Spanish Speakers in the United States Report Differing Levels of Weather Salience Based on Their Ethnocultural Background

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ABSTRACT: Weather profoundly shapes our daily lives, yet its psychological impact varies distinctly among different cultural and ethnic groups. In a comprehensive analysis of 974 Spanish-speaking individuals in the United States, our research delves into three dimensions of weather salience—a measure of the psychological importance attributed to weather. Contrary to expectations, geographic location within the United States does not significantly influence weather salience dimensions among Spanish-speaking populations. Rather, differences in weather salience emerge based on the nativity and origin country of a Spanish speaker. Foreign-born Spanish speakers exhibit higher weather salience compared to their U.S.-born counterparts, with notable differences in daily attention to weather and severe weather events. Additionally, the degree of psychological attunement to weather distinctly varies among different Hispanic and Latino ethnic groups within Spanish-speaking communities. These findings help explain why weather salience may be lower among Spanish-speaking groups and highlight the variability across different cultural groups. Tailoring messages to the unique experiences and backgrounds of diverse Spanish-speaking communities is essential, moving beyond simple language translation to embrace the rich cultural tapestry of these groups.

SIGNIFICANCE STATEMENT: Our research explored how different Spanish-speaking groups in the United States conceptualize weather in their daily lives. Surprisingly, where they live in the United States does not change their views much. Instead, whether they were born in the United States or elsewhere, and their specific cultural background, really matters. People born outside the United States generally apply more significance to the weather and its changes. This shows us that when communicating about weather to these groups, it is important to understand and respect the diverse cultures of Spanish-speaking communities, going beyond just translating messages into Spanish.

KEYWORDS: Social Science; Communications/decision making; Emergency preparedness; Vulnerability

1. Introduction

During the 10–11 December 2021, tornado outbreak, Spanish-speaking communities faced disproportionate inequities when receiving lifesaving information (Trujillo-Falcón et al. 2024a). Amid the outbreak, the absence of warning messages in languages other than English and a lack of culturally sensitive risk communication severely hindered these communities. Multilingual residents, caught in a critical window where every minute mattered, faced delays in making crucial decisions, as they tried to make sense out of the emerging catastrophe from their cultural viewpoint. For those who never experienced a tornado, the lack of reference points made it nearly impossible to make swift, lifesaving decisions. Interviews with tornado survivors revealed disparities in risk perception rooted in the varied cultures and experiences of individuals from different Latin American countries.

Representing one in ten Americans, the Spanish-speaking community in the United States, numbering 41.2 million, predominantly comprises individuals of Hispanic or Latino origin,[1] who constitute 94% of this linguistic group (U.S. Census Bureau 2021). The Spanish-speaking population is expected to expand significantly in the next couple of decades, with some estimates reporting that nearly one in four Americans will speak Spanish by 2060 (Instituto Cervantes 2022). As populations diversify, the weather enterprise has focused its attention on creating equitable approaches to risk communication to underserved communities or people who have limited access to lifesaving resources and information (Smith et al. 2023; Tripati et al. 2024). Specifically for Spanish-speaking groups, the absence of a nationwide multilingual system limits the proper accessibility of lifesaving information (Trujillo-Falcón et al. 2022). Government agencies also tend to view these communities as monolithic, categorizing entire Hispanic and Latino populations as a single group (Bethel et al. 2013). As evidenced in the 10–11 December

[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. About 71% of Hispanics or Latinos speak Spanish. Therefore, a distinction is made between cultural identity and linguistic ability.

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2021, tornado outbreak example, this approach can be extremely problematic, as Hispanic and Latino populations tend to respond differently to disasters depending on their ethnic origin, language dialect, and nativity, or place of birth (Bitterman et al. 2023; Gaviria Pabon 2022).

To gain deeper insight into the diverse levels of risk awareness and perception among Spanish-speaking groups, we refer to the measure of weather salience. Stewart (2009) coined the term weather salience to describe "the degree to which individuals attribute psychological value or importance to the weather and the extent to which they are attuned to their atmospheric environments." Through a national survey, Stewart et al. (2012) found that people's level of weather salience influences their use of and confidence in weather information. This finding spearheaded a ton of studies that have expanded our understanding of how people perceive and respond to weather events. Silver (2015) used weather salience to explore perceptions and preferences of weather information among the Canadian public. Bolton et al. (2020) incorporated weather salience scales to provide evidence that individuals with autism tend to assign increased psychological importance to the weather. Williams et al. (2017) took a more operational approach to explore how weather-salient populations incorporate products from the NWS into their everyday lives. While much research has emerged from the weather salience literature, there are still avenues for further investigation. Stewart et al. (2014), for example, noted that Spanish-speaking communities have lower levels of weather salience due to cultural factors in how they consume and make sense of weather events. However, these cultural variables have not been explored in detail.

Our study aims to provide a deeper understanding of Spanish speakers in the United States by exploring how cultural and geographical variables influence their psychological attunement to the weather and its changes. We focus specifically on two dimensions of weather salience to unravel differences among Spanish-speaking groups. Namely, the two subscales of focus are 1) attention to weather and weather information and 2) attachment to weather patterns. Additionally, we developed a third subscale to analyze attention to and perception of severe weather, as many Spanish speakers are disproportionately affected by these phenomena: 3) attention to the weather when it can become severe or hazardous (Senkbeil et al. 2014; Stewart et al. 2014). In section 2, we review the concept of weather salience in more detail and provide our hypotheses and rationale for the study. Sections 3 and 4 review the national survey and the statistical analyses we conducted. Section 5 provides recommendations on how researchers should analyze Spanish-speaking communities in the future based on our findings and literature from intercultural and risk communication, along with insights for practitioners looking to expand their reach to underserved populations.

2. Weather salience: Why might it differ among multilingual groups?

a. The measure of weather salience

When Stewart (2009) first conceptualized the term weather salience, the author relied extensively on literature from environmental psychology to explain its theoretical foundation and properly measure it in research (Campbell 1983; Stokols 1979). Primarily an individual construct, weather salience can be complex to quantify, as it involves various psychological processes. Stewart (2009) included five key constructs when developing the term weather salience: 1) perceptual salience, 2) emotional valence, 3) duration and periodicity of the weather event, 4) degree of predictability and controllability of environmental events, and 5) psychological attachment to types of weather.

The first component of weather salience revolves around the premise that weather is perceived as salient by people in proportion to how it affects their sensory and perceptual abilities (Taylor and Fiske 1978). In other words, perceptual salience explains that people will pay attention to the weather or changes in the weather when they become aware of them overall. Second, emotional valence describes how individuals experience weather and how it affects their emotions (Campbell 1983). Depending on the magnitude and severity, weather can bring about emotional reactions among populations that prompt them to take different actions (Ortony 2009). Third, depending on their duration and periodicity, weather events can be significant to an individual if they are repetitive and/or variable (Evans and Cohen 1987). While extreme weather can be more common in certain areas than others, it is important to note that the weather does not have to be severe for it to be significant. The fourth weather salience construct, degree of predictability and controllability, describes how one's weather salience varies based on how the weather affects one's everyday life and routine (Campbell 1983). The fifth and final construct of weather salience relates to the psychological attachment to types of weather. As individuals become accustomed to the local geography of their surrounding area (Altman and Low 1992), they can also become attached to the local weather of their area (Knez 2005). Recent national surveys support this construct quantitatively, as the U.S. public tends to rate their level of risk to hazards, they are more attached to geographically (Ripberger et al. 2020).

Based on these five theoretical constructs, Stewart (2009) developed the Weather Salience Questionnaire (WxSQ) by assessing 53 statements with undergraduate students to explore various aspects of weather salience. Participants rated their agreement or the frequency of occurrences on a five-point scale (1 = strongly disagree to 5 = strongly agree; 1 = never to 5 = always). Through factor analysis, the list was refined to 29 items, which fit well with the data and measured seven dimensions of weather salience. These seven dimensions, grounded in environmental psychology theories reviewed above, include the following:

1) Attention to weather and to weather information (e.g., "I seek out more up-to-date weather information than what is provided on the television or radio").
2) Sensing and observing weather directly (e.g., "I notice how the clouds look during various kinds of weather").
3) Effects of daily weather on daily activities [e.g., "The work that I do (or did previously) is affected by the daily weather conditions"].

4) Effects of weather on daily mood (e.g., "There is a particular kind of weather that makes me feel good emotionally").
5) Attachment to weather patterns (e.g., "I am attached to the weather and climate that exists in the location where I lived as a child or adolescent").
6) Need to experience weather variability (e.g., "It is important to me to live in a place that offers a variety of different weather conditions throughout the year").
7) Attention to weather when it may result in a holiday or cancellation (e.g., "In the past, I have wished for weather that would result in a weather-related holiday").

For more information about the 29-item measure that assesses the reviewed dimensions, see Stewart (2009).

b. *Exploring weather salience dimensions in Spanish-speaking communities*

Despite the growing number of Spanish speakers, little is known about how different subgroups within these communities are psychologically attuned to weather and weather changes. (Stewart et al. 2012). Our study focuses on the first and fifth of the aforementioned dimensions of weather salience: "attention to weather and weather information" and "attachment to weather patterns." We also introduce a new dimension to specifically study severe weather contexts: "attention to the weather when it has potential to become severe or hazardous." After consulting with the creator of the WxSQ, we selected these dimensions because initial studies of Spanish speakers revealed intercultural differences in these areas (Stewart et al. 2014). This makes them particularly suited for examining variations among Spanish speakers. The following paragraphs provide our rationale for these choices and hypotheses, linking them to existing literature in risk and intercultural communication.

"Attention to weather and weather information," or perceptual salience, is a weather salience dimension that reflects how actively individuals seek out and prioritize weather updates. A person's preferences, perceptions, and behavioral responses when immersed in weather information develop based on a variety of factors, including the climate they live in and even their demographic characteristics (Lazo et al. 2009; Sherman-Morris 2013; Weyrich et al. 2020). Spanish-speaking communities encounter linguistic barriers that can limit their access to essential weather information, especially when it is primarily available in English (Abukhalaf and von Meding 2021; Méndez et al. 2020; Trujillo-Falcón et al. 2021). These vulnerabilities become compounded if they have never experienced a weather hazard, particularly if their current or previous place of residence never faced such hazards (Gaviria Pabon 2022). Studies suggest that some multilingual individuals, particularly those who are foreign born, may ignore emergency updates altogether due to cultural differences in how information is received in their native countries, regardless of access to information in their dominant language (Johnson 2014). These cultural viewpoints can help explain variations among ethnic groups in how they consume disaster-related content, as influences from Latin America shape their preferences and priorities (Bitterman et al. 2023).

"Attachment to weather patterns" examines individuals' emotional and psychological connections to the climate and weather of their place of origin, hometown, and current residence. In a meteorological event, individuals may experience similar weather phenomena but undergo different social processes to make sense of what is happening around them (Demuth et al. 2011). Individuals develop disaster subcultures, or cultures of emergency preparedness, as they are exposed to repeated hazards, creating an emotional and psychological connection to the phenomena (Anderson 1965; Wenger and Weller 1973). For Spanish-speaking communities, this connection extends beyond their current and previous places of residence to encompass their ethnic origins, which shape their preparedness behaviors and overall disaster response (Carter-Pokras et al. 2007). Foreign-born Spanish speakers may face challenges in adapting to a new disaster subculture in the United States due to language barriers (Trujillo-Falcón et al. 2024a). As individuals relocate across different geographical regions in the United States, Spanish speakers must also acclimate to new meteorological experiences, leading to disparities in how they receive, understand, and respond to warning information (Ripberger et al. 2020).

We developed a third subscale, "attention to the weather when it has potential to become severe or hazardous", in collaboration with the creator of the WxSQ after observing cultural disparities among Spanish speakers in severe weather contexts. Previous severe weather events, such as the 27 April 2011, tornado super outbreak, highlighted differences in tornado hazard perception, preparedness, and shelter lead time between Hispanic and non-Hispanic populations (Senkbeil et al. 2014). To investigate these inequities further, Stewart et al. (2014) conducted a regional survey in Georgia and found notable differences in how Spanish-speaking residents obtained and personalized weather information. Tornadoes and severe weather ranked as the top hazards they felt unknowledgeable about and unprepared for. Stewart et al. (2014) also found that this lack of knowledge correlated with lower levels of overall weather salience when compared to English speakers. Therefore, we aim to explore what factors contribute to these lower levels of weather salience among Spanish-speaking communities in the United States.

Tying previous research into the concept of weather salience, we hypothesize that the outlined weather salience dimensions are variable among Spanish-speaking communities depending on their geographic location in the United States, the ethnic group with which they identify, and whether they were born in the United States. The first hypothesis is supported by previous research on weather salience among the English-speaking population, which found that weather salience varies by geographical location in the United States (Stewart et al. 2012). The subsequent hypotheses take into account bilingual risk and crisis communication research reviewed in this section (Trujillo-Falcón et al. 2021; Gaviria Pabon 2022):

H1: Weather salience of Spanish-speaking communities, specifically (i) perceptual salience, (ii) attachment, and (iii) attention to

potentially severe weather, will vary by geographic location in the United States.

H2: Weather salience of Spanish speakers, specifically (i) perceptual salience, (ii) attachment, and (iii) attention to potentially severe weather, will differ significantly between Hispanic and Latino groups born in the United States and those born outside the United States.

H3: Among those born outside the United States, weather salience, specifically (i) perceptual salience, (ii) attachment, and (iii) attention to potentially severe weather, will vary by ethnic origin.

3. Methods

a. Survey

Data from the analysis originate from a national survey of U.S. Spanish speakers developed by the authors. The survey explored how respondents receive weather information, how they are familiar with different threats and their cultural upbringings, and how prepared they are for disasters. Weather salience, specifically, was measured using items from the WxSQ (Stewart 2009). The first author, who holds a degree in Spanish and is familiar with weather terminology, translated the WxSQ into Spanish. Three bilingual meteorologists then reviewed the survey. Finally, a group of native Spanish speakers outside of the meteorological field, representing various dialects, cross checked and validated the translations. Prior to taking the survey, participants answered screening questions that verified they spoke Spanish. Acknowledging the preference of possible bilingual speakers, we allowed participants to take the survey either in English or in Spanish. Participants born in the United States answered questions based on their experiences in the United States. Foreign-born participants were asked about their weather experiences and information sources both in the United States and their country of origin. For more information about the overall survey and to view frequencies of each survey item, visit the open-access database and report by Trujillo-Falcón et al. (2024b). Survey items in both English and Spanish are available in appendixes A and B.

b. Participants

We recruited participants through Centiment, a market research company partnered with the online survey tool Qualtrics, to take the survey from 22 December 2022 to 26 January 2023. Eligibility to participate was restricted to individuals who are 18 years of age or older and currently residing in the United States. To increase the representation of Spanish-speaking communities, we established the following quotas. First, to measure a broad range of bilingual communities, even quotas were set for individuals who use only Spanish, individuals who use Spanish more than half of the time, and individuals who use Spanish and English equally. Second, we set a 50/50 quota between individuals born in the United States and foreign-born individuals to be able to measure the weather perception and response of specific ethnic groups. People could complete the survey only once. We confirmed the survey's functionality and data quality after 30 responses.

A total of 1297 participants consented to participate in the study. Responses from 323 participants were deleted because they either dropped out of the study, did not meet participation eligibility criteria, submitted excessive serial responses on scale items, or omitted necessary demographic information (e.g., zip code). The remaining responses (n = 995) passed all the quality checks. For this manuscript, we focused our analysis on the 974 participants that identified as Hispanic or Latino. Detailed demographics are reported in Table 1. Of the 974 cases, 289 participants indicated that English is their primary language; 405 of them primarily use Spanish; and 280 individuals reported using English and Spanish equally. 417 participants completed the Spanish version of the survey, while 557 completed the English version. Though our sample does not completely represent the overall U.S. Spanish-speaking population, we ensured that our participants were diverse in terms of their age, gender, ethnic origin, nativity, income, and geographical location.

c. Measures

After consenting to participate and selecting the survey language, participants proceeded to respond to questionnaires measuring the major study variables. Geographical analysis was conducted through the classification of each respondent into one of four major climate zones using the most up-to-date Köppen classification that included high-resolution, observation-based climatologies from 1991 to 2020 (Beck et al. 2023). This method has previously been used by Stewart et al. (2012) to compare weather salience values across geographies. We incorporated it into our study for consistency. First, we used geographic information system (GIS) software to determine the Köppen classification of each zip code that our respondents provided. Our respondents fell into 14 distinct climate zones out of 44 across the world. Second, we grouped these climate zones into four main climate groups: (i) tropical (megathermal, n = 120, 12.1%), (ii) dry (arid and semiarid, n = 174, 17.5%), (iii) temperate (mesothermal, n = 495, 49.7%), and (iv) continental (microthermal, n = 99, 9.9%). We omitted 107 participants from the analysis as they did not provide zip code information.

Weather salience subscales were measured using an adapted version of Stewart's (2009) WxSQ. All weather salience items were measured on a 1–7 Likert scale where 1 = strongly disagree and 7 = strongly agree; hence, higher scores indicate higher salience. See appendixes A and B for the specific subscales and items. Following the guidance of Hayes and Coutts (2020) and Malkewitz et al. (2023), McDonald's total omegas were used to estimate reliability. Perceptual salience (McDonald's ω_t = 0.832) was captured by six items (i.e., items 1–5 and item 9 of the original WxSQ scale). Attachment to weather patterns (McDonald's ω_t = 0.721) was measured using three items (i.e., items 15, 16, and 17 of the original WxSQ scale). Finally, responding to Stewart et al. (2014)'s call for additional research attention to be paid to severe weather events, five additional items were created for the current study to capture an additional subscale: attention to the weather when it has potential to become severe or hazardous (i.e., items 10–14). These new items (Table 2) demonstrated good internal reliability, McDonald's ω_t = 0.805.

TABLE 1. Demographic information about the nationwide survey compared to Spanish speakers from U.S. Census Bureau (2021) data. Note. To determine NWS region, we matched zip codes from participants to NWS regions established by the NWS (2024).

	Survey participants (%)	U.S. Spanish-speaking adult population (%)
Age		
18–34	41.6	35.5
35–64	49.2	52.6
65+	9.2	11.9
Gender		
Female	53.4	49.9
Male	45.3	50.1
Nonbinary	0.2	–
Transgender	0.6	–
Other	0.5	–
Ethnicity and origin		
Mexican	38.1	55.2
Puerto Rican	16.8	8.0
Cuban	10.4	4.6
Other Hispanic	34.7	26.1
Nativity		
U.S. born	48.4	44.6
Foreign born	51.6	55.4
Income		
Less than $50,000	50.6	34.1
$50,000–$100,000	35.6	33.5
$100,000–$150,000	10.8	16.9
$150,000+	2.9	15.4
NWS region		
Western region (including Alaska and Hawaii)	18.2	33.8
Southern region (including Puerto Rico)	49.1	35.8
Central region	7.6	9.5
Eastern region	25.2	20.9

4. Results

Prior to hypothesis testing, covariate analyses were conducted to explore whether demographic variables significantly differed among the NWS regions and ethnic groups represented within the dataset. A multivariate analysis of variance (MANOVA) was conducted to test for possible covariates, with climate zone and ethnic origin entered as fixed factors, while age, education, and income were entered as dependent variables. Results of the multivariate tests indicated a significant main effect of climate zone [Wilk's $\lfloor = 0.98$, $F(9, 1990.95) = 2.07$, $p = 0.029$, $/_p^2 = 0.01$] and ethnic group [Wilk's $\lfloor = 0.88$, $F(66, 2443.65) = 1.58$, $p = 0.002$, $/_p^2 = 0.04$]. Tests of between-subjects effects did not confirm the significant main effect of climate zone for age [$F(3, 820) = 1.93$, $p = 0.123$, $/_p^2 = 0.01$], education [$F(3, 820) = 1.65$, $p = 0.177$, $/_p^2 = 0.01$], or income [$F(3, 820) = 2.49$, $p = 0.059$, $/_p^2 = 0.01$]. Comparatively, tests of between-subjects effects confirmed that age [$F(22, 820) = 2.49$, $p < 0.001$, $/_p^2 = 0.06$] varied significantly across ethnic groups, while education [$F(22, 820) = 1.24$, $p = 0.204$, $/_p^2 = 0.03$] and income [$F(22, 820) = 1.15$, $p = 0.289$, $/_p^2 = 0.03$] did not. Hence, age was treated as a covariate in all subsequent analyses.

H1: Weather salience of Spanish-speaking communities, specifically (i) perceptual salience, (ii) attachment, and (iii) attention to potentially severe weather, will vary by geographic location in the United States.

Hypothesis 1 was tested using a multivariate analysis of covariance (MANCOVA), with climate zone entered as the fixed factor; perceptual salience, attachment to the weather, and attention to potentially severe weather entered as dependent variables; and age entered as a covariate. Controlling for the effects of the covariate, the results of the MANCOVA indicated no significant variance in the weather salience variables by climate zone [Wilk's $\lfloor = 0.98$, $F(9, 2144.27) = 1.72$, $p = 0.08$, $/_p^2 = 0.01$]. Hence, H1 was not supported.

H2: Weather salience of Spanish speakers, specifically (i) perceptual salience, (ii) attachment, and (iii) attention to potentially severe weather, will differ significantly between Hispanic and Latino groups born in the United States and those born outside the United States.

Hypothesis 2 was tested using an independent samples t test. Results indicate that the two groups differed significantly across the three outcome variables. Specifically, participants born outside the United States reported significantly higher perceptual salience [$M = 4.99$, standard deviation (SD) = 0.85] than those born in the United States ($M = 4.70$, SD = 0.91) [$t(886) = -4.92$, $p < 0.001$, Cohen's $d = 0.33$]. Similarly, attention to potentially severe weather was also higher among those born outside the United States ($M = 5.12$, SD = 0.95) than those born in the United States ($M = 4.67$, SD = 0.95) [$t(886) = -6.91$, $p < 0.001$, Cohen's $d = 0.46$]. Only for the attachment dimension of weather salience were scores among those born in the United States ($M = 4.61$, SD = 1.36) higher than those born outside of the United States ($M = 4.37$, SD = 1.33) [$t(886) = 2.66$, $p < 0.01$, Cohen's $d = 0.18$]. Hence, H2 was supported.

H3: Among those born outside the United States, weather salience will vary by ethnic origin.

To meet the assumptions of multivariate analysis of covariance (Green and Salkind 2017), our analysis only included those ethnic groups with at least 50 participants. Hence, H3 was tested by comparing Cuban ($n = 76$), Mexican ($n = 129$), Puerto Rican ($n = 69$), and Venezuelan ($n = 50$) participants who identified as having been born outside of the United States.

Hypothesis 3 was tested using a MANCOVA, with ethnic group entered as the fixed factor; perceptual salience, attachment, and attention during severe weather entered as dependent variables; and age entered as a covariate. Controlling for the effects of the covariate, results of the MANCOVA indicated a significant overall effect of ethnicity on the weather salience subscales [Wilk's $\lfloor = 0.90$, $F(9, 774.08) = 3.82$, $p < 0.001$, $/_p^2 = 0.04$]. Hence, H3 was supported. Post hoc ANCOVAs (controlling for age) were conducted to explore the differences in the individual weather salience subscales across

TABLE 2. Means, SDs, and bivariate correlations among major variables. Note. $N = 974$; ** notes statistical significance where $p < 0.01$.

Variables	M	SD	No. 1	No. 2	No. 3
Perceptual salience (No. 1)	4.91	0.97			
Attachment to weather patterns (No. 2)	4.28	1.62	0.46**	0.20**	
Attention to potentially severe weather (No. 3)	5.21	1.19	0.90**	0.77**	0.36**

the ethnic groups. For all pairwise comparisons, Bonferroni's adjustments were made to alphas to control for type I error (Green and Salkind 2017).

Post hoc analyses of the ethnic group main effect indicated that neither perceptual salience [$F(3, 320) = 1.02$, $p = 0.20$, $/_p^2 = 0.01$], nor attention during severe weather [$F(3, 320) = 0.85$, $p = 0.35$, $/_p^2 = 0.01$], differed significantly between the four ethnic groups (see Table 3). Only the attachment subscale of weather salience differed significantly across these ethnic groups [$F(3, 320) = 7.82$, $p < 0.001$, $/_p^2 = 0.07$].

5. Discussion

We conducted a national survey of Spanish-speaking adults in the United States ($n = 974$) to examine how cultural and geographical variables influence three dimensions of weather salience: 1) attention to weather and weather information, 2) attachment to weather patterns, and 3) attention to the weather when it can become severe or hazardous. Our study found that geographical location in the United States did not significantly affect weather salience dimensions. Instead, nativity and Hispanic origin emerged as stronger predictors. These insights help us better understand why weather salience values are lower among Spanish-speaking populations in the United States, as first reported by Stewart et al. (2014). They also illustrate how cultural variables influence how Spanish speakers attribute psychological value or importance to the weather and its changes.

Our first hypothesis posited that weather salience dimensions in Spanish-speaking groups varied by geographic location in the United States, which was based on Köppen climate zones (Beck et al. 2023). *Our hypothesis, however, was not supported*. Previous research in English-speaking United States populations has found a relationship between geographic climate zones and one's weather salience (Stewart et al. 2012). However, this is not the case for Spanish speakers. From the mountainous areas of Perú to the dense forests of Guatemala, Spanish-speaking populations experience a plethora of different climates in their origin countries. Whether they immigrate to the United States or inherit traditions from previous generations, the disaster subculture of a Spanish-speaking individual can shape their psychological attunement to the weather and its changes (Gaviria Pabon 2022; Trujillo-Falcón et al. 2024a). Consequently, Spanish speakers may not consider their current residence in the United States as "home" and may feel disconnected from their environment, despite being physically present in it (Schultz et al. 2000). This explains why English speakers differ from Spanish speakers in this variable, as they are more likely to have a stronger bond with their local environment (Stewart et al. 2012). The concept of "nature connectedness" is further explored in the second hypothesis.

The second, *supported* hypothesis examined whether nativity, or whether someone is native or foreign born, results in significant differences in weather salience. Results demonstrated that foreign-born Spanish-speaking individuals expressed higher subscales of daily attention to everyday and severe weather than their U.S.-born counterparts. Previous research supports these findings. Foreign-born status has also been associated with heightened perceptions of risk to natural hazards (Adeola 2007). Specifically for immigrant communities, Carter-Pokras et al. (2007) revealed that, despite having limited access to bilingual information, foreign-born immigrants expressed serious concern for various environmental disasters due to not experiencing them before. This heightened anxiety may prompt foreign-born individuals to become more aware of their surrounding environment, especially if they come from a country that rarely experiences extreme weather hazards (Trujillo-Falcón et al. 2024a).

Despite paying more daily attention to both every day and severe weather than U.S.-born individuals, foreign-born participants reported significantly lower attachment to the weather. This difference can be better understood through the concept of nature connectedness, which refers to an individual's emotional and psychological relationship with their natural environment (Keaulana et al. 2021). Bolton and Lazzaro (2021) and Bolton (2023a,b) extensively quantified the relationship between nature

TABLE 3. Means and standard errors for weather salience variables across ethnic groups. Note. Means are adjusted for the covariance of age. Adjusted means with different superscripts (e.g., a, b, and c) in rows differ significantly at $p < 0.05$ (alphas were adjusted using the Bonferroni method).

	Ethnic groups							
	Cubans		Mexicans		Puerto Ricans		Venezuelans	
	M	SE	M	SE	M	SE	M	SE
Perceptual salience	5.24^a	0.09	4.99^b	0.07	5.05^a	0.10	5.07^a	0.12
Attention to potentially severe weather	5.30^a	0.10	5.16^a	0.08	5.12^a	0.11	5.36^a	0.13
Attachment to weather patterns	4.95^a	0.15	4.35^b	0.12	4.60^a	0.16	3.86^c	0.19

connectedness and weather salience, highlighting these factors as important components of cross-cultural weather salience. This is especially relevant for Spanish-speaking populations, given the diverse regions of the world from which many of the participants originated. We speculate that the lack of nature connectedness with their place of residence in the United States contributes to the lower attachment to the weather and the lower association between weather salience and geographic location among foreign-born individuals (as explored in the last hypothesis). This finding can help explain how some of the most vulnerable Spanish speakers, foreign-born individuals, navigate complex psychological mechanisms to make sense of a completely new climate and environment in the United States.

The third hypothesis explored whether significant differences in weather salience dimensions existed between Hispanic and Latino ethnic groups. Our hypothesis was supported after considering four ethnic groups, including Cuba, Mexico, Puerto Rico, and Venezuela. When examining differences among weather salience dimensions, a closer look into the data revealed that only psychological attachment to the weather differed significantly across ethnic groups. Out of the four groups examined, Cubans reported the highest psychological attachment to weather, while Venezuelans reported the lowest. Several factors may explain this variation. According to previous research, Venezuelans are not exposed to natural hazards in the same proportion as other places in Latin America (Pielke et al. 2003), with only 3% of their overall population being prone to extreme weather events (Nagy et al. 2018). Additionally, while citizens of Mexico, Puerto Rico, and Cuba had access to a governmental meteorological agency as of 1877, 1899, and 1965, respectively, Venezuela only recently opened its weather service in 2007 (Instituto Nacional de Meteorología e Hidrología 2023). Since Venezuelans might not have had access to experiences and resources to encourage them to be aware of weather and its changes, their disaster subculture can explain the degree of psychological attachment they have to the weather (Gaviria Pabon 2022).

Another interesting finding from the third hypothesis reveals that while weather salience dimensions vary among the four ethnic groups, the subscales of daily attention to everyday and severe weather do not differ among people from Cuba, Mexico, Puerto Rico, and Venezuela. This distinction between paying attention to the weather and being attached to it is important and can be explained by the different weather conditions individuals experience in Latin America and the United States. In Central America and Mexico, the primary disasters causing the loss of human life are due to exogenic processes, such as floods and landslides, as well as endogenic processes, which include volcanic and seismic activity (Latrubesse 2010). The Caribbean region, including Cuba and Puerto Rico, is mainly exposed to hurricanes, floods, landslides, earthquakes, and volcanoes (López-Marrero et al. 2013). Countries along the Andes chain in South America and the Pacific Ring of Fire, including Venezuela, are most susceptible to earthquakes and, in some cases, volcanic activity (Latrubesse 2010). In the United States, while flooding is the most common natural disaster, extreme weather can vary depending on the region, with occurrences of severe storms, wildfires, earthquakes, tornadoes, and hurricanes (U.S. Department of Homeland Security 2024). To adapt to these new, extreme hazards and the associated disaster subculture, individuals must increase their awareness to understand how to stay safe (Adeola 2007). Therefore, this finding reveals that although different ethnic groups pay more attention to weather hazards in the United States, they do not necessarily become attached to them due to their disaster subculture. This underscores the need to create tailored information so that people not only become aware of extreme weather but also recognize its importance and take it seriously in the future.

Our research has elevated the importance of multiculturalism in risk communication research and practice. Spanish-speaking communities place a great deal of importance on the weather based on their ancestry, nativity, and culture, rather than their geographic location in the United States. As a result, our communication system needs to incorporate culturally competent messaging to better engage these communities; simply translating information into Spanish is not enough (Morales et al. 2023). In other words, bilingual risk communicators need to consider the composition of their communities prior to developing effective messages. For example, a broadcast meteorologist in the Dallas/Fort Worth metropolitan area should acknowledge that the majority of their Hispanic and Latino community comes from Mexico and Central America. With that information, they can tailor their risk messages and personalize their communication for communities that may be unfamiliar with certain hazards. However, it is important to acknowledge that implementing such tailored messaging is not without its challenges. Practitioners often face significant constraints related to time, resources, and capacity, which can make it difficult to create and tailor messages for diverse audiences (Smith et al. 2023). The ongoing demand for further personalization and localization in weather risk communication necessitates additional effort and resources, which should become a priority in future policymaking (Tripati et al. 2024).

Researchers can also benefit from our findings. By considering cultural variables in our measures, such as nativity and ethnic origin, our study identified important distinctions among an underserved population. Betancourt and López (1993) recommend incorporating cultural variables in research, as it can strengthen theories, frameworks, and proposed solutions. Morss et al. (2020) further applied this approach in weather risk communication, discovering significant variations in risk perception among different cultural worldviews. Our findings emphasize that cultural variables, such as nativity and ethnic origin, can provide deeper insights into the Spanish-speaking community. Going forward, researchers should incorporate these cultural variables, especially when aiming to better understand vulnerability among racial and ethnic groups.

6. Limitations

Our study contributes to understanding weather salience among Spanish-speaking communities in the United States, yet several limitations should be noted. First, our reliance on

self-reported data from a survey introduces potential biases, including social desirability bias and recall bias (King and Bruner 2000; Colombo et al. 2020). Participants may have provided responses they deemed favorable or had difficulty accurately recalling past environmental experiences. Spanish-speaking communities, in particular, are more likely to provide extreme responses (i.e., excessive responses at the endpoints of scales), and significant differences are evident among recently immigrated individuals compared to those who have lived in the United States for some time (Marin et al. 1992). Hispanic and Latino respondents are also more prone to respond based on what is more socially desirable than other ethnic groups (Hopwood et al. 2009). Future research could complement surveys with qualitative methods such as in-depth interviews or focus groups to gain richer insights.

Second, our sample, although diverse in terms of age, gender, ethnic origin, nativity, income, and geographical location, may not fully represent the entire U.S. Spanish-speaking population. The use of online survey tools may have excluded individuals without internet access or those less inclined to participate in online surveys (Brown 2015). In general, Hispanic and Latino communities are wary of the surveying process and many refuse to take surveys altogether, as most are not used to doing so in their cultures of origin (De La Rosa et al. 2012). Efforts to include a more representative sample, including hard-to-reach populations, would strengthen the generalizability of our findings.

Third, although our survey was translated by someone with a degree in Spanish and reviewed by bilingual meteorologists and a panel of diverse Spanish speakers representing different dialects, we did not back translate the items for specific cross-cultural validation. Back translation involves translating the survey from the original language into the target language and then translating it back into the original language by a different translator to check for inconsistencies. Discrepancies in Spanish-language translation can lead to item comprehension differences, lower reliability, and poor psychometrics in Spanish-language surveys (Agans et al. 2020; Berkanovic 1980). We urge researchers to use back-translation methods to ensure that the methodology adheres to best practices in the social sciences.

Fourth, in H2, we found significant differences in weather salience dimension values between foreign-born and U.S.-born populations. Although our initial survey included the length of time spent in the United States, it did not capture the duration at the current area of residence. Being born outside the United States may also indicate a shorter residency period in the current area and less familiarity with its weather. We recommend that future scholars incorporate this measure to strengthen our findings and provide a more comprehensive understanding of how nativity influences weather salience.

Last, our study focused on two dimensions of weather salience: 1) attention to weather and weather information and 2) attachment to weather patterns. We also developed a third subscale: 3) attention to the weather when it can become severe or hazardous. Other dimensions of weather salience, such as sensing and observing weather directly and effects of daily weather on daily activities, were not explored in detail. Expanding the scope to include these additional dimensions could provide a more comprehensive understanding of weather salience among Spanish-speaking communities.

7. Conclusions

Representing more than 20 countries in Latin America, Europe, and Africa, Spanish-speaking populations are often categorized as a singular group in the United States. Our research demonstrated the limitations of such categorizations, as these groups vary in how they perceive and respond to the weather. Through a nationwide survey of 974 Spanish-speaking adults, we found significant differences in weather salience dimensions among participants of different cultures. Unlike the overall U.S. population, Spanish-speaking individuals do not base their weather salience on their geographical location. Instead, their attunement to the weather and its changes is more influenced by their ancestry and nativity. Our study explains how weather salience can be lower among Spanish speakers in the United States, emphasizing the importance of tailored messages in non-English communications.

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Data availability statement. Datasets analyzed during the current study are available in the DesignSafe repository presented in Trujillo-Falcón (2024b).

APPENDIX A

Weather Salience Questionnaire Subscales (English Version)

Items are grouped and numbered in accordance with the Stewart et al. (2012) original WxSQ scale.

a. Attention to weather and to weather information

1) I use the internet to obtain weather forecasts or weather information (temperatures and radar images).
2) I look at the weather radar on television or on the internet to see where precipitation (i.e., rain, thunderstorms, and snow) may be occurring.

3) I seek out more up-to-date weather information than what is provided on the television or radio.
4) I watch television or listen to the radio to get a weather forecast so that I can know what to expect.
5) I plan my daily routine around what the weather may bring.
6) I take notice of changes that occur in the weather.

b. Attention to weather when potentially severe weather

7) I pay attention to the weather when there is a possibility that driving conditions will be hazardous.
8) I pay attention to the weather when there is a possibility that schools in my area will be closed.
9) I pay attention to the weather when there is potential for a severe storm or event.
10) I plan for extreme weather events days in advance.
11) I make sure to let others know of an upcoming severe weather event (e.g., talking to a neighbor, sharing on social media, and texting my family).

c. Attachment to weather patterns

12) I am attached to the weather and climate of my hometown (or of the place where my family of origin lives or lived).
13) I am attached to the climate of the place where I live or used to live.
14) I am attached to the climate that exists in the location where I lived as a child or adolescent.

APPENDIX B

Weather Salience Questionnaire Subscales (Spanish Version)

Los ítems están agrupados y numerados de acuerdo con la escala original del WxSQ de Stewart et al. (2012).

a. Atención al tiempo y a la información meteorológica

1) Utilizo el internet para obtener previsiones meteorológicas o información sobre el tiempo (por ejemplo, las temperaturas, imágenes de radar).
2) Miro el radar meteorológico en la televisión o en el internet para ver dónde pueden producirse precipitaciones (es decir, lluvia, tormentas eléctricas, nieve, etc.).
3) Busco información meteorológica más actualizada que la que se ofrece en la televisión o la radio.
4) Veo la televisión o escucho la radio para conocer el pronóstico meteorológico y así saber qué esperar.
5) Planifico mi rutina diaria en función de lo que pueda traer el tiempo.
6) Me fijo en los cambios que se producen en el tiempo.

b. Atención al mal tiempo

7) Prestó atención al tiempo cuando existe la posibilidad de que las condiciones de conducción sean peligrosas.
8) Prestó atención al tiempo cuando existe la posibilidad de que las escuelas de mi zona estén cerradas.
9) Prestó atención al tiempo cuando hay posibilidad de una tormenta o evento severo.
10) Planifico con días de antelación los fenómenos meteorológicos extremos.
11) Me aseguro de avisar a los demás de un evento meteorológico severo (por ejemplo, hablando con un vecino, compartiendo en las redes sociales, enviando un mensaje de texto a mi familia, etc.).

c. Apego a los patrones climáticos

12) Estoy apegado al tiempo y clima de mi lugar de origen (o el de mi familia).
13) Estoy apegado al clima del lugar donde vivo actualmente.
14) Estoy apegado al clima del lugar donde viví de niño y/o adolescente.

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