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# Operationalizing risk perception and preparedness behavior research for a multi-hazard context

Cheney Shreve[a], Chloe Begg[b], Maureen Fordham[a] and Annemarie Müller[b]
[a]Geography Department, Northumbria University, Newcastle upon Tyne, UK; [b]Department of Urban and Environmental Sociology, Helmholtz Centre for Environmental Research, Leipzig, Germany

Corresponding author: Cheney Shreve
Email: cmshreve@gmail.com

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## ABSTRACT

Increasingly, citizens are being asked to take a more active role in disaster risk reduction (DRR), as decentralization of hazard governance has shifted greater responsibility for hazard preparedness actions onto individuals. Simultaneously, the taxonomy of hazards considered for DRR has expanded to include medical and social crises alongside natural hazards. Risk perception research emerged to support decision-makers with understanding how people characterize and evaluate different hazards to anticipate behavioral response and guide risk communication. Since its inception, the risk perception concept has been incorporated into many behavioral theories, which have been applied to examine preparedness for numerous hazard types. Behavioral theories have had moderate success in predicting or explaining preparedness behaviors; however, they are typically applied to a single hazard type and there is a gap in understanding which theories (if any) are suited for examining multiple hazard types simultaneously. This paper first reviews meta-analyses of behavioral theories to better understand performance. Universal lessons learnt are summarized for survey design. Second, theoretically based preparedness studies for floods, earthquakes, epidemics, and terrorism are reviewed to assess the conceptual requirements for a 'multi-hazard' preparedness approach. The development of an online preparedness self-assessment and learning platform is discussed.

KEYWORDS: Risk perception; preparedness; floods; earthquakes; epidemics; terrorism

## 1. Introduction

Risk perception is central to many health behavior and natural hazard preparedness studies, which have traditionally engaged psychological (cognitive) or social-psychological (social-cognitive) theories to explain how people characterize and evaluate hazard risks and decide whether or not to take protective actions, also termed preparedness actions (Brewer et al., 2007; Wachinger, Renn, Begg, & Kuhlicke, 2013). Hazard perceptions and preparedness behaviors are commonly measured at the household level through surveys with questions derived from cognitive or social-cognitive behavioral theories.

Surveys typically have the dual aim of understanding what preparedness measures people have taken, or plan to undertake, while also identifying barriers to hazard preparedness. Barriers or obstacles to hazard preparedness may be psychological, for example, relating to hazard risk perception, coping capacity, self-esteem, self-efficacy, or psychological biases. Other social factors and social norms, or material resource constraints, might also be obstacles preventing individuals from preparing for hazards. While cognitive and social-cognitive theories for predicting and explaining preparedness behaviors have had moderate success, there is a gap in understanding feasibility of such methods across different hazard types and contexts. One element of this is that researchers continue to repeat methodological errors stemming from the design and interpretation of surveys, which limits comparative ability (Brewer et al., 2007; Milne, Sheeran, & Orbell, 2000; Sutton, 1998; Weinstein, 1988). The limited number of studies in the literature that examine preparedness behaviors for multiple hazard types simultaneously, or which consider the suitability of different theories in predicting or explaining a range of preparedness actions, are other factors which limit understanding of the suitability of different theoretical approaches for assessing hazard preparedness behaviors. For example, medical and social crises are now commonly managed alongside natural hazards under civil contingencies planning for many European countries (Alexander, 2003). Thus, there is a need to understand which (if any) behavioral theories are better suited for a 'multi-hazard' planning approach.
The TACTIC (Tools, methods, and training for communities and society to better prepare for a crisis) project is developing a free online self-assessment and learning platform aimed at fostering preparedness for floods, earthquakes, terrorism, and epidemics; hazards which have significant human, social, and environmental impacts in Europe. TACTIC adopts a holistic definition of preparedness that considers different stakeholders and levels of activity:

> The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions. (The United Nations Office for Disaster Risk Reduction, 2007)

Two self-assessments, one for the general public and one for organizations with risk communication responsibilities, aim to help users assess preparedness levels and develop or improve risk communication strategies, respectively. Users receive feedback on the self-assessments indicating areas requiring improvement and the general scientific basis underpinning the assessment. Users of the self-assessment are also directed to a library of 'good practices', which is a database of preparedness activities that have been reviewed and categorized based on characteristics of the activity (i.e. methods and aims) and other pragmatic considerations (i.e. cost and difficulty). Anonymous results of the general public self-assessment are visible to registered organizations within the local geographic region. Figure 1 shows a schematic of the TACTIC online learning platform (further details in Appendix 1).

[insert Figure 1 here]

This paper first reviews meta-analyses of common behavioral theories that have been

applied to understand preparedness behaviors for selected natural and health hazards. The core conceptual elements of the theories and lessons learnt are discussed. Behavioral analyses have been applied to a range of different hazard types, however an exhaustive review of these studies is beyond the scope of the current paper, which focuses on specific hazards (i.e. floods, earthquakes, epidemics, and terrorism). Meta-analyses of preparedness studies are also less common for some hazard types such as natural hazards, as studies infrequently report the necessary statistical information and often do not utilize a theory, further limiting comparison. Second, this paper reviews theoretically based preparedness studies for floods, earthquakes, epidemics, and terrorism with a focus on Europe. The third section situates results to inform the discussion of behavioral theories suited for a 'multihazard' preparedness context and discusses primary limitations. Results of this analysis contribute to the improved development of hazard preparedness surveys and further the discussion of utilizing behavioral theories for a 'multi-hazard' preparedness approach.

### 1.1. Background

Despite varied ontological perspectives on the nature and experience of risk, risk behavior studies frequently share common aims, assumptions, and methodologies. Whether purposed as predictive or explanatory, at the coremost risk theories assume a cost and benefits approach (Weinstein, 1988). In other words, these theories assume that people weigh the expected benefits of a behavior against its costs and adopt, or will adopt, the behavior if the benefits are favorable (Weinstein, 1988). This section reviews core concepts from popular theories of behavior utilized for the natural and human-made hazards considered here.

### 1.2. Cognitive behavioral theories

#### 1.2.1. Operationalization of risk perception

Risk perception is central to many health behavioral and natural hazard preparedness theories (Brewer et al., 2007; Wachinger et al., 2013); however, different approaches operationalize risk perception differently, primarily regarding the temporal precedence of risk perception with respect to other behavioral determinants; the incorporation of other factors such as coping, trust, and efficacy; and the theorized effects or impacts of perceptions.

[insert Table 1 here]

Table 1 summarizes the general aims and incorporation of risk perception within different behavioral theories. Factor-analytic approaches such as the psychometric paradigm have shown that qualities of risk (e.g. qualitative characteristics of hazards termed factors) such as trust, dread, and voluntariness, in combination with perceptions regarding risk probability, create unique patterns for different hazard types related to perceived risk (Slovic, 2010). A small set of mental strategies, or heuristics, that people employ to deal with uncertainty was a significant breakthrough of the psychometric paradigm (Slovic, Fischhoff, & Lichtenstein, 1982). Risk perception studies focused on natural hazards specifically have identified the need for factors to encompass perceptions about the hazard preparedness activities themselves (Wachinger et al., 2010). For example, factors encompassing the costs and benefits of

specific hazardmeasuresmay be influential in motivating their uptake from both a cognitive (i.e. related to the amount of efficacy and skill involved in adopting such measures) and a social (i.e. perceived responsibility, material costs, and benefits) perspective. Additionally, both natural hazard and health behavior studies commonly incorporate perceptions of susceptibility, severity, and likelihood of the hazard as mediators of risk perception and thus one's inclination to take protective action (Brewer et al., 2007; Weinstein, 1988).

Social-cognitive approaches examining the adoption of preparedness behaviors, whilst frequently incorporating risk perception as an influential factor motivating preparedness intentions, also commonly incorporate coping, threat appraisal, and efficacy determinants. In coping and threat-centered approaches, for instance, risk perception precedes precaution assessment, drawing the distinction between primary (threat) appraisal and secondary (coping) appraisal (Weinstein, 1988). Increasingly, social-cognitive approaches evaluating natural hazard preparedness behavior also consider efficacy determinants (Paton, Smith, & Johnston, 2000). Self-efficacy as it pertains to a person's perceptions and abilities to engage in hazard preparedness actions is often considered an important factor in social-cognitive behavioral theories. Some models incorporate efficacy determinants primarily as factors influencing preparedness intention formation (cf.Paton, 2003), whereas others put significantly more emphasis on efficacy determinants in influencing behavior through outcome expectations and goal setting (cf. Bandura, 1998).

### 1.2.2. The risk perception–behavior relationship

In a meta-analysis of risk perception and vaccination behavior, Brewer et al. (2007, p. 136) conclude that 'consistent relationships exist between risk perception and behavior, larger than suggested by prior meta-analyses, suggesting that risk perceptions are rightly placed as the core concepts in theories of health behavior'; however, 'methodological errors and inappropriate assessments' very frequently skew results, as is detailed below. Brewer et al. (2007) first distinguish between three types of risk perceptions: perceived likelihood (the probability that one will be harmed by the hazard), perceived susceptibility (an individual's constitutional vulnerability to the hazard), and perceived severity (the extent of harm a hazard would cause). The authors then detail how researchers commonly fail to condition risk-related questions to specific risk perceptions; for instance, if the motive is to test if the perceived likelihood of getting the flu motivates getting a flu vaccine, researchers need to ask about the person's perception of what the probability would be if he or she did not get vaccinated, and commonly, these connections are not made by researchers (Brewer et al., 2007, p. 138).

Additionally, the use of unconditional risk questions (e.g. comparing perceptions of people who have been vaccinated with those who have not) is problematic because if the respondent has been vaccinated, then questions of probability ('how likely are you to get the flu?') will reflect their awareness of having had a vaccination (Brewer, 2004). Furthermore, whether or not risk perception questions need to be conditioned depends also on expectations related to the behavior: vaccination behavior, for example, is expected to change the likelihood of contracting a disease, whereas getting a

mammogram is perceived to impact severity (e.g. early detection). Perceived susceptibility, as the term is defined here to pertain to general constitutional resistance independent of particular preventive actions, does not need to be conditioned (Brewer, 2004). Case studies by Harrison, Mullen, and Green (1992) and Floyd, Prentice-Dunn, and Rogers (2000) and the meta-analysis by Milne et al. (2000) included studies that should have used conditional questions to measure risk likelihood; consequently, they likely underestimate the influence of risk perception on behavior (Brewer et al., 2007, p. 138).

Additional considerations pertain to the protective behaviors specifically; risk perceptions are probably more important for behaviors that reduce a specific health threat (e.g. sunscreen use) and less important for more general behaviors (e.g. diet and exercise) that have a wide range of health and non-health consequences (Brewer et al., 2007, p. 138).

### 1.3. Social-cognitive theories

Risk perception is frequently considered as an important factor or motivator for behavior by social-cognitive behavioral models such as the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980), the Theory of Planned Behavior (TPB; Ajzen, 1985), Protection Motivation Theory (PMT; Rogers, 1975), and other social-cognitive models for disaster preparedness (Paton, 2003) (see Appendix 2 for further descriptions). Key differences between factor analytic and social-cognitive approaches are that the former places greater emphasis on individual cognitive processes, whereas the latter incorporates influence of communities or social reference groups on one's behavior. An additional difference is commonly the incorporation of one or more efficacy determinants on preparedness behavior in social cognitive approaches. Efficacy beliefs pertain to individuals' perception of their abilities to perform a skill or not and often include resource considerations.

A meta-analysis by Sutton (1998) evaluates the performance of TRA/TPB in predicting and explaining health intentions and behaviors. On average, these models explain between 40% and 50% of the variance in intention and 19–38% of the variance in behavior. Sutton (1998) identifies several methodological challenges which likely have limited the performance of TRA/TPB and that have import for other risk perception and behavior studies, mainly, recognition that intentions may change; thus, as Ajzen and Fishbein (1980) asserted, the measurement of intention should be as close as possible to the behavior.

Second, that intention may be provisional; for example, some participants may have already formed relevant intentions prior to taking a survey, and others may express hypothetical or provisional intentions. In terms of survey construction, Sutton (1998) emphasizes the use of the principle of compatibility (Ajzen, 2005), which states that the predictor (intention) and criterion (behavior) should be measured at the same level of specificity or generality within questions.

Furthermore, the measure should be matched with regard to four components: action, target, time, and context, a concept that is well supported by empirical studies

(Ajzen, 1988; Putte, 1993). For example, Courneya (1994) presents data that show that violating scale correspondence results in attenuated correlations. Other practical considerations identified include the need to balance the number of intention/behavior response categories (i.e. from a modeling perspective, if a linear relationship between intention and behavior is assumed and these categories do not have equal response categories, it is not possible to get a correlation of 1.0), and the need to consider that factors that influence behavior may not entirely be mediated by intention, for example, past behavior, habit, attitude toward the behavior, and self-identity. Measuring intentions proximally and using highly reliable measures can help to address this challenge (Courneya, 1994).

### 1.3.1. Efficacy

Bandura's reformulation of Social Cognitive Theory (SCT; 1998) embeds self-efficacy into decisions pertaining to outcome expectations, impediments, goals, and behaviors (see Appendix 2). Other models such as TPB incorporate self-efficacy as a factor preceding intention formation. The aim here is not to argue the proper use of efficacy determinants, rather to discuss insights from SCT that are relevant to other theoretical approaches for hazard preparedness. SCT focuses on social systems (socio-structural determinants) on health as well as personal determinants, which are grounded largely in efficacy beliefs (Bandura, 1998). A main critique that Bandura (1998) poses with regard to other theoretical approaches is the emphasis on individual habits, neglecting the health system itself. As medical care cannot substitute for healthful habits, it is necessary to ensure that individuals are taught self-management skills (Bandura, 1998). Second, people's beliefs about their collective efficacy to accomplish social change are identified as critical for motivating and implementing change. Thus, 'a comprehensive approach to health must provide people with the knowledge, skills and sense of collective efficacy to mount social and policy initiatives that affect human health' (Bandura, 1998, p. 646).

## 1.4. Summary: cognitive and social preparedness approaches

While both cognitive and social-cognitive behavioral theories have had moderate success in predicting and explaining preparedness behavior, many avoidable methodological errors skew or attenuate results and limit cross-study comparisons. Specifically, for survey-based assessments, the inattention to specificity and generality of risk (Brewer et al., 2007), failure to properly condition intentions with behaviors (Sutton, 1998), and, more generally, failure to address the level of risk being assessed (i.e. personal versus global) are common mistakes that limit validation and comparison efforts. Questions may not be properly conditioned for the behavior – the influence of repeat behaviors on perceptions or intentions, the characteristics of behaviors themselves such as practicality for the situation, or expectations of the behaviors are not always considered, which can influence results (Brewer et al., 2007; Courneya, 1994; Sutton, 1998). Whilst some methodological challenges can be resolved, other limitations remain for hazard preparedness, primarily, dealing with hypothetical responses (Sutton, 1998), socio-structural constraints (Bandura, 1998), and understanding how other life events intersect with perceptions and behaviors over time (Weinstein, 1988).

## 2. Methods

Web of Science and Google Scholar databases were reviewed for studies addressing risk perceptions and preparedness utilizing the keywords 'risk, risk perception, preparedness, intention*, behavior*, behaviour*, earthquake*, flood*, terrorism, and epidemic*'. European studies were given preference, followed by studies conducted in similarly developed regions. Only theoretical studies are considered in results.

## 3. Results

### 3.1. Floods

Floods had the greatest number of studies examining risk perceptions and behaviors for the European context (Table 2). Factor-analytic approaches such as the psychometric paradigm and affect heuristic were the most common, with results from these studies showing the importance of affect, prior hazard experience, time in residence, and attitude in shaping people's risk perceptions (Keller, Blodgett, & King, 2008; Siegrist & Gutscher, 2008; Terpstra, 2011; Terpstra, Lindell, & Gutteling, 2009). Additionally, results of a mental model study found that the physical processes of flash floods are better understood in comparison to landslide hazards. Social-cognitive approaches showed that perceptions about the risk and potential consequences of the risk, as well as information about the preparedness measures (cost, effectiveness, and possibility) themselves, are influential for motivating preparedness (Grothmann & Reusswig, 2006; Zaalberg, Midden, Meijnders, & McCalley, 2009). Studies focused more strongly on emotion found that worry was positively correlated to general preparedness (Miceli, Sotgiu, & Settanni, 2008) and the feelings of security attached to one's home may create an optimistic bias with regard to the need for taking precautionary measures (Harries, 2008).

[insert Table 2 here]

### 3.2. Earthquakes

Fewer risk perception and preparedness studies on earthquakes were available for Europe (Table 3). Thus, risk perception and preparedness studies were also included from Japan, New Zealand, and the USA. All of the theoretical approaches utilized were social-cognitive theories.

Personal resources, both cognitive and material, and gender were found to influence general distress after an earthquake (Sumer, Karanci, Berument, & Gunes, 2005) and predictors of earthquake expectations and preparedness include fear, perceived control, and educational background (Rüstemli & Karanci, 1999). Paton, Bajek, Okada, and McIvor (2010) examined the degree of cross-cultural equivalence of common predictors of earthquake preparedness in two cities in Japan and New Zealand. Hazard beliefs, expressed as outcome expectancies, and social characteristics (i.e. community participation, collective efficacy, and trust which are all thought to positively impact preparedness) were compared.

Similarities in the manner in which predictor variables interacted with preparedness intentions in both countries were found. In another cross-cultural study, Joffe, Rossetto, Solberg, and O'Connor (2013) compared earthquake awareness, emotions, beliefs, and

self-identity across cities in Japan, Turkey, and the USA finding that, while awareness was similarly high in all three case study sites, Turkish and Japanese respondents reported stronger negative emotions associated with earthquakes and US and Japanese respondents reported greater feelings of security. US respondents were also more likely to show optimistic bias. Preparedness actions reported were low across all countries and low-cost preparedness measures were the most commonly reported.

Three studies utilized the Person-relative-to-Event (Pre) model (Mulilis & Duval, 1995) (see Appendix 2). Duval and Mulilis (1999) examined preparedness levels over time (one month) as threat levels increased, finding that preparedness increased as perceived threat levels increased. Spittal, McClure, Siegert, and Walkey (2008) found that cognitive factors including tendency to take risks and locus of control were associated with different preparedness actions; locus of control predicted mitigation actions and tendency to take risks predicted general earthquake preparedness. Lindell and Whitney (2000) showed that perceptions of different preparedness measures varied and that these perceptions were the strongest predictor of adoption.
Studies by Mileti and Darlington (1997) and Becker, Paton, Johnston, and Ronan (2012) examined the personal and social processes influencing protective decisions utilizing Interactionist Theories (see Appendix 2). It was found that people interact with others to ascribe meaning to risk information before adopting protective behaviors (Mileti & Darlington, 1997) and Becker et al. (2012) showed that this is not a linear process, as cognitive and social factors mediate (e.g. coping and efficacy, and perceived responsibility). Across all the studies examined, reported earthquake preparedness actions were low.

### 3.3. Epidemics

Risk perception and behavior studies were most limited for epidemics (Table 4) and terrorism (Table 5). Social-cognitive approaches were more common for human diseases or zoonoses (infectious diseases that can be transmitted between humans and animals). The majority of studies were disease specific. Two studies examined intentions to be vaccinated (protective action or preparedness behavior) for H1NI, finding that emotions, perceptions about the disease (severity and susceptibility) and of the vaccine (cost and effectiveness), and prior experience were predictors (Myers & Goodwin, 2011; Setbon & Raude, 2010).

[insert Table 3 here]

A third H1N1 study found that affective response fully mediated the relationship between cognitive and social-contextual factors and compliance with recommended behaviors (Prati, Pietrantoni, & Zani, 2011). Economic approaches evaluating willingnessto- pay for bio-security (preparedness) measures found that farmers with higher risk perception and in high-risk areas were willing to pay more (Bennett & Balcombe, 2012) and that perceptions of bio-security measures (cost and effectiveness) and other factors (trust, social networks, experience, and resources) were also important (Toma, Stott, Heffernan, Ringrose, & Gunn, 2013).

[insert Table 4 here]

### 3.4. Terrorism

No risk perception and preparedness behavior studies were found for terrorism in Europe. Therefore, examples from North America are shown in Table 5. Theoretical approaches included social-cognitive theories, communication theories, and appraisal theories. Lee and Lemyre (2009), utilizing a social-cognitive model, found that worry about terrorism, as an affective (emotional response), independently predicted behavioral response more than other social and contextual variables. Perceived coping efficacy was associated with individual preparedness and information seeking. Bourque et al. (2012), utilizing modified PMT, found that risk perception did not have a direct effect on preparedness behavior and its effect is largely mediated by knowledge, perceived efficacy, and milling (information seeking) behavior. Utilizing communication theories, Wood et al. (2012) found that (risk) information observed (e.g. by observing other's actions) and received (e.g. through media) played key, but different, motivational roles for preparedness. The more people hear, read, and see about getting ready, the more they prepare. The same information factors 'indirectly' affect household preparedness by increasing people's knowledge, the perceived efficacy or effectiveness of preparedness actions, and increasing discussions with others regarding preparedness (Wood et al., 2012).

[insert Table 5 here]

## 4. Discussion

Meta-analyses of popular behavioral theories, whilst not available for all hazard types examined here, recommend that each perform moderately well in explaining or predicting preparedness behavior. However, preparedness levels reported across hazard types are typically low and usually associated with lower cost actions, which recommends that motivating preparedness actions should be a continued priority. As preparedness studies have evolved over time, risk perception has remained an important cognitive process for motivation or intention formation; however, other cognitive, social, and material factors have been incorporated into behavioral theories. Early studies on the role of cognitive processes in risk perception in the 1970s led to the discovery of heuristics (Slovicet al., 1982). Factor-analytic approaches, many of which incorporate risk perception as a central concept, are common in flood studies reviewed.

Factor-analytic approaches also commonly incorporate normative factors such as trust, responsibility, prior hazard experience, and affective response. Expectancy valence (EV) approaches centered on appraisals of the threat and the potential benefit of the preparedness action are also popular in the natural hazard studies reviewed. EV approaches originated in work motivation studies in the mid-1960s (cf. Van Eerde & Thierry, 1996), and later iterations integrate situational and contextual factors (cf. Lindell & Hwang, 2008). EV approaches reviewed here illustrate the importance of perceived attributes and expectations of the preparedness actions for the uptake of preparedness measures. Social-cognitive approaches, which grew popular for preparedness studies in the late-1990s, emphasize other cognitive factors in addition to risk perception such as coping and self-efficacy, as well as social norms, as factors influencing preparedness behaviors, especially in the earthquake studies reviewed. Studies on epidemics reviewed focused on economic costs and benefits of preparedness activities, whilst also adding further specificity to risk perceptions – for

example, questioning whether preparedness actions are adopted because of perceptions of risk severity, likelihood, or probability, and the benefit of the action for addressing these different risk traits. Terrorism is the least studied hazard examined here and the least well understood. The definition of terrorism is itself contested, making it difficult to draw comparisons to other hazards. However, terrorist events often overlap with disaster events both as destructive phenomena and as management problems (Alexander, 2003).

Studies reviewed here recommend that emotions play an important role in motivating terrorism preparedness; however, terrorism preparedness was not always the sole motivation, but rather actions were for general safety.
Considering results collectively, it is apparent that cognitive processes including risk perception, coping, and self-efficacy are commonly emphasized across hazard types and behavioral theories as motivators or precursors for behavior. Appraisals of the preparedness behavior and one's ability to enact the behavior, including both cognitive and social factors, were also found to influence preparedness for several behavioral theories and hazard types examined. Social and normative factors including collective efficacy, trust, responsibility, and sense of community were also found to be important, especially for natural hazards. Of the behavioral theories reviewed here, Paton's (2003) social-cognitive model for disaster preparedness captures the dominant cognitive, social, and normative factors emphasized in results. Paton's model incorporates critical awareness of the hazard, risk perception, and hazard anxiety as primary motivators or precursors to intentions.

Intentions are further influenced by appraisals of outcome expectancy, self-efficacy, and coping and response efficacy. Finally, intentions are linked to preparedness actions through normative factors such as trust, perceived responsibility, emotions such as sense of community, and contextual factors such as the timing of the hazard activity and response efficacy (see Appendix 2 for details). TACTIC is utilizing this model as the basis for the primary preparedness self-assessment questions, supplemented with targeted questions on the attributes and expected benefits of specific preparedness actions (see Appendix 1).

Surveys are limited in their ability to capture diversity in individual decision pathways and in understanding influences of the wider social and structural context. Qualitative studies, for instance, have shown diversity in decision pathways for individuals in adopting preparedness actions (Becker et al., 2012). Whilst it is perhaps not practical to utilize qualitative research on larger populations, as they can be time intensive, supplementing survey methods with qualitative research methods can better inform diversity and context. While the TACTIC surveys do collect demographic data such as gender, class, age, and (dis)ability, this information should be utilized as supplemental information and it is not meant to replace vulnerability mapping, or to be representative of the wider social, institutional, and political context.

## 5. Conclusions

This article first reviewed meta-analyses of behavioral theories applied to select hazard types for explaining or predicting preparedness behaviors to better understand performance and lessons learnt. Results show that most theories perform moderately

well; however, methodological errors are common in survey design, often skewing or attenuating results. Lessons learnt are often siloed regarding a specific theory or hazard type; however, many are applicable to other theories and contexts; therefore, universal lessons learnt for survey design are summarized. Second, theoretically based analyses of hazard preparedness behaviors for floods, earthquakes, epidemics, and terrorism are reviewed. Different theoretical approaches are prevalent for different hazard types – factor-analytic approaches were more popular for floods, social-cognitive approaches for earthquakes and epidemics, and other social science theories for terrorism. Results of the review recommend that a theoretical approach for a multi-hazard context should at a minimum consider cognitive factors such as risk perception, coping, and self-efficacy; normative factors such as trust, responsibility, and hazard experience; and social factors such as sense of community and collective efficacy. Ideally, surveys would also incorporate questions pertaining to attributes and appraisals of specific preparedness actions and be accompanied by qualitative techniques such as interviews or group discussions to better understand the wider social and structural context.

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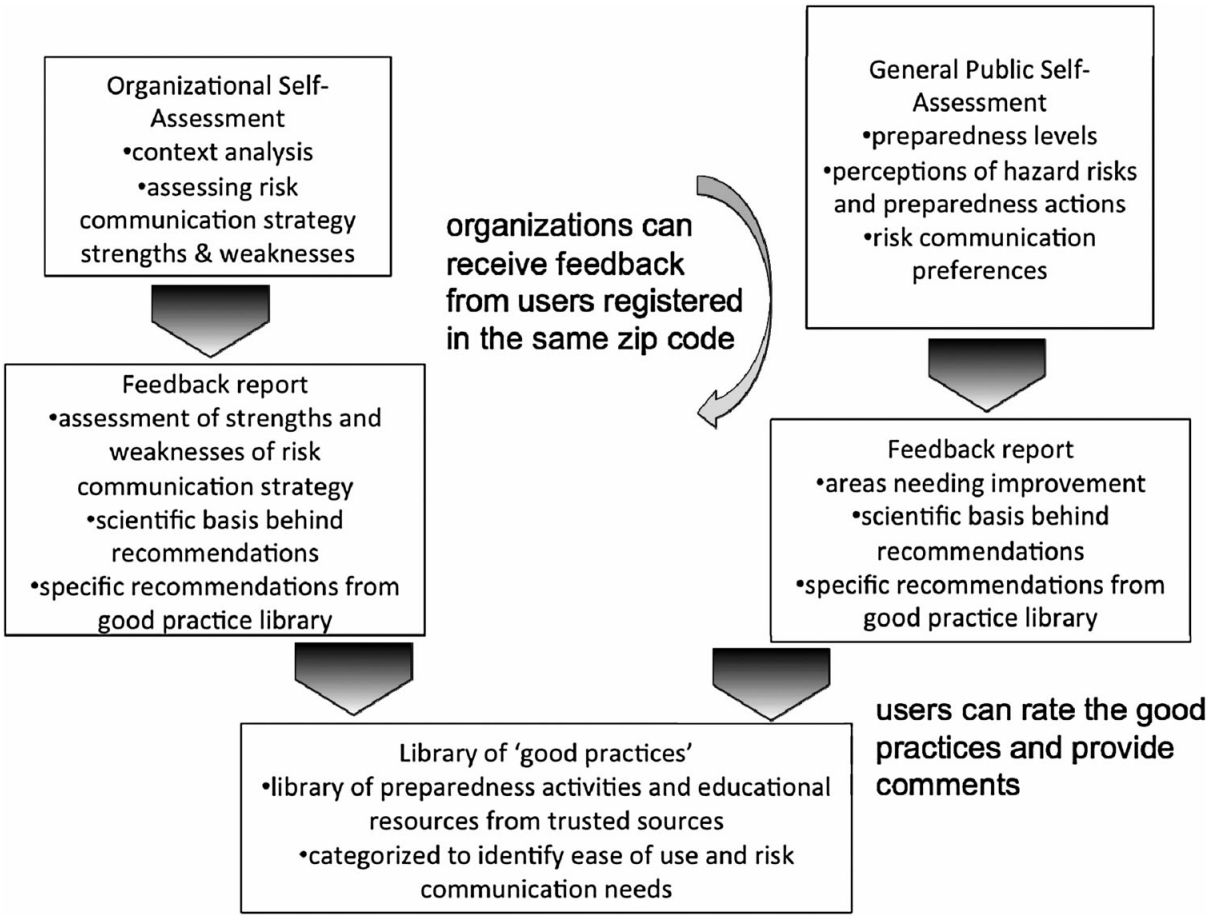


**Figure 1. Schematic of TACTIC's online preparedness self-assessment and learning platform.**

Table 1: Generalizations of common theoretical approaches that have been applied in hazards research to explain preparedness behaviors.

| Category | Description | Role (if any) of risk perception | Examples |
|---|---|---|---|
| Factor analytic | Aim to understand why people perceive risks differently by identifying factors that underlie these perceptions. Heuristics are the mental strategies people invent to interpret uncertainty, sometimes leading to harmful biases in risk judgements. | Risk perception is the central focus. | Psychometric paradigm; heuristics; mental models |
| Appraisal based | Motivation to adopt protective behaviors results from a perceived threat and the desire to avoid potential negative outcomes. | Risk perception may be utilized as an explanatory factor, typically regarding motivation or intention formation. | Health Belief Model; Protection Motivation Theory |
| Expectancy Valence | Focuses on characterizing the behavior in question—the difficulty and desirability, one's ability to perform the behavior, as well as the outcomes of the behavior. | Risk perception may be utilized as an explanatory factor, typically regarding motivation or intention formation. | Theory of Planned Behavior; Person-relative-to-Event; Protective Action Decision Model |
| Social ecology | Emphasizes reciprocal causation through the interplay of cognitive, behavioral, and environmental factors at various levels, e.g. personal, situational, structural. | Cognitive, environmental and structural factors influence preparedness behaviors. | Social Cognitive Theory |

Table 2: European risk perception and flood preparedness behavior studies meeting review criteria and utilizing a theory.

| Citations | Theoretical Approach | Geography | Key findings |
|---|---|---|---|
| Terpstra et al. (2006[1], 2009[2]) | [1]Psychometric paradigm; [2]Psychometric Paradigm and Persuasive Arguments Theory | The Netherlands | [1]49 questionnaires were evaluated using factor analysis. 8 flooding factors and 3 water-nuisance factors were identified. "Dread" is recommended as the most important concept binding factors.<br><br>[2]Findings recommend attitude polarization may cause people to confirm their pre-existing hazard beliefs. |
| Siegrist and Gutscher (2008)[1]; Terpstra (2011)[2] | Affect Heuristic | Switzerland [1]; The Netherlands [2] | [1]It is demonstrated that people who have not been strongly impacted by flooding underestimate the potential negative affect associated with flooding.<br><br>[2]Positive (solidarity) and negative emotions (powerlessness) are related to prior flood experiences. |
| Keller et al. (2008) | Affect and Availability Heuristics | Switzerland | Risk perception is influenced by: length of time in residence, prior flood experience, and affect (manipulated using images of flooding houses). |
| Wagner (2007) | Mental Models | Germany | Results show that mental models are better developed for flash floods than landslides. The general public more easily understands the physical processes of flash floods. People with better knowledge of the hazard have prior hazard experience, are fearful of the hazard, and have received hazard information from multiple sources. |
| Zaalberg et al. (2009)[1]; Grothmann and Reusswig 2006)[2] | Protection Motivation Theory | The Netherlands [1]; Germany[2] | [1]Results show that prior flood experience is associated with social support, worry, vulnerability, perceived consequences, and intentions to take adaptive actions.<br><br>[2]The risk and potential consequences of flooding are essential to communicate to people to inspire preparedness. Information on the possibility, effectiveness and cost of private precautionary measures are also influential. |
| Miceli et al. (2008) | Risk As Feelings | Italy | General preparedness for future flooding seems high and is correlated with risk perception and feelings of worry. |
| Harries (2008) | Social Representations Theory | United Kingdom | Feelings of security associated with one's home may bias some homeowners from taking precautionary measures that could reduce their flood risk. |

Table 3: Risk perception and earthquake preparedness behavior studies from Europe, the US, Japan and New Zealand meeting review criteria and utilizing a theory.

| Citations | Theoretical Approach | Geography | Key findings |
|---|---|---|---|
| Sumer et al. (2005) | Social Cognitive Theory | Turkey | Personal resources (self-esteem, optimism, perceived control), earthquake experience, coping self-efficacy, and gender have direct effects on intrusion and general distress after an earthquake; women experienced greater intrusion and feelings of distress after an earthquake compared to men. Positive psychological traits (optimism, self-esteem, perceived control) are valuable assets in coping after an earthquake. Coping self-efficacy plays a mediating role between optimism, self-esteem and general distress. |
| Paton et al. (2010) | Social Cognitive Model | Japan and New Zealand | Examines the degree of cross-cultural equivalence in predictors of earthquake preparedness including hazard beliefs (outcome expectancies) and social characteristics (community participation, collective efficacy, empowerment, trust) as predictors of earthquake preparedness. Results reveal similarity in the pattern of relationships between predictor variables and intentions to prepare for earthquakes in the Japan and New Zealand case study areas. |
| Joffee et al. (2010) | Social Representations Theory | USA, Japan, Turkey | (Awareness) lay people in each city were aware of earthquake threat; (emotions) Turkish and Japanese respondents reported strong negative emotional associations with earthquakes; (beliefs and collective identity) respondents in USA/Japan reported a greater since of security and safety relative to other countries; (optimistic bias) USA respondents were more likely to report that they felt they would not be harmed; (behavior) preparedness actions were low across all three cities, of actions reported, low-cost measures and information seeking were more common than structural measures |
| Lindell and Whitney (2000)[1]; Spittal et al. (2008)[2]; Duval and | Person-relative-to-Event (PrE) and Theory of Reasoned Action[1]; PrE and Locus of Control; | USA[1,3]; New Zealand[2] | [1]Perceived attributes of hazard adjustments (preparedness measures) differentiated among the adjustments and had stronger correlations with adoption than any other predictors assessed.<br><br>[2](cognitive predictors for preparedness) tendency to take risks and locus of control; (demographic predictors for preparedness) |

| | | | |
|---|---|---|---|
| Mulilis (1999)[3] | PrE | | home ownership, time in residence (owning a home and longer residence time increased preparedness). Locus of control predicted mitigation actions and demographic factors and risk taking tendencies predicted general earthquake preparedness.<br><br>[3]Results generally supported PrE in that preparedness increased over a 1-month period as level of appraised threat increased, but only for those who appraised resources as sufficient relate to the threat. |
| Rustemli and Karanci (1999) | Protection Motivation Theory | Turkey | Predictors of earthquake expectations and preparedness included fear, perceived control, and educational background. Damage anticipation was related to height and perceived strength of the residence, perceived control, and trust in officials. |
| Mileti and Darlington (1997)[1]; Becker et al. (2012)[2] | Interactionist Theory[1]; Symbolic Interactionist Perspective and Grounded Theory | USA[1]; New Zealand[2] | [1]After being exposed to new risk information, actors interacted with others to ascribe meaning to the information, and protective actions followed, supporting the interactionist perspective.<br><br>[2]Identifies personal and social processes that interact to inform the social construction of risk beliefs and how they are enacted as preparedness behaviors and represents in a linear model. Finds that there are feedbacks, supporting other models like PrE which recommend people's appraisals of threat, coping and evaluation of responsibility are not necessarily linear. Agrees with many elements of PMT, TRA/TPB, and Social Cognitive Theory. |

Table 4: Risk perception and epidemic preparedness behavior studies from Europe meeting review criteria and utilizing a theory.

| Citations | Theoretical Approach | Geography | Key findings |
|---|---|---|---|
| Setbon and Raude (2010) | Health Belief Model | France | (H1N1) intentions to vaccinate were associated with emotions (worry), perceptions (susceptibility), prior vaccination experience |
| Valeeva et al. (2011) | Health Behavior Model | United Kingdom | (animal disease) perceived efficacy of bio-security strategies was the strongest predictor of bio-security behavior; risk aversion also directly contributed to farmers' decision to adopt more preparedness behaviors. |
| Myers and Goodwin (2011)[1]; Alarcon et al. (2013)[2] | Theory of Planned Behavior (TPB); TPB and Willingness to Pay (WTP) | United Kingdom | [1] (H1NI) found intention to be vaccinated was predicted by attitudes (positive attitude toward vaccination), perceptions of the disease (susceptibility, severity) and of vaccination (benefits, cost), demographic factors (being unemployed and older were positively influenced intentions)<br>[2] (animal infectious diseases) predictors of disease control (preparedness behavior) included pig mortality, emotions (feelings of despair, trust), perceptions (of economic situation), knowledge (of protective measures) |
| Prati, Pietrantonia and Zani (2011) | Social Cognitive Model (of risk perception & individual preparedness response) | Italy | (HINI) Affective response fully mediated the relationship between cognitive evaluations and social contextual factors and compliance with recommended behaviors. Perceived coping efficacy and preparedness of institutions were not related to compliance with recommended behaviors. |
| Bennett and Balcombe (2011) | Contingent Valuation Method and Choice Experiment | United Kingdom | Willingness to pay for a vaccine was predicted by risk perceptions and people in higher risk areas were willing to pay more for vaccines. |
| Toma et al. (2013) | Behavioral Economics | Great Britain | Predictors of bio-security behavior included perceptions (of biosecurity measures), efficacy and attitude (toward bio-security measures), social networks (membership in cattle/sheep health schemes, organic farming), experience and other economic factors. |

Table 5: Risk perception and terrorism preparedness behavior studies from North America meeting review criteria and utilizing a theory.

| Citations | Theoretical Approach | Geography | Key findings |
|---|---|---|---|
| Lee and Lemyre (2009) | Social Cognitive Model | Canada | Worry and behavioral responses to terrorism such as individual preparedness, information seeking, and avoidance behaviors were associated with both cognitive and social-contextual factors. As an affective response, worry about terrorism independently predicted behavioral response more than other social and contextual variables. Perceived coping efficacy was associated with individual preparedness and information seeking. |
| Bourque et al. (2012) | Protection Motivation Theory (modified) | USA | Risk perception does not have a significant direct effect on preparedness behaviors and its effect is largely mediated by knowledge, perceived efficacy, and milling (information seeking) behavior. |
| Wood et al. (2012) | Diffusion of Innovations and Communications Theories | USA | Information observed and received played key, but different, roles in motivating preparedness actions. The more people hear, read, and see about getting ready, the more they prepare. The same information factors 'indirectly' influence household preparedness by increasing people's knowledge, the perceived efficacy or effectiveness of preparedness actions, and increasing discussions with others regarding preparedness. |
| Lerner et al. (2003) | Appraisal Tendency Theory | USA | Gender and emotion influenced risk estimates: males had less pessimistic risk estimates compared to females. Emotions explained the majority of difference in perceptions between genders and predicted diverging public policy preferences. Fear increased risk estimates and plans for precautionary measures whereas anger had the opposite effect. |

## Appendix 1

The TACTIC project aims to increase preparedness to large-scale and cross-border disasters amongst communities and societies in Europe. Throughout its two-year duration (May 2014–April 2016), TACTIC will analyze risk perceptions and behavior to identify pathways from risk perception to preparedness, and will develop a preparedness self-assessment that communities can use to assess how prepared they are for different types of crises. Additionally, TACTIC will focus on identifying and categorizing good practices of communication and education practices for preparedness. The self-assessment, communication, and education practices will be discussed and analyzed with stakeholders in a series of workshops as part of TACTIC's case studies on four types of crises: terrorism, floods, epidemics, and earthquakes. Subsequently, a long-term learning framework for improving community preparedness to a range of crisis situations will be developed. All of TACTIC's outputs will be presented in a web-based platform available at: https://www.tacticproject.eu/.

A key element of the TACTIC online learning platform are two self-assessments or courses; the general public self-assessment (GPSA) and the organizational self-assessment (OSA). The GPSA aims to assess general preparedness levels; to better understand people's perceptions of hazards and of preparedness behaviors; and to collect information on user's risk communication patterns and preferences. The preparedness questions are based primarily after Paton's (2003) social cognitive model of disaster preparedness (see Appendix 2); however, they are supplemented with additional questions related to the attributes and potential appraisals of specific preparedness behaviors. The risk communication segment of the GPSA collects additional information on user's hazard perceptions by asking questions about additional risk traits (i.e. threat to future generations, questions regarding fairness, control, etc.), as well as patterns and preferences for risk communication such as what sources participants use for information, how frequently they would like to receive information, and what preferences that have for receiving this information. Anonymous results of the GPSA are visible to users registered as organizations in the local geographic region. The OSA asks general questions on preparedness, however the main focus is on developing or improving the organization's risk communication strategy.

Questions from the OSA assess the organization's hazard experience and current risk communication strategy. OSA questions also examine the methods used by the organization to address specific risk communication aims. The OSA helps users to match their risk communication aims to well-suited communication methods. Both the GPSA and the OSA users receive a feedback report upon completion of the self-assessments that provides the scientific rationale for each of the questions asked and recommends areas to improve preparedness. Self-assessment participants are also guided to recommendations for specific 'good practices' to improve preparedness within the online 'good practice' library. The 'good practice' library is a database of preparedness activities from trusted sources that have been reviewed and categorized according to risk communication aims, strengths, and practical considerations such as cost and relative difficulty. Users have the ability to rate the 'good practices' and to provide comments.

## Appendix 2

EV Theory: Several approaches stemming from EV theory (Vroom, 1964) are commonly applied to understand preparedness behaviors for natural hazards, for example, TRA, TPB, PrE (Mulilis & Duval, 1997) and Protective Action Decision Model (PADM; Lindell & Perry, 1992, 2004). EV theory has its origins in work motivation and the central components or behavioral antecedents/determinants are valence, instrumentality, and expectancy. Valence refers to the possible affective orientations toward outcomes (importance, attractiveness, desirability, or anticipated satisfaction), instrumentality refers to an 'outcome–outcome' association (the relationship between one outcome and another, often considering the probability to obtain a certain outcome), and expectancy refers to a subjective probability of an action/effort leading to an outcome or performance (Van Eerde & Thierry, 1996). PMT and PrE are more specific EV models – PMT focuses on explaining response to threatening events by assessing the likelihood and severity of not taking action, a person's self-efficacy, and a protective action's response efficacy (Lindell & Hwang, 2008). PrE adopts the same components as PMT, but also integrates 'responsibility' (Lindell & Hwang, 1996). PADM is similar to EV theory in that it adopts the formulation for perceived personal risks and relative acceptability of different hazards adjustments (preparedness actions), however, it differs in its account of situational conditions (social context, environmental cues, and social information) affecting the process by which the preparedness action is being adopted (Lindell & Hwang, 2008). Paton's (2003) social-cognitive preparedness model: Paton's (2003) model describes three phases between motivating behavior and risk reduction actions (preparedness behavior). The first phase concerns factors that motivate people including risk perception, critical awareness of the hazard risk, and hazard anxiety. The second phase concerns intention formation and includes outcome expectancies (expectations that a person's actions will mitigate or reduce the problem) and self-efficacy. Problem-focused coping and response-efficacy are also included in the intention formation phase: problem-focused coping refers to a predisposition to choose an action directed at changing a situation, which can be mediated by response efficacy (people's perceptions of available resources) (Paton, 2003). The third phase links intentions with preparations, considering the influence of normative beliefs within a community such as perceived responsibility, sense of community, timing of the hazard activity, response efficacy, and other normative factors such as trust and empowerment. Social Cognitive Theory (Bandura, 1998): Bandura posits that people's beliefs about their efficacy are influenced through four mechanisms: mastery experiences, vicarious experiences, social persuasion, and social and somatic states (essentially the stress reaction), which further influence efficacy beliefs.

Interactionist Theories: Mileti and Darlington (1997) and Becker et al. (2012) refer to interactionist theories in addition to social-cognitive behavioral theories for explaining preparedness behaviors. These theories investigate how people make sense or meaning out of the information they are exposed to and how this translates into actions.