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# Bridging the Gap between National Weather Service Heat Terminology and Public Understanding

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**ABSTRACT:** Clearly communicating heat warning information to the public is an important way to reduce heat mortality and morbidity. However, heat communication interventions from the National Weather Service commonly include technical and scientific terms, otherwise known as jargon. These terms, such as heat advisory or heat index, may not be understood by the public. Given the importance of message understanding in protective action decision-making, the purpose of this study is to assess how the public understands National Weather Service heat information. Specifically, we asked 195 participants recruited via Amazon MTurk what the terms excessive heat watch, excessive heat warning, heat advisory, and heat index mean to them. This approach allows us to (i) evaluate how these terms are understood by examining how people give them meaning and (ii) determine if they are jargon by comparing the meanings between the National Weather Service and the public. Our results show that these terms mean something different to the public than to the National Weather Service. Almost half of the participants reported that heat index was synonymous with air temperature, with less than 10% of participants indicating that heat index includes humidity. Furthermore, the timing of heat watches, warnings, and advisories was inconsistent with National Weather Service definitions. To address these differences in understanding, we suggest that researchers and practitioners explore plain language messaging alternatives to improve future heat communication from the National Weather Service and the weather enterprise more broadly.

**SIGNIFICANCE STATEMENT:** In this study, we find that the terms heat index, excessive heat watch, excessive heat warning, and heat advisory are jargon. This means they carry different connotations for the public than for the National Weather Service. Including these terms in public messaging can negatively impact message understanding and protective action decision-making. Therefore, we recommend the use of plain language messaging and additional research on messaging alternatives.

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## 1. Introduction

National Weather Service (NWS) forecasters are tasked with communicating complex weather risks, such as heat and humidity, to various groups. This frequently includes translating the scientific and technical aspects of heat and heat forecasting into accessible language for different populations. However, technical language is commonly found in NWS heat communication (Li et al. 2018), potentially making heat information difficult to understand. For example, Olson et al. (2023) examined 250 NWS social media messages sent during periods of excessive heat. They found that the NWS commonly alerts the public to heat risks via "signal words"—or words used to "attract attention to the warning and indicate the level of hazard present" (Wogalter et al. 2002, p. 221). Currently, these include terms like excessive heat warning, excessive heat watch, and heat advisory—referred to as heat "products" by the NWS (Hawkins et al. 2017). Heat products are one way for people to become aware of current or upcoming heat risks (Benmarhnia et al. 2019). The NWS also uses the term heat index to describe heat. Olson et al. (2023) argue that heat index and language contained in heat products could be jargon.

Jargon is specialized language used by experts to communicate with one another (Bullock et al. 2019; Sharon and Baram-Tsabari 2014; Shulman et al. 2021). It consists of technical terms with accepted definitions that facilitate quick and precise communication among experts who have similar training and skills. Yet jargon is not self-explanatory, familiar, or accessible to those outside of an expert group (Krieger and Gallois 2017; Rice and Giles 2017; Sharon and Baram-Tsabari 2014). Although jargon is most common in fields like law, finance, and medicine, it is also prevalent in scientific communication, including weather and climate messaging (Bruine de Bruin et al. 2021; Sivle and Aamodt 2019; Soden et al. 2022; Venhuizen et al. 2019).

Messages that contain jargon are difficult for nonexperts to process and understand (Bruine de Bruin et al. 2021; Riggs et al. 2022; Shulman et al. 2021). Jargon is especially problematic in messages intended to promote protective action, as understanding is the first step in decision-making. Before individuals assess their risk and decide to act, they first must understand the information a message contains (Mileti and Sorensen 1990). This includes the threat, potential impacts, and actions they can take to protect themselves from those impacts. Indeed, not understanding the threat and its dangers may result in an inaccurate perception of the risk and expose one to danger. For example, heat index is a measure of temperature plus humidity; lacking knowledge of the effects of humidity on one's ability to cool off can result in decisions that can be life threatening if one overexerts themselves. Thus, it is crucial for experts to translate and adjust their communication in a way that is accessible and understandable for all message recipients (Andersen and Spitzberg 2020; Wong-Parodi and Bruine de Bruin 2017).

Given the importance of message understanding for protective action decision-making, in this study, we assess how people understand NWS heat risk information and if terms, such as excessive heat warning and heat index, are jargon. Unlike prior research, however, we do not measure understanding objectively, which relies on individuals accurately defining technical terms (e.g., Balluz et al. 2000; Chaney et al. 2013; Jauernic and Van Den Broeke 2016; Mason and Senkbeil 2015; Mitchem 2003; Nunley and Sherman-Morris 2020; Powell and O'Hair 2008). One measure of objective understanding, for example, might include assessing if people provide (or accurately select from a list) the definition of a term that corresponds to an expert's definition. If these definitions match, they are thought to have a high degree of understanding. Studies that use such measures have inherent limitations in accuracy, especially if one can correctly guess corresponding definitions. Furthermore, using objective understanding measures can, in certain cases, lead to a knowledge deficit approach to risk communication (Grant 2023). This model assumes that if someone does not understand messages or accept message recommendations, it is simply because they lack knowledge on a topic; by educating about the definition of a technical term, the knowledge gap will be closed, and behavior change will ultimately occur.

We observe that heat risk communication interventions often use a knowledge deficit approach, which commonly assumes that providing people information about heat risks, such as communicating heat index values, will lead to behavior change (Mayrhuber et al. 2018). However, this places the burden on message receiver's ability to interpret and understand expert's specialized language. This approach also ignores the social, cultural, and political factors that influence how people approach and process new information, such as one's personal values or previous interactions with the message source (Howes and Kemp 2017; National Academies of Sciences 2017; Sivle and Aamodt 2019).

With this in mind, we define understanding as one's attachment of meaning to information (Mileti and Sorensen 1990), rather than one's ability to correctly define expert's terms. Research on both sensemaking and mental models demonstrates how people make sense of, and thus understand, new scientific and risk information (see Doyle et al. 2022; Lynch et al. 2024). Both approaches argue that when encountering unfamiliar risk information, people use their prior experiences, influential memories, and preexisting beliefs to contextualize and reach conclusions about new dangers (Bruine de Bruin et al. 2021). Therefore, we focus on discovering how people understand risk information by determining what NWS heat information means to them. Instead of "quizzing" participants or asking them to match definitions to terms, we ask them to draw from their knowledge and experience to offer their own definitions of the most common terms in NWS public heat communication (Olson et al. 2023). Thus, we ask the following research questions:

RQ1: What does heat index mean to the public?
RQ2: What does an excessive heat watch mean to the public?
RQ3: What does a heat advisory mean to the public?
RQ4: What does an excessive heat warning mean to the public?

## 2. Method

***a. Materials.*** We used qualitative, open-ended questions to obtain a nuanced description of how the public defines and interprets heat information. Open-ended questions reduce a source of priming by *not* providing participants a discrete set of options to select from. This approach also allows for greater conceptualization of participants' insights and thoughts (Jauernic and Van Den Broeke 2016). Using our research questions as a guide, we asked participants the following questions:

- In your own words, what does it mean if a heat advisory/excessive heat watch/excessive heat warning is in effect for your area?
- In your own words, what does heat index measure?

Participants were randomly assigned to answer what an excessive heat watch, an excessive heat warning, or a heat advisory means to them. Random assignment was used to reduce the likelihood that interpretations about one heat product affected the interpretation of the other products. All participants answered the question about heat index after providing their responses about their assigned heat product. We use the term "in effect" based on our previous analyses of public heat communication on social media, which found that this phrase was a common way to introduce heat products (see Olson et al. 2023).

The general NWS definitions of heat watches, warnings, and advisories can be found in Table 1. Note that watches, warnings, and advisories are issued based on predetermined heat index values for a particular location, although each NWS Weather Forecast Office is encouraged to establish their own criteria (Hawkins et al. 2017). Heat index is the combination of the air temperature and relative humidity, which provides an estimate as to how hot it "feels like" outside (NWS 2024d).

At the end of the survey, we asked participants about their age, income, gender, race/ethnicity, education, state they reside in, and prior experiences with heat (see Esplin et al. 2019; Hass and Ellis 2019; Williams 2018).

***b. Sample.*** Participants were recruited via Amazon MTurk, which is an online crowdsourcing platform that offers organizations the ability to solicit "workers" for various tasks, including participating in research studies (Gerlich et al. 2018). Before agreeing to participate, potential participants were told they would be completing a 10–15-min academic survey about extreme heat information.

MTurk provides a more generalizable and representative sample of the general population than convenience sampling of college students, for example. MTurk is generally accepted among researchers as a viable and acceptable data collection mechanism (Berinsky et al. 2012; Levay et al. 2016; Zhang and Gearhart 2020). However, like other online data collection platforms, data quality issues have been observed. These issues are discussed in the limitations section.

Table 2 presents the demographic characteristics of our 195 participants who chose to answer our demographic questions, which were optional. In addition, participants reported that they most frequently resided in North Carolina ($n$ = 16), Indiana ($n$ = 14), Florida ($n$ = 13), Texas ($n$ = 11), and California ($n$ = 10), with less than 10 participants living in the remainder of the states. Finally, most participants reported having some prior experience with heat (Esplin et al. 2019). The most common experiences were decreased productivity at work (69.8%; $n$ = 118) and personal discomfort (e.g., inability to sleep; 88.6%; $n$ = 150).

**Table 1. NWS Definitions for Excessive Heat Watch, Excessive Heat Warning, and Heat Advisories. From https://www.weather.gov/safety/heat-ww. Accessed November 2023.**

| Product | Definition |
|---|---|
| Excessive heat warning | An excessive heat warning is issued within 12 h of the onset of extremely dangerous heat conditions. The general rule of thumb for this warning is when the maximum heat index temperature is expected to be 105° or higher for at least 2 days and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas not used to extreme heat conditions. If you do not take precautions immediately when conditions are extreme, you may become seriously ill or even die. |
| Excessive heat watches | Heat watches are issued when conditions are favorable for an excessive heat event in the next 24–72 h. A watch is used when the risk of a heat wave has increased but its occurrence and timing are still uncertain. |
| Heat advisory | A heat advisory is issued within 12 h of the onset of extremely dangerous heat conditions. The general rule of thumb for this advisory is when the maximum heat index temperature is expected to be 100° or higher for at least 2 days, and nighttime air temperatures will not drop below 75°; however, these criteria vary across the country, especially for areas that are not used to dangerous heat conditions. Take precautions to avoid heat illness. If you do not take precautions, you may become seriously ill or even die. |

***c. Data collection.*** The initial survey was pretested with 10 participants for a $2.50 Amazon MTurk incentive. These participants were not retained for analysis, as they were found to be copying and pasting from external sources, such as NWS websites. This was determined by the lead author searching for the identical text via Google. If a participant's answer matched that of an external source precisely (i.e., word for word), their response was not retained for analysis. After pretesting the survey, we solicited 250 participants via MTurk. The survey was updated to advise participants not to copy from external sources to receive their MTurk incentive. After data collection was complete, the lead author went through each participant's responses to approve their incentives. Overall, 55 participants were rejected because their responses copied information from external sources (as identified using an identical procedure as the pretest survey), included duplicate responses, or exhibited other data quality issues (e.g., one word, yes/no responses, nonsensical and/or generic answers). As Griffin et al. (2022) note, using these qualitative data-specific cleaning procedures also helps us identify and remove responses from possible bots. These respondents were also ineligible to receive their incentive. The final number of participants retained for analysis is 195.

**Table 2. Sample demographic characteristics.**

| Characteristic | *n* |
|---|---|
| Gender (*N* = 170) | |
| Male | 111 |
| Female | 58 |
| Prefer not to say | 1 |
| Race/ethnicity (*N* = 170) | |
| White/Caucasian | 126 |
| Asian/Asian American | 24 |
| Black/African American | 11 |
| Other/multiple categories | 9 |
| Age (*N* = 169) | |
| 18–24 years old | 7 |
| 25–34 years old | 76 |
| 35–44 years old | 48 |
| 45–54 years old | 22 |
| 55–64 years old | 13 |
| 65+ years old | 3 |
| Household income (*N* = 169) | |
| Less than $25,000 | 14 |
| $25,000–$49,999 | 53 |
| $50,000–$99,999 | 75 |
| $100,000–$199,999 | 25 |
| I do not know/prefer not to say | 2 |
| Education (*N* = 169) | |
| Less than high school degree | 2 |
| High school degree or equivalent (e.g., GED) | 17 |
| Some college but no degree | 24 |
| Associate degree | 14 |
| Bachelor's degree | 96 |
| Master's, doctoral, or professional degree | 16 |

***d. Data analysis.*** The analysis began with the first author conducting iterative readings of the data to become familiar with its content. During this stage, initial codes were generated to describe key ideas, concepts, and patterns that emerged. These codes were derived inductively, meaning they were grounded in the data itself rather than being predetermined, while also being informed by the guiding research questions. The codes were also not mutually exclusive, which allowed for more complex and overlapping ideas to be captured.

This initial coding phase involved documenting key ideas, words, and phrases from participant responses via Microsoft Excel spreadsheets, along with reflective notes about potential connections between codes. The second author reviewed the developing codes, provided feedback on recurring ideas, and identified areas of overlap or ambiguity. Together, the authors refined the codes, which resulted in a final codebook that articulated clear definitions and applications for each code.

Then, the first author systematically applied the codebook to the dataset. Once the data were fully coded, the authors worked collaboratively to group similar codes into topic summaries. These summaries were defined and reviewed to ensure they accurately reflected participants' responses. As Braun and Clarke (2021) note, topic summaries capture the explicit ideas emerging from the data and provide a structured way to organize and categorize coded content. Specifically, this process allowed us to identify overarching patterns and connections within the data, which we discuss next.

## 3. Results

***a. Heat index.*** Although most participants knew that heat index measures heat in some capacity, almost half of the 195 participants thought heat index is akin to temperature. This belief was the prevailing interpretation of heat index. Specifically, participants commonly mentioned that heat index measures the temperature and/or heat for an area, meaning they specified "temperature" or how hot it is absent of additional factors. For example, participants indicated "it measures the temperature to determine how hot it is outside" or "it tells you how hot it will be today." Others mentioned that heat index means the temperature is measured on some type of scale or includes a range for different levels of heat. For example, one participant said, "heat index measures the temperature [in] degrees like 102°–109°F," while another mentioned that heat index is "how hot it is on a scale of 1–10."

Many participants mentioned that heat index measures what it feels like outside. This means they used the word "feels like" absent humidity. For example, participants stated that heat index is "how hot it actually feels instead of just the objective temperature" or that it means what "the temperature will actually feel like. It usually means it will be warmer than the actual temperature." However, a few participants were unsure if this is correct (e.g., "I am not sure, but I think the heat index means how hot it actually feels outside as opposed to the actual temperature").

Importantly, heat index is the combination of air temperature and relative humidity for an area. However, few participants mentioned humidity *and* temperature in their responses. For example, one participant said heat index is a "measure [of] the level of hotness along with humidity factor and natural air temperature." Other participants seemed unsure of their answer by using question marks or hedging language (e.g., "I think it measures how hot it feels by taking into account both humidity and temperature?").

Participants also mentioned additional factors that may impact the heat index, such as the sun, air quality, air pressure, and cloud coverage. For example, one participant said heat index is "maybe a point of how uncomfortable it will feel when you combine the temperature with the humidity and air quality." Another participant stated "heat index measures the temperature of the air, humidity, UV ray index, dry conditions, etc."

Although less frequent, a few participants provided insights into how they thought the heat index is calculated. For example, several participants thought that heat index is a comparison with the average, "usual," or historical temperatures for an area, with one participant stating that heat index is "the total amount of heat and humidity as compared to the usual temperature." Another participant said, "I never learned what it means, but I expect that it measures the heat level now in relation to the average heat level for the same time of year." One participant focused on the word "index" by stating "if something is being indexed, it is being measured against other data. Therefore, I would infer that a heat index compares present heat measurements with [the] past." However, participants were unsure that they were correct in how heat index is calculated by stating "does it measure the heat relative to what it's been in a region in past years?" or it is "the average? not sure."

Finally, a smaller subset of participants stated that heat index measures the severity of a heat event and the consequences that might ensue. For example, one participant stated that heat index is "how hot the temperature is in terms of lethality." Again, others were unsure. One participant stated, "I'm not too sure about the heat index, but I assume that it's a measurement of how severe the heat is and whether it would be a danger to people and/or animals," while another said heat index is "the level of heat based on UV radiation levels? Higher index = higher UV and sunburn most likely to occur?" Two participants indicated they "don't know" what heat index means to them.

***b. Excessive heat watch, heat advisory, and excessive heat warning.*** Although similar themes emerged for heat watches, warnings, and advisories, we describe our results by signal word (i.e., product) in order to provide a more nuanced understanding of how people interpret each type of information they may receive.

**1) Excessive heat watch.** An excessive heat watch is a type of signal word meant to prepare the public for a possible heat event in their area (NWS 2024a). This means that forecast conditions suggest elevated heat/heat index values are expected within the next 24–72 h based on a Weather Forecast Office's locally established criteria. Therefore, elevated heat conditions are not currently happening.

First, many participants had some timing elements emerge in their responses. Here, many participants used present-tense verbs like "is" or "are" when describing an excessive heat watch. For example, participants said that "it means that heat levels are dangerous." Those who described a watch as being hot in the future used words like "going to be" or "will" (e.g., "I guess that means it is going to be very hot"). It is possible that the inclusion of timing relative to heat events was meaningful to participants (i.e., whether heat is current, ongoing, or in the future). However, it is also possible that this finding is influenced by factors such as what time of day a participant took the survey.

Next, participants frequently mentioned the negative impacts of heat in their responses, which were primarily related to one's health. For example, one participant stated, "it means that there is a health risk from being outside for very long at a time." These impacts also included death.

Interestingly, participants also discussed if they and/or others should change their behavior in response to a heat watch, as well as the location where this should occur. Here, more participants indicated that an excessive heat watch means they now need to protect themselves versus needing to "be aware" of unsafe conditions that may occur later. The outdoors was also commonly included in these responses. For example, participants stated they "need to be extremely careful going outside" or "it means to be careful [to] do anything outside because it's so hot that your health could be in danger." No one mentioned the need to protect themselves or be aware while indoors.

Who is vulnerable to heat was another theme that emerged, with several participants discussing who is at risk in their responses. Participants more commonly mentioned that only certain groups are vulnerable to heat impacts under an excessive heat watch. The most frequent group mentioned was the "elderly" or "older people" (e.g., "it means that it's so hot it might be dangerous for people like the elderly or people with breathing problems"). Fewer participants mentioned that everyone is potentially at risk for heat impacts.

Finally, the factors that make it hot and/or dangerous were also discussed. To some, an excessive heat watch means it will be "hotter than normal" and/or they are experiencing high temperatures in their area. Humidity and heat index were rarely mentioned, with no one mentioning the "real feel" or "feels like" temperature.

**2) Heat advisory.** A heat advisory is "issued within 12 h of the onset of extremely dangerous heat conditions . . . [and] take precautions to avoid heat illness" (NWS 2024a, para. 3). An advisory is like a warning in terms of timing and protective action but is issued for lower heat index thresholds based on local criteria (Hawkins et al. 2017).

First, unlike an excessive heat watch, more participants used future-tense verbs (e.g., "going to be" or "will") to describe a heat advisory, indicating it *will be* hot compared to currently hot outside. Participants also believed that advisories include hotter than normal conditions and/or high temperatures. However, humidity and feels like were rarely mentioned, with no one mentioning the heat index.

Similar to excessive heat watches, participants mentioned the consequences of a heat advisory, which again were primarily related to one's health. Furthermore, these participants mentioned that heat advisories can be fatal. Many also mentioned how they and/or others should respond to a heat advisory, with more participants stating that heat advisory information means protect yourself (e.g., "stay where it is cool" or "don't go outside"). In contrast, fewer participants believed that under heat advisories, one should be aware (e.g., "be mindful of . . . the heat"). Finally, participants also discussed who is vulnerable. Here, more participants indicated that only some groups are at risk for severe heat impacts under heat advisories, whereas only a few participants specified that everyone is potentially at risk to experience heat impacts.

**3) Excessive heat warning.** According to the NWS (2024a), an "Excessive Heat Warning is issued within 12 h of the onset of extremely dangerous heat conditions . . . if you don't take precautions immediately when conditions are extreme, you may become seriously ill or even die" (para. 2). Thus, a warning is more imminent than a watch.

First, more participants used future-tense verbs like "going to be" or "will" to describe an excessive heat warning. This finding is similar to heat advisories but dissimilar to excessive heat watches. As with other heat products, no one mentioned humidity, heat index, real feel, or feels like temperatures in their responses.

The consequences of heat were mentioned, but unlike watches and advisories, no one mentioned death or fatalities. Participants also commonly discussed populations that are especially vulnerable to heat in their responses, with more participants indicating that everyone was vulnerable to heat impacts compared to those who expressed that only certain groups of people are vulnerable. Finally, participants discussed behaviors, with more participants indicating that an excessive heat warning means they and/or others need to protect themselves versus be aware of future heat threats.

## 4. Discussion

When examining what the three levels of NWS heat alerts and heat index mean to the public, our results show that the public expresses different meanings of these terms compared to the NWS. When this occurs, experts often assume they should educate the public about how a term is defined, which adopts a knowledge deficit approach to risk communication. Instead, we propose that experts can better bridge this "gap" by meeting the public where they are in terms of their understanding and adjusting their communication accordingly.

First, we find that almost half of the participants thought that heat index was similar to air temperature, with far fewer participants indicating that heat index involves humidity. However, it is possible that humidity is included in participant's mental representations of "heat" or "high temperature" without being explicitly mentioned in their responses. Furthermore, about a quarter of participants indicated that heat index is the "feels like" temperature. But these participants did not indicate why it feels a certain way (i.e., they did not mention humidity). Participants also revealed how they thought heat index was calculated, with most believing heat index is a comparison with previous or "normal" temperatures for their area or that it includes factors such as air quality or ultraviolet rays. These findings suggest that humidity needs to be mentioned as a contributor to what it feels like outside, rather than using the term "heat index" in isolation.

Next, similar themes emerged from the data for watches, warnings, and advisories. Although the exact frequencies vary, these terms appear similar in the eyes of the public. First, in many parts of the country, watches, warnings, and advisories are issued based on heat index values (Hawkins et al. 2017). Yet heat index, humidity, real feel, or feels like temperatures were seldom mentioned or absent in participant's responses. This shows that people may be unaware of one of the primary impacts that necessitated the NWS issuing a particular product: humidity. People will not automatically assume that because a watch, warning, or advisory is in effect, this may include humidity or know what conditions will feel like. If humidity is important for people to consider when a watch, warning, or advisory is in effect, they are not making that connection inherently. Thus, our findings suggest the need to highlight the importance of humidity in public messaging during watches, warnings, and advisories if applicable.

Specifically, due to climate change, humidity will continue to increase in certain regions, making previous places that were "just hot" especially dangerous for populations (Yuan et al. 2020). Messages should address our changing environment by specifying when humidity will be a factor and why it is dangerous. Indeed, humidity is important for people to consider because it negatively affects the body's ability to cool off via sweat evaporation. This information is especially important for populations who already have lower thermoregulation abilities, such as older adults, who must be increasingly careful in humid versus dry conditions (Klompmaker et al. 2023). However, less humid areas of the country will need to adopt a different messaging approach based on their local criteria. How other tools used to make watch, warning, and advisory decisions (e.g., the new NWS HeatRisk) should be incorporated into public messaging needs to be considered (Olson et al. 2024).

Furthermore, the time in which one can expect impacts was not clear. For example, many participants used future-tense verbs to describe advisories and warnings and present-tense verbs to describe watches. Provided that the verb tense used is a meaningful indicator of how participants were thinking about the timing of heat products, these results suggest that people may not be able to intuit when they are or will be at risk from these terms alone. We know from previous research on warning message design that timing information is an essential element in complete messages that help people protect themselves (Mileti and Sorensen 1990). However, explicit and easily understandable timing information is often missing from NWS public heat communication, such as when hot conditions are expected to start (Olson et al. 2023). To include additional timing information, messages could indicate when impacts will occur (e.g., the hottest parts of the day) and when people need to take protective action (e.g., the time in which they should get to a cooling shelter).

With these findings in mind, we recommend that researchers and practitioners explore plain language messaging alternatives to the terms heat index, excessive heat watch/warning, and heat advisory when communicating to nonmeteorologist groups. Although these terms may be important "shorthand" to NWS partners and other high-end users, more research in this area is needed to determine exactly what types of alternative messaging should be used with the public. We recommend eliminating jargon based on prior research, which has found that providing definitions does not mitigate or eliminate its negative effects (see Shulman et al. 2020). Thus, plain, everyday language should be used to increase the likelihood that people will attend to, understand, and recall information, as well as see themselves at risk and follow message recommendations (Bruine de Bruin et al. 2021; Riggs et al. 2022; Shulman et al. 2020; Williams and Ogden 2004).

The Plain Writing Act of 2010 defines plain language as "writing that is clear, concise, [and] well-organized," which can be achieved by using simple, straightforward words to express an idea. For heat products, plain language can include breaking down technical words into their ensuing parts. For example, this could include replacing an "excessive heat warning" with the expected temperatures and the time in which they will occur. Furthermore, some situations may allow for the replacement of jargon with telling message recipients it will feel like a certain temperature due to the humidity, instead of using the term heat index. Plain language also applies to other components of the message, including timing, impacts, and protective action(s).

Yet we recognize that experts are often hesitant to remove jargon and adopt a plain language messaging approach because they feel they will lose scientific accuracy or do not want to be seen as "talking down" or "dumbing things down" to their audiences (Krieger and Gallois 2017; Sharon and Baram-Tsabari 2014; Wong-Parodi and Bruine de Bruin 2017). But when people speak to one another using a shared language, we are adhering to the communication norms and inherent rules we have for our conversation partners—that we should comprehend and understand the intent of one another's messages (Grice 1975). We have identified that the terms heat advisory, excessive heat watch, excessive heat warning, and heat index are jargon, and thus should be avoided when possible and practical. Although we provide recommendations above, addressing what messages should specifically say is an open question for future research, which we discuss next.

***Limitations and future research.*** We used qualitative methods as the first step in assessing understanding and jargon (Bruine de Bruin and Bostrom 2013). Specifically, we used open-ended questions distributed via a survey to help us identify a problem: NWS heat terms have different meanings to the public. However, this approach restricts our ability to ask follow-up questions to participants. Furthermore, we do not measure how or whether differences in understanding lead to behavior change. As our next step, we will assess understanding via focus groups by asking about people's mental models, that is, their interpretation of "how things work." In this case, we may ask participants what causes heat and what it does to a person's body. These qualitative findings will then inform a large-scale survey with a representative sample of the United States to determine the extent to which heat beliefs are present and how they may vary, including examining regional differences. For example, more humid areas of the country may have a better understanding of heat index, and regions that have more heat products may be more familiar with their definitions.

Future research could also ask about heat terms that represent more ordinary or colloquial concepts (e.g., extreme heat, heat wave), but whose meanings likely vary between experts and the public (Castro et al. 2007; Venhuizen et al. 2019). Research could also include how people interpret heat impacts (e.g., heat illness) or protective action information (VanderMolen et al. 2022). Additionally, as Pitt and Hendrickson (2020) argue, the ways in which information is presented can also disrupt message processing; thus, stylistic choices, such as the use of acronyms, could also be assessed as a form of jargon. Furthermore, the NWS Hazard Simplification Program indicates that heat advisories will be replaced with "plain language" headlines that "more clearly describe weather and water hazards" (NWS 2024c, paragraph 1). The word "excessive" in watches and warnings is also being replaced with "extreme" (NWS 2024b), which could also be assessed to see if this word resonates more with the public. Future research should also expand the types of participants included by recruiting more diverse participants in a more systematic manner. This includes prioritizing vulnerable groups to see if they comprehend heat information differently (e.g., Lazrus et al. 2020).

Finally, it is important to note potential issues with data quality for online surveys. Although MTurk can match the data quality of more expensive panel participant providers (Snowberg and Yariv 2021), the effects of bots have been noted even on platforms with built-in protections (see Griffin et al. 2022). Furthermore, all researchers using asynchronous qualitative methods will have to be aware of the rise of applications like ChatGPT that participants may use to generate their responses. Thus, screening for data quality becomes even more important as data collection methods move increasingly online.

## 5. Conclusions

Because experts are deeply immersed in their field and accustomed to its specialized language, they may find it challenging to identify jargon. We demonstrate that excessive heat watches, excessive heat warnings, heat advisories, and heat index are jargon, as they mean something different to the public.

Jargon is a barrier to effective scientific and risk communication because it inhibits message understanding and protective action decision-making. Therefore, we recommend that these terms be avoided when possible and practical, or defined using plain language messaging.

**Data availability statement.** Data may be made available upon request.

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