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Making it stick: Exploring the effects of information and behavioral training on self-protectiveness of citizens in a real-life safety setting

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ABSTRACT

This study contributes to our knowledge of whether and why citizens engage in self-protective behavior with regard to a real-life risk (the transportation of chemical substances by train). We assume that the way in which relevant risk information is processed, actively vs. passively, is a crucial factor. We hypothesize that behavioral training on self-protectiveness (the active approach) will increase respondents' perceived feasibility (self-efficacy) and the expected usefulness (response-efficacy) of risk-mitigating options to a larger extent than the passive approach (merely read about it). We subsequently propose that behaviorally trained participants will show more self-protectiveness than merely informed participants. Both groups are also compared to an uninformed control group.

First, a behavioral-training-effectiveness-study was conducted in order to explore whether the training developed led to an increase in participants' efficacy beliefs and self-protectiveness (N = 47). Second, in our main study we took a random sample from the town's population (N = 614) and tested if the instructional method (behavioral training vs. information only vs. no information) is a predictor of efficacy beliefs and self-protectiveness.

As expected, the instructional method used and the level of perceived response-efficacy positively influence self-protectiveness. Behaviorally trained respondents perceived risk mitigating options as more useful and showed more self-protectiveness than merely informed and uninformed participants. Furthermore, response-efficacy turned out to be a partial mediator between instructional method and self-protectiveness. Self-efficacy did not significantly predict self-protectiveness in this study.

This study demonstrates that using appropriate risk communication tools is crucial in order to increase self-protective behavior of citizens.

1. Introduction

Around the world, citizens are faced with many low-probability high-consequence risks. One example of such a risk is the transportation of highly dangerous chemical substances by train. The likelihood of the occurrence of such a serious incident is fairly small and many high quality precautionary measures are being taken by the government to diminish the potential threat (Ministry of Infrastructure and Environment, 2014). However, the consequences of a serious incident – as for instance illustrated by the effect of the fatal freight train crash in the Belgian municipality Wetteren in 2013 - can be severe and quick and accurate responses of citizens are crucial since early threat detection might give those at risk important additional time (NOS, 2014). Therefore, in mitigating the potential outcomes of low-probability high-consequence risks, the importance of individual citizens' responsibilities in taking risk-preparatory action is stressed. In addition to the already existing precautionary measures, protection of the public is best served by encouraging additional self-protective measures and resilience. Also in other safety fields where individuals' behavior is a key element in reducing possible negative consequences of risks - such as for instance health safety and occupational safety – insight in factors that stimulate the adoption of adequate risk behaviors is necessary. Since inadequate behavior of individuals in these fields might also lead to injuries and even fatalities (Eurostat, 2013; Silva et al., 2017), individuals should undertake self-protective actions in order to reduce potential negative risk outcomes.

In order to seek for determinants influencing adequate risk behavior of citizens, self-protectiveness has emerged as an important topic within the risk communication literature (e.g. ter Huurne and Gutteling, 2008; Terpstra, 2010; Kievik and Gutteling, 2011; Kievik et al., 2012). Several

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studies have been conducted within the safety domain looking at the determinants of persuasion of the at-risk audiences, stimulating the adoption of self-protective behavior. These studies show that perceived feasibility (self-efficacy) and usefulness (response-efficacy) of self-protective behaviors are, besides risk perception, important predictors of self-protectiveness (Kievik and Gutteling, 2011; Lindell and Perry, 2012).

However, some pieces of the puzzle are still missing. We still do not know when an individual perceives risk mitigating options as feasible (self-efficacy) and useful (response-efficacy). This calls for a better understanding of the factors that influence the perceived feasibility and usefulness of risk mitigating options and how these factors ultimately affect individuals' behavioral adaptations in the face of a specific risk. Although research shows that citizens perceiving risk mitigating options as more feasible and useful are more likely to undertake adequate self-protective measures (e.g. Kievik and Gutteling, 2011; Lindell and Perry, 2012), we still do not understand when and why levels of self- and response-efficacy are most optimally stimulated.

In this study, we propose that actively processing relevant risk information might be the missing piece to our puzzle. In most studies on self-protective behavior, the results are based on responses of respondents after receiving mere information only (e.g. Kievik and Gutteling, 2011; Kievik et al., 2012; Lindell and Perry, 2012). Although providing information seems promising, this rather passive approach does face possible limitations: during stressful events declarative knowledge (facts) must be remembered and then transferred into action (Burke and Hutchins, 2007). During highly stressful situations such as incidents with freight trains transporting highly dangerous chemical substances, declarative memory may not be activated as easily as procedural knowledge (de Quervain et al., 1998; Kuhlmann et al., 2005). Procedural knowledge is defined as knowing how to perform a certain task and can be acquired through behavioral training (Anderson, 1982; Tulving, 1983). Increasing the levels of procedural knowledge (instead of declarative knowledge only) seems to be beneficial in such situations. This might lead to more knowledge on how to perform a certain task, which is necessary in order to behave adequately during highly stressful situations such as disasters (Tulving, 1983). Previous research in different safety domains shows that self-protective behavior can be more effectively trained through highly engaging measures such as behavioral trainings (Burke et al., 2011). For instance, research in the field of occupational safety shows that trainings in which participant-interaction is actively stimulated and in which trainees are asked to practice relevant risk behaviors, are particularly effective (Glendon et al., 2006). Behavioral trainings increase knowledge and adequate risk mitigating behaviors of participants. During a behavioral training, participants are far more likely to remember the presented information when compared to passive forms of communication such as only hearing words or reading the relevant material (Glendon et al., 2006). Not only will the level of procedural knowledge increase making the behavior a routine activity, the behavioral training will also increase perceived levels of feasibility and usefulness (Sitzman, 2011). When citizens engage in relevant risk mitigating behavior during a behavioral training, they receive important feedback on how easily these self-protective measures can be executed and how these behaviors reduce the threat. Training these risk mitigating behaviors in a real life setting thus increases citizens' understanding of the usefulness (the level of perceived response-efficacy) and feasibility (the level of perceived self-efficacy) of such behaviors (Kinateder et al., 2013).

In the current study, we propose that behavioral training (an active way of processing information) is a key element in enhancing citizens' procedural knowledge as well as their perceived levels of self-efficacy and response-efficacy and, subsequently, their self-protective behavior.

2. Theory and hypotheses

Over the last few years, some studies have contributed to our understanding why citizens do, or do not, engage in self-protective actions with regard to safety risks (Terpstra and Gutteling, 2008; Kievik and Gutteling, 2011; Kievik et al., 2012). Firstly, the level of risk perception is an important predictor of adequate risk behavior. Moderate to high levels of risk perception are seen as necessary conditions for individuals to take action (Larsman et al., 2012). This might be one explanation for the lack of motivation to take precautionary measures among residents (Miceli et al., 2007). Secondly, both self-efficacy and response efficacy are significant predictors of self-protectiveness. Following Bandura (Bandura, 1991), - self-efficacy can be defined as "people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives" – or the level of perceived feasibility. Response efficacy is defined as the belief that a specific response will help effectively diminish a certain risk (Bandura, 1986) – or the perceived usefulness of risk mitigating behavior. Research shows that, when citizens do not know whether they are capable of executing actions that may reduce their vulnerability to risks (low level of self-efficacy), and they are uncertain that advised actions may be effective in mitigating the threat (low level of response-efficacy), they will not engage in risk mitigating behavior (Rimal and Real, 2003; Gore and Bracken, 2005; Kievik and Gutteling, 2011).

According to the Extended Parallel Process Model (EPPM) (Witte, 1992) the combination of elevated levels of risk perception, self-efficacy, and response-efficacy would motivate people to adopt self-protective measures. The more individuals believe they are susceptible to a serious threat, the more motivated they are to evaluate the efficacy of the recommended response. If the threat is perceived as irrelevant or insignificant, then there is no motivation to further process the message, and people will simply ignore the message. In contrast, when a threat is believed to be serious and relevant, individuals may become motivated to take some sort of action to reduce the induced level of fear (Witte and Allen, 2000).

The EPPM further predicts that perceived self-efficacy and response-efficacy jointly determine whether people will become motivated to control the danger or control their fear about the threat. Under these conditions, people carefully think about the recommended responses advocated in the persuasive message and adopt those as a means to control the danger. Alternatively, when people are uncertain about the effectiveness of recommended actions (i.e., the advice is perceived as low on self-efficacy and/or response efficacy), they are motivated to control their fear through denial, defensive avoidance, or reactance (Witte and Allen, 2000).

Recently, studies within the safety domain show evidence supporting these assumptions. For instance, the Protective Action Decision Model shows that threat perceptions as well as protective action perceptions are important predictors of self-protective behavior. Higher levels of self-protectiveness were seen among citizens who perceived a certain risk as risky and felt that protective actions were useful and feasible (Lindell and Perry, 2012). Furthermore, a study conducted by Kievik and Gutteling (2011) on flooding preparedness showed that higher levels of self-protectiveness are indeed seen when respondents have both high levels of risk perception as well as high levels of efficacy beliefs. Perceiving a risk as threatening and judging risk-mitigating options as both feasible and useful, leads to the intention to engage in self-protectiveness.

However, other studies on the intentions of citizens to engage in self-protectiveness with regard to severe weather circumstances (van Leeuwen, 2012) and citizens' behavior during crisis situations (Gutteling and de Vries, 2016), show that efficacy beliefs were insignificant predictors of adequate risk behavior. These studies show that stressing the fact that certain behavior is adequate in mitigating a threat does lead to a slight increase in perceived efficacy. However, although a significant change in perceived efficacy was found, the average scores on efficacy beliefs – even after this increase – were relatively low (around 3 on a scale from 1 to 5). Other studies that did find an effect of efficacy beliefs on self-protectiveness reported much higher scores on

average (Rimal and Real, 2003; Kievik et al., 2012). Therefore, and similar to results found in studies on other risk behaviors such as the risks of speeding and HIV risk behavior (De Leonardis et al., 2004; Rosenstock et al., 1994), we argue that the perceived usefulness and feasibility of adequate risk behaviors need to be enhanced substantially in order to increase self-protectiveness. In this study, we take the perspective that the way in which relevant risk information is processed, active vs. passive information processing, is a crucial factor. We hypothesize that behavioral training on self-protectiveness (the active approach) will increase respondents' procedural knowledge as well as their perceived feasibility and usefulness of risk mitigating behaviors to a larger extent than the passive approach (merely reading about it) or having no information at all. The active approach will lead to a substantial increase in efficacy beliefs and, subsequently, lead to more actual self-protective behavior than the more passive approach.

2.1. The effect of behavioral training

Adequate behavioral reactions of citizens during disasters are of great importance. And although providing relevant risk information that citizens perceive as both feasible and useful seems promising (e.g. Kievik and Gutteling, 2011; Kievik et al., 2012), there are some possible limitations to these results. As already pointed out, during stressful events declarative knowledge (facts) must be remembered and then transferred into action (Burke and Hutchins, 2007). Research shows that in highly stressful situations, it is more difficult to activate declarative knowledge than procedural knowledge (de Quervain et al., 1998; Kuhlmann et al., 2005), and therefore increasing levels of procedural knowledge may be beneficial. Procedural knowledge is defined as knowing how to perform a certain task and can be acquired through behavioral training (Anderson, 1982; Tulving, 1983). Recent meta-analysis show that safety behaviors such as drivers' threat detection can be more effectively trained through highly engaging measures such as behavioral trainings (Burke et al., 2011; Sitzman, 2011). Behavioral training is known to have several positive outcomes on learning and transfer of knowledge (e.g. Bell and Kozlowski, 2008). For example, a study looking at drivers' threat detection strategies, shows that a behavioral training improved respondents skills more compared to a passive classroom lecture (Romoser and Fisher, 2009). Applied to the current topic, increasing procedural knowledge and training relevant skills might thus be beneficial.

In addition, behavioral training also positively influences citizens' perception of the usefulness (response efficacy) and feasibility (self-efficacy) of risk mitigating behavior. For example, a driving training program that provided feedback during the training was found to lead to a more internalized locus of control (Huang and Ford, 2012). After the training, respondents felt more capable and confident than prior to the training, as is in line with research conducted by Bandura (1986) on the positive influence of high levels of self-efficacy on adequate behavior. The idea that behavioral training might lead to a more positive judgment of risk mitigating behaviors is also supported by research from the educational domain. Research looking at the influence of actively practicing certain tasks on adequate behavior shows that when a message is processed actively by the audience, this will positively affect individuals' knowledge as well as behavior (Oblinger, 2004). Actively processing the risk communication messages has a positive impact on the judgement of the effectiveness of self-protective options as well as the intention to engage in self-protectiveness. These findings are corroborated by a literature review looking at studies on risk related behaviors of citizens who experienced a natural disaster, showing that actively processing risk messages and engaging in self-protectiveness leads to more knowledge as well as higher problem solving capacities (Lindell and Perry, 2012) .

In the field of disaster research, people's beliefs about their own level of responsibility for protection from a hazard is generally believed to be an important predictor of intentions to engage in self-protective behavior, contributing to the further understanding of why people fail or succeed in protecting themselves form hazards (Lindell and Perry, 2000; Paton, 2003). Research shows that individuals who believe that protection against risks is their personal responsibility, will perceive risk mitigating options as more useful and feasible (Nouwen et al., 2009). This might be because responsibility motivates people to be open to and actively process risk-mitigating information. On the other hand, denial of personal responsibility (e.g. by attributing all risk-mitigating responsibility to governmental authorities or a higher-order being, or fate) might lead to a lack of interest in information. We thus assume that, from a psychological perspective, levels of responsibility are related to perceptions of efficacy beliefs. Also, research shows that higher levels of personal responsibility as well as perceived efficacy might lead to a stronger tendency to take protective actions (Lindell and Perry, 2000; Paton, 2003; Terpstra and Gutteling, 2008).

Thus, increasing procedural knowledge is likely to have a positive effect on the perceived levels of personal responsibility (e.g. De Young, 1993; Pongiglione, 2011) as well as on efficacy beliefs (e.g. Kinateder et al., 2013), which might lead to a more positive judgement of risk mitigating options and ultimately create higher levels of self-protectiveness. We therefore conclude that a behavioral training might lead to higher levels of perceived feasibility (self-efficacy) and usefulness (response-efficacy) of adequate risk behaviors than mere information or no information at all. We expect to find a similar relation with personal responsibility. This might subsequently lead to more actual self-protectiveness in the domain of railroad transportation risks for citizens.

2.2. Current study

The current study focuses on safety behavior with regard to freight train incidents concerning dangerous chemical substances. We used Borne (a small town in the Eastern part of the Netherlands with approximately 22.000 inhabitants [CBS, 2015]) as an area for experimentation. Trains transporting highly dangerous chemical substances ride through the center of this village daily, making it a high risk area. Expectations are that the number of freight trains passing Borne will increase drastically over the next few years (Ministry of Infrastructure and Environment, 2014). Adequate behavioral reactions to disasters with dangerous chemical substances is therefore of great importance in this area. Citizens should be able to estimate when to evacuate or shelter in place, based on the type of incident (a fire with the possibility of explosion or the release of highly toxic chemicals). The aim of the present study is to determine the effect of behavioral training (the active approach) compared to the situation in which citizens received mere information (the passive approach), or no information at all, on efficacy beliefs and self-protective behavior. The following hypotheses are formulated:

H1a. Behaviorally trained participants feel more self- and response-efficacious than passively informed participants and uninformed participants.

H1b. Behaviorally trained participants show more adequate self-protective behavior than passively informed participants and uninformed participants.

With regard to the effect of efficacy beliefs on self-protective behavior, we expect to find similar results as in previous studies (Kievik and Gutteling, 2011). Therefore, the following (replication) hypothesis is formulated:

H2. High levels of efficacy beliefs lead to higher levels of self-protective behavior than low levels of efficacy beliefs.

Finally, following the procedure of Baron and Kenny (1986), we hypothesize that the efficacy beliefs act as mediators between the independent variable instructional method and the dependent variable self-protective behavior (see Fig. 1). Since the aim of governmental

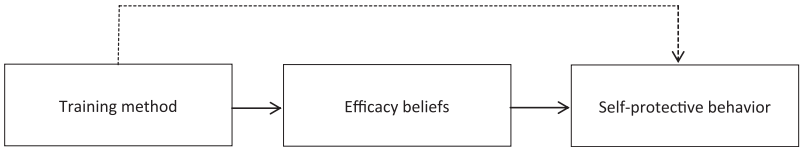

Fig. 1. Model of expected mediation efficacy beliefs.

campaigns is to enhance the self-protectiveness among citizens (Grothmann and Reusswig, 2006) and the assumption is that the judgment of risk mitigating options in terms of usefulness and feasibility is an essential link between the risk campaign and individual risk behavior, efficacy beliefs are assumed to mediate the relationship between the provided stimuli and behavior. In this respect we follow the conclusions drawn in studies on health behaviors in which efficacy beliefs proved to mediate this relationship (Nouwen et al., 2009). We expect stronger effects on self-protectiveness due to the trainings' impact on efficacy beliefs (the cognitive support of having procedural knowledge) than between instructional method and self-protectiveness directly. Therefore, the final hypotheses that have been established are as following:

H3a. Self-efficacy mediates the relationship between the independent variable instructional method and the level of self-protectiveness of citizens.

H3b. Response-efficacy mediates the relationship between the independent variable instructional method and the level of self-protectiveness of citizens.

3. Method

3.1. Research context

The Dutch railways include some of the world's most intensively used stretches of track (Ministry of Infrastructure and Environment, 2014). Due to a new program introduced in 2014 by the Dutch government called "Programma Hoogfrequent Spoorvervoer" ("Program Highfrequent Railtransport"), these tracks will be used even more intensively over the next few years, transporting highly dangerous chemical substances through the centers of many densely populated cities and villages in the Netherlands (Ministry of Infrastructure and Environment, 2014). Although many high quality precautionary measures are being taken to diminish potential risks related to the transportation of these substances by train and it actually is a low-probability risk, accidents with freight trains – the impact of which has been painfully illustrated by the effect of fatal freight train crashes in the Belgian municipality Wetteren in 2013 and later that year in Lac Megantic in Canada (NOS, 2014) – might have severe consequences. This poses a serious threat to the public.

Potential rail incidents, especially the ones concerning dangerous chemical substances, develop quickly in time. The Dutch government is aware that under such circumstances it cannot guarantee full calamity protection to its citizens. When dangerous chemical substances are released in case of a freight train accident, quick evacuation is crucial since early threat detection might give users important additional time. Therefore, in mitigating the potential outcomes of such low-probability high-consequence risks the government is stressing the importance of individual citizens' responsibilities in taking risk-preparation activities. The protection of the public is best served by encouraging additional self-protective measures and resilience (Grothmann and Reusswig, 2006; de Wit et al., 2008). Citizens are expected to proactively prepare themselves for potential freight train incidents to increase their personal safety.

As discussed above, we used Borne (a small town in the Eastern part of the Netherlands with approximately 22.000 inhabitants [CBS, 2015]) as an area for experimentation since this area is prone to the risks related to chemical substance transportation by train.

3.2. Two studies: behavioral training effectiveness study and main study

The current research consists of a behavioral training effectiveness study and a main study with a random sample of the Borne population. The behavioral training effectiveness study (n = 47) was conducted with inhabitants who voluntary attended a behavioral training. This study was done in order to see whether the behavioral training indeed led to an increase in self-efficacy, response-efficacy and self-protectiveness. Since, to our knowledge, not many studies have been conducted on the effect of behavioral training on self-protectiveness in a real-life safety setting, we first wanted to see whether there was a short-term effect on our independent and dependent variables.

In our main study (n = 614) we tested our hypotheses by means of a questionnaire, on the effect of instructional method on perceived efficacy and self-protectiveness and on the mediating role of efficacy beliefs in the relationship between instructional method at the one hand and actual self-protective behavior at the other. The participants in this main study were randomly selected citizens of Borne, all equally prone to the risk of getting affected by a potential disaster concerning freight trains, since everyone lived equally close to the railroad in Borne. The random sample included citizens in all three instruction categories.

3.3. Behavioral training effectiveness study

3.3.1. Procedure

A behavioral training was developed to see whether practicing relevant risk-mitigating behaviors concerning freight train incidents would lead – as expected – to elevated levels of efficacy beliefs and self-protective behavior. During the behavioral training, it is important that participants are able to increase their procedural knowledge, experience the feasibility and usefulness of risk mitigating behaviors and receive adequate feedback (e.g. Kinateder et al., 2013; Wang et al., 2015). In order to do so, together with governmental institutions (Safety Region Twente; the municipality of Borne; and the local fire department), a short behavioral training was developed in which state-of-the-art risk mitigating options of risks related to the transportation of dangerous chemical substances by train were practiced. During a freight train accident with dangerous chemical substances, three different scenarios can occur, asking for different responses of the public. Freight trains can either (1) release highly toxic chemicals, (2) be on fire and/or (3) explode. Adequate behavioral reactions to these scenarios is of great importance. Citizens should be able to:

(1) Estimate whether dangerous toxic chemicals were released during the accident.
(2) Estimate whether the accident concerns a fire with a possible risk of explosion.
(3) Make a proper judgement on whether to evacuate (in case of potential explosion risk) or shelter in place (in case of the release of toxic chemicals).

These adequate risk behaviors were trained during a behavioral training on a Saturday in November 2014, making sure that it was easy for citizens to attend the training. Before the training, several real life scenarios were created simulating these possible risks of freight train accidents. For instance, in one scenario, the risk of a possible explosion of a train carrying Liquid Petroleum Gas (LPG) was simulated by

Fig. 2. Pictures of the behavioral training illustrating the training environment and one footage of a risk scenario.

showing footage and simulating the high-tone sound of such a disaster. During the training, participants went through several of these scenarios actively practicing the risk mitigating options related to the scenario provided. They were asked to indicate which self-protective behavior they perceived as adequate in every scenario using electronic voting devices. Also, they were asked to actually behave in a way they thought was suitable to the situation. In every scenario they could choose whether they would evacuate (which would be appropriate in case of a possible explosion or a fire), shelter in place (which would be appropriate when toxic chemicals are released) or do nothing (when there is no risky situation). Also, adequate behaviors such as shutting down ventilation systems and choosing the right emergency route are risk mitigating options that were actively practiced. Each participant went through every scenario and each scenario was then extensively evaluated and discussed with all participants (see Fig. 2).

3.3.2. Participants

A total of 47 residents of Borne signed up for the behavioral training and participated. Of the 47 participants, 20 were female and 27 were male.

3.3.3. Measures

A pre- and posttest was conducted measuring levels of self-efficacy, response-efficacy and levels of self-protectiveness. Approximately ten minutes prior to the training as well as directly after the training, respondents were asked to fill out a questionnaire measuring these three variables. The questionnaire was based on a previously validated questionnaire (ter Huurne, 2008). This questionnaire, unless stated otherwise, measured responses on five-point Likert scales, with extremes *strongly disagree* (1) to *strongly agree* (5).

3.3.3.1. Self-efficacy. Level of self-efficacy was measured in the pre- and posttest using a self-evaluation item, namely “I deem myself capable of responding adequately in these specific high-risk situations”. The answers on this item showed sufficient variance.

3.3.3.2. Response-efficacy. Level of response-efficacy was measured in the pre- and posttest using a self-evaluation item, namely “I perceive this risk mitigating options provided as effective in reducing the threat”. The answers on this item showed sufficient variance.

3.3.3.3. Intention to engage in self-protectiveness. Intention to engage in self-protectiveness was measured in the pre- and posttest using a self-evaluation item, namely “I have the intention to protect myself against this threat”. The answers on this item showed sufficient variance.

3.4. Main study: a representative sample comparing the effects of instructional method

3.4.1. Procedure and participants

In this study we want to determine whether attending a behavioral training leads to higher levels of self-efficacy and response-efficacy, subsequently leading to more self-protective behavior in a real life safety setting compared to mere information only and no information. Also, we wanted to see whether perceived levels of personal responsibility could affect the levels of efficacy beliefs and self-protectiveness, as would be expected based on recent research (e.g. De Young, 1993; Lindell and Perry, 2002; Paton, 2003; Terpstra and Gutteling, 2008; Pongiglione, 2011; Rickard et al., 2014). Since these studies have shown that feeling personally responsible for taking self-protective actions has a positive influence on actual levels of self-protectiveness, we included this variable in our study as a vital addition to our other measures.

In December of 2014, a total of 2731 randomly selected residents of Borne were asked to participate in our main study. They received a letter from the municipality of Borne inviting them to fill out an online-questionnaire. Respondents were informed that the objective of the questionnaire was to measure their opinions, ideas and thoughts on the transportation of chemical substances by train through Borne. The questionnaire measured their levels of risk perception, efficacy beliefs, personal responsibility and levels of self-protectiveness.

A total of 614 randomly selected residents of Borne filled out the questionnaire (22% response). The mean age of participants was 57 years. Of the initial cohort, 55% of the participants were female and 45% male. The cohort was divided into three conditions in order to look at differences in efficacy beliefs and self-protectiveness between respondents who attended a behavioral training, received information only or were uninformed (see Table 2).

Control group (n = 225) - Respondents that we assigned to the control group are all respondents that had self-reported to have not read information on the risks related to the transportation of chemical substances by train. In the Summer of 2014, governmental institutions communicated with the public about the risks related to the transportation of dangerous chemicals by train. All residents of Borne received information about these risks, including adequate risk mitigating options. The information was spread using newsletters, pamphlets, leaflets and the website of the municipality of Borne, making sure that every household had access to the information. All respondents that had self-reported to have not read this information nor participated in the behavioral training were assigned to the control group. These respondents were all uninformed.

Information condition (n = 363) - Respondents in the information condition had self-reported to have received and read the relevant risk information on freight train transportation. We assigned all respondents that had self-reported to have read the information provided by the government but did not attend the behavioral training, to the information only condition.

Table 1
Mean scores pre- and posttest of independent and dependent variables.

	Pre-test (n = 47) Prior to behavioral training	Post-test (n = 47) After behavioral training
Self-efficacy	2.78	3.94**
Response-efficacy	3.21	4.00**
Intention self-protectiveness	3.26	4.19**

** Significant at 0.01 level.

Table 2
Conditions based on received instructional method.

Condition 1 – n = 26 Behaviorally trained	Condition 2 – n = 363 Informed	Condition 3 – n = 225 Uninformed
Attended the behavioral training and passively informed	Did not attend the behavioral training, but passively informed	Did not attend the behavioral training and not informed

Behavioral training condition (n = 26) – During the risk communication effort, all residents were also asked to sign up for the behavioral training as previously discussed. All participants who had self-reported to have received and read the information provided by the government as well as attended the behavioral training were assigned to the behavioral training condition. These respondents were passively informed as well as behaviorally trained.

Between the three conditions, no differences were found in gender ($\chi^2(2) = 2.13$, n.s.) or education ($\chi^2(18) = 18.82$, n.s.). However, a significant difference in age was found ($F(2,611) = 6.94$, $p < 0.01$). Respondents in the control group (no information) were significantly younger than respondents in the behavioral training condition ($t(237) = 2.37$, $p < 0.05$) and 2 ($t(581) = 3.32$, $p < 0.01$).

3.4.2. Measures

All respondents were asked to fill out a questionnaire measuring levels of self-efficacy, response-efficacy, risk perception, personal responsibility and self-protective behavior. This questionnaire was filled out by respondents approximately two weeks after the behavioral training effectiveness study was conducted. The questionnaire was based on a previously validated questionnaire (ter Huurne, 2008). This questionnaire, unless otherwise stated, measured responses on five-point Likert scales, with extremes *strongly disagree* (1) to *strongly agree* (5).

3.4.2.1. Self-efficacy. Level of self-efficacy was measured using a three-item scale ($\alpha = 0.75$). Respondents were asked to indicate to what extent they thought they could prepare themselves for the risks related to the transportation of dangerous chemical substances by train.

3.4.2.2. Response-efficacy. Level of response-efficacy was measured using a three-item scale ($\alpha = 0.76$). Respondents were asked to indicate to what extent they thought the risk mitigating options provided by governmental institutions were effective in reducing the risks related to the transportation of dangerous chemical substances by train.

3.4.2.3. Risk perception. Level of risk perception was measured using a ten-item scale ($\alpha = 0.83$). Respondents were asked to indicate to what extent they thought they were susceptible to the risks related to the transportation of dangerous substances as well as indicate the severity of these risks.

3.4.2.4. Personal responsibility. Perceived personal responsibility was measured using a three-item scale ($\alpha = 0.86$). Respondents were asked to indicate to what extent they thought they themselves were responsible for seeking relevant risk information as well as engage in self-protective actions.

3.4.2.5. Self-protective behavior. Actual levels of self-protective behavior was measured using nine items concerning various self-protective behaviors (e.g. did you install the official governmental warning service on your mobile phone?; did you practice shutting down the ventilation system in your house?; do you have a flyer with the disaster instructions at home?; did you seek for relevant risk information online?). Engagement in a specific type of self-protective behavior was scored 1. If not, they were scored a 0. The scores were added and divided by the total number of items to create one total construct measuring actual levels of self-protectiveness and thus creating a score somewhere between 0 (not self-protective) to 1 (fully self-protective).

3.5. Analysis of the results

In order to test our first set of hypothesis regarding the effect of instructional method on (predictors of) self-protective behavior, we used analysis of variance. Our second hypothesis on the effect of efficacy beliefs on self-protectiveness was tested using regression analysis. In order to test our final set of hypothesis regarding a possible mediation effect of efficacy beliefs on the relationship between instructional method and self-protective behavior, mediation analysis was conducted following the procedure of Baron and Kenny (1986). Since the instructional method consisted of different conditions, two dummy variables were constructed following the procedure of Hayes and Preacher (2014), in order to be able to conduct the mediation analysis.

4. Results

4.1. Results behavioral training effectiveness study

Table 1 shows the mean scores of all 47 participants on self-efficacy, response-efficacy and self-protectiveness. A significant increase in self-efficacy, response-efficacy as well as intention to engage in self-protective behavior was found, indicating that the behavioral training enhanced these factors. The results indicate that – after a behavioral training – respondents are more self-efficacious as well as self-protective than prior to the training. Since we did not compare behaviorally trained citizens to merely informed and uninformed citizens in this first study, our second main study will focus on the differences between respondents receiving different instructional methods (behavioral training vs. information only vs. no information).

4.2. Results main study

4.2.1. Descriptive statistics

Table 3 presents the correlations of the main variables in our study. Significant correlations were found between levels of response-efficacy and personal responsibility on the one hand and self-protectiveness on the other (respectively $r = 0.16$ and $r = 0.11$). However, risk perception and self-efficacy did not significantly correlate with self-protectiveness (respectively $r = -0.03$ and $r = 0.06$).

4.2.2. Effect of the instruction method

Of all respondents participating in this study, more than 36% self-reported to have not read the information provided by the government on the risks related to the transportation of chemical substances by train and were thus uninformed. Almost 60% of the respondents were merely informed since they self-reported to have read the information provided by the government, but did not attend the behavioral training. The other respondents were informed as well as behaviorally trained.

Table 3
correlations between the main variables of the representative sample (n = 614).

	1.	2.	3.	4.
1. Risk perception				
2. Self-efficacy	−0.14**			
3. Response-efficacy	0.11**	0.19**		
4. Responsibility	−0.15**	0.29**	0.20**	
5. Self-protectiveness	−0.03	0.06	0.16**	0.11**

** Significant at 0.01 level.

Table 4
Mean scores of independent and dependent variables between conditions.

	Behaviorally trained $n = 26$	Informed $n = 363$	Uninformed $n = 225$
Risk perception	3.63	3.57	3.58
Self-efficacy	3.90[b*c**]	3.49[ac*]	3.23[ab**]
Response-efficacy	3.90[bc**]	3.38[ac**]	3.09[ab**]
Responsibility	3.33[c**]	3.00[c**]	2.67[ab**]
Self-protectiveness	0.44[bc**]	0.20[ac**]	0.10[ab**]

Self-protectiveness was measured on a scale from 0 (no self-protectiveness) till 1 (absolute self-protectiveness). Other variables on a scale from 1 (low levels) till 5 (high levels).
** Significant at 0.01 level.
* Significant at 0.05 level.
[a] Significant difference with trained.
[b] Significant difference with informed.
[c] Significant difference with uninformed.

With regard to the effect of the instructional method on efficacy beliefs as well as self-protectiveness, our first Hypotheses 1a and 1b were tested with an analysis of variance. As can be seen in Table 4, between the three conditions, significant differences were found in levels of self-efficacy ($F(2,612) = 6.86$, $p < 0.01$), response-efficacy ($F(2,612) = 9.71$, $p < 0.01$) and self-protective behavior ($F(2,612) = 75.69$, $p < 0.01$).

Respondents who attended the training scored significantly higher on self-efficacy, response-efficacy and self-protectiveness than respondents who were merely informed or were uninformed. Merely informed respondents scored significantly higher on these variables than uninformed respondents. These results support our first set of hypotheses. Also, we found significant differences between the three conditions in level of personal responsibility ($F(2,612) = 9.11$, $p < 0.01$). Behaviorally trained and informed respondents felt significantly more responsible to take self-protective actions than respondents who had not read information about the risks related to the transportation of dangerous chemical substances by train. However, no significant differences in personal responsibility were found between the behaviorally trained and informed groups. Also, no differences were found between the conditions in level of risk perception ($F(2,612) = 0.09$, n.s.).

4.2.3. Effect of efficacy beliefs

With regard to the effect of efficacy beliefs on self-protectiveness, our second hypothesis was tested using regression analysis. Regression analysis involving all participants showed that the relation between response efficacy and self-protectiveness proved to be significant ($b = 0.04$, $p < 0.01$), indicating that high levels of response-efficacy indeed lead to high levels of self-protectiveness. However, self-efficacy did not show a significant relation with self-protectiveness ($b = -0.01$, n.s.). Therefore, our second hypothesis can only be partially confirmed in that response-efficacy indeed is a predictor of self-protective behavior whereas self-efficacy in this case is not.

4.2.4. Mediation effect efficacy beliefs

A mediation analysis tested the final Hypotheses 3a and 3b that self-efficacy and response-efficacy mediate the relationship between instructional method on the one hand and self-protective behavior on the other hand. Since self-efficacy showed to have an insignificant relation with self-protectiveness, the hypothesis that self-efficacy mediates the relations between the instructional method as independent variables and self-protectiveness as dependents variable (Hypothesis 3a), could not be confirmed. Therefore, mediation analysis was only conducted with response-efficacy as a mediator.

4.2.4.1. Instructional method. Since the instructional method consisted of different conditions, two dummy variables were constructed. The first dummy variable (contrast 1) looked at the contrast between behaviorally trained (code: 0) and uninformed (code: 1) respondents. The second dummy looked at the contrast between behaviorally trained (code: 0) and informed (code: 1) respondents.

The first regression analysis with the level of self-protectiveness as a dependent variable and instructional method as an independent variable yielded a significant relation for both contrast 1 ($b = -0.31$, $p < 0.01$) and contrast 2 ($b = -0.23$, $p < 0.01$). Since the behaviorally trained condition was coded 0 and the informed and control conditions were coded 1, the negative betas imply that more elaborate instruction leads to higher levels of self-protectiveness. The second regression analysis with the mediator (response efficacy) as the dependent variables and instructional method as the predictor, showed that the instructional method influences response-efficacy (contrast 1 ($b = -0.81$, $p < 0.01$); contrast 2 ($b = -0.52$, $p < 0.05$)) significantly. Behaviorally trained respondents experienced higher levels of response efficacy than merely informed and uninformed respondents. Subsequently, a regression analysis with instructional method and the mediator as predictors and self-protectiveness as the dependent variable was conducted. Although the relationship between the instructional method and self-protectiveness became less significant for both contrast groups (contrast 1 ($b = -0.28$, $p < 0.01$); contrast 2 ($b = -0.21$, $p < 0.01$), these relations stayed significant. The relation between response efficacy and self-protectiveness proved to be significant ($b = 0.04$, $p < 0.01$), indicating a partial mediation of response efficacy on the relationship between instructional method and self-protectiveness (Figs. 3 and 4). A Sobel test confirmed this effect ($Z = -3.33$, $p < 0.01$) partially supporting Hypothesis 3b.

4.2.4.2. Personal responsibility. Finally, we also tested whether efficacy beliefs mediate the relationship between personal responsibility and self-protectiveness. Since self-efficacy showed to have an insignificant relation with self-protectiveness, mediation analysis was only conducted with response-efficacy as a mediator.

The first regression analysis with the level of self-protectiveness as a dependent variable and personal responsibility as an independent variable yielded a significant relation ($b = 0.01$, $p < 0.05$). The second regression analysis with the mediator (response-efficacy) as the dependent variable and responsibility as the predictor, showed that personal responsibility influences response-efficacy ($b = 0.20$, $p < 0.01$) significantly. Subsequently, a regression analysis with responsibility and the mediator as predictors and self-protectiveness as the dependent variable revealed that the previously found relationship between responsibility and the intention to take self-protective behavior became non-significant ($b = 0.01$, n.s.), whereas the mediator response-efficacy showed a highly significant relation ($b = 0.20$, $p < 0.01$), which indicated full mediation of response efficacy (Fig. 5).

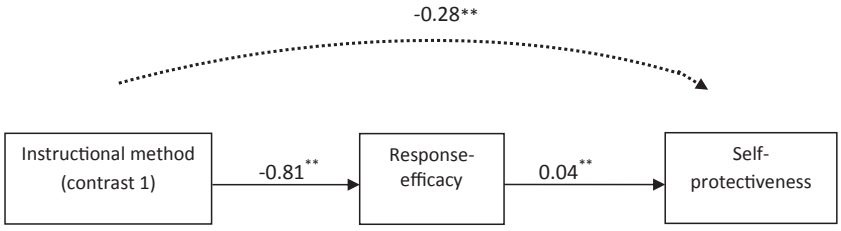

Fig. 3. Mediation model efficacy beliefs contrast 1 (behaviorally trained vs. no information) showing betas (N = 251).

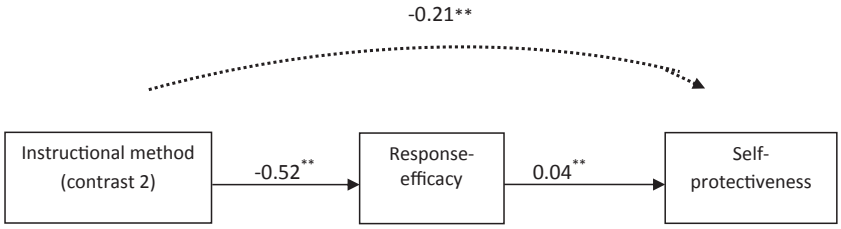

Fig. 4. Mediation model efficacy beliefs contrast 2 (behaviorally trained vs. informed) showing betas (N = 389).

A Sobel test confirmed that response-efficacy fully mediates the relation between responsibility and the intention of respondents to engage in self-protection ($Z = 5.07$, $p < 0.01$), supporting our final hypothesis.

5. Discussion

Research on self-protectiveness in a man-made-low-probability-high-consequence risk domain is receiving increasing scholarly attention (Ter Huurne and Gutteling, 2008; Rickard et al., 2014). This study provides new insights in the effect of instructional method on efficacy beliefs and self-protectiveness in this domain. Results show that citizens who are behaviorally trained and have gained experience by this training with risk mitigating options are more inclined to engage in self-protectiveness, possibly because their procedural knowledge has been increased. This research project with participants that actually live in an area prone to the risks related to the transportation of dangerous chemical substances by train thus indicates that adequate risk communication can be effective in stimulating actual self-protective behavior. Also, this study shows support for the idea that personal responsibility is a vital element in enhancing self-protectiveness of citizens. Feeling personally responsible for taking self-protective actions leads to higher levels of self-efficacy and response-efficacy, subsequently leading to a stronger tendency to take protective actions.

To our knowledge, this is one of the first studies aiming at measuring actual levels of self-protectiveness in the public domain. Unlike studies that measure intentions only, this study gives insight in actual behavior of citizens in a real-life setting. Also, no behavioral training has ever been developed within this safety field for as far as we know. This behavioral training with state-of-the-art risk mitigating behaviors is therefore unique and the results are promising, showing that its usage positively influences self-protectiveness.

This study stresses the need for additional and more active ways to inform the public about relevant risks. As the results in this study show, the passive approach often used by the government (merely informing citizens) is not sufficient. Actively informing citizens (by means of a behavioral training) increases levels of efficacy beliefs and self-protectiveness to a significantly larger extent than the passive approach, thus indicating that an active approach is more effective in increasing the resilience of the population. Furthermore, although the passive approach provides the public with relevant risk information, this does not necessarily mean that the receiver also processes this information effectively. Results in this study indicate that more than one-third of the public doesn't feel the need or urgency to read and process the received information, making the risk communication effort ineffective. These results are societally important since the evidence that self-protective behavior can be stimulated using appropriate risk communication tools is scarce. Although this study specifically focused on the risks related to the transportation of dangerous chemical substances by train, the results might also be relevant to other safety domains – such as for instance occupational health and safety - since a behavioral training might be effective in stimulating a wide range of adequate risk behaviors. A behavioral training might be more beneficial than standard passive techniques of risk communicating in making knowledge on all kinds of adequate risk behaviors stick. This asks for further research on the effect of behavioral trainings on adequate risk behaviors regarding different types of safety risks within several safety fields.

Contrary to our expectations, the perceived feasibility (self-efficacy) proved to be an insignificant predictor of actual self-protectiveness. Whether self-efficacy has an effect on self-protectiveness or not, remains questionable. Some studies show support for a positive relationship between these two constructs (Kievik and Gutteling, 2011; Kievik et al., 2012), whereas this study, in line with others (f.i. Gutteling and de Vries, 2016), did not find a significant effect of self-efficacy on self-protectiveness. We assume that a possible explanation for these differences in results might be due to different risk domains being studied. The type of risk (based on f.i. whether people are familiar with a risk; whether they have ever experienced a certain risk; the novelty of a risk) might influence the perceived feasibility of risk mitigating options. However, since the current study doesn't provide proof for this assumption, further research is necessary in order to look further into the relationship between self-efficacy and self-protective behavior. In the current study, however, we did observe that respondents perceiving risk-mitigating options as useful (response-efficacy), are more inclined to engage in self-protective actions than respondents perceiving the opposite. Furthermore, response-efficacy turned out to be a (respectively) full and partial mediator between the independent variables personal responsibility and instructional method and the dependent variable self-protectiveness. This indicated that enhancing the perceived usefulness of risk mitigating options provided by the government has a positive influence on the intention to take preventive actions. This study thus shows support for the idea that risk communication can only be effective when recommended risk mitigating actions can be viewed by the public as effective in mitigating the threat (Kievik and Gutteling, 2011). Therefore, risk communication efforts should focus utmost on communicating risk-mitigating options that the target audience perceives useful and each effort should be tailored to the needs of the audience in order to be effective (Collins McLaughlin and Mayhorn, 2014). Providing citizens with the opportunity to practice these behaviors as well as emphasizing their own personal responsibility are two options that might positively influence this perceived usefulness of risk mitigating options.

This study was conducted in a real-life safety setting. From an

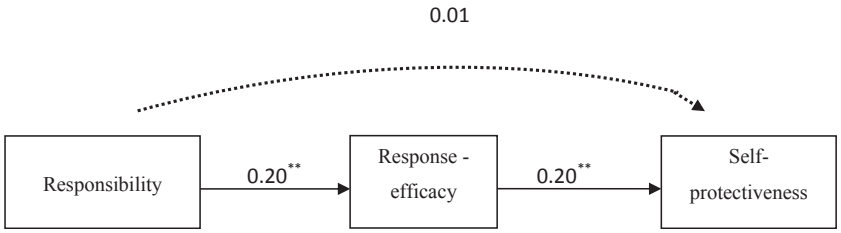

Fig. 5. Mediation model response efficacy responsibility showing betas (N = 614).

academic point of view, the nature of this study led to some remaining questions that need to be addressed. First of all, participants attending the behavioral training and that thus were assigned to the 'behavioral training condition', were all citizens that signed up for the training voluntarily. It is not quite clear whether – due to the self-selection - this group differs from the other respondents in characteristics that might be potentially relevant for the training's success (e.g. some specific interest in the risk). Secondly, although every participant in the main study was randomly selected and the number of participants was fairly high, they were assigned to a condition based on their self-reported received instructional method (behavioral training vs. information vs. no information). The question that thus remains is whether these results would be replicated in a more controlled setting randomly assigning respondents to a condition. Finally, the impact assessment of the behavioral training effectiveness study was conducted immediately after the training session, since the focus was on the immediate effect of the behavioral training. This results in a lack of insight in the trainings' long-term effects. Also, the results in our main study might not be consistent over time. A possible decay of learned information may arise, asking for a longitudinal study to see if attitudes and behavioral changes persist over a longer time period.

Despite these remaining questions, the results found in this study are highly useful and valuable from a more practical point of view. First of all, this study was conducted in a real-life safety setting and can therefore be seen as very similar to a real-life crisis or disaster. The results therefore more adequately describe citizens' actual behavior during a freight train incident than studies that use non-realistic scenario's. Secondly, it is very important that the behavioral training does have a significant impact on attitudes and behavior. Unfortunately it is impossible to ensure that 100% of the public is prepared for a possible crisis or disaster, since risk communication has to compete with a myriad of other messages and activities in citizens' daily lives. However, the respondents that were assigned to the 'behavioral training' condition in this study all voluntarily signed up for the training (maybe due to some sort of foreknowledge and interest in the risk topic). Perhaps this group can be considered as people that might spread their knowledge and motivation to others, and strive to help others in time of need. The fact that the behavioral training is very beneficial for this research group in particular is promising. Thirdly, this study anticipates upon the changing roles of recipients and communicators in the risk communication process. Although governmental institution often still rely upon a passive, one-way approach in communicating risks aimed at enhancing risk awareness, the current study shows proof for the effectiveness of a novel, more active, two-way approach of risk communication aimed at enhancing self-protectiveness.

The current study is one, though a quite promising study in a real-life situation aiming at measuring actual levels of self-protectiveness in the public domain. In order to gain more insight in the effect of behavioral training on self-protectiveness in real-life safety settings, more research on this topic is needed within multiple safety domains. This might increase our knowledge on how to enhance actual self-protective behavior of individuals regarding safety risks and how we can make these behaviors stick. More insights in the conditions under which a behavioral training is beneficial as an addition to standard-passive – more inexpensive – forms of risk communication is highly relevant, since it helps increase our understanding of the cost-effectiveness of different risk communication efforts aimed at increasing the overall resilience of the population.

6. Conclusion

The results provide valuable implications for future risk communication efforts directed at preventive actions. First, the results of this study indicate that risk communication can no longer be seen as a passive, one-way process in which citizens are informed using standard techniques. Based on this study, an active two-way approach in which adequate behavior is actively trained, procedural knowledge of risk mitigation is increased and in which people feel they are personally responsible for taking preparatory measures should be the new consensus. Secondly, the results of this study suggest that risk messages aimed at promoting self-protectiveness are effective under the conditions that the advised actions are perceived by the public as useful. Providing such messages that stress the usefulness of risk mitigating options is thus of the utmost importance. The designers of these message can therefore no longer suffice to take their own perception of message effectiveness as the sole guideline. Messages should be carefully crafted and designed along the lines of behavioral actions that are seen as efficacious by large numbers of people in the target audience. Crafting messages that stress the usefulness of risk-mitigating options and ensuring the active processing of this information by the public most likely will lead to more effectiveness of risk communication campaigns.

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