BAMS Article

¿Aviso o Alerta? Developing Effective, Inclusive, and Consistent Watch and Warning Translations for U.S. Spanish Speakers

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ABSTRACT: Spanish-speaking populations in the United States are more vulnerable in disaster contexts due to inequities, such as language barriers, that prevent them from receiving life-saving information. For the past couple of decades, governmental organizations have addressed these issues by translating weather watches, warnings, and advisories into Spanish. Previous studies suggest that these Spanish translations do not communicate the same level of urgency as their English counterparts. To identify whether these translated products result in inequities between English and Spanish speaker reception and comprehension of forecast information, we asked a representative sample of U.S. English (n = 1,550) and Spanish (n = 1,050) speakers to correctly identify the translations of weather watches and warnings and found significant language inequities. Additionally, we asked U.S. Spanish speakers to indicate the urgency they felt when shown different Spanish words used in weather watch and warning translations. When presented with various translations for watch and warning terminology, respondents consistently rated *aviso*, the current translation of warning by the NWS and FEMA, as less urgent than many other alternatives. Additionally, the current translation of *advisory*, advertencia, communicated more urgency than both existing watch and warning translations in Spanish. To increase the effectiveness of severe weather messaging in multilingual contexts, translations should take into consideration factors such as culture and dialects of Spanish speakers in the United States and focus on translating the meaning, not the words, of key risk statements in weather products. We recommend *vigilancia* for "watch" and *alerta* for "warning" as research-supported terminologies to communicate urgency in Spanish.

KEYWORDS: Social science; Communications/decision making; Emergency preparedness; Policy; Societal impacts; Vulnerability

https://doi.org/10.1175/BAMS-D-22-0050.1

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In final form 8 August 2022

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In 1987, residents of a small, agricultural town in Saragosa, Texas, experienced a catastrophic F4 tornado with 151 of the town's 183 residents suffering injuries or casualties (Alexander 1987). As a sizable proportion of Saragosa's residents were non-English speaking, the majority of residents tuned in to Spanish-language programming during the night of the tornado (Aguirre 1988). Unfortunately, only English-language television programming offered emergency weather warnings, leaving Spanish radio as the only source of information for many that night. Spanish-speaking communities received inadequate communication from Spanish-language radio stations that night due to their use of a literal translation of the word "warning." Aguirre (1988) emphasized that the literal translation of "warning" in Spanish, *aviso*, does not convey the same meaning that the English-equivalent word does. The meaning of the word "warning," representing an imminent threat to life and property, has no literal translation into Spanish and creates an obstacle toward achieving equitable disaster communication in multilingual settings.

Nearly three decades later, the importance of multilingual disaster communication in the United States has only increased. Today, over 41 million Americans speak Spanish at home, with 93.6% of those Spanish speakers having Hispanic and Latinx[1] origin (U.S. Census Bureau 2019, 2020). By the year 2060, it is estimated that nearly one in four Americans will be of Hispanic/Latinx origin (Instituto Cervantes 2021). These communities also continue to diversify as new nationalities immigrate to the United States. It is crucial to understand these populations, as their culture and language can affect how they perceive, interpret, and react to different weather hazards, forecasts, and warnings (Trujillo-Falcón et al. 2021).

[1] The U.S. Census Bureau defines "Hispanic or Latino" as individuals of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture of origin regardless of race. We use the gender-inclusive term *Latinx* throughout the manuscript.

Despite ongoing efforts to diversify emergency communication, bilingual practitioners continue to produce inconsistent translations in their risk communication efforts, mainly due to a lack of reference materials in Spanish (Trujillo-Falcón et al. 2021). The NWS and FEMA have standardized watch and warning terminology that mainly stem from literal translations that frequently do not match across the two agencies. For example, the NWS translates the word "watch" as *vigilancia* and "warning" as *aviso* (Fig. 1; NWS 2021). Meanwhile, FEMA uses two different words to translate "watch" in their messaging: *advertencia*[2] and *vigilancia* (FEMA 2021). For "warning," FEMA uses *aviso*. However, in their social media graphics, FEMA also uses *advertencia* for "warning" and *amenaza* for "watch" (Fig. 2). Bilingual broadcast meteorologists

[2] The NWS also uses *advertencia* as the translation for "advisory." However, the NWS has announced the discontinuation of advisory products by no later than 2024 through the NWS Hazard Simplification project (Jacks 2021).

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Fig. 1. Translations that the NWS uses for Spanish-speaking audiences (www.weather.gov/wrn/tornado-graphics-SP).

throughout the United States have also used different versions of these words when translating them from English to Spanish, including *alerta* for "warning" and *amenaza* for "watch." Two issues emerge from these inconsistencies. First, government agencies are creating confusion, using some translations interchangeably for "watch" and "warning." Second, due to their

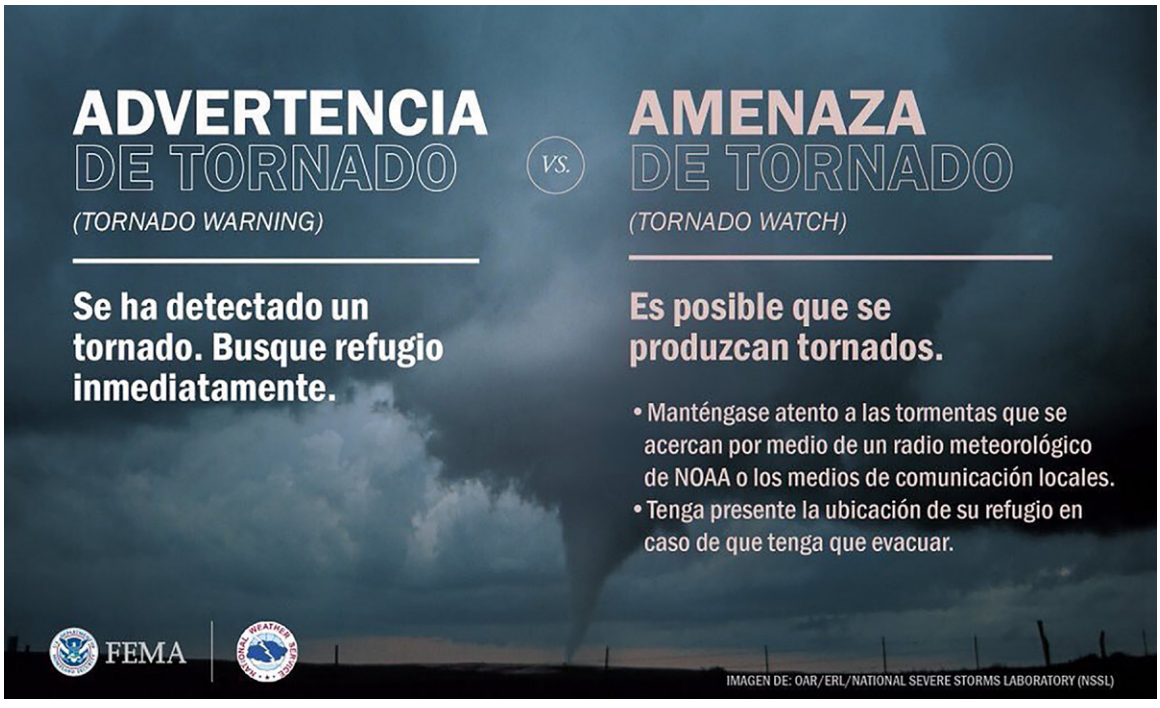

Fig. 2. Graphics that FEMA uses in their Spanish social media channels (www.ready.gov/collection/severe-weather).

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dialect, education, or other societal factors, Spanish speakers may interpret the various translations in different ways, resulting in different levels of disaster response (Lipski 2008; Trujillo-Falcón et al. 2021).

As there is no benchmark for translations that effectively communicate an imminent hazardous weather threat in Spanish, we sought to collect community data on U.S. English and Spanish speakers to understand current inequities and propose effective, inclusive, and consistent terminology going forward. The data on English speakers come from the Severe Weather and Society Survey (WxSurvey) conducted by the University of Oklahoma Institute for Public Policy Research and Analysis. The WxSurvey is a nationwide measure that evaluates how Americans receive, comprehend, and respond to weather-related risks (Ripberger et al. 2020). Conducted on an annual basis since 2017, the WxSurvey provides valuable feedback on how citizens from across the country react to deterministic and probabilistic information and make decisions with regards to the weather. In collaboration with The Pennsylvania State University, the survey was translated and fielded in Spanish (WxEncuesta) for the first time in 2021 to assess how Spanish speakers interpret meteorological hazards, forecasts, and warnings. Using both the WxSurvey and WxEncuesta, we explored how Spanish speakers interpret current watch and warning terminology and tested a variety of translations that could be more effective at communicating urgency. These data were then used to generate a series of research-driven recommendations to improve our warning communication terminology for all Spanish-speaking Americans.

A review of the warning system and its inequities to Spanish-speaking Americans

How warnings motivate populations to take action. Warnings, functional messages or systems of messages informing audiences of an imminent threat or danger, are essential in severe weather communication and have the potential to save lives and reduce harm (Vihalemm et al. 2012; Seeger and Sellnow 2016). Individuals perform an ongoing and evolving process of perception and interpretation when they first receive a warning message from trusted sources (Mileti and Sorensen 1990). Gathering cues and information from their surroundings, individuals consciously define whether a threat is real and pertinent to them. Using this theoretical framework, warning research has largely focused on three components: 1) message content, or *what* is said (e.g., Mileti and Sorensen 1990), 2) message style, or *how* it is said (e.g., Mileti and Peek 2000), and 3) message structure, or the *presentation* of information (e.g., Shen and Bigsby 2013). For the purpose of this manuscript, we focus on message style as it is interpreted by Spanish-speaking communities.

Message style, or how messages are written, impacts the way people respond to messages (Mileti and Peek 2000). Warning messages have the highest potential to promote appropriate response if they are specific, consistent, certain, clear, accurate, informative, and broadcast across multiple channels. These message characteristics were proven effective in experimental settings for a variety of population groups and hazards (e.g., Mileti and Beck 1975; Mileti and Peek 2000; Wood et al. 2018; Sutton et al. 2021). Specifically, for Spanish-speaking audiences, Aguirre (1988) found that language barriers inhibit individuals from properly interpreting and processing warning messages.

Warning inequities in multilingual settings. The NWS formally identified language inaccessibility as a vulnerability for Spanish-speaking communities in 1970, when an F5 tornado impacted the city of Lubbock, Texas (Environmental Science Services Administration 1970). As the tornado approached the city, the only Spanish-language radio station in the area stopped broadcasting to the public. Of the 26 people who died that day, half were identified as Spanish speakers. Forty years later, on 20 May 2013, a Spanish-speaking family perished in floodwaters after seeking shelter from a widely covered tornado threat in a storm drain

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(NWS 2014). Having no warning information in Spanish available to them, the family heard storm sirens and assumed they needed to prepare for tornadoes but were completely uninformed about the threat posed by an imminent flash flood. Both events resulted in tragedy for Spanish-speaking communities due to the lack of resources and information available in their native language. To prevent these losses in the future, scholars have recommended that preparedness efforts fully integrate factors including culture and language into emergency communication and policy at all levels (Benavides and Arlikatti 2010; Bethel et al. 2013; Méndez et al. 2020).

Despite these recommendations, government agencies continue to view underserved populations in the United States as monoliths, often providing blanket recommendations for various groups (Nepal et al. 2011). This practice has resulted in disaster agencies directly translating information to Spanish as a solution to reach and engage these groups. This is a laudable first step, but it is wrong to assume that the dialects spoken by different Spanish-speaking communities are addressed by such literal translations. Spanish-speaking populations also come from various parts of the world, experience different types of hazards, and can inherit different cultures of appropriate disaster response. Anderson (1965) and Wenger and Weller (1973) described this phenomenon as "disaster subcultures" and illustrated how some groups can be more knowledgeable than others. For example, consider a Spanish speaker of Mexican origin. Susceptible to earthquake threats in their home country, Mexicans have generational knowledge in surviving and adapting to geological hazards. In addition, Mexico has built their emergency systems, infrastructure, and messaging around earthquake hazards. If a Spanish speaker of Mexican origin immigrated to the United States, they would likely be ill-equipped to deal with hazards that are unknown to them, such as tornadoes. This vulnerability is exacerbated by the lack of a multilingual communication system in the United States, placing non-English speakers in general at a disadvantage to receive effective risk communication (Burke et al. 2012; Liu 2007).

A lack of studies of non-English speaking populations has limited advances to diversify emergency communication. Specifically, for severe weather, Spanish-language warning research is largely uncharted territory. The only pieces related to multilingual tornado information disparity known to date stem from Spanish tornado "watch" and "warning" mistranslation studies in the late 1980s (Aguirre 1988), a case study of the 2011 tornado outbreak in Georgia and Alabama (Stewart et al. 2014), and a case study conducted in northeast Oklahoma (Ahlborn and Franc 2012). All three studies revealed strong inequities in tornado warning reception and response between English- and Spanish-speaking individuals due to cultural and language disparities; however, recommendations have not been supported by a nationwide sample of Spanish speakers. To provide solutions forward, Trujillo-Falcón et al. (2021) suggested that *risk* terminology (not scientific jargon) need to be neutral across all dialects of Spanish so that it can be understood by all groups. Overall, researchers need to incorporate the viewpoints of the most marginalized in disaster contexts and view Spanish-speaking communities as complex groups with varying cultures, dialects, and origins, instead of as nothing more than communities that speak Spanish.

Methods

Participants. Survey data for this analysis are based on the 2021 iteration of the WxSurvey, an annual survey that measures tornado forecast and warning reception, comprehension, and response. This is the fifth survey in an annual series (see Silva et al. 2017, 2018, 2019; Krocak et al. 2020, 2021) and is the first to be simultaneously conducted in Spanish (Bitterman et al. 2021). The two versions of the survey were fielded from 9 June to 17 July 2021 using an online questionnaire that was completed by 1,550 English speakers and 1,050 U.S. Spanish-speaking adults aged 18 and older. Participants from both surveys were recruited

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by Qualtrics, a research company that maintains a pool of internet users who have agreed to take surveys. Qualtrics employs a dynamic sampling process to identify people in their panels and invite them to participate in the survey. The research company employs various strategies in recruiting respondents to match the sample to the demographic characteristics of the U.S. adult population, including targeted recruitment in underserved communities.

The WxEncuesta began with a screening question that asked respondents, "Do you speak Spanish?" Respondents had to say "yes, well" or "yes, very well" to participate in the survey. Broadly, the sample for WxEncuesta was representative of the U.S. Census for Spanish speakers based on age, sex, ethnic, and language composition (see Table 1 for a comparison of the census estimates to the WxEncuesta sample estimates). Populations that were undersampled include 65+ age adults (4%), males (39%), Mexicans (32%), and Spanish speakers from the NWS western region (25%). The analysis uses poststratification ("raking") survey weights to adjust for these discrepancies. In addition to ensuring the survey respondents were as representative of the U.S. Census as possible, we also measured socioeconomic factors like income, education, what state respondents live in, and what type of home they live in. To find more information about the WxEncuesta, including the survey instrument and basic statistics for every question, please see Bitterman et al. (2021). This manuscript also considers data from the English-language survey, the WxSurvey. Participants in the WxSurvey were also broadly representative of the population according to the U.S. Census [see Krocak et al. (2021) for more information about the survey].

Table 1. Demographic representation of the WxEncuesta participants. Population estimates were obtained from the American Community Survey microdata records, made available by IPUMS USA (www.ipums.org) (Ruggles et al. 2021).

	U.S. Spanish speakers (2020 Census) (%)	Survey participants (WxEncuesta) (%)
Age		
18–34	35	46
35–64	52	50
65+	13	4
Sex		
Female	50	61
Male	50	39
Ethnicity/nationality		
Not Hispanic	6	22
Mexican	55	32
Puerto Rican	8	15
Cuban	5	5
Other Hispanic	27	26
Speaks English		
No, not at all	8	3
Yes, but not well	16	16
Yes, well	19	27
Yes, very well	57	54
NWS region		
Eastern region	20	28
Southern region	37	38
Central region	9	10
Western region	34	25

Survey design. The WxEncuesta consisted of 150 questions that took participants an average of 20–25 min to complete. Questions were designed to assess how U.S. Spanish speakers receive, comprehend, and respond to severe weather information, following Ripberger et al. (2020). The survey was developed and validated for clarity in English, then translated to Spanish by the first, second, eighth, and ninth authors. The eighth and ninth authors are experts in Spanish translation, and, being outside the physical sciences, they were able to develop simple and effective Spanish translations to all questions. The survey was also piloted to bilingual meteorologists in the academic, public, and broadcast sectors to ensure that terminology reflected what is currently being used in the field since there is no official U.S. English-to-Spanish weather and climate dictionary at the time of publication

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Table 2. Survey questions of interest for WxSurvey and WxEncuesta participants.

Questions	English (WxSurvey)	Spanish (WxEncuesta)
Tornado watch (Q1)	To the best of your knowledge, is the following alert considered a tornado watch or a warning? This alert is issued when severe thunderstorms and tornadoes are possible in and near the area. It does not mean that they will occur. It only means they are possible.	A su mejor conocimiento, ¿la siguiente descripción es considerada una [vigilancia | amenaza] o [un aviso | una alerta] de tornado? Esta alerta se emite cuando tormentas severas y tornados son posibles en o cerca del área. Esto no significa que vayan a ocurrir. Sólo significa que son posibles.
Tornado warning (Q2)	To the best of your knowledge, is the following alert considered a tornado watch or a warning? This alert is used when a tornado is imminent. When this alert is issued, seek safe shelter immediately	A su mejor conocimiento, ¿la siguiente descripción es considerada una [vigilancia | amenaza] o [un aviso | una alerta] de tornado? Esta alerta es utilizada cuando un tornado es inminente. Cuando se emite esta alerta, busque refugio inmediatamente.
Rating urgency of Spanish terminology (Q3)	—	Cuando ves las siguientes palabras de alerta, ¿cómo categorizas la urgencia de tomar medidas de protección?

(Trujillo-Falcón et al. 2021). Refinements to the translation and terms used were made based on feedback from these bilingual professionals, but no major changes to the survey content were made. Prior to distribution, the questions in English and Spanish were approved by the University of Oklahoma Institutional Review Board (OU IRB 9418).

For the purpose of this manuscript, we analyzed questions that focused on tornado watches and warnings. First, we provided the definitions of a watch (Q1) and warning (Q2) in English for the WxSurvey and in Spanish for the WxEncuesta (Table 2). Afterward, we asked both groups to correctly identify whether a given example of a weather product described a watch or warning. Since government agencies and bilingual broadcast stations use various terminology for watches and warnings, we randomly assigned the words *vigilancia* or *amenaza* for watch and *aviso* or *alerta* for warning in the survey question to best simulate the inconsistency that various bilingual speakers experience when receiving warning information. We decided on these terms after speaking with various bilingual practitioners in the field. Consulting with the eighth and ninth authors, who are Spanish dialectology experts, our team also identified a series of different translations for watch and warning: *advertencia*, *vigilancia*, *amenaza*, *aviso*, *alerta*, and *emergencia* (Q3). The list was further verified by bilingual meteorologists in the NWS and in the broadcast enterprise. WxEncuesta participants were asked to rate the urgency that each word conveyed to them from not at all urgent to extremely urgent on a 1–5 Likert scale.

All WxEncuesta participants were also asked questions that sought to identify their ethnicity, nationality (i.e., country of origin), and English proficiency. Suggested by the literature reviewed in the previous section, the WxEncuesta made sure to view Spanish speakers as groups of varying cultures and dialects. This additional information guarantees that the most disadvantaged Spanish speakers are considered in our study. For example, a Spanish speaker with no English proficiency is more vulnerable than someone who can interpret English and potentially confirm their doubts about a weather product with English-language warning information (Burke et al. 2012; Stewart et al. 2014).

Results

Beginning with our first research question (Q1), we found significant differences in how U.S. English- and Spanish-speaking populations interpreted watch and warning terminology. Where 66% of English speakers correctly identified a tornado watch with the given descriptions, only 38% of Spanish speakers were able to do so (Fig. 3a). Nearly half of Spanish speakers (49%) thought that the description for a tornado watch was actually a warning, choosing the warning word option (*aviso* or *alerta*) as their answer instead of the watch word option (*vigilancia* or *amenaza*). This was nearly twice the percentage of English speakers that suggested a description of a tornado watch was an example of a tornado warning (28%). Spanish speakers were also more likely to not know the answer to the watch description questions altogether (13% versus 6% for English speakers).

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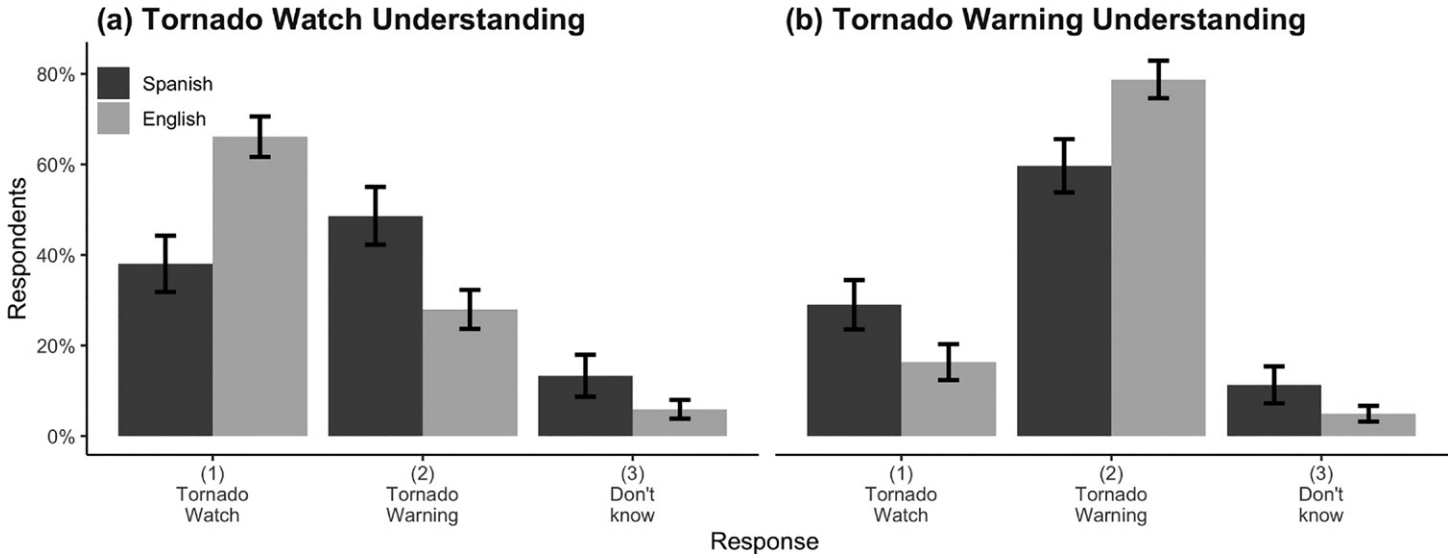

Fig. 3. How WxSurvey and WxEncuesta participants responded when asked to correctly identify a (a) tornado watch and (b) tornado warning.

This trend continued for the warning terminology (Fig. 3). While 79% of English speakers correctly identified the definition of a tornado warning, only 60% of Spanish speakers were able to do so. Nearly one-third (29%) of Spanish participants chose the watch word option (*vigilancia* or *amenaza*) when given the definition of a warning. This was, again, nearly double the fraction of English speakers that defined a warning as a watch (16%). Twice as many Spanish speakers responded that they did not know the answer to the warning description question (11%) when compared to their English-speaking counterparts (5%).

Participants were also asked to rank the urgency of a series of variations of watch and warning terminology in Spanish using a Likert scale, where 1 was least urgent and 5 was most urgent (Q3). Figure 4a shows that *emergencia* (emergency) was rated the most urgent

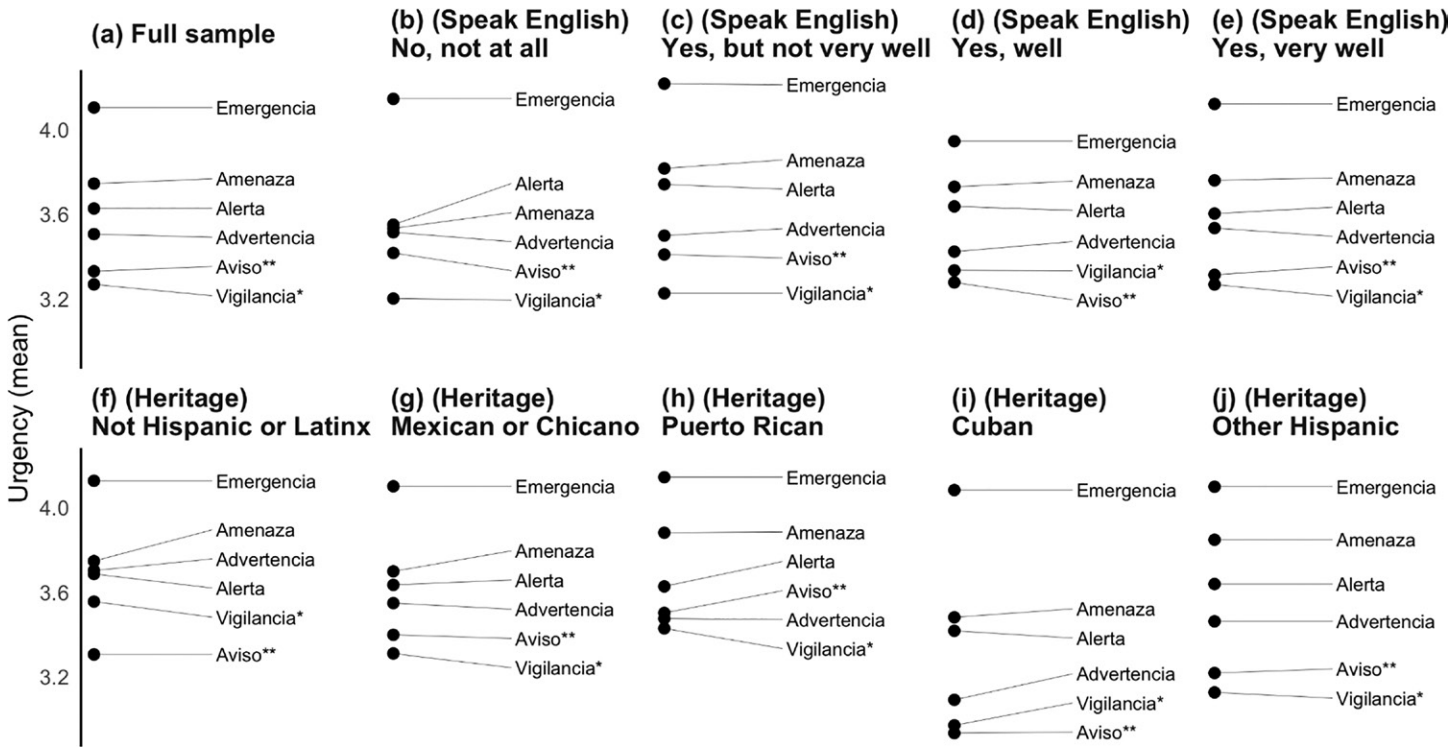

Fig. 4. How WxEncuesta participants rated variations of watch and warning terminology based on *urgency*. The Asterisks denote current NWS translations of watch (*) and warning (**).

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with an average response of 4.11 out of 5. Following *emergencia*, the word *amenaza* was rated second, with a mean score of 3.75 out of 5. *Alerta* came in third, averaging a mean urgency score of 3.63 out of 5. *Advertencia* followed in fourth place with a mean urgency score of 3.51 out of 5. Finally, the words *aviso* and *vigilancia* (i.e., the current NWS translations for warning and watch) were rated the least urgent words with average scores of 3.33 and 3.27 out of 5, respectively.

As shown in Figs. 4b–e, all participants across the English proficiency subcategories rated *emergencia*, *alerta*, and *amenaza* as words that communicate the most urgency. Participants from the most vulnerable group (no English proficiency), rated *vigilancia* and *aviso* as the least urgent terms. It is important to note that, for this group, *alerta* conveyed more urgency than *amenaza*. In terms of ethnicity and nationality, the means shown in Figs. 4f–j indicated that all origin groups classified *emergencia*, *alerta*, and *amenaza* as the preferred terminology to communicate urgency. And again, respondents in all five groups categorized *vigilancia* and *aviso* at the lowest level of urgency. Overall, these results indicated few dialectical differences between the various translations of watch and warning, suggesting that any translation embraced in the future can be applicable across all dialectical groups.

Discussion

To ensure that life-saving information overcomes language barriers, warning translations need to be relevant to the communities that they serve (Trujillo-Falcón et al. 2021). One important aspect involves the use of dialect-neutral translations for risk terminology so that Spanish speakers can understand the message being communicated and give them the proper tools to interpret and process the threat that will ultimately result in protective action (Mileti and Sorensen 1990). Given the complexities of communicating weather warnings to U.S. Spanish speakers, this study sought to 1) explore the inequities between English and Spanish speakers and 2) assess the best terminology to communicate urgency when it comes to imminent severe weather threats.

Compared to English speakers, Spanish speakers were less successful at identifying the correct definition for current tornado watches and warnings. In the case of watch information, there was a significant divide between English and Spanish speakers in their understanding altogether (67% and 38%, respectively). A possible explanation behind Spanish speakers' confusion revolves around current practices in the bilingual weather enterprise. It is hardly surprising that there is significant confusion surrounding the terms used to communicate products when different agencies are using those words interchangeably. Such inequities in bilingual risk communication can translate to ineffective preparedness planning (Aguirre 1988). This work finds that the warning inequities that previous studies have identified among local populations of native English and Spanish speakers (Ahlborn and Franc 2012) also exist in the national context.

These findings are immediately relevant to an operational forecast context, as they suggest that the terminology employed by the NWS and FEMA to communicate watch and warning information is not ideal for communicating urgency of a threat to Spanish speakers in the United States. Our data show that the NWS definitions for watch and warning, *vigilancia* and *aviso*, were ranked as conveying the least sense of urgency among all different variations of watch and warning terminology by Spanish-speaking participants. The NWS definition of "advisory," *advertencia*, communicated more urgency than their watch and warning counterparts. Extending research from the NWS Hazard Simplification project (Eastern Research Group 2018), our data explain how *advertencia* can cause confusion when communicated alongside current NWS watch and warning translations. To alleviate this misunderstanding, our data support the discontinuation of advisory products by the NWS in Spanish as well (Jacks 2021). As for FEMA, their watch translations, *advertencia* and *amenaza*, communicated

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more urgency than their warning translation, *aviso*. Overall, our findings verify previous claims by Aguirre (1988) that *aviso* does not communicate urgency and action during severe weather threats. In addition, this difference in level of urgency may also explain why Spanish speakers were not able to correctly identify the definitions of watch and warning (Q1).

Our study also reveals how consistency may look across different languages. Social science literature has debated whether consistency is necessary to achieve effective risk communication (e.g., Weyrich et al. 2019; Burgeno and Joslyn 2020; Su et al. 2020; Williams and Eosco 2021). However, previous studies and definitions have not analyzed consistency *across languages*. When translating emergency messages from English to Spanish, practitioners should consider the translation of the *meaning* rather than the *word* when developing consistent, effective, and inclusive multilingual communication. Government agencies may miss valuable contexts that alternate translations can provide if they only translate the word and not the meaning. Our study provides empirical evidence of this, as the literal translation of warning (*aviso*) did not communicate more urgency than other translations. This work provides evidence that government agencies should adopt policies that embrace *relevant*, not *literal*, translations that resonate with the communities they serve. To a non-Spanish speaker, a relevant translation might seem like a translation is not "consistent" with the English word (e.g., the literal translation of *alerta* is "alert," not "warning"). However, it is important to point out that many bilingual speakers understand the differences between literal and relevant translations, and this approach would only improve the understanding of multilingual risk communication messaging. Furthermore, government agencies should incorporate language experts (e.g., certified translators) that are able to create relevant and clear translations to multilingual communities. Our study provides a valuable framework for future terminology development, as it fostered collaboration with language experts and social scientists to confirm the best terminology to use in disaster contexts.

To best communicate urgency and action during severe weather threats, these findings suggest that the word *alerta* should be used for warning and *vigilancia* for watch. Though *emergencia* communicated the most urgency of all the words examined, the NWS currently uses the translation for tornado emergencies, a special warning issued in confirmed, catastrophic scenarios (NWS 2021). Across all linguistic and speaking proficiency groups, *amenaza* and *alerta* communicated the most urgency after *emergencia* (Fig. 4); however, the most vulnerable group (i.e., Spanish speakers that do not speak English at all) preferred *alerta* over *amenaza*. Additionally, FEMA currently uses *amenaza* for watch (Fig. 2) and it may cause additional confusion if the definition suddenly changed to warning. Therefore, using the word *alerta* would provide a fresh beginning for government agencies to embark on educational campaigns. Future work should investigate how using the words *alerta* and *vigilancia* impact watch and warning interpretation, urgency, and intended response actions.

Limitations

As mentioned in the "A review of the warning system and its inequities to Spanish-speaking Americans" section, warning research focuses on three main areas: 1) message content (Mileti and Sorensen 1990), 2) message style (Mileti and Peek 2000), and 3) message structure (Shen and Bigsby 2013). Our findings mainly contributed to understanding the impacts of changes to message style, or how a message is crafted. More specifically, we explored how literal translations are insufficient and unclear for many Spanish speakers, as the meaning of the message gets lost in translation. Future research for bilingual populations should emphasize on what type of information (message content) Spanish speakers most resonate with, in addition to how they prefer to receive it (message structure). Additionally, aspects beyond ethnicity and nationality should be explored, including gender, age, income level, and other demographic and socioeconomic characteristics.

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Finally, it is important to acknowledge that large surveys like this provide valuable data, but they likely ostracize important and especially vulnerable members of Spanish-speaking communities, such as those who do not trust researchers or who do not have access to technologies that allow survey participation and would much prefer qualitative, interactive approaches (De La Rosa et al. 2011). It is recommended that future studies consider qualitative analyses and mixed methods approaches, as these approaches have the best opportunity to capture all groups.

Conclusions

For decades, Spanish-speaking communities have experienced inequities in risk communication during life-threatening weather hazards and continue to face the consequences of an emergency system that does not incorporate multilingual and multicultural perspectives. As a first step in engaging non-English populations in the United States, disaster communicators should create translations that resonate with these communities. This requires that the *meaning*, rather than the *word*, be translated from English. Our study found that, in the context of weather watches and warnings, *vigilancia* and *alerta* are good candidates to communicate urgency after considering the perspectives of Spanish speakers who do not speak English at all. Future work should specifically investigate these terms with Spanish-speaking populations to evaluate interpretation and intended response. By no longer analyzing Spanish-speaking communities as monoliths, but rather as groups of cultures and dialects, researchers and government agencies can develop best practices that resonate with underserved communities in the United States.

Acknowledgments. Special appreciation goes to Scott Robinson, Sebastián Torres, and Kodi Berry for insightful review. Data collection for this project was funded by the OU Office of the Vice President for Research and Partnerships. Data analysis and research support was funded by the NOAA Weather Program Office (Accelerating Development of the U.S. Extreme Weather and Society Survey Series, NA16OAR4320115). Trujillo-Falcón's funding was provided by the NOAA/Office of Oceanic and Atmospheric Research under NOAA–University of Oklahoma Cooperative Agreement NA21OAR4320204, U.S. Department of Commerce.

Data availability statement. All data used in this study are openly available from the Harvard Dataverse at https://dataverse.harvard.edu/dataverse/wxsurvey as cited in Bitterman et al. (2021) and Krocak et al. (2021).

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References

Aguirre, B. E., 1988: Feedback from the field: The lack of warnings before the Saragosa tornado. *Int. J. Mass Emerg. Disasters*, **6**, 65–74, www.ijmed.org/articles/133/download/.

Ahlborn, L., and J. M. Franc, 2012: Tornado hazard communication disparities among Spanish-speaking individuals in an English-speaking community. *Prehosp. Disaster Med.*, **27**, 98–102, https://doi.org/10.1017/S1049023X12000015.

Alexander, B., 1987: The Saragosa, TX tornado. Storm Track, accessed 14 December 2021, https://stormtrack.org/library/1987/saragosa.htm.

Anderson, W. A., 1965: Some observations on a disaster subculture: The organizational response of Cincinnati, Ohio, to the 1964 flood. Ohio State University Disaster Research Center Research Note 6., 26 pp., https://udspace.udel.edu/bitstream/handle/19716/1242/RN6.pdf?sequence=1&isAllowed=y.

Benavides, A., and S. Arlikatti, 2010: The role of the Spanish-language media in disaster warning dissemination: An examination of the Emergency Alert System. *J. Span. Lang. Med.*, **3**, 41–58.

Bethel, J. W., S. C. Burke, and A. F. Britt, 2013: Disparity in disaster preparedness between racial/ethnic groups. *Disaster Health*, **1**, 110–116, https://doi.org/10.4161/dish.27085.

Bitterman, A., J. Ripberger, M. Krocak, C. Silva, H. Jenkins-Smith, J. E. Trujillo-Falcón, and A. Gaviria Pabón, 2021: Developing a baseline: Public reception, understanding, and responses to severe weather forecasts and warnings for U.S. Spanish speakers. Institute for Public Policy Research and Analysis–University of Oklahoma Ref. Rep., 29 pp., https://doi.org/10.7910/DVN/IZNQVA.

Burgeno, J. N., and S. L. Joslyn, 2020: The impact of weather forecast inconsistency on user trust. *Wea. Climate Soc.*, **12**, 679–694, https://doi.org/10.1175/WCAS-D-19-0074.1.

Burke, S., J. W. Bethel, and A. F. Britt, 2012: Assessing disaster preparedness among Latino migrant and seasonal farmworkers in eastern North Carolina. *Int. J. Environ. Res. Public Health*, **9**, 3115–3133, https://doi.org/10.3390/ijerph9093115.

De La Rosa, M., R. Babino, A. Rosario, N. V. Martinez, and L. Aijaz, 2011: Challenges and strategies in recruiting, interviewing, and retaining recent Latino immigrants in substance abuse and HIV epidemiologic studies. *Amer. J. Addict.*, **21**, 11–22, https://doi.org/10.1111/j.1521-0391.2011.00193.x.

Eastern Research Group, 2018: Final report: National Weather Service hazard simplification: Public survey. NOAA/NWS Rep., 161 pp., www.weather.gov/media/hazardsimplification/HazSimp%20Public%20Survey%20-%20Final%20Report%20-%2006-01-18.pdf.

Environmental Science Services Administration, 1970: The Lubbock, Texas, tornado May 11, 1970. Natural Disaster Survey Rep. 70-1, 33 pp., www.weather.gov/media/publications/assessments/Lubbock%20Tornado%201965.pdf.

FEMA, 2021: Prepárese: Definición de los términos clave de preparación. FEMA, www.fema.gov/es/fact-sheet/be-prepared-defining-key-preparedness-terms.

Instituto Cervantes, 2021: El español: Una lengua viva. Instituto Cervantes Annual Rep., 86 pp., https://cvc.cervantes.es/lengua/espanol_lengua_viva/pdf/espanol_lengua_viva_2021.pdf.

Jacks, E., 2021: Planned major change to NWS' hazard messaging headlines no earlier than calendar year 2024. NWS Public Information Statement 21-12, 3 pp., www.weather.gov/media/notification/pdf2/pns21-12_haz_simp_headlines.pdf.

Krocak, M., J. Ripberger, C. Silva, H. Jenkins-Smith, S. Ernst, A. Bell, and J. Allan, 2020: Measuring change: Public reception, understanding, and responses to severe weather forecasts and warnings in the contiguous United States. Center for Risk and Crisis Management Ref. Rep., 31 pp., https://doi.org/10.7910/DVN/EWOCUA/XYEHYZ.

——, ——, ——, ——, A. Gaviria-Pabón, A. Forney, and A. Bitterman, 2021: Continuing the series: Public reception, understanding, and responses to severe weather forecasts and warnings in the contiguous United States. Center for Risk and Crisis Management Ref. Rep., 33 pp., https://doi.org/10.7910/DVN/QYZLSO.

Lipski, J. M., 2008: *Varieties of Spanish in the United States.* Georgetown University Press, 320 pp.

Liu, B. F., 2007: Communicating with Hispanics about crises: How counties produce and provide Spanish-language disaster information. *Public Relat. Rev.*, **33**, 330–333, https://doi.org/10.1016/j.pubrev.2007.04.001.

Méndez, M., G. Flores-Haro, and L. Zucker, 2020: The (in)visible victims of disaster: Understanding the vulnerability of undocumented Latino/a and indigenous immigrants. *Geoforum*, **116**, 50–62, https://doi.org/10.1016/j.geoforum.2020.07.007.

Mileti, D. S., and E. M. Beck, 1975: Communication in crisis: Explaining evacuation symbolically. *Commun. Res.*, **2**, 24–49, https://doi.org/10.1177/009365027500200102.

——, and J. H. Sorensen, 1990: Communication of emergency public warnings: A social science perspective and state-of-the-art assessment. Oak Ridge National Laboratory Rep. ORNL-6609, 162 pp., https://doi.org/10.2172/6137387.

——, and L. Peek, 2000: The social psychology of public response to warnings of a nuclear power plant accident. *J. Hazard. Mater.*, **75**, 181–194, https://doi.org/10.1016/S0304-3894(00)00179-5.

Nepal, V., D. Banerjee, M. Perry, and D. Scott, 2011: Disaster preparedness of linguistically isolated populations: Practical issues for planners. *Health Promot. Pract.*, **13**, 265–271, https://doi.org/10.1177/1524839910384932.

NWS, 2014: May 2013 Oklahoma tornadoes and flash flooding. NWS Service Assessment, 63 pp., www.weather.gov/media/publications/assessments/13oklahoma_tornadoes.pdf.

——, 2021: English-Spanish dictionary. National Oceanographic and Atmospheric Administration, accessed 14 December 2021, www.weather.gov/mfl/EngSpaDict.

Ripberger, J., C. L. Silva, H. C. Jenkins-Smith, J. Allan, M. Krocak, W. Wehde, and S. Ernst, 2020: Exploring community differences in tornado warning reception, comprehension, and response across the United States. *Bull. Amer. Meteor. Soc.*, **101**, 936–948, https://doi.org/10.1175/BAMS-D-19-0064.1.

Ruggles, S., S. Flood, S. Foster, R. Goeken, J. Pacas, M. Schouweiler, and M. Sobek, 2021: IPUMS USA, version 11.0. IPUMS, accessed 18 April 2022, https://doi.org/10.18128/D010.V11.0.

Seeger, M. W., and T. L. Sellnow, 2016: *Narratives of Crisis: Telling Stories of Ruin and Renewal.* Stanford University Press, 216 pp.

Shen, L., and E. Bigsby, 2013: The effects of message features: Content, structure, and style. *The Sage Handbook of Persuasion: Developments in Theory and Practice*, J. P. Dillard and L. Shen, Eds., Sage, 20–35.

Silva, C., J. Ripberger, H. Jenkins-Smith, and M. Krocak, 2017: Establishing the baseline: Public reception, understanding, and responses to severe weather forecasts and warnings in the contiguous United States. Center for Risk and Crisis Management Ref. Rep., 30 pp., http://risk.ou.edu/downloads/news/WX17-Reference-Report.pdf.

——, ——, ——, ——, and W. Wehde, 2018: Refining the baseline: Public reception, understanding, and responses to severe weather forecasts and warnings in the contiguous United States. Center for Risk and Crisis Management Ref. Rep., 29 pp., http://risk.ou.edu/downloads/news/WX18-Reference-Report.pdf.

——, ——, ——, ——, S. Ernst, and A. Bell, 2019: Continuing the baseline: Public reception, understanding, and responses to severe weather forecasts and warnings in the contiguous United States. Center for Risk and Crisis Management Ref. Rep., 33 pp., http://risk.ou.edu/downloads/news/WX19-Reference-Report.pdf.

Stewart, A. E., C. Capielo, and I. P. Ocampo, 2014: Sources, perceptions, and needs for weather information by Spanish-speaking residents in Georgia. *Ninth Symp. on Policy and Socio-Economic Research*, Athens, GA, Amer. Meteor. Soc., J.6.1, https://ams.confex.com/ams/94Annual/webprogram/Paper236423.html.

Su, C., J. N. Burgeno, and S. Joslyn, 2020: The effects of consistency among simultaneous forecasts on weather-related decisions. *Wea. Climate Soc.*, **13**, 3–10, https://doi.org/10.1175/WCAS-D-19-0089.1.

Sutton, J., L. Fischer, and M. M. Wood, 2021: Tornado warning guidance and graphics: Implications for the inclusion of protective action information on perceptions and efficacy. *Wea. Climate Soc.*, **13**, 1003–1014, https://doi.org/10.1175/WCAS-D-21-0097.1.

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Trujillo-Falcón, J. E., O. Bermúdez, K. Negrón-Hernández, J. Lipski, E. Leitman, and K. Berry, 2021: Hazardous weather communication en español: Challenges, current resources, and future practices. *Bull. Amer. Meteor. Soc.*, **102**, 765–773, https://doi.org/10.1175/BAMS-D-20-0249.1.

U.S. Census Bureau, 2019: B16006: Language spoken at home by ability to speak English for the population 5 years and over (Hispanic or Latino). 2019 American Community Survey 5-year estimates, accessed 10 November 2021, https://data.census.gov/cedsci/.

——, 2020: P2: Hispanic or Latino, and not Hispanic or Latino by race. 2020 Decennial Census, accessed 12 December 2021, https://data.census.gov/cedsci/.

Vihalemm, T., M. Kiisel, and H. Harro-Loit, 2012: Citizens' response patterns to warning messages. *J. Contingencies Crisis Manage.*, **20**, 13–25, https://doi.org/10.1111/j.1468-5973.2011.00655.x.

Wenger, D. E., and J. M. Weller, 1973: Disaster subcultures: The cultural residues of community disasters. University of Delaware Disaster Research Center Preliminary Paper 9, 18 pp., https://udspace.udel.edu/handle/19716/399#files-area.

Weyrich, P., A. Solobig, and A. Patt, 2019: Dealing with inconsistent weather warnings: Effects of warning quality and intended actions. *Meteor. Appl.*, **26**, 569–583, https://doi.org/10.1002/met.1785.

Williams, C. A., and G. M. Eosco, 2021: Is a consistent message achievable? Defining "message consistency" for weather enterprise researchers and practitioners. *Bull. Amer. Meteor. Soc.*, **102**, 279–295, https://doi.org/10.1175/BAMS-D-18-0250.1.

Wood, M. M., D. S. Mileti, H. Bean, B. F. Liu, J. Sutton, and S. Madden, 2018: Milling and public warnings. *Environ. Behav.*, **50**, 535–566, https://doi.org/10.1177/0013916517709561.

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