Sjöberg, L. 2000a. Factors in risk perception. *Risk Analysis*, 20, (1) 1-11

Sjöberg, L. 2000f. The Methodology of Risk Perception Research. *Quality and Quantity*, 34, (4) 407-418

Sjöberg, L. 2002. Are received risk perception models alive and well? *Risk Analysis*, 22, (4) 665-669

Sjöberg, L. 2003. Distal factors in risk perception. *Journal of Risk Research*, 6, (3) 187-211

Sjöberg, L. 2006, *Myths of the psychometric paradigm and how they can misinform risk communication* 2006:10.

Sjöberg, L. 2000b. The Methodology of Risk Perception Research. *Quality and Quantity*, 34, (4) 407-418

Sjöberg, L. 2000c. The Methodology of Risk Perception Research. *Quality and Quantity*, 34, (4) 407-418

Sjöberg, L. 2000d. The Methodology of Risk Perception Research. *Quality and Quantity*, 34, (4) 407-418

Sjöberg, L. 2000e. The Methodology of Risk Perception Research. *Quality and Quantity*, 34, (4) 407-418

Sjöberg, L. & af Wåhlberg, A. 2002. Risk perception and New Age beliefs. *Risk Analysis*, 22, (4) 751-763

Sjöberg, L., Moen, B. E., & Rundmo, T. 2004, *Explaining risk perception. An evalutation of the psychometric paradigm in risk perception research*, Rotunde, Trondheim, 84.

Slovic, P., Finucane, M.L., Peters, E., & MacGregor, D.G. 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, (2) 311-322

Slovic, P., Finucane, M.L., Peters, E., & MacGregor, D.G. 2007. The affect heuristic. *European Journal of Operational Research*, 177, (3) 1333-1352

Slovic, P., Fischoff, B., & Lichtenstein, S. 2000a, "Rating the risks," *In The perception of risk*, P. Slovic, ed., London: Earthscan Publication Ltd, pp. 104-120.

Slovic, P., Fischoff, B., & Lichtenstein, S. 2000b, "Facts and Fears: Understanding perceived risk," *In The Perception of RIsk*, P. Slovic, ed., London: Earthscan Publications, pp. 135-153.

Slovic, P., Layman, M., Kraus, N., Flynn, J., Chalmers, J., & Gesell, G. 1991. Perceived Risk, Stigma, and Potential Economic-Impacts of A High-Level Nuclear Waste Repository in Nevada. *Risk Analysis*, 11, (4) 683-696

Slovic, P. & Peters, E. 2006. Risk perception and affect. *Current Directions in Psychological Science*, 15, (6) 322-325

Slovic, P., Peters, E., Finucane, M.L., & MacGregor, D.G. 2005a. Affect, risk, and decision making. *Health Psychology*, 24, (4) S35-S40

Slovic, P., Peters, E., Finucane, M.L., & MacGregor, D.G. 2005b. Affect, risk, and decision making. *Health Psychology*, 24, (4) S35-S40

Slovic, P. & Weber, E. U. Perception of Risk Posed by Extreme Events. 2002. Ref Type: Unpublished Work

Slovic, P. 2000. *The perception of risk* London, Earthscan.

Summala, H. 1988. Risk Control Is Not Risk Adjustment - the Zero-Risk Theory of Driver Behavior and Its Implications. *Ergonomics*, 31, (4) 491-506

Teigen, K.H., Brun, W., & Slovic, P. 1988. Societal risks as seen by a Norwegian public. *Journal of Behavioral Decision Making*, 1, 111-130

Thomas, L.J., Rhind, D.J.A., & Robinson, K.J. 2006. Rail passenger perceptions of risk and safety and priorities for improvement. *Cognition Technology and Work*, 8, 67-75

Vaa, T. 2003, *Survival or deviance? A Model for Driver Behaviour. Final report*, Institute of Transport Economics, Oslo, 666/2003.

Wilde, G.S. 1994. *Target risk : dealing with the danger of death, disease and damage in everyday decisions* Toronto, PDE Publications.

Zajonc, R.B. 1980. Feeling and Thinking: Preferences need no inferences. *American Psychologist*, 35, 151-175

Appendices

Table 1a. Cultural Bias Items. British edition of Dake's Cultural Biases Queistionnaire.

Hierarchy
I think there should be more discipline in the youth of today.
I would support the introduction of compulsory National Service.
I am more strict than most people about what is right and wrong.
I think it is important to carry on family traditions.
I value regular routines highly.
I think being on time is important.
Individualism
In a fair system people with more ability should earn more.
A free society can only exist by giving companies the opportunity to prosper.
If a person has the get-up-and-go to acquire wealth, that person should have the right to enjoy it.
It is just as well that life tends to sort out those who try harder from those who don't
Making money is the main reason for hard work
Egalitarianism
If people in this country were treated more equally we would have fewer problems.
The government should make sure everyone has a good standard of living.
Those who get ahead should be taxed more to support the less fortunate.
I would support at tax change that made people with large incomes pay more.
The world could be a more peaceful place if its wealth and were divided more equally among nations.
Racial discrimination is a very serious problem in our society
What this country needs is a "fairness revolution" to make the distribution of goods more equal
Most of the meals I eat are vegetarian
Health requirements are very important in my choice of foods
I prefer simple and unprocessed food
Fatalism
There is no use in doing things for people – you only get it in the neck in the long run
Cooperating with others rarely works
The future is too uncertain for a person to make serious plans
I have often been treated unfairly
A person is better off if he or she doesn't trust anyone
Most people make friends only because friends are useful to them
I feel that life is like a lottery

Table 2a. Operationalisation of risk perception and worry in cited empirical studies. Alphabetical order.

Reference	Key words	Risk perception/worry operationalised as:
Alm & Lindberg (2000). Perceived risk, feelings of safety and worry associated with different travel modes.	Perceived risk, worry, transport, hazard dimensions	Perceived risk of a) being involved in an accident and b) being exposed to violence/threat for seven different means of transport. Frequency of feelings of unsafety and worry. Rated by putting a mark on a 101 mm long line with end points labelled for instance "no risk at all" to "very risky".
Alm & Lindberg (2002). Upplevd trygghet vid resor med kollektiva transportmedel.	Perceived attractiveness, feelings of safety, perceived risk, transport	Perceived risk and worry of a) traffic accidents and b) unpleasant passengers, threats or violence. 9 point scales.
Alm & Lindberg (2004). Betydelsen av upplevda risker och känslor av otrygghet vid resor med kollektivtrafik.	Perceived risk, feelings of unsafety, transport	Perceived risk and worry of a) being seriously injured in traffic accidents and b) unpleasant passengers, threats or violence. 9 point scales.
Backer-Grøndahl, Fyhri, & Ulleberg (2008). Worry and transport: Predictors of worry and transport behaviour.	Worry, risk perception, transport, individual variations	"To what degree do you think about the possibility of an accident/an unpleasant incident, when you travel with….." 5 point rating scales. 1 "not at all" to 5 "to a high degree"
Baron, Hershey, & Kunreuther (2000). Determinants of priority for risk reduction: The role of worry.	Risk attitudes, worry, emotion, expertise	"How much do you worry about each of these risks, on the average, for you and your immediate family? Answer on a scale of 1 to 7, where 1 means "not at all" and 7 means "a great deal". A "great deal" means that you tnink about it often and that you are greatly bothered by the thought of the bad event in question."
Boyer, Bagdassarian, Chaabanne, & Mullet (2001). Personality correlates of risk perception.	Risk perception, personality, anxiety, world views	Risk perception: risk of being seriously ill, wounded or dying. Measured on 11 point scales, 0 "no risk" – 10 "extremely severe risk" 141 risk hazard items?
Brenot, Bonnefous, & Marris (1998). Testing the cultural theory of risk in France.	Risk perception, cultural biases	"Do you think that the existence of X endangers you or your relatives?" 5 point scale, from "no, not at all" to "yes, absolutely"
Chauvin, Hermand, & Mullet (2007). Risk Perception and personality facets.	Risk perception, personality	11 point scales, 0 "no risk" – 100 "extremely severe risk". 24 hazards
Elvik & Bjørnskau (2005).How accurately does the public perceive differences in transport risks? An exploratory analysis of scales representing perceived risk	Risk perception, transport, accidents, statistical estimates of risks	"How safe do you think it is to travel by means of (airplane, train, ship etc.)? Do you think it is: a) very safe, b) safe, c) a little unsafe, d) very unsafe, or are you e) unable to answer (do not know).
Fischoff, Slovic, Lichtenstein, Read, & Combs (1978/2000). How safe is safe enough? A psychometric study of attitudes toward technological risks and benefits.	Perceived risk and benefits, hazard dimensions, psychometric model	"Consider the risk of dying as a consequence of this activity or technology" (30 hazards) Order the hazards from least to most risky. The least risky hazard was to be given the number 10, the others were to be rated accordingly. A hazard rated 200 would be 20 times as risky as the least risky hazard. 9 risk dimensions, 7 point (e.g., involuntary – voluntary)

Reference	Key words	Risk perception/worry operationalised as:
Kraus & Slovic (1988). Taxonomic analysis of perceived risk: Modeling individual and group perceptions within homogeneous hazard domains	Perceived risk, risk analysis, group and individual variations	"Overall level of riskiness" Scale from 0 (not risky) to 100 (extremely risky) 38 hazards
MacGregor (1991). Worry over technological activities and life concerns.	Worry, risk perception, concern, nuclear risk	Worry: Scale from 0 (I never worry about this) to 20 (I worry about this often, intensely, and for long periods of time). 37 "worry-items"
Marris, Langford, & O'Riordan (1998). A quantitative test of the cultural theory of risk perceptions: Comparison with the psychometric paradigm.	Risk perception, cultural model, psychometric paradigm	Riskiness: "How much risk do you think is associated with…?" Fatalities: "How many people do you think die every year as a consequence of…?" Injuries: "How many people do you think are inured or become ill….?" Environmental Harm: "How much hard do you think is done to things other than people as a consequence of….?" Unacceptability: "How acceptable do you feel the current risk is for…."? 5 point rating-scales
Moen & Rundmo (2006). Perception of transport risk in the Norwegian public.	Risk perception, probability, consequence, worry	General risk assessment: "how do you evaluate the risks when using the following transport modes? 1 (extremely large) to 7 (non-existent") Probability of personal injury "How comprehensive do you think the consequences would be?" "How worried are you when you think about the possibility of an accident with personal injury when travelling by (airplane etc.)" 7 point Likert scales (e.g., "very unlikely" to "very likely")
Moen (2008). Applying the risk-as-feelings framework to explain demand for risk mitigation.	Risk-as-feelings, demand for risk mitigation, risk perception, worry	a) probability of harm, b) assessment of consequences, c) worry, d) general risk assessment, e) thinking about the risk, e) negative associations with each transport mode. 7 point Likert scales, 1 "low prob/low risk etc", 7 "high prob/high risk etc".
Noland (1995). Perceived risk and modal choice: Risk compensation in transportation systems.	Perceived risk, risk compensation, mode choice	Evaluation of probability and severity of consequences: 1) "Please rate how likely you think it is for you to be in an accident, during the next five years..?", 2) " Please rate how seriously injured you think you would be if you were to be in an accident….". Risk perception=(probability of accident) X10 (severity of accidents)
Oltedal & Rundmo (2007). Using cluster analysis to test the cultural theory of risk perception.	Risk perception, cultural theory, transport, accidents	Assessment of probability, consequence and worry provoked by accidents. Each of the tree constructs measured by 11 items, 7 point Likert scales. Items concerned both public and private transport.
Sjöberg (1999). Consequences of perceived risk: Demand for mitigation	Risk perception, risk reduction, trivial risks	7 point scales, 0 (non-existent risk) to 6 (extremely large risk)

Reference	Key words	Risk perception/worry operationalised as:
		43 hazards, 7 hazard dimensions, also rated on 7 point scales. Risk target: general and personal
Sjöberg. (2003). Distal factors in risk perception.	Risk perception, personality, world views, new age, new environmental paradigm	8 point scales, 0- 7 26 hazards Risk target: personal, general
Sjöberg & Wåhlberg. (2002). Risk perception and New Age beliefs.	Risk perception, new age, personality, religious involvement.	Scale: 0 (nonexistent risk) to 7 (a very large risk) 34 hazards Risk target: personal, general 24 hazard dimensions
Sjöberg (2000). Factors in risk perception.	Discussion of various factors in risk perception research	Respondents instructed to "rate the risks on a scale from 0 (no risk at all) to 6 (an extremely large risk). Risk target: oneself, family, people in general.
Sjöberg (1998). Worry and risk perception.	Risk perception, worry	Worry: 12 items, general worry, i.e., how often individuals had had experience of worry in the last 5 years. Risk perception: specification of risk target (personal, family and general). No information about more specific operationsalisation.
Slovic, Fischoff and Lichtenstein (1980/2000). Facts and Fears: Understanding the risk.	Perceived risk and benefit, hazards, extension of 1978-study, psychometric model	Perceived risk of dying. Scale from 0 – 100. (90 hazards) 18 hazard dimensions, 7 point
Teigen, Brun & Slovic (1988). Perceived Societal Risks.	Psychometric model, cross-cultural generalisation of psychometric model	"Risk of dying for the Norwegian society as a whole" Graphical rating scale from 0 "not risky" to 100 "extremely risky" (30 hazards) 9 risk dimensions, 7 point?
Thomas, Rhind, & Robinson (2006). Rail passenger perceptions of risk and safety and priorities for improvement.	Rail passenger, safety preferences, risk perception, objective risk	Passengers asked to estimate the percentage of injuries/fatalities caused by various types of incidents and accidents.

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