Point-by-point response to the reviews

The manuscript has been revised according to the comments and suggestions received by the two reviewers. We would like to thank them for their inputs and useful insight. The reviewers' comments are reproduced below, followed by our response.

Reviewer 1

Comment part 1: The overall presentation is well structured, easy to read and clear to understand bya wide and diversified audience. It would be of great benefit, if the authors woulddescribe the "general behavioral recommendations" which are part of their SW, in moredetail; e.g. by listing them in an additional table similar to Table 1 ("Additional impact-based information").

Response: We thank the Reviewer very much for the comment. The weather company with which we partnered for this study, developed 31 different behavioural recommendations for the three severity levels. Depending of the geographical situation, the time of the year and other factors, the forecaster decides ad-hoc which behavioural recommendations to include in the message. Thus, we include a Table with a selection of only some of the recommendations.

"In Table 1 we list the general behavioural recommendations that were provided in both standard and impact-based warnings." Change Table numeration

Table 1. Behavioural recommendations per severity level in the warning messages. Note that this list is not exclusive.

Warning severity level		
Moderate (level 1)	*Severe (level 2)*	*Very severe (level 3)*
Don't make fire	Avoid wind-exposed areas	Be aware of falling objects
Close windows	Secure lose items	Follow instructions of emergency services
Drive slowly	Avoid forests	Seek protection in buildings

Comment part 2: The term SW is chosen a little bit unfortunate, as in the Europeancontext standard meteorological warnings usually just include location, timing, hazard-type, severity level and eventually some meteorological information (e.g. Rainfall withamounts up to 100 mm), but generally no (generic) behavioral recommendations. Inthe Sendai context, behavioral recommendations are often seen, together with theimpact description, already as a part of an IbW or Impact-oriented warning (e.g. [1]).

Response: The Reviewer pointed out correctly that most European Meteorological Services issue standard warnings that do not include behavioural recommendations. However, we decided to keep the term SW as these are the standard warnings of our „weather partner" and are still close to the average standard warning in Europe. In the end, we believe that it is just a definition and with the additional Table, it should be clear what we understand under SW. However, we acknowledge the Reviewer’s comment in a sentence and also include the suggested reference.

“It’s important to note that most European Meteorological Services do not include generic behavioural recommendations in their standard warning *.”

* Kaltenberger, R., Schaffhauser, A., and Staudinger, M.: “What the weather will do” – results of a survey on impact-oriented and impact-based warnings in European NMHSs, Adv. Sci. Res., 17, 29–38, https://doi.org/10.5194/asr-17-29-2020, 2020.

<u>Comment part 3:</u> Obviously some of the additional impact descriptions according to Table 1 (e.g. "Fallingof smaller branches“) are very similar to the behavioral recommendation ("Präventions-Tipp“) of the depicted SW in Fig. 1, saying to be aware of falling items ("Vorsicht vorherunterfallenden Gegenständen“). This provision of rather little additional informationin the warning message might be one of the main reasons for the principal finding, thatin their field experiment IBW did not result in greater behavioral response compared toSW which should be discussed by the authors. It is likely, that SW without behavioraladvices, IBWs with richer (or more empathic) impact descriptions or generally moretailormade warning texts would have changed the results significantly. Acknowledgingthis and other limitations, e.g. just warnings for one hazard were investigated, nowarnings with the highest severity level due to the relatively short period of just 2.5months, some concluding statements would benefit from being expressed a little bitmore cautious and less generalized.

Response: We thank the Reviewer for his comments regarding the discussion of the results. We included these in the conclusion section of the paper.

„Also, we should be cautious in generalizing the results as these are somehow contextually dependent. The provision of rather little additional information in the warning message might be another reason that in the field experiment IBW did not result in greater behavioural response compared to SW. It could be that SWs without behavioural recommendations, and IBWs with stronger language and richer impact descriptions could have resulted in different findings. “

In the final paragraph, we highlight some of the limitations of the study. We explain that the lack of very severe hazards may have influenced our results, as well as the fact that we only investigated the hazard wind. Based on the Reviewer’s feedback, we also mentioned the relatively short study period that was in winter (and results may differ in summer).

„Thus, additional research could analyse whether these results are also valid for other natural hazards, as well as for different time periods in the year”.

<u>Reviewer 2</u>

Introduction :

<u>Comment #1</u>: In the introduction, I appreciate that the authors try to draw on relevant theory from psychology and decision sciences. However, how the introduction stands now, it is long and in some parts confusing. I’d recommend to focus more on the applied value of this applied study and the factors varied in them, and what it adds to the current literature. The cited work of Casteel (2016, for example) or Andrea Taylor, University of Leeds, UK (2019) are excellent examples for how this could be done. If

it is necessary to draw on several theories from cognitive and decision sciences, please clarify what are the precise predictions regarding the main independent variables explored here, based on these theories. This should be either based on theories, previous findings, or ideally integrate both. Regarding theory, I'd suggest narrow the theoretical focus and delineate precise predictions; and then pick these up again in the discussion and discuss whether and how they have been met, and why. If however, the aim of the authors is to review several theories rather than focusing on only one, please clarify why and how those were selected and relevant for IBW (for example construal level theory would then currently be missing).

Response: We are somewhat confused by this comment, as indeed we attempt to do in the introduction exactly what the reviewer suggest. In the first paragraph we focus on the question of whether more information leads to improved decisions, with a particular focus on the additional information contained in impact-based warnings (IBW) over standard warnings. Our question is thus whether it is worthwhile to include the added information that IBW contain. We then describe two different theoretical predictions, based on different cognitive pathways leading to human behaviour. When the analytic pathway is engaged, the rational actor model suggest that IBW will necessarily lead to improved decision-making. Where the affective pathway is engaged, it is unclear whether IBW will trigger improved decision-making. Additionally, we suggest that the method of investigating the response to IBW is important, because some methods (e.g. hypothetical surveys) make it more likely that the analytic pathway will be engaged, and these methods would then have an inherent bias in favour of showing IBWs to be superior. To capture the likely behaviour in real-world situations, we argue, it is necessary to replicate the conditions that could lead the affective pathway to be engaged. In this case, it is unclear whether IBWs will outperform SWs, and indeed the results may be highly context specific. Because we have tried to capture these points in the introduction, we are unclear how to revise it to meet the reviewer's request.

<u>Comment #2</u>: On a side note, I'd like to put forward that a dual systems-approach is widely ac- cepted is not correct – the 'ecological rationality' approach (see reference to Gigerenzer & Gaissmaier, 2011 below) is an entire interdisciplinary research paradigm in psychology and decision sciences (in social sciences more broadly, a much wider range of theories exist). It contrasts the dual system-approach. In my view, the inherent problem of the latter is that it doesn't clarify, generally and also in potentially threatening situations where people may rely on weather warnings, what a 'rational' and there- fore 'correct' decision actually is. Extreme weather leads to situations characterised by high uncertainty, where not all information is known and a 'rational' decision, based on all available information, is impossible to make. Also, quick and intuitive decisions could potentially be very helpful and adaptive in such uncertain emergency situations, if performed in the right decision context. While the introduction of the current paper is not the place to reflect this entire debate, the point I wish to illustrate is that the most important existing theories and predictions based on these need to be selected and described more carefully.

Response: We thank the reviewer for this side note, and agree that it does not require a change to the manuscript.

<u>Comment #3</u>: Having a more clear outline in the introduction would also clarify from an applied viewpoint what type of behavioural response is actually adequate in the authors' view (and 'rational', though I'd recommend to skip this term overall) – this may be based on general recommendations by weather warning services, or insurances, or Table 2? If there is an adequate response, please describe

it in the introduction. If not, that also needs to be clear, because then there isn't such a thing as a rational decision in this context. A more applied focus as mentioned above would help in clarifying this.

Response: As with comment 1, we are challenged as to how to modify the manuscript to address this concern, as it is one that we have tried to address in our original submission. It is clear that in most situations, there is not one "correct" or "rational" response. In our study, our dependent variable is whether people attempt to change their behaviour in response to a piece of information. While we make no claim that a change of behaviour is a "correct" response for all people, it is also the case that a change in behaviour suggests that people both took note of the information and chose the change their behaviour, whereas not changing behaviour indicates either (a) that they failed to take note of the information, or (b) that they took note of it and decided actively not to change their behaviour. Observing a greater rate of behavioural change would suggest that at least some people who would have otherwise fallen into group (a) did take note of the information.

Comment #4: This would also help re-structuring the abstract according to short background, re-search question, design, method and sample, main findings and a short comment on results. Currently, it doesn't precisely reflect what was done here – and lacks for ex- ample the impact-based weather warning manipulation, or introduces the term 'stress' which doesn't re-appear prominently anywhere else (as far as I can see).

Response: We thank the reviewer for this comment, and agree that the abstract could be restructured to better reflect the overall content of the paper. The new abstract is as follows:

"When public agencies provide information provision to help people make better decisions, they often face the choice between parsimony and completeness. For weather services warning people of high-impact weather events, this choice is between offering standard warning (SWs) only of the weather event itself , such as wind-speed, or also describing the likely impacts (so called impact-based warnings, IBWs). Previous studies have shown IBWs to lead to a greater behavioural response. These studies, however, have relied on surveys describing hypothetical weather events; given that participants did not feel threatened, they may have been more likely to process the warning slowly and analytically, which could bias the results towards finding a greater response to the IBWs. In this study, we conducted a field experiment involving actual and potentially threatening weather events, where there was variance with respect to the time interval between the warning and the forecasted event, and where we randomly assigned participants to receive SWs or IBWs. We observe that shorter time intervals led to a greater behavioural response, suggesting that fear of an imminent threat to be an important factor motivating behaviour. We observe that IBWs did not lead to greater rates of behavioural change than SWs, suggesting that where fear is a driving factor, the additional information in IBWs may be of little importance. We note that our findings are highly contextualized, but we call into question the prevailing belief that IBWs and necessarily more helpful than SWs."

Methods:

Comment #5: #5 P.5 l.10 says "we asked participants whether the weather described inthe warning would pose a risk to them and whether it would affect them in carrying outtheir usual activities (e.g., commuting, working, shopping etc.). If they answered yes,they continued with the survey" – wouldn't this exclusion of people who don't change,be an explanation of why no effects were observed – if for example more people didn'treact to a SW, compared to a IBW?

Response: These questions that the Reviewer is referring too, helped to filter out those people who were not affected by the warning at all, because they were for instance the whole day at work and thus the wind warning from 2 to 5 pm would not be relevant for them at all. In the following we asked questions whether people changed behaviour as we also explain in the manuscript. So, there was a slight misunderstanding: we did not exclude people who did not react to the warning, but only those for which the warning was not relevant in the first place!

Comment #6: Page 5 l.34 reports that the regression isconducted on behaviour, but the regression table header indicates that it predicts be-haviour 'change' – please clarify whether it predicted absolute behaviors or a differ-ence score reflecting change (I don't think it did the latter).

Response: The Reviewer is right it is about this comment on behaviour and thus we adapted the language in the Table heading "…with behaviour as dependent variable".

Comment #7: Table 2: Please reporta measure of dispersion for age, and a range.

Response: We included a measure of dispersion (St. dev.) and a range

Comment #8: Figure 2: I think this is not aboutlikelihood (as the header implies) but a continuous score measuring actual behavior. Ithink the figure header should accordingly be something like "Mean self-reported be-haviour in response to two warning types,...". Please avoid the use of acronyms orexplain them again in the caption to allow the figure to stand on its' own. I'd also preferto see the full scale that was presented to participants on the y-axis; to get an ideaabout effect magnitude. Please do also apply these points to all other figures where appropriate.

Response: The Reviewer is absolutely right with respect to the measuring scale. We also avoid acronyms. Thus, we changed the header into "Mean self-reported behaviour in response to two warning types (standard and impact-based) and the three lead times (no, short and long), respectively the two severity levels (moderate and severe)." However, we decided to not present the full scale on the y-axis as this would deteriorate the readability of the figure. Also, the scale is explained in the caption.

Comment #9: Table 3 and overall results section: The use of standard significancelevels and *** has been widely criticized in psychology and decision sciences, andother fields (see for example https://www.nature.com/articles/d41586-019-00857-9 orhttps://journals.sagepub.com/doi/abs/10.1177/0959354302126005 for some context).Albeit still widely in use unfortunately, I'd thus refrain from marking results with *** andin bold, dependent on these levels; and follow reporting standards outlined in this litera-ture; including for example confidence intervals where appropriate for all study results.

Response: We thank the Reviewer very much for her comment. As the reviewer highlights, the use of standard significance levels is widely used in research, we believe that this approach is absolutely fine even though there exists some criticism. We also included error bars in the figures and indicate standardized coefficients in the regression analysis.

Discussion:

Comment #10: As the authors note in line 27 on page 7, the study is based on self-reports and a self-selected sample. Please acknowledge the dearth of literature on samples and self-reports in psychology and social sciences more generally where this has been criticized, and provide a recommendation for future studies.

Response: We are happy to include this note. We have revised the relevant text as follows, following the reviewer's suggestion:

"This may indicate higher levels of weather awareness and knowledge, which could also be another explanation for the lack of effect of warning type. There is a dearth of literature on the effects of such self-selection in social science research, though ideally researchers would design field experiments where self-selection is not present."

Technical corrections

Comments #11 - #17: Were all addressed. We only did not include the comparison to the general population in the table (comment #15) as the table is explicitly about the results of the study. However, the information is still available in the text.

Responses to severe weather warnings and affective decision-making

Philippe Weyrich[1], Anna Scolobig[2], Florian Walther[3], Anthony Patt[1]
[1] Climate Policy Group, Department of Environmental Systems Science, Swiss Federal Institute of Technology (ETH Zurich), 8092 Zurich, Switzerland
[2] Environmental Governance and Territorial Development Institute, University of Geneva, 1205 Geneva, Switzerland
[3] Wetter-Alarm, GVB Services AG, 3063 Ittigen, Switzerland

Correspondence to: Philippe Weyrich philippe.weyrich@usys.ethz.ch

Abstract

When public agencies provide information provision to help people make better decisions, they often face the choice between parsimony and completeness. For weather services warning people of high-impact weather events, this choice is between offering standard warning (SWs) only of the weather event itself , such as wind-speed, or also describing the likely impacts (so called impact-based warnings, IBWs). Previous studies have shown IBWs to lead to a greater behavioural response. These studies, however, have relied on surveys describing hypothetical weather events; given that participants did not feel threatened, they may have been more likely to process the warning slowly and analytically, which could bias the results towards finding a greater response to the IBWs. In this study, we conducted a field experiment involving actual and potentially threatening weather events, where there was variance with respect to the time interval between the warning and the forecasted event, and where we randomly assigned participants to receive SWs or IBWs. We observe that shorter time intervals led to a greater behavioural response, suggesting that fear of an imminent threat to be an important factor motivating behaviour. We observe that IBWs did not lead to greater rates of behavioural change than SWs, suggesting that where fear is a driving factor, the additional information in IBWs may be of little importance. We note that our findings are highly contextualized, but we call into question the prevailing belief that IBWs and necessarily more helpful than SWs.

Deleted: Informing people of an impending hazard can lead them to adopt behavior to mitigate the harm. In this study we examine whether giving more information, and giving it earlier, leads to a greater behavioral response. Our results, which are contextually dependent, show that providing more information has no effect on behavior, and that longer lead times lead to less behavioral change. These results conflict with those from previous studies. These previous studies differed from ours in terms of the research methods: while past studies examined people's anticipated responses to hypothetical warnings, we conducted a field experiment to observe people's responses to actual warnings of real hazards. Theory from cognitive science suggests that this difference matters. In situations of high stress people may make decisions using a faster decision pathway that is rather emotion-driven, while in less stressful situations they are more likely to base their decisions on information. The difference between actual and hypothetical warnings would capture this mismatch in stress levels, and account for the divergent findings. At the same time, the cognitive theory has been hard to test in the field, because of the ethical challenge of submitting people to actually dangerous conditions. Therefore, our results are not only relevant for the design of warning information, but also provide important empirical support for the theory of different decision-making pathways.

1. Introduction

To the extent that people make decisions based on information, it would seem right that the more information they receive about a situation demanding potential action, and the earlier they receive it, the better they can adjust their behavior. However, there is evidence that people often make decisions based on their emotional response to information (Slovic et al., 2004, 2007). In such cases, more information is not necessarily better. Moreover, which decision-making pathway people utilize may depend on the context. However, this pathway is not necessarily self-exclusive and could involve the interaction of information-based reasoning and emotions (Kahneman, 2011). Here, we investigate the effectiveness of different kinds of information, as well as its timing, used in warning people about impending high impact weather events. Our primary focus is on the difference between standard warnings (SW), which describe the weather event itself, compared to impact-based warnings (IBW), which, in addition, describe the impacts that result from the weather.

Research in social sciences has broadly accepted two ideas about human nature. The analytical or cognitive idea suggests that people make rational decisions based on formal logic, risk assessment and statistical probabilities, for instance on the impacts and likelihood of a hazard (Loewenstein et al., 2001; Slovic et al., 2004). This system is rather slow as it requires mental work, which is effortful and orderly (Kahneman, 2011; Slovic et al., 2004). The affective decision-making relates to the importance of emotions and feelings in making decisions (Slovic et al., 2004). It operates automatically and fast, with neither effort nor sense of voluntary control, although it is often influenced by beliefs, or mental models, about how the world works (Morgan et al., 2002; Slovic et al., 2004).

Research that has investigated whether feelings, information-based action or both influence people's behaviors related to risks has primarily relied on laboratory studies. For example, scholars have used different messages to manipulate affect by increasing or decreasing perceived benefits and risks of different technologies (Finucane et al., 2000). In two experiments, these researchers demonstrated that affect influenced judgments directly and was not simply a response to a prior deliberate evaluation. In only two studies, which we describe below, have researchers evaluated behavior under varying conditions of actual fear, something that cannot be simulated in a laboratory.

A real-world situation where the emotional decision-making pathway could dominate is the response to warnings of potentially life-threatening weather events, such as tornados or severe storms. Research that is based on information-based decision-making has suggested that message content and style are important factors in determining whether people take self-protective behavior to an extent that rational analysis would deem appropriate (Mileti and Sorensen, 1990). In order to be effective at inducing such behavior, a message should contain five information elements – hazard, location, time, guidance and source – which should be addressed each by five stylistic dimensions – specificity, consistency, accuracy, certainty, and clarity (Mileti and Sorensen, 1990). A warning with these characteristics is easy to understand, to believe and to personalize for the recipient, identified as prerequisites for triggering behavioral change (Mileti and Peek, 2000). Thus

IBW, which provides more specific and clear information on the impacts of the hazard, should help people to better understand the message compared to SW. IBW should also increase the personalization of risk and make people feel more concerned for their safety, resulting in stronger behavioral response compared to SW. For example, some people have difficulties to interpret a “heavy” rainfall warning, indicating 100 mm of rain, into effective impacts. In this case communicating specific impacts, for instance on road and rail transport, and possibilities of delays, ought to improve warning effectiveness. Interviews with forecasters, emergency managers and broadcast meteorologists (Harrison et al., 2014; Losego et al., 2013), as well as with officials from the public and private sector (Weyrich et al., 2018) all reveal a widespread belief within the expert community that providing impact information creates an added value in the specific case of high impact weather warnings.

Recent studies offer empirical support for this belief, although the results are somewhat mixed (Kox et al., 2018). For example, scholars showed that IBW, compared to SW, positively influenced the recipient's sense of threat and concern associated with a hypothetical event, as well as their understanding of the potential impacts (Morss et al., 2018; Potter et al., 2018; Weyrich et al., 2018). More importantly, the IBW of the hypothetical event resulted in a greater likelihood of people planning to take self-protective action, should such an event occur (Casteel, 2016; Morss et al., 2018; Weyrich et al., 2018). There have also been contradictory findings. One study detected no effect of IBW on perception of warning credibility or on intended behavioral response (Perreault et al., 2014), while another study identified a threshold beyond which increasing the projected impact of a storm no longer significantly increased the probability of taking protective action (Ripberger et al., 2014). All of these empirical studies, however, share a common research design: they used hypothetical scenarios, and relied on people’s anticipated and intended reactions to study the effects of IBW. For example, in one study of tornado warnings, the effectiveness of IBW was examined with respondents in the hypothetical role of a factory operator having to decide whether to order workers to take shelter in response to SW and IBW (Casteel, 2016). In another study, participants had to imagine that they would be hiking in the Swiss mountains when receiving a thunderstorm warning, and then had to decide upon several intended actions; those receiving an IBW were more likely to modify their plans than those receiving an SW (Weyrich et al., 2018).

If indeed it is feelings that dominate behavioral decision-making in real-life situations, then it may be that these studies on the effectiveness of IBW are poor predictors of actual behavior, as it is unlikely that the respondents experienced real feelings of fear, since they were not actually at risk. Two studies exist that have looked at actual self-protective behavior during a crisis suggest this to be the case. Researchers in Indonesia investigated evacuation behaviors and intentions during tsunamis, and observed that feelings, and not rational evaluation, drive decision-making (McCaughey et al., submitted). Their findings suggest that under an imminent threat of life, information-based action may be absent or far less influential than feelings. Scholars from the Netherlands analyzed the behavioral effects to mobile fire warning messages (Gutteling et al., 2017). They found that emotions and the social environment were the main predictors for adaptive behavior. Even though perceived message quality was significant, other factors, such as perceived threat, were insignificant. These results confirm the importance of affective reactions as a driver for behavior.

If affective decision-making is the dominant pathway in real-world crises, then SW may provide all the information that is needed to trigger the feelings of fear, with IBW adding no additional trigger. We speculate that hazard severity and warning lead time could also influence the response to weather warnings in different ways depending on the model of decision-making. If information-based action dominates then more severe events and greater lead times should generate a greater behavioral response: longer lead times would translate into greater ease of preparing for and actually taking self-protective behavior. If affective decision-making dominates, however, more severe events and shorter lead times should increase response, since the fear should be heightened at the time of the information reception.

There have been two studies examining the effect of warning lead time, and one related to event magnitude. One of these examined tornado response, and showed that an increase in lead time up to about 15 minutes reduces fatalities, while lead times longer than 15 minutes increase fatalities compared with no warning (Simmons and Sutter, 2008). The second study showed more generally that people have lead time preferences that do not always match with what the warning system offers, and that they engage in different protective behaviors depending on the lead time (Hoekstra et al., 2011). The one study examining event magnitude, using a hypothetical survey design, showed that the greater the severity the more likely people are to take protective action (Kox and Thieken, 2017). Perceived severity of the hazard is also used in many decision-making theories. For instance in Protection Motivation Theory, it is one of four core perceptions that form the basis for decisions about how to respond to a threat (Maddux and Rogers, 1983).

In this paper we report on results from a randomized control trial in which we disseminated wind warnings through an existing smartphone application of a Swiss weather provider (*Wetter-Alarm*), and collected real-time data on people's responses. The information that people received varied randomly in terms of being SW or IBW, and given that there were a number of events for which the warnings were issued, in terms of both the warning lead time and the events' anticipated severity.

2. Materials and Methods

The method used here was a large field experiment conducted in Switzerland, which tested for effects of warning type, severity level and lead time on warning response. SW and IBW for wind were disseminated to users via the smartphone weather application (app) 'Wetter-Alarm'. The application resulted out of a cooperation between the GVB (House Insurance Bern) Services_AG (joint-stock company) (which is responsible for the app) and SRF (Swiss Radio and Television) Meteo, which provides the weather (i.e., warnings for frost, thunderstorm, slipperiness, rain, snow and wind among others). The users could receive warnings for three severity levels: moderate (slight risk of damage), severe (increased risk of damage) and very severe (big risk of damage or even risk of death). The standard warnings disseminated in the Wetter-Alarm app included information about the type of hazard, its severity, the timing and location, as well as some general behavioral recommendations (e.g., secure lose items or avoid forests). Figure 1 shows a standard wind warning of medium severity. In Table 1 we list the general behavioural recommendations that were provided in both standard and impact-based warnings. It's important to note that most European Meteorological Services do not include generic behavioural recommendations in their standard warning (Kaltenberger et al., 2020). The impact-based warning included the identical information than the SW, but with an additional impact information of the weather which are shown in Table 2. We developed these messages based on publicly available information on impacts of wind in Switzerland and in close collaboration with the staff of Wetter-Alarm. A link was provided at the end of the warning message, which directed participants to a short survey. The survey was available from the moment on when the warning message was disseminated until the end of the event. We focused on severe wind due to its frequency, the time of the year (winter season) and the possibility to investigate different lead times. We collected data for two wind severity levels: moderate and severe. As this research involves research on humans, appropriate ethical procedures were followed, which was approved by the Ethics Commission of ETH Zürich. Participants voluntarily participated once they had been informed about the research project and signed a declaration of consent. They received no incentive to complete the survey.

Deleted: 1

Deleted: questionnaire

Deleted: questionnaire

Figure 1. Standard wind warning of medium severity level for the region La Côte/Morges.

Table 1. Behavioural recommendations per severity level in the warning messages.

Table 2. Additional impact-based information per severity level in the impact-based warnings.

Deleted: 1

A total of 3,223 participants completed the online survey from 1.12.2018 to 10.02.2019. We excluded 611 people from the analysis as they believed to have responded to a warning message with a different severity level than it was actually the case. This can be explained by the fact that the warning message they received initially, was updated in the meantime (e.g., from a moderate to a severe level) or that the participants received multiple warning messages for different locations and got confused. Thus, to avoid any possible misinterpretation of data, the analysis was conducted with data from 2,615 participants that indicated the correct severity level. As respondents were randomly assigned to either a SW or IBW, the subgroups are roughly even (1,364 and 1,247). However, more people responded to severe warning messages (n=1,667) than to moderate messages (n=948). No very severe wind was observed. Warning lead times also differed and people were grouped into three groups depending on when they looked at the warning message (i.e., participated in the survey); during the wind event itself (n=932, 35.6 %), in the 6 hours preceding the wind event (17.1 %, n=448) and prior to 6 hours, 47.2 % (n=1,235). On average, people responded to the survey 5.14 hours in advance of the wind event.

Information about the basic socio-demographic characteristics of the sample is provided in Table 3. The sample matches the profile of the general Wetter-Alarm app user which is older (48.8 years) than the Swiss average (43.14 years), is more often male (63.1 %) than female (Swiss average 49.5 % vs. 50.5 %) (FSO, 2017b) and slightly more educated than the Swiss population (FSO, 2017a). As the survey was conducted online based on actively users of the app Wetter-Alarm, it did not reach people who did not download the application, who do not actively use the app or who do not have internet access. People could only participate once in the survey, which was guaranteed through posing the question whether they already participated in a Wetter-Alarm survey recently.

Table 3. Socio-demographic characteristics of participants in the field experiment.

In the survey, we asked questions on warning perception and subjective understanding. Perceptions that we measured using a five-point Likert scale from ‘totally disagree’ to ‘totally agree’ were credibility, and concern. We measured three types of understanding: the warning, the threats to safety, and how to respond. Then, we asked participants whether the weather described in the warning would pose a risk to them and whether it would affect them in carrying out their usual activities (e.g., commuting, working, shopping etc.). If they answered yes, they continued with the survey. The following three questions were used to build the variable behavioral response. First, participants had to indicate whether they responded to the warning. If answered ‘Yes’, they had to indicate whether they adapted, but continued with their activities or whether they cancelled their activities (respectively taking other measures for protection). If answered ‘No’, participants had to indicate whether they would not change their behavior, or still plan to do so, i.e., adapting activities or cancelling activities. Thus, we computed the variable behavioral response on a five-point scale (1= no action planned, 2= plan to adapt, 3= plan to protect, 4= did adapt, 5= did protect). We used this scale from no response to strongest risk minimizing behavior as we believe that it catches more variance than only the binary question on whether people responded to the warning or not. Similar to other research (Gutteling et al., 2017), we used a battery to ask what kind of feelings the warning did trigger: relaxed, anxious, concerned, reassured and angry (five-point Likert-scale from ‘not at all’ to ‘very much’). These questions were used in other studies that investigated behavioral responses to emergencies (Gutteling et al., 2017; Kievik et al., 2012; Kievik and Gutteling, 2011) and thus seemed to be an appropriate measure also in this study’s context. The items ‘relaxed’ and ‘reassured’ were inverted and the scale yielded good internal consistency (Cronbach’s alpha = 0.68, N = 5). We also gathered data on whether people consulted other information for advice or confirmation (binary question Yes/No). Finally, we collected information on the most important personal factors: gender, age, and education. The full survey is available in the supplement.

For the data analysis we use standard statistical software (IBM SPSS 25) to conduct a factorial ANOVA to study the effects of warning type, severity level and lead time on behavioral response. In addition, we did a multiple regression analysis to investigate the effects of other covariables (e.g. warning perception and understanding) on behavior.

3. Results

We first describe the effects of warning type, lead time, and event magnitude on participants’ perception and subjective understanding. We summarize the mean values in the appendix. IBW were not perceived to be more credible, nor to be better understood in terms of the warning, the threats to safety, and how to respond compared to SW. People were only slightly more concerned for their safety when receiving IBW. Participants’ perception and understanding did not change with different lead times. However, people indicated higher perceived concern levels for severe compared to moderate warnings. Not surprisingly, people reported increased feelings with decreasing lead times and increasing severity levels.

To analyze the effects of warning type, severity level and lead time on behavior, we focus on those people who indicated the warning to be relevant and analyzed their behavior. Fifty-four percent of people (n=1426)

Deleted: 2

Deleted: 2

Deleted: questionnaire

reported that the warning message affected their personal safety, impacted their daily routine or both. The majority of those people already changed their behavior, either by adapting their activities (35.2 %) or by cancelling them (25.7 %). Fewer people indicated that they still planned to adapt (22.7 %) or to cancel (6.9 %) their activities. Nine percent of people reported not changing their behavior, even though the message was found to be relevant. We conducted a factorial ANOVA (2 (Warning Type) X 3 (Lead Time) X 2 (Warning Severity Level) predicting behavior, which showed no effect of warning type (p=.963), but effects of lead time ($F(1, 1410)=11.00$, $p<.001$, $\eta_p^2=0.02$), and of severity level ($F(1,1410)=12.21$, $p<.001$, $\eta_p^2=0.01$). The Bonferroni post hoc test revealed that changing behavior was significantly lower for long lead times compared to short (p=.007) or no lead times (p<.001). All interaction effects between any of the three variables (type, severity and time) on behavior were non-significant (p-values between 0.360 and 0.546). Figure 2 underlines that IBW did not result in greater behavioral response compared to SW. However, as Fig. 3 highlights, lead time and warning severity significantly influenced people's decisions to change behavior: decreasing lead times and increasing severity level resulted in a greater response. We also observe that the differences in behavioral response between moderate and severe warnings are quite low for long lead times. This difference becomes more important for shorter lead times. However, the interaction is not significant (p=.360). In the next set of relationships, we examined what additional factors influence behavioral response. In specific, we analyze the relationship between feelings, respectively warning perception/understanding, and behavioral action. Table 4 shows that irrespective of warning type received, feelings (a unit increase in feelings 0.25 unit increase in changing behavior), perceptions of credibility (β=0.134) and concern (β=0.098), as well as understanding the threats (β=0.193) and how to respond to the message (β=0.154) significantly influence taking protective action. Moreover, age (β=0.081) and information behavior (β=0.100) showed significant positive effects. Thus, the more people felt in danger, the better they perceived or understood the message, the older they are, and the more they looked for information, the more likely they were to undertake strong risk minimizing behaviors. The linear regression analysis again confirms the importance of lead time (*p*<.001) and warning severity (*p*<.01) on the behavior variable. With decreasing lead times, people are more likely to take protective action (a unit increase in lead time predicted a 0.154 unit decrease in changing behavior). For severe warnings, people were also more likely to change their behavior (by 0.073 unit) compared to people who received moderate severity warnings.

Deleted: 3

Figure 2. Mean self-reported behaviour in response to two warning types (standard and impact-based) and the three lead times (no, short and long), respectively the two severity levels (moderate and severe).

Deleted: Mean likelihood to change behavior for the two warning types (SW and IBW) and the three lead times (no, short and long), respectively the two severity levels (moderate and severe)…

Figure 3. Mean self-reported behaviour for all three lead times (no, short and long) and two severity levels (moderate and severe).

Table 4. Multiple linear regression with behaviour as dependent variable.

Deleted: 3

Deleted: with the behavioral change as dependent variable

4. Discussion

This research investigates the effectiveness of impact information, as well as its timing, used in warning people about an imminent threat. Our results show that while IBW result in no greater behavioral response, decreasing lead times and stronger severity level do increase response. Taken together, these results suggest that affective decision-making appears to be the dominant mode of decision-making in real-world situations.

IBW do not significantly impact warning perception and subjective understanding, nor do they result in greater behavioral response compared to SW. This result contradicts the majority of previous studies that used hypothetical situations to collect their data (Casteel, 2016; Morss et al., 2018; Weyrich et al., 2018). We speculate that this difference in research findings can be explained by the different levels of fear experienced in a hypothetical and a real crisis. Unlike in an imagined situation, where information-based action is the dominant factor, our findings suggest that in a crisis situation, real feelings of fear arise and dominate decision-making. We assume that SW provide all the information that is needed to trigger the feeling of fear. Indeed, IBW may leave less to the imagination of the recipient, which could – in some cases – dampen the fear response.

Our results on the effects of lead time and hazard severity are also consistent with affective reactions. We observe lead time and self-protective behavior to be inversely correlated and find that increasing lead times, decrease the likelihood to engage in greater behavioral response and observe the greatest response when the event has already unfolded. These results complement other research on different lead times for tornado warnings (Hoekstra et al., 2011). We also show that stronger events generate a greater response than weaker events, which is in line with previous research (Kox and Thieken, 2017). Moreover, we observe that longer lead times do not generate a greater additional response to stronger rather than weaker events. This interaction (even though not significant) is in line with an affective reaction: with long lead times, the additional fear associated with the stronger event may dissipate, meaning that the stronger events would generate little more response than weaker events.

These findings support scholars who reached a similar conclusion when investigating evacuation behaviors following a strong earthquake (McCaughey et al., submitted). Nonetheless, cognitive factors, such as warning perception and understanding can also influence decision-making. In our study, four of these information-based attributes correlate with changing behavior and thus seem to be obvious prerequisites for behavior (Gutteling et al., 2017). Indeed, the two decision-making pathways should not be seen as independent systems, they can interact and influence each other as the rational process can modify, to some extent, the way we make intuitive and affective decisions by changing the normally automatic functions of attention and memory (Kahneman, 2011). The research also shows that the two systems are not always self-exclusive, for instance when people are asked to judge risk, they first consider how they feel about the risk and then collect further information, usually to support their feelings (Slovic et al., 2004). Therefore, further empirical studies of real-world crises are needed to understand if, and how feelings and information-based action interact to influence people's behaviors to risks.

5. Conclusions

We conclude that practitioners cannot assume that additional impact-based information necessarily results in greater behavioral response in real-world crises. Appropriate lead times and a communication that addresses the decision-makers' feelings (e.g., by relying on images) may be more beneficial and result in a stronger behavioral response. Ultimately, the results show that people may respond differently in a field than in a scenario-based experiment, based on more affective, respectively rational decision-making. This has serious implications for future research emphasizing that we should examine responses to risks using research designs that capture realistic conditions and be cautious in interpreting results from hypothetical research designs as these could be a poor predictor of actual behavior.

The research has some limitations. One shortcoming of this study is the absence of a very severe wind event in the winter season 2018/19 in Switzerland, and additional data should be collected for these events too. Indeed, most of the research on IBW used hypothetical warning messages of the most severe category, as people are least familiar with these messages and, thus, the added information could help them in decision-making. In consequence, the difference in the results on the effectiveness of IBW in our and previous studies could also be due - to some extent - to the differences in event severity level. Moreover, participants were self-selected as they had downloaded the weather app and decided whether or not to participate in the survey. This may indicate higher levels of weather awareness and knowledge, which could also be another explanation for the lack of effect of warning type. Another limitation is that, even though we collect data on actual behaviors in response to real-life warnings, these were still self-reported. This may indicate higher levels of weather awareness and knowledge, which could also be another explanation for the lack of effect of warning type. There is a dearth of literature on the effects of such self-selection in social science research, though ideally researchers would design field experiments where self-selection is not present. Thus, additional research could analyse whether these results are also valid for other natural hazards, as well as for different time periods in the year.

Deleted: Thus, additional research could analyze whether these results are valid for other natural hazards as well

Also, we should be cautious in generalizing the results as these are somehow contextually dependent. The provision of rather little additional information in the warning message might be another reason that in the field experiment IBW did not result in greater behavioural response compared to SW. It could be that SWs without behavioural recommendations, and IBWs with stronger language and richer impact descriptions could have resulted in different findings.

Appendix

Table A. **Descriptive statistics**. M=Mean, SE= Standard error. Variables were measured on a five-point scale from 1='totally disagree' to 5='totally agree'.

	Warning type		Lead time			Severity level	
	SW	IBW	No	Short	Long	Moderate	Severe
Credibility perception	(M=4.07, SE=0.02)	(M=4.04, SE=0.02)	(M=4.09, SE=0.03)	(M=4.03, SE=0.04)	(M=4.04, SE=0.02)	(M=4.02, SE=0.03)	(M=4.07, SE=0.02)
Concern perception	(M=2.00, SE=0.03)	(M=2.10, SE=0.03)	(M=2.09, SE=0.03)	(M=2.02, SE=0.04)	(M=2.02, SE=0.03)	(M=1.91, SE=0.03)	(M=2.12, SE=0.02)
Understanding the warning	(M=4.38, SE=0.02)	(M=4.36, SE=0.02)	(M=4.36, SE=0.02)	(M=4.36, SE=0.03)	(M=4.39, SE=0.02)	(M=4.37, SE=0.02)	(M=4.38, SE=0.02)
Understanding the threat	(M=3.96, SE=0.02)	(M=4.02, SE=0.02)	(M=4.00, SE=0.02)	(M=4.02, SE=0.04)	(M=3.98, SE=0.02)	(M=3.99, SE=0.03)	(M=4.00, SE=0.02)
Understanding how to respond	(M=3.94, SE=0.02)	(M=3.96, SE=0.02)	(M=3.92, SE=0.03)	(M=3.98, SE=0.04)	(M=3.96, SE=0.02)	(M=3.94, SE=0.03)	(M=3.95, SE=0.02)
Affective reaction	(M=2.10, SE=0.02)	(M=2.15, SE=0.02)	(M=2.20, SE=0.02)	(M=2.13, SE=0.03	(M=2.10, SE=0.02)	(M=1.98, SE=0.02)	(M=2.21, SE=0.02)

Author contribution

PW designed and performed the research. PW analyzed the data and wrote most of the paper. AS helped designing the survey and FW performing the research. AP helped designing the research and structuring, respectively writing the paper.

Data availability

In the research design that we originally submitted to our Ethical Commission (equivalent to an Internal Review Board), we had stated that all data would be deleted from ETH computers after the end of the project, but would be stored on servers at our partner (Wetteralarm), and would be potentially used to improve the design of their mobile application. Thus, interested researchers should contact us, and we should be able to work with Wetteralarm to provide the data requested.

Competing interests

The authors declare that they have no conflict of interest.

Acknowledgments

We thank the entire Wetter-Alarm Team for their help in the implementation of our research design. Conducting the field experiment would not have been possible without their permission to use the Wetter-Alarm mobile application to. Within the Wetter-Alarm Team, we would like to especially thank Marlène Käsermann for her valuable inputs.

References

Casteel, M. A.: Communicating Increased Risk: An Empirical Investigation of the National Weather Service's Impact-Based Warnings, Weather Clim. Soc., 8(3), 219–232, doi:10.1175/WCAS-D-15-0044.1, 2016.

Finucane, M. L., Alhakami, A., Slovic, P. and Johnson, S. M.: The Affect Heuristic in Judgments of Risks and Benefits, J. Behav. Decis. Mak., 13(1), 1, 2000.

Gutteling, J. M., Terpstra, T. and Kerstholt, J. H.: Citizens' Adaptive or Avoiding Behavioral Response to an Emergency Message on their Mobile Phone, J. Risk Res. [online] Available from: https://www.tandfonline.com/doi/abs/10.1080/13669877.2017.1351477 (Accessed 27 February 2018), 2017.

Harrison, J., Bunting-Howarth, K., Ellis, C., McCoy, C., Sorensen, H. and Williams, K.: Evaluation of the National Weather Service Impact Based Warning Tool, in Eighth Symp. on Policy and Socio-Economic Research, Atlanta, GA. [online] Available from:

Deleted: D

Deleted: deviation

https://ams.confex.com/ams/94Annual/videogateway.cgi/id/26579?recordingid=26579 (Accessed 19 June 2017), 2014.

Hoekstra, S., Klockow, K., Riley, R., Brotzge, J., Brooks, H. and Erickson, S.: A Preliminary Look at the Social Perspective of Warn-on-Forecast: Preferred Tornado Warning Lead Time and the General Public's Perceptions of Weather Risks, Weather Clim. Soc., 3(2), 128–140, doi:10.1175/2011WCAS1076.1, 2011.

Kahneman, D.: Thinking, Fast and Slow, Macmillan., 2011.

Kaltenberger, R., Schaffhauser, A. and Staudinger, M.: "What the weather will do"–Results of a Survey on Impact-oriented and Impact-based Warnings in European NMHSs, Adv. Sci. Res., 17, 29–38, 2020.

Kievik, M. and Gutteling, J. M.: Yes, We Can: Motivate Dutch Citizens to Engage in Self-Protective Behavior with Regard to Flood Risks, Nat. Hazards, 59(3), 1475, 2011.

Kievik, M., ter Huurne, E. F. and Gutteling, J. M.: The Action Suited to the Word? Use of the Framework of Risk Information Seeking to Understand Risk-Related Behaviors, J. Risk Res., 15(2), 131–147, 2012.

Kox, T. and Thieken, A. H.: To Act or Not To Act? Factors Influencing the General Public's Decision about Whether to Take Protective Action against Severe Weather, Weather Clim. Soc., 9(2), 299–315, doi:10.1175/WCAS-D-15-0078.1, 2017.

Kox, T., Kempf, H., Lüder, C., Hagedorn, R. and Gerhold, L.: Towards User-orientated Weather Warnings, Int. J. Disaster Risk Reduct., doi:10.1016/j.ijdrr.2018.02.033, 2018.

Loewenstein, G. F., Weber, E. U., Hsee, C. K. and Welch, N.: Risk as Feelings., Psychol. Bull., 127(2), 267, 2001.

Losego, J., Montz, B., Gallupi, K., Hudson, M. J. and Harding, K.: Evaluating the Effectiveness of IBW, in Eighth Symp. on Policy and Socio-Economic Research, Austin, TX. [online] Available from: https://ams.confex.com/ams/93Annual/webprgram/Paper226066.html (Accessed 19 June 2017), 2013.

Maddux, J. E. and Rogers, R. W.: Protection Motivation and Self-efficacy: A rRvised Theory of Fear Appeals and Attitude Change, J. Exp. Soc. Psychol., 19(5), 469–479, doi:10.1016/0022-1031(83)90023-9, 1983.

McCaughey, J. W., Mundir, I., Safrina, L., Rosemary, R., Mahdi, S., Daly, P. and Patt, A.: Thinking, Feeling, and Acting in Moments of Imminent Threat., Nat. Hum. Behav., submitted.

Mileti, D. S. and Peek, L.: The Social Psychology of Public Response to Warnings of a Nuclear Power Plant Accident, J. Hazard. Mater., 75(2), 181–194, 2000.

Mileti, D. S. and Sorensen, J. H.: Communication of Emergency Public Warnings: A Social Science Perspective and State-of-the-ART Assessment, Oak Ridge National Lab., TN (USA)., 1990.

Morgan, M. G., Fischhoff, B., Bostrom, A. and Atman, C. J.: Risk Communication: A Mental Models Approach, Cambridge University Press, New York, USA. [online] Available from: https://books.google.ch/books?hl=de&lr=&id=ieXbkmYf3mAC&oi=fnd&pg=PR1&dq=mental+models+approach+risk+communication&ots=xMA9g91CV8&sig=OPbjZqGLrZLYtQzkWFHVa3STmOE (Accessed 7 February 2017), 2002.

Morss, R. E., Cuite, C. L., Demuth, J. L., Hallman, W. K. and Shwom, R. L.: Is Storm Surge Scary? The Influence of Hazard, Impact, and Fear-based Messages and Individual Differences on Responses to Hurricane Risks in the USA, Int. J. Disaster Risk Reduct., 30, 44–58, doi:10.1016/j.ijdrr.2018.01.023, 2018.

Perreault, M. F., Houston, J. B. and Wilkins, L.: Does Scary Matter?: Testing the Effectiveness of New National Weather Service Tornado Warning Messages, Commun. Stud., 65(5), 484–499, doi:10.1080/10510974.2014.956942, 2014.

Potter, S. H., Kreft, P. V., Milojev, P., Noble, C., Montz, B., Dhellemmes, A., Woods, R. J. and Gauden_Ing, S.: The Influence of Impact-based Severe Weather Warnings on Risk Perceptions and Intended Protective Actions, Int. J. Disaster Risk Reduct., 30(Part A), 34–43, doi:https://doi.org/10.1016/j.ijdrr.2018.03.031, 2018.

Ripberger, J. T., Silva, C. L., Jenkins-Smith, H. C. and James, M.: The Influence of Consequence-Based Messages on Public Responses to Tornado Warnings, Bull. Am. Meteorol. Soc., 96(4), 577–590, doi:10.1175/BAMS-D-13-00213.1, 2014.

Simmons, K. M. and Sutter, D.: Tornado Warnings, Lead Times, and Tornado Casualties: An Empirical Investigation, Weather Forecast., 23(2), 246–258, doi:10.1175/2007WAF2006027.1, 2008.

Slovic, P., Finucane, M. L., Peters, E. and MacGregor, D. G.: Risk as Analysis and Risk as Feelings: Some Thoughts about Affect, Reason, Risk, and Rationality, Risk Anal., 24(2), 311–322, doi:10.1111/j.0272-4332.2004.00433.x, 2004.

Slovic, P., Finucane, M. L., Peters, E. and MacGregor, D. G.: The Affect Heuristic, Eur. J. Oper. Res., 177(3), 1333–1352, doi:10.1016/j.ejor.2005.04.006, 2007.

Weyrich, P., Scolobig, A., Bresch, D. N. and Patt, A.: Effects of Impact-Based Warnings and Behavioral Recommendations for Extreme Weather Events, Weather Clim. Soc., 10(4), 781–796, doi:10.1175/WCAS-D-18-0038.1, 2018.

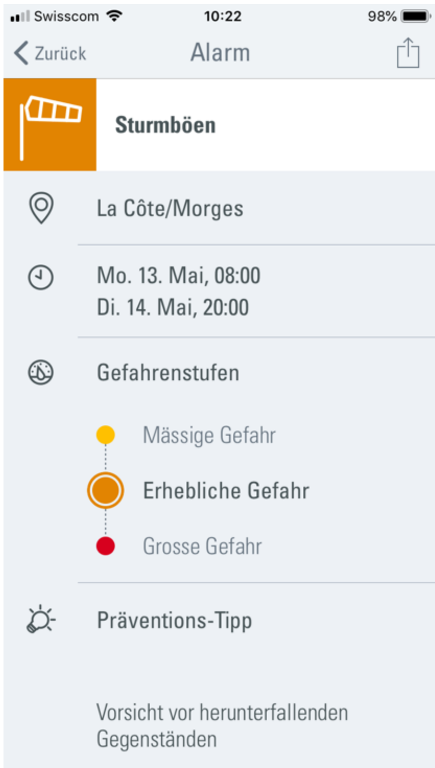

Figure 1. Standard wind warning of medium severity level for the region La Côte/Morges.

Table 1. Behavioural recommendations per severity level in the warning messages. Note that this list is not exclusive.

Warning severity level		
Moderate (level 1)	*Severe (level 2)*	*Very severe (level 3)*
Don't make fire	Avoid wind-exposed areas	Be aware of falling objects
Close windows	Secure lose items	Follow instructions of emergency services
Drive slowly	Avoid forests	Seek protection in buildings

Table 2. Additional impact-based information per severity level in the impact-based warnings. Note that we did not observe any very severe (level 3) warnings during the data collection period.

Warning severity level		
Moderate (level 1)	*Severe (level 2)*	*Very severe (level 3)*
Traffic delay	Traffic disruption or restriction	Traffic disruptions or standstill
Overturning of objects	Damage to individual buildings/roofs	Damage to buildings/roofs
Falling of smaller branches	Falling of big branches	Falling trees

Deleted: 1

Table 3. Socio-demographic characteristics of participants in the field experiment.

Gender	Males: n=1645, 63.1 % Females: n=970, 56.9 %
Age	48.8 years, (standard deviation: 13.8; range: 18- 98)
Completed educational level	34.6 % vocational school, 20.2 % university degree, 19.2 % collage, 18.9 % technical or high school, 7.1 % some compulsory education

Deleted: 2

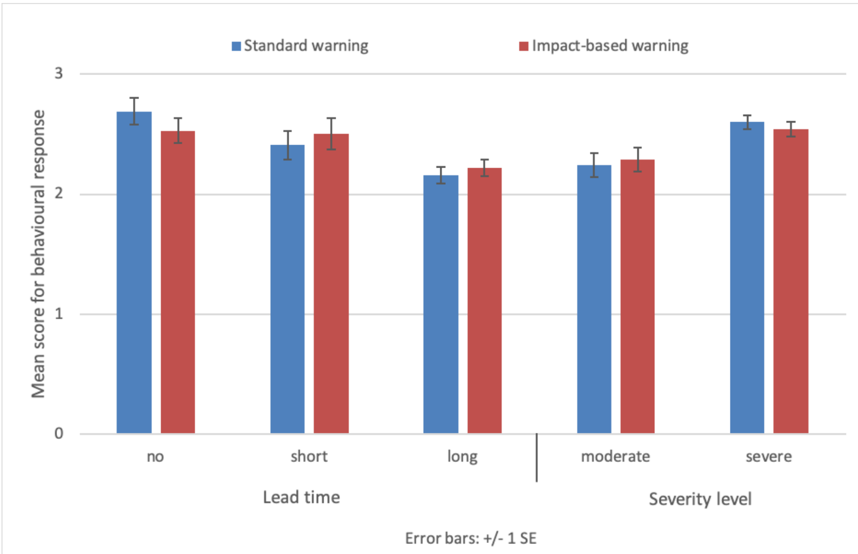

Figure 2. Mean self-reported behavior in response to two warning types (standard and impact-based) and the three lead times (no, short and long), respectively the two severity levels (moderate and severe). Behavioral response was measured on a five-point scale from no response to strongest risk minimizing behavior. For lead times, "no" indicates that respondents considered the warning during the event, "short" refers to 0-6 hours prior to the event and "long" to more than 6 hours. Error bars indicate +/- 1 the standard error. N=1426.

> **Deleted: Mean likelihood to change behavior for the two warning types (SW and IBW) and the three lead times (no, short and long), respectively the two severity levels (moderate and severe)**

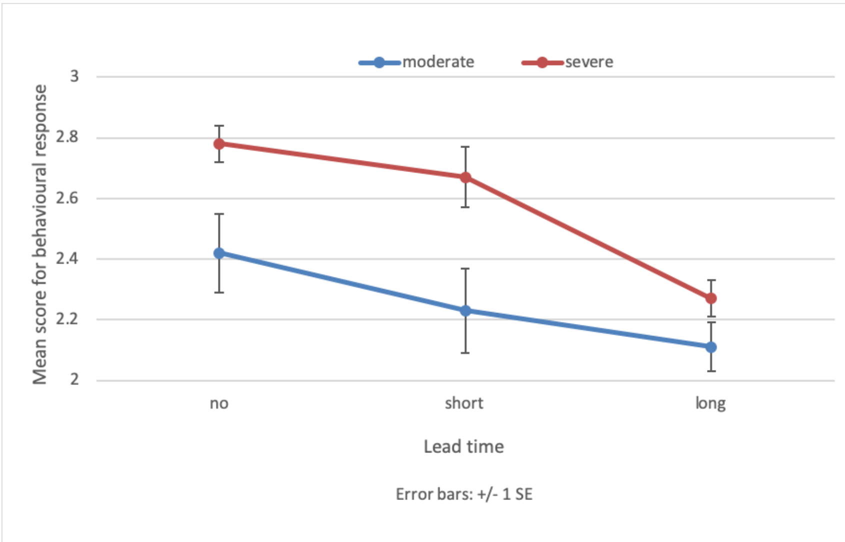

Figure 3. **Mean self-reported behavior for all three lead times (no, short and long) and two severity levels (moderate and severe).** Behavioral response was measured on a five-point scale from no response to strongest risk minimizing behavior. For lead times, "no" indicates that respondents considered the warning during the event, "short" refers to 0-6 hours prior to the event and "long" to more than 6 hours. Error bars indicate +/- 1 the standard error. N=1426.

Deleted: likelihood

Deleted: to change behavior

Table 4. Multiple linear regression with behaviour as dependent variable. R^2=0.36 (p<.001), N=1426. Note: **p<.01, ***p<.001. Significant results are in bold. B indicates the unstandardized coefficients, SE the standard error and β the standardized coefficients. Note that factors with a 1 are binary, factors with a 2 were measured on a 1-5 scale and with a 3 on a 1-3 scale).

	B	SE B	β
Constant	-.600	.399	
Gender[1] (female=0; male=1)	-.107	.073	-.040
Age (scale)	**.008**	**.003**	**.081****
Education level[2]	.024	.019	.032
Credibility perception[2]	**.134**	**.055**	**.068***
Concern perception[2]	**.098**	**.041**	**.071***
Understanding the warning[2]	-.28	0.59	-0.14
Understanding the threat[2]	**.193**	**.058**	**.108****
Understanding how to respond[2]	**.154**	**.053**	**.092****
Feelings[2]	**.250**	**.062**	**.122*****
Information behavior[1] (no=0, yes=1)	**.690**	**.179**	**.100*****
Lead time[3] (none=0, short=1, long=2)	**-.224**	**.038**	**-.154*****
Warning severity level[1] (moderate=0, severe =1)	**.212**	**.077**	**.072****

Deleted: 3

Deleted: with the behavioral change as dependent variable

Deleted: (year scale)

Deleted: (scale 1-6)

Deleted: (1-5 scale)

Deleted: (1-5 scale)

Deleted: (1-5 scale)

Deleted: (1-5 scale)

Deleted: (1-5 scale)

Deleted: (1-5 scale)