



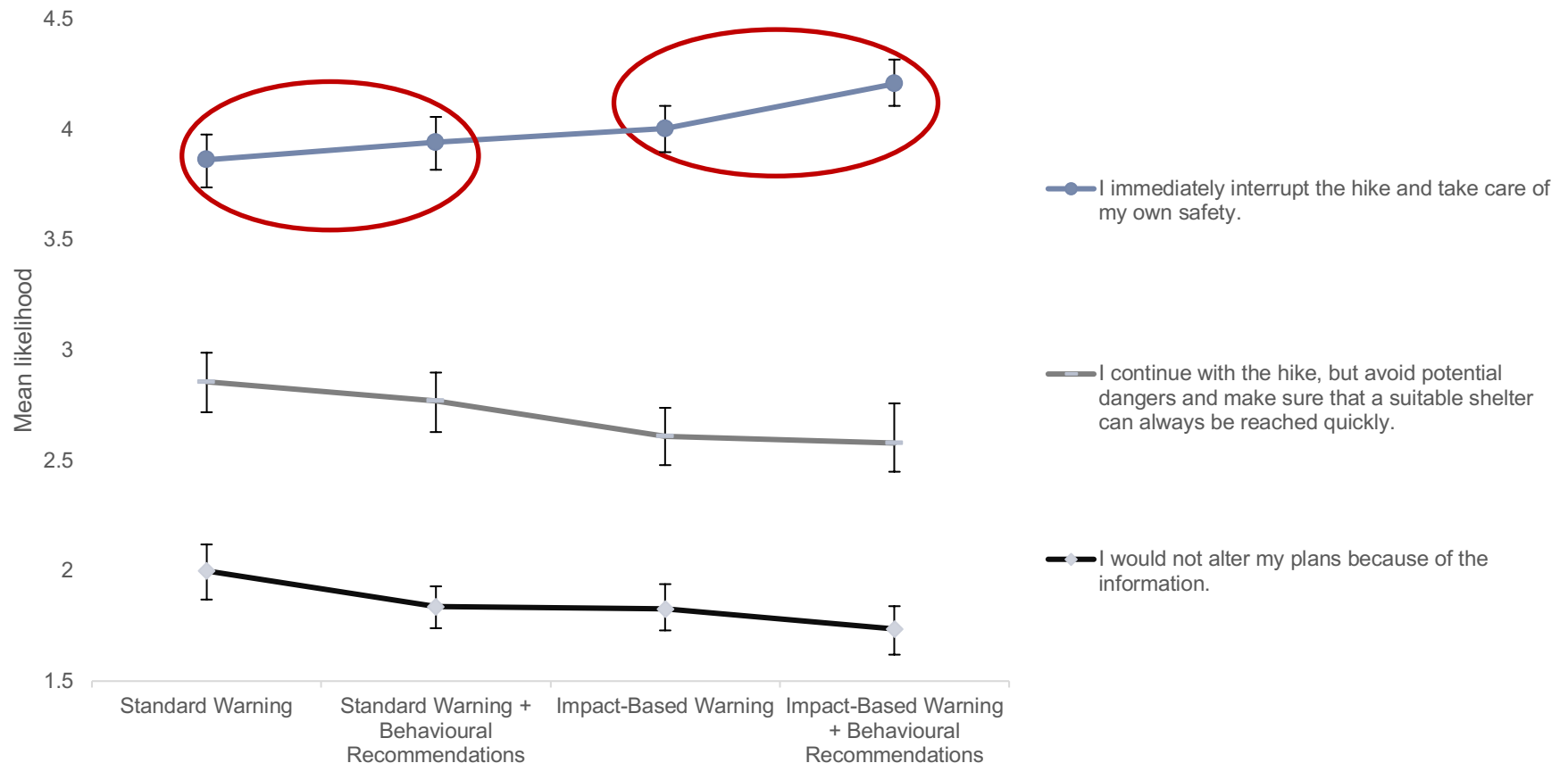
# Effects of impact-based warnings and behavioural recommendations for extreme weather events

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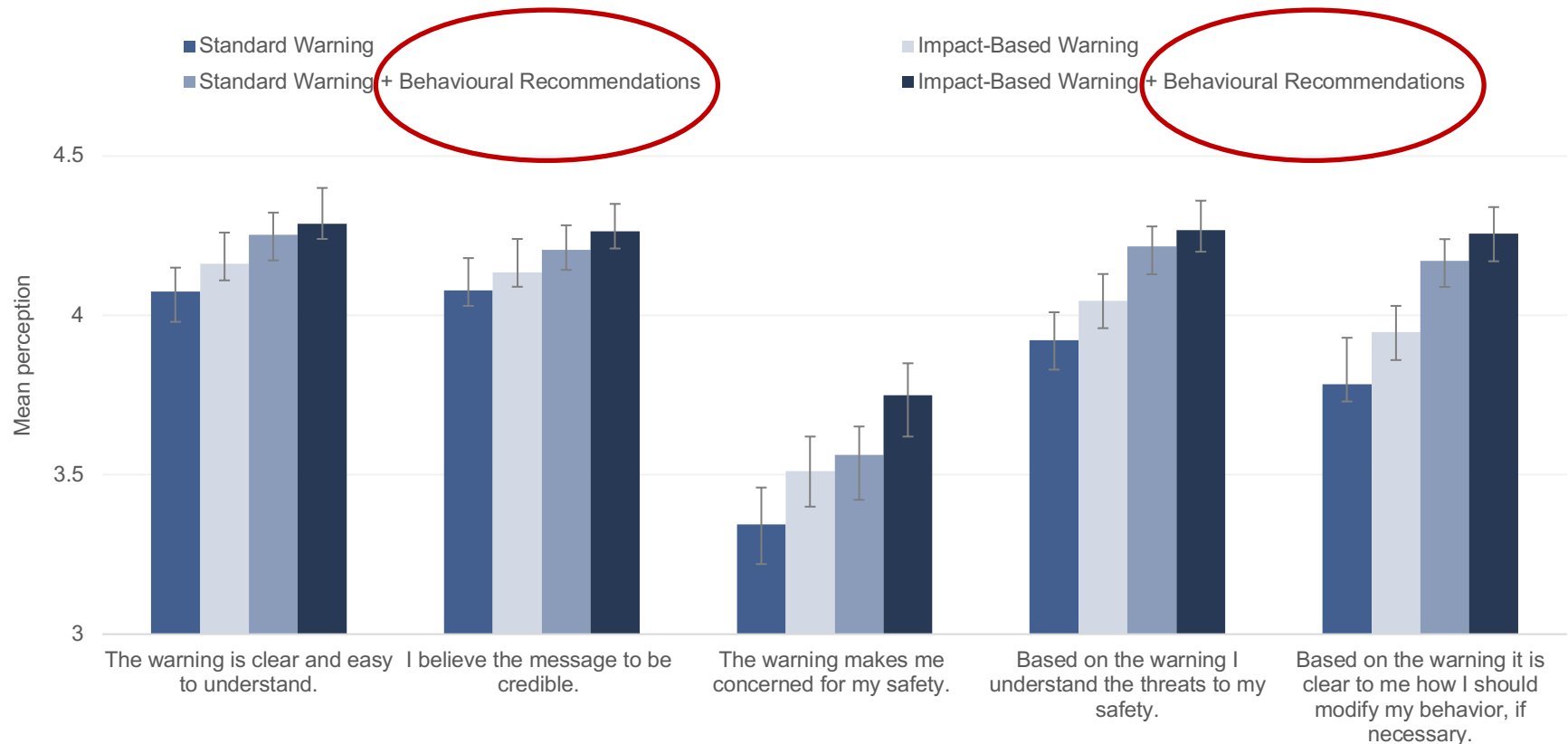


<http://www.storm-chasing.de/tsc/aktivitaeten/211-unwetter-polarlichter-und-meteore-im-hainich>

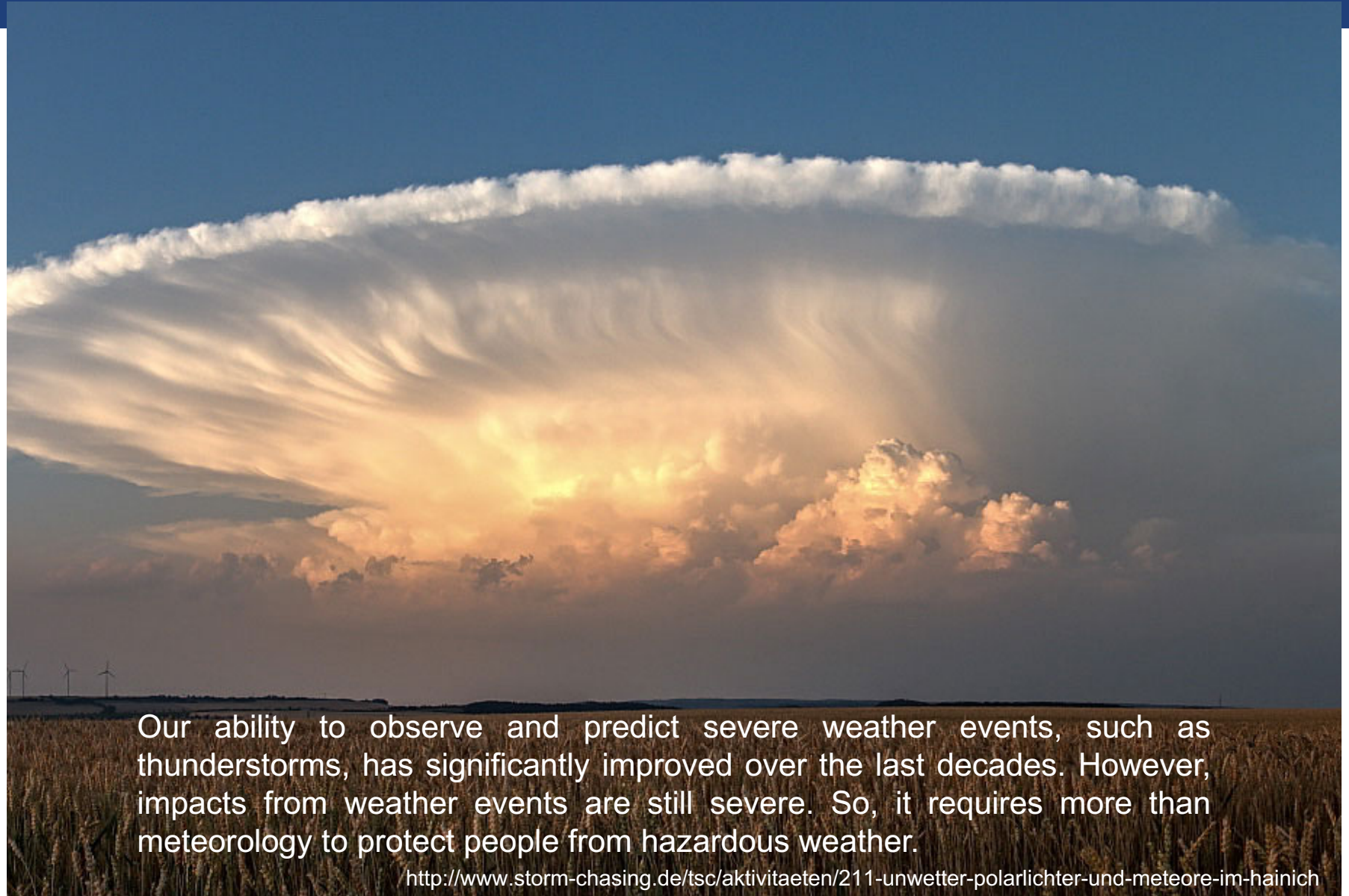
# Do impact-based warnings and behavioural recommendations have an effect on behavioural response?



# Do impact-based warnings and behavioural recommendations have an effect on warning perception?







Our ability to observe and predict severe weather events, such as thunderstorms, has significantly improved over the last decades. However, impacts from weather events are still severe. So, it requires more than meteorology to protect people from hazardous weather.

<http://www.storm-chasing.de/tsc/aktivitaeten/211-unwetter-polarlichter-und-meteore-im-hainich>





In 2012, Superstorm Sandy was preceded by accurate forecasts and widespread warnings, but failed to trigger appropriate protective behaviors that experts recommended and were hoping to see.

[https://commons.wikimedia.org/wiki/File:Superstorm\\_Sandy\\_on\\_10-30-2012.png](https://commons.wikimedia.org/wiki/File:Superstorm_Sandy_on_10-30-2012.png)

With more information made available by responsible authorities about the impacts of the storm, lives would have been saved.



<https://www.thoughtco.com/introduction-to-tornadoes-3444288>





# Standard warnings (SW's) VS Impact-based warnings (IBW's)

- SW's are based on the weather.
- SW's describe the hazard.
- Standard rainfall warning:  
Rainfall accumulations of 30 mm to 40 mm expected tomorrow between 14:00 and midnight.
- IBW's are based on the weather and vulnerability.
- IBW's describe the hazard and its potential effects.
- Impact-based rainfall warning:
- Rainfall accumulations of 30 mm to 40 mm expected tomorrow between 14:00 and midnight, resulting in possible road closures due to flooding across the south-east.



# Opinion of the expert community

- Qualitative research:
  - IBW's thought to be especially helpful for the public (Harrison 2014; Losego 2013).
  - Interviews with Swiss stakeholders involved in the natural hazard chain:
    - IBW's increase the understanding and interpretation of warnings.
    - “Warnings should focus on impacts and recommendations, instead of warning categories”.
    - Two concerns: too general impact and behavioural information and too much information for the public.

# Background

- 4 studies (Perreault et al. 2014; Ripberger et al. 2014; Casteel 2016; Potter et al. submitted)
- The effect of **IBW's** on *behavioural response*: ambiguity!
- The effect of **BR's** on *behavioural response*: ?
- The additive effect of **IBW's and BR's** on *response*: ambiguity!
- The effects of **IBW's** and **BR's**, individual and **additive**, on *perception of information*: ?

Impact-based warnings = IBW

Behavioural recommendations = BR

	Perreault et al. (2014)	Ripberger et al. (2014)	Casteel (2016)	Potter et al. (submitted)
Effects of IBW's on behavioural response	X	✓	✓	X
Effects of BR's on behavioural response	n/a	n/a	n/a	n/a
Additive effects of IBW's and BR's on behavioural response	X	n/a	✓	n/a
Effects of IBW's on perception	X	n/a	n/a	✓
Effects of BR's on perception	n/a	n/a	n/a	n/a
Additive effects of IBW's and BR's on perception	X	n/a	n/a	n/a
Influence of perception on action	n/a	n/a	n/a	✓

# Research questions

- Do both **BR's** and **IBW's** have effects, and what are their relative magnitudes?
- Are effects to be found on both *perception* and *behavioural response*?

# Methods

Questionnaire construction		22 questions addressing following topics: 1. Likelihood to take protective behaviour; 2. Evaluation of quality of warning information; 3. Risk perception; 4. Thunderstorm experience; 5. Warning experience and reaction; 6. Thunderstorm knowledge; 7. General information
Sampling procedures		Swiss residents from the German-speaking part, participants were randomly assigned to one of four warning types
Survey	Preparation	Analysis of the Swiss warning system for natural hazards Interviews with stakeholders of the natural hazard warning system (16) Questionnaire pre-test (40)
	Data collection	Online survey via an access panel provider
	Questionnaires collected	1219 (98 answers excluded due to short answering times, leading to 1121 participants)
Data analysis		One-way and two-way analyses of variances and covariances, multiple regression analysis

<u>Warning</u>	SW	SW+BR	IBW	IBW+BR
<u>Element</u>	A	A and C	A and B	A, B and C



## Warning message with three elements: standard text (A), impacts (B), behavioural recommendations (C)

A

Thunderstorm; Severity; Category 4  
 Validity: 24.08.2017, 2.30pm – 24.08.2017, 6pm

- Type of thunderstorm: Thunderstorm line
- Movement: pulling from Southwest
- Particularly affected areas: Pre-Alps
- Accompanying factors: wind gusts >120km/h, hail 2-4cm, heavy rain >50mm/h

B

Thunderstorm: In the case of rapidly developing thunderstorms, you have to expect strong wind gusts, as well as hail. Heavy wind often occurs before lightning activity and heavy rain showers.

Source: Radar images

Possible Impacts:

- Flash flooding of streams
- Toppling of trees
- Possibility of landslides on steep slopes
- Damage from hail and lightning strikes
- Failure of drainage and sewer systems. Flooding of underpasses, underground garages and cellars
- Disruption to road, rail and traffic
- Danger to vessels on lakes from very strong gusts of wind arising rapidly without warning

C

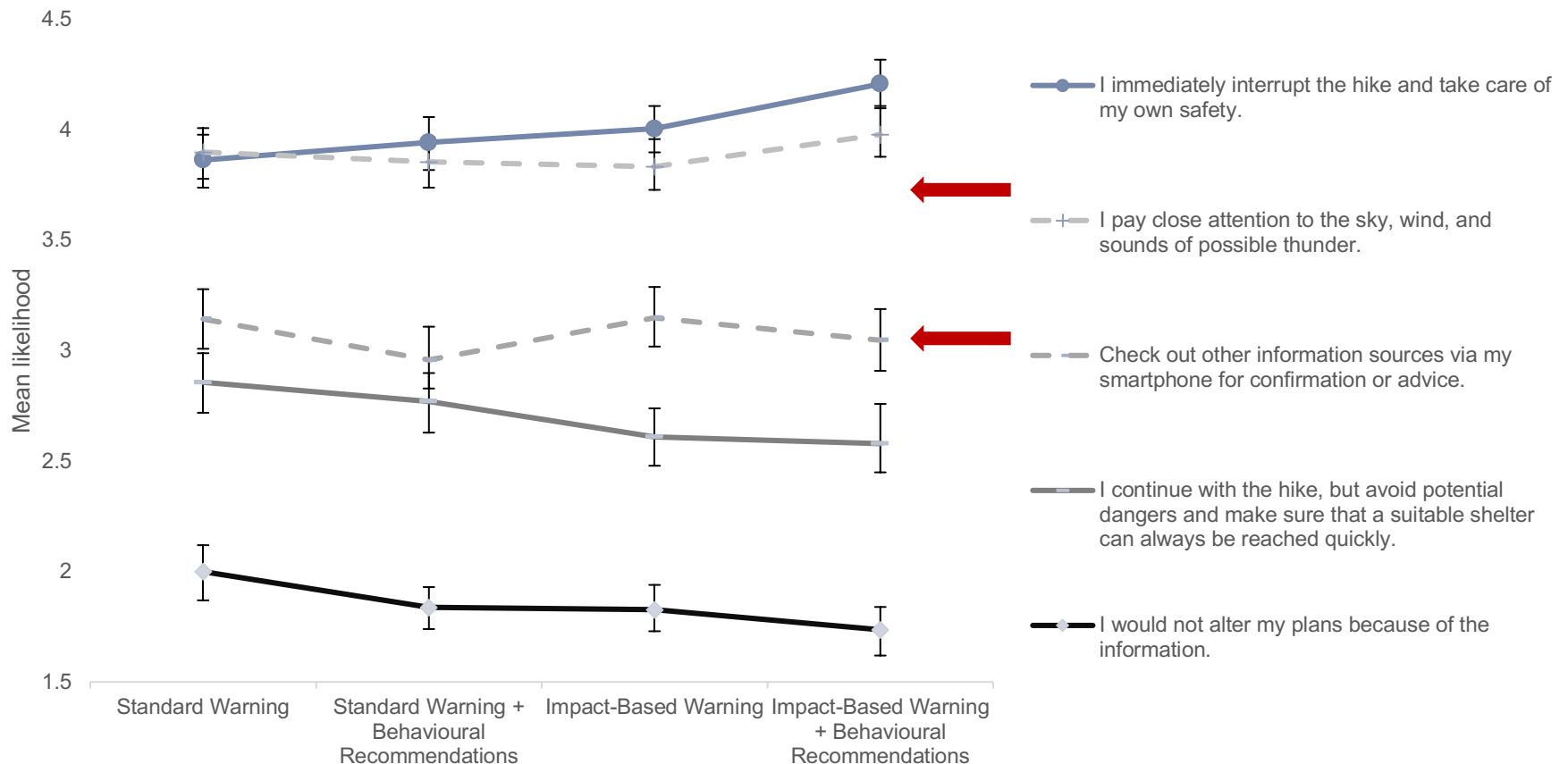
General recommendations during a thunderstorm:

- Avoid mountain ridges, exposed trees, groups of trees, masts and towers, all of which are at risk of lightning strikes
- Seek shelter – in a building or car (acts as a Faraday cage)
- If there is no shelter in sight, assume a crouched position
- Do not go hiking in the mountains and renounce to all outdoor activities
- Stay away from metal objects and water
- If a thunderstorm takes you by surprise when swimming, get out of the water immediately

Warning	Element
SW	A
SW+BR	A and C
IBW	A and B
IBW+BR	A, B, and C

# Do IBW's and BR's have an effect on behavioural response?

No significant effect of IBW's and BR's on seeking more or less information.



# Do IBW's and BR's have an effect on behavioural response?

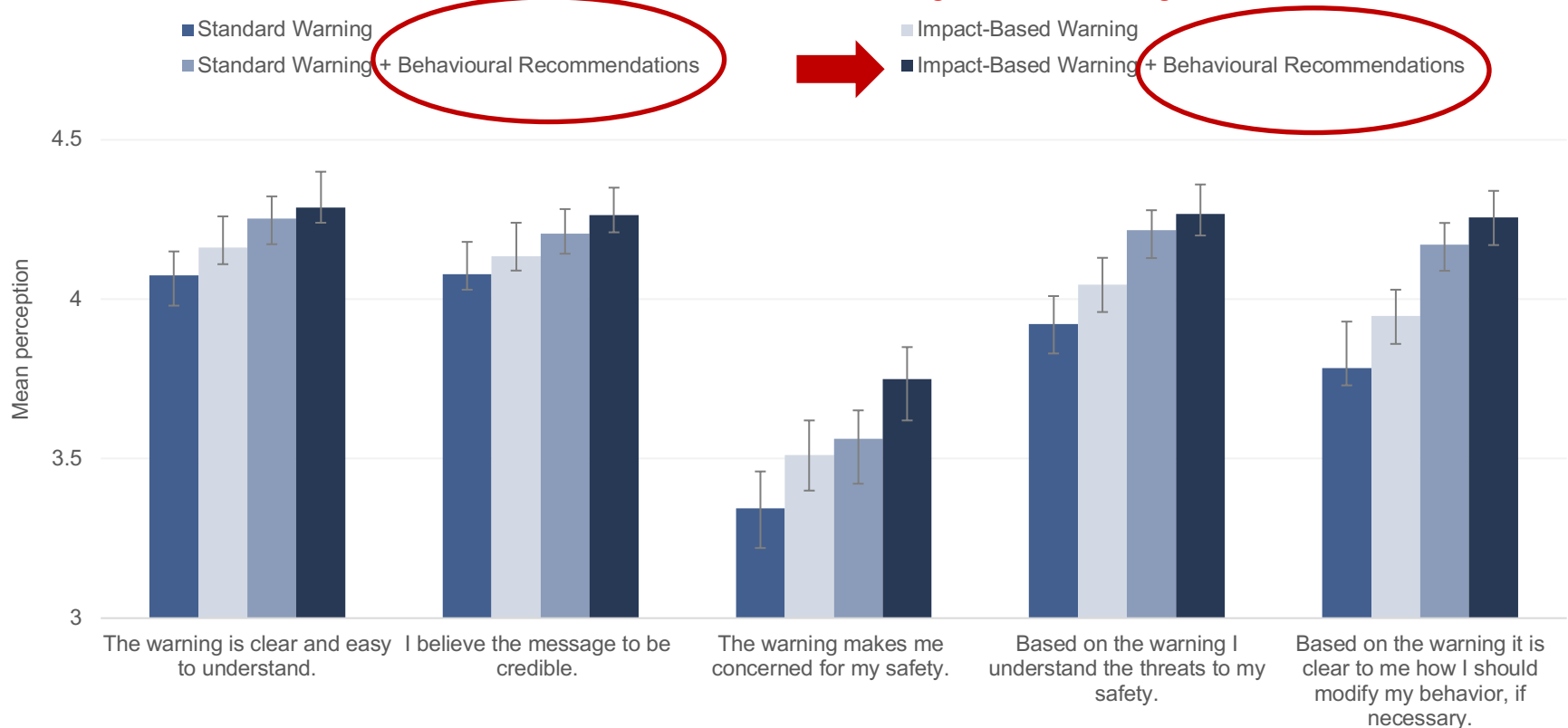
As the warnings provide more information, the likelihood to stop the hike increased proportionately.  $SW's < SW's + BR's < IBW's < IBW's + BR's$ .



People who received a SW are more likely to “not alter plans” (i.e. to engage in a dangerous behaviour) than those receiving SW's + BR's or both IBW's.

# Do IBW's and BR's have an effect on warning perception?

Recipients of warnings that included information about behavioural recommendations reported finding the warning clearer, easier to understand, and more credible, than recipients of warnings without these recommendations. They were also more concerned about their safety, and understood better the threat and behaviours to engage in. However, IBW and BR together had the greatest effect.



# What perception attributes influence taking protective actions?

	B	SE B	$\beta$
Constant	1.419	.273	
Gender (male=0; female=1)	.056	.034	.057
Age (yr)	.002	.002	.035
Education level	-.045	.020	-.078
Living area (rural=0; urban=1)	-.027	.033	-.028
Risk perception (1-5 scale)	<b>.058</b>	<b>.016</b>	<b>.128***</b>
Thunderstorm experience (no, don't know=0; yes=1)	-.023	.021	-.039
Warning experience (scale from only bad=0 to only good=1)	.088	.059	.054
Warning reaction (no=0; yes=1)	<b>.298</b>	<b>.073</b>	<b>.149***</b>
Thunderstorm knowledge (scale from none=0 to full=1)	-.220	.179	-.043
Understand perception (1-5 scale)	-.028	.061	-.021
Credibility perception (1-5 scale)	<b>.166</b>	<b>.061</b>	<b>.119**</b>
Concern perception (1-5 scale)	<b>.334</b>	<b>.038</b>	<b>.343***</b>
Threat perception (1-5 scale)	<b>.193</b>	<b>.063</b>	<b>.146**</b>
Behavioral response perception (1-5 scale)	-.083	.055	-.069



# Key findings

- **IBW's** and **BR's** both **increase** *warning perception* and improve *behavioural response*, with effects that are **additive**.
- The ordering between **IBW's** and **BR's** **differed** according to *perception* or *behavioural response*.
- **IBW's** alone have a **greater effect** than **BR's** alone in promoting *behavioural response*.
- **BR's** alone have a **greater effect** than **IBW's** in increasing *perception*.
- **IBW's and BR's** together had the **greatest effect** on improving *behavioural response* and *perception*.
- **Differences between individuals** had **no significant effect** on either *perception* or *behavioural response*.
- *Perceptions* of credibility, concern and threat **influence** taking protective actions.

→ confirming and extending  
previous findings

	Perreault et al. (2014)	Ripberger et al. (2014)	Casteel (2016)	Potter et al. (submitted)	Our study
Effects of IBW's on behavioural response	<b>X</b>	✓	✓	<b>X</b>	✓
Effects of BR's on behavioural response	n/a	n/a	n/a	n/a	✓
Additive effects of IBW's and BR's on behavioural response	<b>X</b>	n/a	✓	n/a	✓
Effects of IBW's on perception	<b>X</b>	n/a	n/a	✓	<b>X</b>
Effects of BR's on perception	n/a	n/a	n/a	n/a	✓
Additive effects of IBW's and BR's on perception	<b>X</b>	n/a	n/a	n/a	✓
Influence of perception on action	n/a	n/a	n/a	✓	✓

# Recommendations for practitioners

Use **IBW's** with **BR's** in high-impact weather warnings warnings!

**IBW's** and **BR's** are clear and understandable, regardless of the target audiences' (social and knowledge) characteristics.

Targeting warning messages on the basis of these characteristics may not be as important as providing **IBW's** with **BR's**.

Warnings should address perceptions of credibility, concern and threat!



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# Shortcoming of our (and previous) studies

- Self-reported responses to a hypothetical and imagined situation, rather than a field observation of actual behaviour in response to actual danger
  - lack of real consequences for decisions
  - feelings may influence behaviours
- Test the effectiveness of **IBW's** and **BR's** during a real event!
  - complicated methodological and ethical challenges

# References

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## ■ Pictures

- <http://www.storm-chasing.de/tsc/aktivitaeten/211-unwetter-polarlichter-und-meteore-im-hainich>
- [https://commons.wikimedia.org/wiki/File:Superstorm\\_Sandy\\_on\\_10-30-2012.png](https://commons.wikimedia.org/wiki/File:Superstorm_Sandy_on_10-30-2012.png)
- <https://www.thoughtco.com/introduction-to-tornadoes-3444288>
- [www.CliProject.info](http://www.CliProject.info)



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