Culture and cognition: Understanding public perceptions of risk and (in)action

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Much is known about the effects of risk on behavior and communication, yet little research has considered how these risks influence modes of cultural and cognitive processing dynamics that underlie public perceptions, communications, and social (in)action. This article presents a psychological model of risk communications that demonstrates how cognitive structure, cultural schema, and environment awareness could be combined to improve risk communication. We illustrate the explanatory value of the model's usefulness on two qualitative case studies: one on decision-makers facing extreme heat, and another on homeowners facing flood events. Consistent with the model predictions, we find that cognitive structure, cultural schema, and environment awareness dynamics are not only necessary determinants to strengthen risk communications, but also important for understanding perceptions of risk and people's (in)action to engage in mitigation and adoption efforts. This suggests that decision-makers hoping to reduce disaster risk or improve disaster resilience may wish to consider how these three dynamics exist and interact.

1 Introduction

Nearly 60 years ago, social science and economic researchers generally accepted two broad approaches to studying human judgment and decision-making. As Kahneman later put it, the first approach, system one, was that "people are generally rational, and their thinking is normally sound" [1, p. 8]. The second approach, system two, explains how "emotions such as fear, affection, and hatred explain most of the occasions on which people depart from rationality" [1, p. 8]. A decade and a half later in the late 1970s, several psychologists and behavioral economists offered an alternative approach to the study of human behavior, one that referenced the application of scientific insights and economic decisions. Among these researchers, Tversky and Kahneman's *Judgement Under Uncertainty: Heuristics and Biases* was one of the most influential in steering the human decision-making discussion [2]. They reported systematic errors in the thinking of normal people that can be traced to human cognitive flaws rather directly to errors in emotions [2]. This perspective resulted in an outpouring of empirical investigations, including Kahneman's *Thinking, Fast and Slow* that documents a fully loaded accounting of errors humans systematically make throughout their everyday lives [1]. A seminal work in the field of behavioral economics, Kahneman emphasizes the importance of understanding the routine nature in the inconsistencies between mainstream economic paradigm and what actually happens to people in real life [1].

Exacerbating this, previous research has noted that people may both fail to comprehend risk properly, and also fail to accept their role in risk mitigation (e.g., [3–5]). Additionally, the communication gaps between experts and local residents are important and well documented (e.g., [6–10]). A common misperception is that if only people were given enough information, they would clearly do the correct action. This applies to various situations in which natural events and disasters pose risks that individuals and households must prepare for and respond to. For instance, one might think *if only* municipal decision-makers had enough information about how its constituents preferred to obtain information on heat risks, *then* clearly the appropriate information would be released. As a result, the

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city's general public would know more about heat risks. Or, *if only* a homeowner knew more about how to obtain federal funding to protect their house from floods, *then* one might assume that they would pursue the necessary steps to obtain that funding and additional benefits. Unfortunately, information deficit models such as these often fail because they neglect to consider the intersection of contemporary behavioral economics and communication science.

Communication science highlights the role of three important features: the value, barrier, and ask of a problem [11]. Understanding these three features can then help construct communication to achieve a desired goal [11]. Unfortunately, many communication barriers exist. This includes but is not limited to: agreeing on goals, balancing complexity and simplicity, relying on data instead of intuition, and negotiating external pressures [12]. For instance, framing (e.g., political cues, affect, or terminology such as "Resilience" versus "Adaptation") can alter people's mindset, and thus how they behave [13, 14]. Alternatively, considering different temporal phases of the risk mitigation or adaption response (e.g., Prepare, Absorb, Recover, and Adapt [15]) can elicit different responses.

Studies can be carefully written to address many of these issues, including both problem framing and temporal considerations. One of the most fundamental drivers of communications in hazard mitigation or adoption is human behavior, particularly people's willingness to take risks (or even behave dishonestly, e.g., [16]) to avoid a loss than to acquire an equivalent gain. Referred to by Kahneman and Tversky as loss aversion under the prospect theory, the basic idea is that "losses loom larger than gains" [17, p. 279]. Thus, it is likely important to emphasize the important role of culture on people's behavior in the context of risk mitigation. For example, contemporary sociologists suggest that "culture matters both as a social and psychological justification and as a motivation for action" [18, p. 1676]. According to these two distinct conceptualizations, culture is viewed as 1) loose justifications that rationalize or make sense of the choices that people make to solve their everyday problems [18–20] and 2) meanings or values that play a motivational role in shaping their behavior [18, 21–23].

Drawing on insights from sociological practice theories and research in behavioral economics and cognitive science, the goal of this article is to take one step towards understanding how culture and cognition matter for both risk communication and people (in)action for mitigation. This research article is organized in two parts. First, we apply Vaisey's dual-process model of culture in action [18] with insights from Kahneman and Tversky's principle of loss aversion [17] to sketch a psychological model of risk communications that provide a foundation considering why risk communications may or may not be successful at informing mitigation efforts as well as their perceptions of risk more broadly. This section outlines the model's three major components, coupled with two empirical propositions to strengthen risk communications that should be adopted versus what actually happens in real life. Second, we illustrate the explanatory value of the communications model's usefulness on two qualitative case studies [24, 25]: one on decision-makers facing extreme heat, and another on homeowners facing flood events. The empirical illustrations of the model elicit information on adaption and risk mitigation response using an interview approach for understanding what people 1) think about natural hazards now and in the future, and 2) consider to be potential strategies to mitigate risks. The goal of this empirical exercise is to demonstrate rather than provide the utility of a psychological model of real-life risk communications for understanding how and when forms of culture, cognition, and ecological factors matter in risk mitigation and adoption. We conclude with a discussion of our significance of our findings for informing risk communication policies and practices.

2 Psychological model of risk communications

Several theories exist for both the effectiveness and the ineffectiveness of risk communications. In this section, we combine complementary theories to sketch a psychological model of risk communications that replaces the notion of communications as ineffective with a view of communications as constituting and constituted by a broader set of cultural and cognition factors that shape people's perceptions and decisions about risk mitigation. The dual-process model of culture in action provides the theoretical and practical foundation of risk communications. As shown in **Figure 1**, the new psychosocial model of risk communications indicates the relationship between cognitive structure, cultural schema, and environment awareness. These three components help explain risk communications that should be adopted versus what actually happens in real life. In short, this model anticipates that risk communications elicited during or in anticipation of a risk event cues a sequence of cognitive, cultural, and environmental processes that can shape perceptions of risk and (in)action to risk mitigation and adoption. Developing a psychological model of risk communications requires consideration of cognitive structure (i.e., system-one and system-two cognition), cultural schema (e.g., loss aversion), and environment awareness (e.g., the impact and consequences of residing in disaster-prone areas). It is important to note that no single model can fully explain risk communications, but this model takes one step in documenting people's perceptions and (in) action to risk mitigation and adoption efforts.

2.1 Component 1: Cognitive structure

The first component of our model, cognitive structure, leverages Vaisey's dual-process model of culture [18], suggesting that cognitive motivations and justifications will serve to subjectively influence people's action or inaction

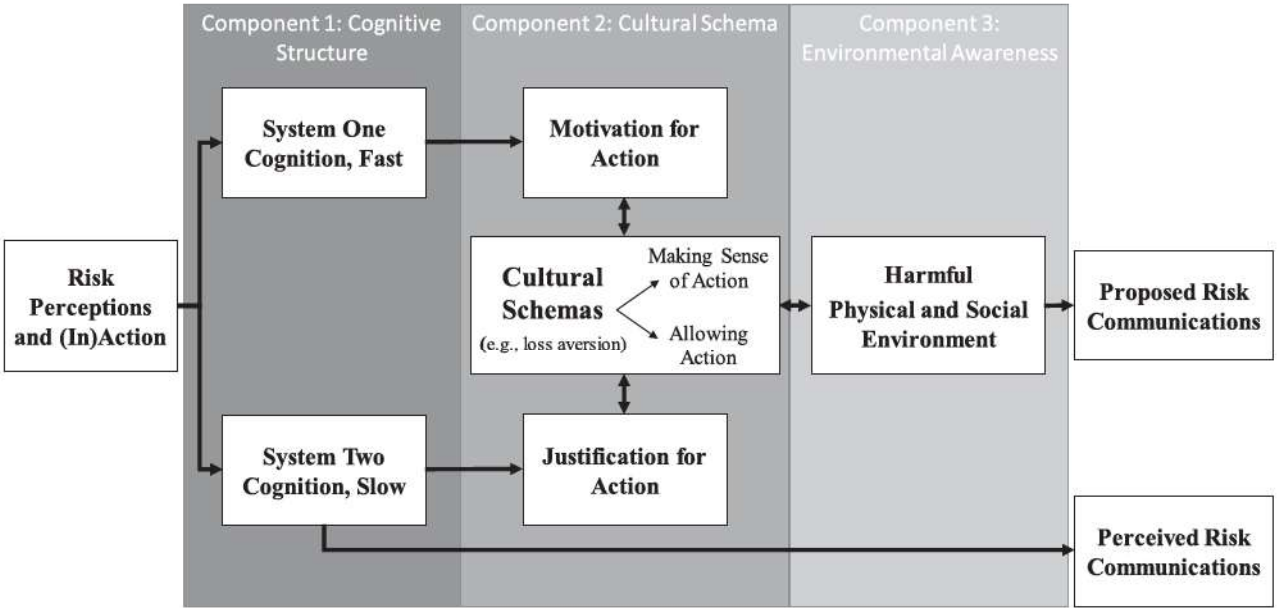

Figure 1

Psychological process model of risk perceptions and (in)action on risk communications.

when engaging in risk mitigation and adoption. Bringing together Bourdieu's notion of habitus as well as cognitive psychologists' system-one and system-two cognition distinctions (e.g., [1, 26, 27]), the theory's argument is twofold: 1) the greater threshold of emotional discourse and subconscious cultural schemas (e.g., attraction/repulsion) within habitus, or system-one cognition, the more likely people will be motivated to behave in consistent ways across time and space, and 2) motivations operating below the threshold of discourse and consciousness, or system two, are cognitive *ex post facto* justifications that generally accompany people's subjective action or inaction [18].

In [1], Kahneman states system-one conditions are the "fast," often automatic and unconscious motives by people; whereas system-two conditions are the "slow," more flexible behavior that supports consistent (in)actions but with limited capacity. Vaisey's application of the dual-process model reveals that people "seem to be profoundly influenced by cultural forces in ways that they are largely unaware of and unable to articulate but that nevertheless shape their moral judgments and choices" [18, p. 1704]. Although the implications of this dual-process model are promising for understanding people's motives and justifications as evidence for their action, there is limited evidence of its application to risk communications, or disaster management more broadly.

2.2 Component 2: Cultural schema

The second component of our model, cultural schema, describes the interaction of cultural schemas with cognitive structures. Cultural schemas are characterized as cognitive and unconscious "default assumptions" or rules about a risk adoption and mitigation [28, p. 269]. These socially generalizable assumptions are often used to guide social action [29, 30]. Put differently, schemas can be regarded as a hidden script or unwritten guidelines explaining its set of rules and how it functions [29]. Recognizing cultural schemas activated in people's risk mitigation and adoption strategies allows for the examination of risk communications not only as guided by individual consciousness, but also as inconstant and adaptive to people and space [28, 29, 31]. Cultural schemas thus provide a set of "fundamental tools of thought" [32, p. 7] for cognitive structures and the utility of Vaisey's dual-process model of culture in action.

People's motives and justifications (cognitive structures) of risk mitigation and adoption, under Vaisey's dual-process model of culture in action, can reinforce underlying cultural schemas. An example of this is Kahneman and Tversky's loss aversion principle, which describes people's motives and justifications. The loss aversion principle suggests that people are influenced by their behavior to weigh losses to risk events more heavily than gains [17, 18]. Kahneman's application of the principle to "bad events" provides evidence to show people's willingness to take risks to avoid a loss than to acquire an equivalent gain [1]. Under this principle, aversion to risk mitigation and adoption buttress the reification of motivation and justifications, or Vaisey's dual-process model of culture in action, and concretize cultural biases towards (in)action in risk

mitigation and adoption. Both recognizing that "losses loom larger than gains" and considering aspects of culture and cognition as a motivation or justification for (in)action are essential for the development of risk communications that actually happen more in real life versus theoretical strategies across time and space [17, p. 279].

2.3 Component 3: Environmental awareness

The final component of our model, environmental awareness, captures the importance of "physical and social environments" [28, p. 267]. Researchers suggest that awareness of these environments (e.g., disaster-prone areas) can activate cultural schemas (e.g., cause one to rely on an existing cognitive structure), thereby accounting for the consistency in cognitive structures related to risk perceptions and in(actions) over time [28, p. 267]. Environmental awareness captures risk (in)action in mitigation or adoption that are produced once cultural schemas connect to resources [33, 34]. These resources may encapsulate social, material, and organizational forms of risk. Examples include geographical disparities in exposure to risk, physical damage as a result of prior risk, or simple residing in disaster-prone areas.

At the root of risk communications are the profound influence of environmental factors—and the relationship of these factors to structural and cultural conditions and to the political economy—on people's perceptions of risk and (in)action toward mitigation and adoption strategies [35–37]. Bioecological theory suggests that people, their behavior, and risk communications are shaped by the emergence and continuity of environmental and contextual "forces emanating from multiple settings [and levels] and from the relations among these settings" [35, p.817]. Disaster-prone neighborhoods provide one such environmental force that has the potential to trickle down to shape risk communications and the perceptions and behavior of people at the most basic individual level. Seeing behavioral phenomena as constitutive of ecological systems helps us better understand the formation, everyday functioning, and relations to structural conditions and to the political economy that undergirds a host of risks occurring across time and space. This conceptualization of people's perceptions of risk and (in)action toward mitigation and adoption within larger structural environmental conditions and the political economy helps to consider distinct trajectories and neighborhood ecologies in disaster-prone areas that shape the ways many people perceive risk and decisions to engage in mitigation and/or adoption efforts. Furthermore, incorporating environmental awareness processes can provide insight on how neighborhood conditions influence the stability, change, and the institutionalization of risks within disaster-prone neighborhoods.

Taken together, the three components provide the foundation to our psychological model of risk communications that replaces the notion of communications as ineffective with a view of communications as constituting and constituted by a broader set of cultural and cognition factors that shape people's perceptions and decisions about risk mitigation. Our final psychological model asserts that risk (in)action results from the failure to examine ways that expected risk communication polices and norms interact with cultural schemas, isolating culture and cognition structures, and disaster-prone ecological environments to influence people's risk mitigation and adoption strategies. To strengthen risk communications that happen in real life, one must clearly treat the interaction of these three dimensions as *post hoc* to risks [18]. The model suggests that risk communications should delineate both adoption and mitigation strategies, and attach the ramifications to these communications according to disaster-prone areas. Such communications would facilitate the interaction of cognitive structure, cultural schema, and environmental awareness on (in)actions of risk mitigation and adoption efforts.

Focusing on the relationships between cognitive structure, cultural schema, and environment awareness as a demonstration to improve risk communications, the following two propositions are considered for understanding what people 1) think about natural hazards now and in the future, and 2) consider to be potential strategies to mitigate risks.

Proposition 1: *Because perceived risk communications largely involve system-two cognition for understanding risk perceptions and (in)action, interview participants will either a) explain their perceptions of risk and engagement in risk mitigation in intuitive, unsubstantial, and emotional ways, or b) offer multiple,* post facto *justifications to generally accompany their subjective perceptions and (in)action [18].*

Proposition 2: *Because our proposed risk communications will tend to generate risk perceptions and (in)action that are consistent to its cognitive structure, cultural schema, and environmental awareness, interview participants' cultural–moral perceptions will be predicative of their decisions of risk mitigation and adoption overtime and across space [18].*

To test these propositions, we conduct two case studies. We employ a descriptive, normative, and prescriptive framework [38] to examine peoples' current and future views about natural hazards and potential ways to mitigate risks. In order to apply this approach, we first need to understand what people are currently doing and thinking under the descriptive framework [39, 40]. Subsequent studies can focus on the normative and prescriptive components. In what follows, we focus on questions that consider the value and barriers approach [11]. Specifically, we examine what people 1) understand about the current frequency and impact of the natural hazard, 2) believe about

the future frequency and impact of the natural hazard, and 3) are planning to do to prepare for these events.

To elicit these data, we use a mental models approach [41]. This method begins with a small set of focused interviews that elicit very specific mental constructs. This approach has been used to understand many other areas, such as eliciting information on climate change [42, 43].

Given the questions and the style of interviews, we must then find a way to choose a sample of people that can answer these questions. Perhaps a researcher is interested in what experts are already thinking and trying to do about risks. In this case, a researcher may choose to use their network and their interviewees, networks (e.g., snowball recruiting) to define several experts or decision-makers to be interviewed (see, for example, Case 1). Alternatively, maybe a researcher may want to understand what portion of the public is at high risk, and what they might think about these potential risks. In this case, one could determine a sample set of households by overlaying public tax record data with hazard maps (see, for example, Case 2). We demonstrate each of these approaches in the case studies that follow.

3 Case study 1: Excessive heat event risk and response: How the public and public health experts prepare, respond, and interpret extreme heat

Extreme heat events (EHEs) are the leading weather-related cause of death in the United States [44]. Estimates claim over 1,000 deaths occur per year due to EHEs [45, 46]. In fact, a large fraction of these are in the Mediterranean climate region of California [47]. Research suggests that EHEs contribute to morbidity and mortality in many of the areas of the world; in examining Mediterranean climate regions similar to California, research has found that EHEs are the leading cause of weather-related death in many Mediterranean countries [48], Australia [49, 50], and South Africa [51, Table 4.12]. These numbers likely underestimate the impact that heat has on public health, as a heat-related death is hard to define and can often be classified simply as a heart attack or respiratory problem [52].

Furthermore, as climate change continues to warm the planet, extreme events are expected to increase [53, 54]. For instance, Fischer and Schar [55] show that climate change in Europe will cause many more heat wave events in the Mediterranean region, regardless of climate model examined; events like the deadly European heat wave of 2003, which killed 70,000 people, will become more common [56].

Much work has focused on improving our understanding of heat wave measurement [52, 57], vulnerabilities [58–60], risks (e.g., [61, 62]), and responses [60]. To expand on this work, an improved understanding of the public's knowledge of EHEs, including where they would go to obtain more information and what they would do to prepare, could help inform public officials in their methods of dealing with heat risks. Unfortunately, fewer studies exist on the public perceptions of EHEs. Chowdhurya et al. [63] used a mental models approach to consider precautionary measures that can be taken to reduce heat wave mortality; however, the study area focused on Canada, where heat-related mortality is uncommon, and therefore respondents may not have a well-developed mental model. Akompab et al. [64, 65] conducted a mental models study of perceptions of heat waves, but did so in an area experiencing a heat wave, suggesting that some of their results might be a phenomenon of the representative heuristic [66] and thus not useful during less extreme times. To our knowledge, we are not aware of a study examining public perceptions of heat waves in 1) an area prone to heat waves and 2) at a time when a heat wave was not occurring; a study such as this could help government agencies understand how to better prepare residents.

The Environmental Protection Agency (EPA) [67] defines an EHE as "weather that is substantially hotter and/or more humid than average for a location at that time of year." Since the relative risk of mortality begins to increase at approximately 80 °F/27 °C [68], this article focuses on extreme heat events in the summer months of warm and humid locations. Pittsburgh, located in the state of Pennsylvania, is just one of many important cities that could experience heat-wave impacts from both temperatures above 80 °F/27 °C as well as high humidity.

In the current study, we ask a convenience sample[1] of Pittsburgh experts and decision-makers the following questions:

1) What information do people already know about extreme heat and its risks?
2) How do people currently obtain information on heat waves?
3) How do people prepare for heat waves?

3.1 Sample

We conducted in-depth, semi-structured interviews among a convenience sample of 14 residents in Pittsburgh, PA. Data were collected from January 27, 2016 through April 22, 2016. Four participants were deemed "experts," as they currently work in the public health (or related) field and hold more knowledge than the average citizen about Pittsburgh's extreme weather protocol and responses. The remaining ten participants were considered "non-expert" decision-makers since they were decision-makers currently living in the city of Pittsburgh with no known background in or extensive

[1] A "convenience sample" is a sample that has been drawn from the population available, rather than drawn probabilistically to reflect total population characteristics.

knowledge of extreme weather events or protocol. Interviews lasted an average of 15.6 minutes, and participants were compensated with a $10 Amazon gift card upon completion. The average age of participants was 38.4 years old with a range from 21 to 68 years old. Nine participants were female, five were male, and ten participants were white. While this convenience sample included more female participants and more white participants than is representative of the Pittsburgh population, we consider it a sufficient sample for this demonstration of method. To achieve more representative results, a larger follow-up survey should be distributed to achieve a more representative sample of the larger Pittsburgh population. Future research could be informed by the results found in the current case study.

3.2 Procedure

The interviews included the same set of questions for both experts and non-expert decision-makers. The interview was semi-structured such that a set of questions was asked of each participant, but participants were able to expand upon questions or points of conversation that were important to them. Thus, the conversations were kept open-ended to ensure that all related information was covered. Some participants, especially experts, elaborated on what information they knew, which was encouraged so as to fill gaps in information related to extreme heat risk perception, communication, and response. All participants were asked how they defined heat waves, where they received information about them, and how they personally responded to them, as well as if they were familiar with Pittsburgh's current EHE public health mitigation strategies, such as cooling centers. The conversations were recorded, transcribed, and coded in order to detect possible patterns and trends in participant responses. Appendix A lists the full interview protocol.

3.3 Results

3.3.1 What information do people already know about extreme heat and its risks?

Based on the interviews, both the experts and non-expert decision-makers have a poor understanding of EHEs. While 11 participants correctly responded that EHEs are defined by increases in temperature, seven participants were unsure of the differences between above average temperatures and extreme heat events. In addition, ten participants incorrectly defined EHEs using the duration of the event, typically specifying a number of days of heat. Only one expert participant correctly identified humidity and cloud coverage as defining conditions of EHEs.

Regarding risks, only three participants initiated discussion of human health risks before being directly asked about these risks. When participants were prompted to discuss health risks, all of the participants correctly indicated that the most dangerous time of the day during a heat wave is the afternoon.

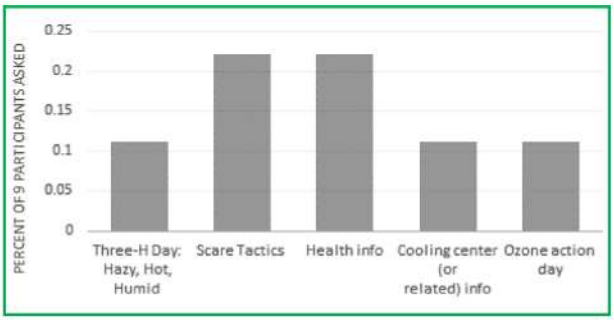

Figure 2

Participant perception of the language or messaging used by information sources. These results reflect the percentage of participants giving this response out of the total number of participants asked this question.

3.3.2 How do people currently obtain information on heat waves?

Participants were encouraged to state as many sources of information as necessary to reflect their understanding of where to obtain information on temperature-related information and warnings. Most participants self-reported receiving EHE warnings from the news (9 responses), followed by newspaper (2), radio (2), and a cell phone app (1) or a public service announcement (1). No one claimed to use the Internet, and only one participant used a cell phone as a source of information. Participants were then asked about how they perceived the nature of the messages and information communicated by these information sources. Responses included scare tactics ($n = 3$), health information dissemination ($n = 3$), "ozone action day" warnings ($n = 2$), "three-H day" for "Hazy, Hot, and Humid" ($n = 2$), and mitigation techniques such as information dissemination on public cooling centers ($n = 2$), see **Figure 2**.

No participant stated that they were confident in their personal knowledge of who was locally responsible for issuing and communicating EHE warnings. When asked who is responsible, participants mentioned the city council (7), meteorologists (7), the Mayor's office (5), city parks and recreation (2), or some other form of local media (1). In addition, one participant would not mention who they felt was responsible. Even among experts who worked for public outreach services, it is unclear how and who first issued EHE warnings. Interviewees who worked for Healthy Active Living Centers, which are senior assisted living centers in the city, indicated that they were informed of extreme heat through public news broadcasts; there were no known direct lines of communication between meteorologists or the Mayor's office.

Table 1 Proposed actions to minimize EHE risks.

Response Action	Mentions (N=13)
Stay indoors	10
Seek air conditioning	8
Stay hydrated	6
Avoid sun	3
Use fan	2
Wear appropriate clothing (exposed skin)	2
Wear appropriate clothing (covered skin)	1
Heat isn't a problem for me	2
Proper diet	1
Exercise outside at appropriate times	1

The defining actions shown in the table represent the free-response answers when participants were asked how they personally respond to excessive heat events. Participants were able to provide however many variables they wished. The frequency of given responses is shown in Table 2. All 14 participants were asked to answer this question.

3.3.3 How do people prepare for heat waves?

Table 1 provides the participants' responses regarding how they said they prepared for heat waves. Most responses aligned with the suggestions of the EPA guidebook for extreme heat events [69]. Participants indicated their top response would be to stay inside where air conditioning, shade, and fans would be available (ten responses). Four participants indicated that they would dress appropriately, though there seemed to be some inconsistency as to whether exposed or covered skin provided the best protection. In addition, only five participants claimed that others likely respond to heat waves in ways that are similar to themselves, and nine acknowledged that others may respond differently, which could mostly be explained by differences in income and age.

Two participants claimed they felt EHEs did not present personal health risks, as heat did not bother them. This suggests lack of educational awareness, as virtually everyone is prone to heat-related illness.

The EPA guidebook discusses various strategies and protocols to avoid heat-related illness that were not mentioned by those interviewed in this sample [69]. The EPA recommends canceling or rescheduling outdoor events and avoiding alcohol and drugs. Considering how many outdoor activities and gatherings take place in the summer, this suggests a need to increase awareness and education on the health risks associated with alcoholic beverage intake.

In addition, five non-expert decision-makers and three experts claimed that they were unsure of how EHEs were managed by the city. For instance, only four of the non-expert decision-makers had heard of Pittsburgh's cooling centers, while each of the four experts interviewed had heard of them. Thus, a knowledge gap may exist between public health officials and the public regarding information and public resources designed to mitigate EHE health risks.

3.4 Heat risk conclusion

This case study shows three main findings. First, both the experts and non-expert decision-makers do not seem to differentiate between warm weather and EHEs, which impose real health risks. Second, most participants believe people find out about EHEs from the news, but are unclear what organizational entity will issue the warning. Third, while participants know of the ways to protect themselves from heat risks, and recognize that socioeconomic disparities may result in different responses.

These results are indicative of potential communication gaps between local government, meteorologists, and public health and outreach services. The results underscore the importance of the various ways to enhance and streamline communication between outreach services, the city government, the county government, and meteorologists so that they can work together to make weather advisories and services as effective as possible. When these lines of communication are made more secure, greater focus can be placed on communication with vulnerable populations, especially the elderly and homeless.

At least from the public perspective as documented in this case study, there appears to be many gaps in who is and should be responsible for managing heat waves. This gap in information suggests the need for a more comprehensive, transparent plan to manage and communicate extreme heat warnings and responses. It is also important for the public to understand how heat (and other weather-related) information is disseminated. If the public does not know who is responsible for distributing information, it may be difficult to know where to go for related information. Additionally, officials may want to determine whether they want their messaging to be interpreted as "scare tactics," or whether a different communication technique might be preferred.

As noted in the current case study, most participants acknowledged that some people may face additional challenges in acting adequately and timely to reduce their risk of EHE health risks. Income was mentioned by participants as an important characteristic of EHE response and safety practices. For instance, individuals and households may face financial constraints in affording air conditioning, and homeless populations struggle to escape the heat and sun and to find clean water. These are only two of the many vulnerable populations that may not be able to respond as adequately or effectively as others. Financial and mobility constraints may be faced by those of lower socioeconomic statuses, disabled individuals, and elderly individuals. Most of the participants interviewed here identified that these groups may be at greater risk of EHE health impacts, and their identification of the problem may

reflect a larger public concern for vulnerable and economically aggrieved populations facing weather-related risks.

In thinking about mitigating the EHE-related health risks, particularly for vulnerable populations, suggested interventions occur at different points along the risk reduction process [70]. First, Pittsburgh meteorologists should communicate forecasted EHEs days in advance of their occurrence. This would allow shelters and cooling centers to communicate their services to the public, and this would allow those managing the shelters to prepare their facilities and staff for possible influxes of people, extended hours, and resource adequacy [57]. It should be noted that this level of preparation may come to an additional cost to the city.

Second, city officials should focus on establishing clear lines of communication in EHE management and public education. As one expert suggested, this could also help reduce the number of people admitted to emergency rooms due to extreme heat. For instance, if increased publicity and awareness of Pittsburgh's cooling centers made them a more prominent resource, then the public may be informed of resources they did not know were previously available. Additionally, paramedics might be able to refer at-risk populations to cooling center services rather than occupying emergency rooms. This would occur under the assumption that those working in cooling centers would be trained and prepared to care adequately and appropriately for those experiencing heat exhaustion, heat cramps, and other mild physical symptoms associated with heat. As cooling centers are less expensive to maintain than emergency medical attention, the costs of savings should be an incentive for the city to invest in cooling centers and educational outreach. In a similar action plan, the Allegheny County Department of Human Services contracts organizations to work with the homeless populations in a "buddy system." This service encourages friends, neighbors, families, town watch groups, and several others to visit elderly or vulnerable people during periods of hot weather to ensure they are in good health and have adequate water and shade. These preventative services can help establish that individuals have the resources necessary for thwarting heat-related illness, which can escalate without such resources.

Finally, officials should more carefully consider where cooling centers and day shelters are placed. At present, there are far more warming shelters than cooling shelters in the city, despite the serious health consequences of heat. It may be beneficial to open more smaller cooling centers so that more people have physical access to the centers. As one expert noted, Pittsburgh is currently discussing these options and plans to establish centers that are conveniently located for homeless, elderly, and lower-income populations.

As this study article is a convenience sample, these results are preliminary and provide a baseline assessment of how the public and public health officials perceive the risks and responses of EHEs. A possible next research step to better capture public perceptions might be to conduct a survey of residents (e.g., [71]) or to hold a deliberative democracy event (e.g., [72]). Complementary to these efforts, one could obtain improved temperature data with higher local resolution to understand differences in local temperature (e.g., [73]).

4 Case study 2: Involving homeowners in floodplain management: Examining current and future mitigation behavior and beliefs

Flooding is the most common type of presidential disaster declaration in the United States [74]. While the National Flood Insurance Program exists to insure homeowners [75], the risk will continue as long as homes exist in the floodplain. The Community Rating System is in place to help incentivize communities to reduce their flood risk [76]. Part of this system includes providing information and sometimes funding to address a community's severe repetitive loss structures via adaptation (such as elevating the home out of the floodplain) or removing the structure altogether.

There are many barriers to homeowners taking advantage of existent funding or Community Rating System suggestions through the Federal Emergency Management Agency (FEMA). For example, consider a state with a large number of presidential disaster declarations for flooding: Pennsylvania [74]. Studies in Pittsburgh, PA, have shown that people believe floods are currently threatening and will become worse in the future [77]. However, while there is significant local support for improving infrastructure, it is unclear how community-wide and household-level choices will be paid for [78]. While a number of analyses to support these decision-makers could be conducted [79], we first need to know what homeowners are thinking about flooding and potential mitigation techniques.

Thus, here we ask a convenience sample of Pittsburgh and Philadelphia homeowners the following questions:

1) What information do homeowners already know about flooding and its risks to their home?
2) What are the expected costs and consequences?
3) What barriers do homeowners have for mitigation?

4.1 Sample

The participants that were examined for this study article included Pennsylvania homeowners of Pittsburgh and Philadelphia. We retrieved public tax record data homeowners in Pittsburgh and Philadelphia. These addresses were geo-coded and then imported into GIS. This sample was limited to only single-family homes.

Next, we imported geo-referenced flood hazard zone maps developed by FEMA with information from its

Digital Flood Insurance Rate Map Database. These maps were overlaid with the public tax record data. The final produced thematic raster maps included addresses of single-family home homeowners in the 100-year flood plain, which refers to a flood that has a 1% change of happening in any given year [75].

Recruitment for the research study began in summer 2018. First, postcards advertising the study were sent to 528 Pittsburgh and Philadelphia single-family-home homeowners in July and August of 2018. The postcard included an e-mail address and phone number to contact for participation in a 1-hour phone interview. A $50 Amazon gift card was offered as an incentive to participate. A total of 47 postcards were returned by mail for a variety of reasons, including vacant unit or "no address found." Twelve homeowners responded and sent an e-mail to schedule an interview (2% response rate). Of these, four homeowners completed the interview, with eight homeowners later choosing not to participate. The low response rate might be a function of a number of reasons and is discussed further in Section 4.4.

Regarding demographics, while we had attempted to gain Philadelphia respondents, all four participants were Pittsburgh homeowners of two-story homes. The average number of years of homeownership was 6 years, and ranged from 1.5 to 12 years. The salary of participants ranged from 0–$50K to over $200K. Of the four participants, three were female and one was male. The median age group reported was 45–64 years old.

4.2 Procedure

Participants who expressed interest via e-mail or phone were provided with a toll-free conference call to take part in the study. Participation was entirely voluntarily, and participants were informed that their responses were anonymized. They were also informed not to mention anyone by name during the interview. Finally, participants were informed of their right to withdraw from the study at any time.

One-on-one semi-structured interviews were conducted with each participant. All interviews were tape-recorded, transcribed, and coded. Our analyses of the interviews were motivated by previous theory and empirical research about homeowners' approaches to thinking and preparing for flood events [77–79].

To analyze these data, we first reviewed all the data to identify general themes. Next, we applied a multistep thematic analysis to the interview transcripts. All interviews were coded [80, 81] to identify specific themes, patterns, and individual quotes that summarized the key discussion points relevant to the study's research questions. This analysis was conducted based on the following domains: 1) current beliefs about floods, 2) current flood mitigation behavior, 3) future beliefs about floods, and 4) future flood mitigation behavior. The rationale behind this process was based on our hypothesis that these critical themes were salient for Pennsylvania homeowners of Pittsburgh and Philadelphia. Next, several themes were identified and catalogued for each major domain. The data were then reviewed through several iterations and compared across domains and against other data in the same thematic category. Researchers refer to this process as the "constant comparison method" [82]. This method repeated itself until redundancy was reduced and the data represented its appropriate domains and themes [83–85]. Immediately after each interview, participants were e-mailed their gift card. For those participants who wanted information about resources, a separate e-mail was sent that included a list of flood mitigation programs and a contact number from a representative from the Pennsylvania Emergency Management Agency who offered to answer any questions.

Appendix B lists the full interview protocol.

4.3 Results

4.3.1 Current beliefs about floods

All participants (100%) reported having had experienced at least one flooding event within the past three to five years. All four participants were also relatively knowledgeable with respect to the impact of these flooding events, acknowledging several areas affected. This included their actual home (i.e., basement), land surrounding their property (i.e., front or back yard), neighbor's home, and nearby streets and roads. For example, one participant stated how ". . . where I live it's pretty bad . . . and streets that are very common for people to use have been basically flooded while we were on the road. And even the street we live on gets kind of bad. I think this is probably why we got it in our basement twice. . .." Another participant described the impact to the land surrounding their property, stating how "it probably happened three times since I've been here about two years. Each winter the waters rise quite a bit, and have taken out parts of land behind the house and have risen 10–12 feet on the tree up behind the house . . . this past summer we had some really high waters."

Three of the four participants expressed some level of fear or worry about floods that have occurred within the past three to five years. One participant stated that "it is sort of a fear right now because we do have a lot of stuff [in the basement] that we can't put in the upstairs of the house." Another participant explained how "my fear is that I'm stuck out of my house if I go shopping and very, very hard rain comes, I can get to my home, I can't get into my house."

Three of the four participants reported receiving early flood alerts via short message service (SMS) alerts on their cell phones. Although important, one participant shared their concern with these alerts: "you get the storm warnings and most of them you ignore because there's a whole lot of

them that don't impact you at all . . . but you get those storm warnings and one night the storm comes and the water does back up. You could say you had a warning but it's kind of like crying wolf all the time. You know after a while after crying wolf so many times you kind of say 'oh it's just another storm.'"

4.3.2 Current flood mitigation behavior

Three of the four participants appeared relatively knowledgeable about property protection measures (PPMs), steps used to modify to buildings subject to flood damage rather than to keep floodwaters away [75]. The most common measures reported by these participants were removal of items from basements and purchasing sand bags. These steps are considered by FEMA as floodproofing [75]. However, despite participants' knowledge about these measures, all three reported not personally engaging in any flood proofing activity to their home. The rationale for this disengagement includes not seeing flood proofing as important. One participant shared that "there was a lot of other stuff going on so this is not priority. . .." Another participant added, "the problem would be putting my money towards something that I don't really need."

In addition to not prioritizing PPMs, three of the four participants also reported the following barriers to mitigation: perceived ineffectiveness of measures, and various financial, social, and emotional costs. One participant explained how "some people can't afford [mitigation steps] . . . and how . . . people make choices to buy something other than flood insurance . . .." Another participant added, ". . . you can't do anything, but you can put barriers up to your house, barriers up to where the water will be entering your house, sometimes that doesn't protect the house though when the water is flowing that quickly." The third participant discussed how "there [is] always the financial cost—you always have to pay money to drill, to get old stuff out, to get new stuff, new furnaces, new water tanks, and there's a cost of time because you're cleaning . . . the mud and gunk and that is in the house [and finally] . . . the emotional fear of infection and having your house be infected with organisms that get into the cracks and walls of your house and basement."

Two of the four participants appeared very knowledgeable about prevention measures, designed from keeping the flooding problem from occurring or getting worse [75]. These measures are typically administered by building, zoning planning, and/or code enforcement officers.

4.3.3 Future beliefs about floods

Three of the four participants expect chances of future flooding to stay the same. There was a consensus that "the floods will happen every single time there is a hard rain." One participant expects chances of future flooding to fluctuate in severity.

Two of the four participants expect chances of future flooding to "continue to happen until the city and the government and opens up more the waterways to allow it to flow easier in improve the waterway system." These two participants see prevention measures by the city and government as more of a priority than personal mitigation efforts.

All participants (100%) hold high perceptions of social, psychological, and financial risks associated with future flooding. For example, one participant explained how future flooding "could have significant financial cost, both either repairing any damage done by flooding and/or being able to have a property." The same participant further described the social and psychological consequences of "not having a place to live for the time probably depend on other people for living accommodations and . . . the stress that comes with living in a place for your health and mental health." Another participant stated how future floods "could erode part of the island that our houses are on it, affect our family. . ..It could definitely touch our living space, our cars, our air conditioning, the infrastructure of our house, decrease the value of the property, and probably make it impossible to sell."

4.3.4 Future flood mitigation behavior

Two of the four participants relied heavily on prevention measures to mitigate flood risk. For example, one participant stated, "It's going to continue to happen until the city and the government open up more of the waterways to allow it to flow easier and improve the waterway system." These two participants also appeared relatively resistant or unwilling to PPMs, ultimately deferring mitigation responsibility away from themselves and towards the city and government.

Two of the four participants mentioned relocation as their only mitigation measure. Although relocation is a "mitigation measure that can offer the greatest protection from future flooding," these two participants are unknowledgeable about other PPMs. One participant stated, "I do not think I have enough knowledge yet about it to know what to do."

All participants are unaware of any federal, state, or local flood mitigation assistance programs and resources. It is important to note that one participant did mention knowledge about restoration companies in support of homeowners who have experienced damages to their homes as a result of flooding.

4.4 Flood conclusion

This case study shows three findings. First, homeowners understand that flooding is a risk both now and in the future. Second, unfortunately most homeowners' ability to mitigate

is low. Third, homeowners were unaware of the supports offered by the Pennsylvania Emergency Management Agency or FEMA to help them reduce flood risks.

A limitation to this study is that of the sample size of 528, only four responses were received in response to a $50 incentive. Although the sample size for this current case study is low, this study suggests important findings for decision-makers to consider. First, it appears there is little need to provide additional information to these homeowners on flooding risk. Decision-makers may have limited resources, and therefore may wish to instead prioritize alternative options based on flood risk as outlined in the current study. Furthermore, sometimes more information can lead a homeowner to wait to make mitigation decisions [86]; if this study reflects real-world actions among homeowners, providing additional risk information could be detrimental. However, if a decision-maker decides to provide additional information, studies on overlaying flood-risk maps with specific houses (e.g., [87]) may provide helpful information.

Second, the low response rate and the finding of low ability to mitigate may be a reflection of what we heard from all of the participants: a hopelessness surrounding their ability to deal with flooding events. Hopelessness depression is a subtype of depression. Research considers "hopeless as a proximal sufficient cause of the symptoms" of depression [88] and can be measured in a population [89]. In practice, the hopelessness could lead to depression, which results in decreased ability to take even small actions to reduce the problem. A study in Pakistan suggests that the mental health of homeowners after flooding includes hopelessness depression [90]. In addition, studies suggest post-traumatic stress disorder may be occurring during flooding events in the United States, India, and China [91–93]. Decision-makers may wish to consider providing mental health services for flood survivors to assist them in rebuilding their lives.

Third, participants felt that government agencies (such as the Pennsylvania Emergency Management Agency or FEMA) could do more to help them reduce their flood risks. This included all forms of help, ranging from information on how to mitigate through monetary support to elevating or buying out the house. This is in line with studies suggesting that there are many hazard mitigation professionals who could benefit from improved ability to work with mental health officials [94]. This also suggests that there is additional research needed to understand how to better disseminate this information. For example, just as a discrete choice model surrounding willingness to pay has been used to help compare homeowners' understanding of different types of ways to reduce stormwater runoff [78], perhaps a similar study could be run to examine potential barriers and ways to distribute the information.

5 Discussion and conclusion

This article has taken one step toward illustrating the usefulness of our psychological model of risk communications through an empirical illustration of two qualitative case studies: [24, 25]: one on decision-makers facing extreme heat, and another on homeowners facing flood events. These empirical illustrations of the model elicited information on adaption and risk mitigation response using an interview approach for understanding what people 1) think about natural hazards now and in the future, and 2) consider to be potential strategies to mitigate risks.

This article lays out a systematic method of identifying stakeholders and conducting in-depth mental model interviews to understand public approaches to preparing for extreme events. We then demonstrate this method on Pennsylvania experts, decision-makers, and homeowners for two case studies: extreme heat events and severe precipitation events. Our findings highlight that most people are aware of past and future risks, and how they have and will be affected by extreme heat or flooding events. However, people lack a plan for how to prepare or respond to these hazards. This leads to confusion about information, monetary resources, and potential risk preparation efforts. We also find that while residents are aware of some ways to protect themselves from risks, that in some cases, socioeconomic disparities and/or mental health following a disaster may exhibit abilities and behaviors that differ from expert understandings and recommendations. These findings are indicative of gaps in environmental hazard management, specifically related to the communication lines and expectations between experts and local residents.

The empirical illustration of the above two qualitative case studies demonstrates the utility of a psychological model of risk communications. The results of the case studies evaluate two empirical propositions of the model.

First, consider Proposition 1.

Proposition 1: *Because perceived risk communications largely involve system-two cognition for understanding risk perceptions and (in)action, interview participants will either a) explain their perceptions of risk and engagement in risk mitigation in intuitive, unsubstantial, and emotional ways, or b) offer multiple,* post facto *justifications to generally accompany their subjective perceptions and (in)action [18].*

Consistent with previous research, our findings indicate that interview participants knew the impact and difference between action and inaction to risk mitigation and adoption strategies, yet are largely incapable of articulating, in substantial ways, the influence of risk communications on their cultural–moral decisions [18].

Now, consider Proposition 2.

Proposition 2: *Because our proposed risk communications will tend to generate risk perceptions and (in)action that are consistent to its cognitive structure, cultural schema, and environmental awareness, interview participants' cultural–moral perceptions will be predicative of their decisions of risk mitigation and adoption overtime and across space [18].*

Our findings suggest that when interview participants attempted to articulate their decisions and the important role of risk communications, their perceptions and (in)action are maintained even when the evidence they offer is insufficient or even self-contradictory to risk communications. An example of this behavior is observed in case study 2, participants not wanting to commit the time and money to flood proofing their homes because the loss of time and money played a stronger role than the potential of future gains from risk mitigation and adoption. This behavior is explained through Kahneman and Tversky's loss aversion principle [17], which affirmed and allowed for (in)actions of risk mitigation and adoption efforts for many participants throughout our case studies.

Consistent with the predictions of our model, we find that cognitive structure, cultural schema, and environment awareness dynamics are not only necessary determinants to strengthen risk communications but also important for understanding perceptions of risk and people's (in)action to engage in mitigation and adoption efforts. For next steps, we suggest a range of research projects to fully test this psychological model of risk communications, which could include surveys and interviews. These approaches can be compared to the results of other methodological approaches (e.g., observations, focus groups, and ethnographies) with the same participants to further understand the effectiveness of such methods in capturing different forms of cognitive structure, cultural schema, and environmental awareness for risk communications. Future research should also examine when and how current risk communications encourage and respond to cognitive structure, cultural schema, and environmental awareness.

Beyond intellectual merit, this new framework has the potential for multiple broader impacts. For example, this framework suggests possible next steps exist to improve communication and decision analysis for disaster management. For example, it is likely that there are many ways to enhance and streamline communication between outreach services, the city government, the county government, and meteorologists so that they can work together to make weather advisories and disaster mitigation as effective as possible. To inform these improvements, we suggest that future surveys collect more relevant information on these topics. For example, in both sets of interviews, we asked questions regarding how the respondent obtained information about either their heat risk or flood risk. If a survey were to be created, one possible question that could tease out more information on how to streamline this information could read something like: "Check all that apply: Do you get information from print media, online, TV, radio, or conversation?" Similarly, in the interviews on heat waves, we asked about location and use of cooling centers. In natural disaster events, many communities are opening up libraries, malls, and community centers to relieve the effects of disaster events; a future survey could gauge knowledge and interest in the use of such options.

Ultimately, risk communications should not be merely guided by people's risk perceptions and (in)actions, but also by the psychological processes underlying these perceptions and decisions. A greater integration/application of cognitive structure, cultural schema, and environmental awareness—focused on the psychological dimensions informing risk perceptions and (in)actions—can provide a better guide to risk communications that should be adopted versus what actually happens in real life. We posit a twofold explanation behind the link between risk perceptions and (in)action and risk communication: that is, proposed risk communications are undergirded by cognitive structure (system-one or-two cognition), cultural schema, and environmental awareness; whereas current risk communications only rely on one component of our proposed psychological model—cognitive structure, particularly system-two cognition. The psychological model of risk communications outlined in this article ultimately serves as a policy and practical model for understanding people's risk perceptions and (in)action that works through not only psychological dimensions but also larger structural forces. If the goal of future risk communications is to increase risk mitigation and adoption efforts, then interventions that target people's cognitive structure, cultural schema, and environmental awareness hold promise.

Appendix A: Extreme heat event interview protocol

Introduction

Let's begin with an overview of the research project. The City of Pittsburgh experiences numerous heat waves every year. These environmental events threaten public health, as they can increase the number of daily deaths and other nonfatal health outcomes. Some populations face a greater risk to the negative health outcomes associated with heat waves. CMU recognizes this risk, and we are interested in promoting Pittsburgh's cooling centers as a way to remedy heat-related illness and death. To do so, we want to effectively communicate with the public and experts about heat waves risks. So, we are interviewing a portion of Pittsburgh's citizens

and experts in order to inform the development of communicating heat-related health risks and solutions.

General heat wave questions

I'm going to start by asking you some questions about heat waves in Pittsburgh. Some questions may seem simple, but we are just trying to catch small nuances and information we may have missed.

- Tell me about heat waves in Pittsburgh.
- In your own words... what is a heat wave?
- What time of day are heat waves a problem? Why?
- What time of year is it a problem? Why?
- Can you tell me the difference between an above average temperature and a heat wave?
- Can you tell me how you personally respond to heat waves?
- Can you tell me how you think others could respond to heat waves?
- Where have you seen heat-wave warnings?
- What health problems do you think heat waves pose?
- Help me understand the ways that heat wave responses are managed in Pittsburgh.
- How are heat waves currently managed?
- Who do you think is in charge of issuing heat-wave warnings?
- Where have you seen heat wave information or warnings?
- Do you feel there is a need for new infrastructure to better support the public during heat waves?
- Who do you think should pay for this infrastructure? Why?
- Have you heard of Pittsburgh cooling centers?
- If so, have you ever used one? If more than once, about how many times per summer have you
- If you have not personally used one, do you know anyone who has? If so, do you know how?

Challenges and barriers to responding to heat waves in pittsburgh

Do you know of any challenges or barriers the city faces in responding to heat waves?

- What about customers' political ideology?
- What about their perceptions of climate change?
- What about their prior experience with heat waves?
- What about their perceptions of air quality?
- Of those you mentioned, which is the most important?

Close-out

Our next step is to continue to survey experts and the public about heat waves in Pittsburgh. We are going to take what you and other experts have told us about heat waves to develop a survey that helps us improve heat risk communication. To close out, we have a few more questions:

- Are there any other questions you would have liked us to ask that we didn't?
- Do you have any other thoughts or comments?
- If you could add a single question to our survey, what would it be?

Demographic information (5 minutes)

Before we conclude, I'd like to collect some basic demographic information. This information should have little bearing on our final results. We only wish to collect this information in order to highlight more accurately the sum of the skills and experience we have managed to incorporate into our investigation. This information will be aggregated and kept anonymous.

- What is your gender? (Male/Female/Do not wish to respond)
- What is your age group?(<18 years, 18–24, 25–44, 45–64, >64)
- What is your ethnicity?
- What is your highest level of educational attainment?
- What is your occupation?
- What is your average annual salary range?
- When did you first work on heat-related topics?

Appendix B: Flood interview protocol

Brief introduction/ (1 minute)

Let us begin. For the purposes of today's discussion, do you currently own your home? Also, how long have you lived in your home?

Pennsylvania homeowners' beliefs about current floods

Let's discuss your beliefs about floods within the past 3–5 years in your surrounding community. Have you, or your neighbor, been impacted by any floods within the past 3–5 years (or during the time you've lived in your home, if less than 3–5 years)? If so, how many times have your home been flooded?

- [What happened] Describe the ways you, or your neighbor, were affected by the flood.
- [Potential Follow-up Questions] How high did the floodwaters rise? About how long did your property remain flooded?
- What were the effects to and around your property?
- [What did you do] Describe how you, or your neighbor, responded to the flood.
- [If not mentioned]. Describe your level of agency.
- Describe the steps you took after the flood (e.g., time, labor, and money).
- Describe the long-term consequences of this flood to and around your property.
- [Did you know?] Did you receive any warning before your property was flooded? Describe your level of awareness (e.g., timing).
- [If yes] Describe your source of warning.
- Describe why you think this flood have occurred to your property.
- [If not mentioned] Do you live on a flood-plain?
- Describe how you feel about floods that have occurred within the past 3–5 years in your community.
- [If not mentioned]. Describe your level of worry.
- [If not mentioned]. Describe your level of fear.
- Describe how often this flooding occurs.

Pennsylvania homeowners' beliefs about future floods

Next, let us discuss your beliefs about future floods to your property.

- Describe whether or not you think future floods will happen to your property.
- [If yes] Describe where or who you think you would learn this from.
- Describe how you think your property will be affected.
- Describe how you think you will respond to the flood.
- [If not mentioned]. Describe your level of agency.
- Describe why you think these floods will occur.
- Describe how you think you will feel these floods.
- [If not mentioned]. Describe your level of worry.
- [If not mentioned]. Describe your level of fear.
- Describe how often you think flooding will occur in the future around your community.
- Explain.

Pennsylvania homeowners' beliefs about current flood mitigation actions

Next, let us discuss your beliefs about your flood mitigation actions within the past 3–5 years to your property.

- Have you, or your neighbor, considered taking steps to minimize the impacts of flood damage to your property?
- [If yes, or previously mentioned]. Describe the steps you, or your neighbor, have taken in the past 3–5 years to reduce flood damage to your property.
- Describe when these steps were taken, before or after the flood.
- Describe why these steps were taken.
- Describe the cost (e.g., labor, housing, psychological) of these efforts.
- What, if anything, would you do different in the future to reduce flood damage?

Pennsylvania homeowners' beliefs about future flood mitigation actions

Now, let us discuss your beliefs about your future flood mitigation actions to your property.

- Describe the future steps you would take to reduce damage to your property.
- Describe when you think these steps will be taken.
- Describe why think these steps will be taken.
- Describe the expected cost of these efforts.
- Describe what barriers might prevent you, or your neighbor, from taking future flood mitigation actions.
- Where would your neighbor to go for more information about flood mitigation?
- Are you aware of any local or state flood mitigation assistance programs or resources?

Close-out

Our next step is to continue to survey experts and the public about heat waves in Pittsburgh. We are going to take what you and other experts have told us about heat waves to develop a survey that helps us improve heat risk communication. To close out, we have a few more questions:

- Are there any other questions you would have liked us to ask that we didn't?
- Do you have any other thoughts or comments?
- If you could add a single question to our survey, what would it be?

Demographics

Before we conclude, I'd like to collect some basic demographic information. This information should have little bearing on our final results. We only wish to collect this information in order to highlight more accurately the sum of the skills and experience we have managed to incorporate into our investigation. This information will be aggregated and kept anonymous.

- What is your gender? (Male/Female/Do not wish to respond)
- What is your age group?(<18 years, 18–24, 25–44, 45–64, >64)
- What is your ethnicity?
- What is your highest level of educational attainment?
- What is your occupation?
- What is your average annual salary range?
- What kind of house do you own?
- How long have you lived in this house?
- Did you own a house before this?

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