The Relationships among Actual Weather Events, Perceived Unusual Weather, Media Use, and Global Warming Belief Certainty in China

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ABSTRACT

Previous research revealed that if individuals personally experience an unusual weather event as a result of global warming (vs no personal experience), they may hold higher belief certainty that global warming is happening and hence develop more favorable attitudes toward mitigation actions. However, much of the previous research focused on self-reported personal experience and global warming beliefs using cross-sectional surveys; reverse causality is thus possible. Based on weather records and survey data, the present research examined whether actual weather events can influence one’s perceptions of unusual weather and belief certainty. Severe Typhoon Fitow 2013, but not hot summer temperatures, directly predicted the Chinese perceived experience of unusual weather and indirectly predicted their belief certainty and attitudes toward mitigation behavior. However, the effects were relatively small. Possible explanations and implications for environmental education are discussed.

1. Introduction

Global warming can bring about devastating consequences to Earth and humans, for example, severe weather patterns, heat waves, drought/flooding, and public health problems (IPCC 2015). However, in many western countries, climate change often is considered to affect the environment and people in remote places on Earth and is not considered to be personally relevant (Taylor et al. 2014). Perhaps in order to make global warming relevant to individuals, recent research has begun to explore whether personally experiencing the effects of global warming may influence one’s perceptions of global warming and subsequent support for global warming mitigation behaviors and policies (e.g., Spence et al. 2011; Wang 2017). Such research adds to our understanding of the relationships between personal experience and global warming–related beliefs.

However, when examining the effects of personally experienced weather events on global warming perceptions, researchers often measured the concept based on self-reports (i.e., perceived weather change), which can be inaccurate. The result also can be susceptible to alternative explanations: it is possible that individuals who believe (vs not) that global warming is happening are more likely to perceive local weather change. Or it is possible that those who detect or experience local weather change (vs not) are more likely to hold higher belief certainty toward global warming. One way to address this issue is to examine how objectively recorded weather events may impact one’s global warming–related beliefs and information seeking using the media. Because individuals cannot influence short-term weather patterns, a correlation between actual weather patterns and global warming–related beliefs and behaviors, if found, is thus one directional. That is, the actual weather patterns that individuals experienced influence their global warming beliefs, and it is not the other way around. Furthermore, we measure the public’s belief certainty about global warming and their attitudes toward mitigation behaviors after weather events.

In this manuscript, two typical weather events (i.e., severe typhoon and hot summer) are used to predict participants’ climate-related beliefs and media behaviors. Furthermore, our research examines such relationships in a Chinese context; the effects of global warming have
manifested in China and the economic development is carried out at the expense of the living environment (IPCC 2015; Tsinghua University’s Institute of Energy Environment and Economy 2014). Because previous research on personal experience and global warming beliefs was conducted in western countries (e.g., Spence et al. 2011), our present research will further contribute to the literature on personal experience and global warming perceptions by examining the relationship in an international context.

2. Actual weather events, perceived unusual weather, and media information seeking

Typhoons and hot summers are two common “obtrusive” events in many cities in China. Although it should be acknowledged here that not all weather events are the result of climate change, Typhoon Fitow and the hot summer in 2013, two extreme events that we analyze in this article, were considered the consequences of climate change (McNew 2014; Sun et al. 2014). Summer 2013 was the hottest summer in eastern China since the 1950s; the average of the highest daily temperatures in June to August 2013 was 0.82°C higher than the previous summer average since a reliable weather record was first established in the 1950s (Sun et al. 2014).

Signs of global warming may manifest differently in different geographic areas (Hamilton and Keim 2009). Furthermore, climate is an abstract concept and by definition is “the weather condition prevailing in an area in general or over a long period of time” (Oxford Dictionary 2017). Thus, it can be difficult to detect by a layperson who does not have access to long-term weather records. However, scholars agree that some past weather events can be detected and recognized by those who are affected by them (Moser and Dilling 2011; Weber and Stern 2011), for example, severe typhoon or an unusually hot summer. Akerlof et al. (2013) indicated that participants’ recall of experienced weather patterns (e.g., changes in seasons, storms, and lake level) were largely consistent with objective weather data.

There are a number of reasons why personal experience is related to information processing. According to Shiffrin and Schneider’s (1977) theory of automatic learning, individuals can quickly process environmental stimuli that they experience in their daily lives. Such processes can be a result of thousands of years of evolution. Learning can occur quickly and automatically (Chaiken and Trope 1999; Shiffrin and Schneider 1977; Weber 2006); that is, learning through personal experience can occur as events happen. In addition, personal experience of weather events is easy to understand. However, information acquired through personal experience can be limited to obtrusive issues. Mutz (1992) stated that for issues of an obtrusive nature, individuals may rely on their personal experience to form a judgment, whereas for issues of a nonobtrusive nature, individuals may rely on the media or other information sources.

Individuals can also process environmental stimuli in a more conscious and controlled manner (Shiffrin and Schneider 1977). Global warming information acquired through other channels (e.g., the media) can be more abstract and may focus on uncertainty, conflict, or balance in reporting (e.g., Boykoff 2007). Such information may not be personally relevant and requires participants to actively process the information. When individuals experience or are about to experience a weather event (vs not), they may find weather patterns or other related information relevant and may be more personally involved with the event. Petty et al. (1995) state that direct personal experience can increase participants’ involvement with an issue. That is, unlike the information represented in and acquired through the media (i.e., indirect experience), past weather events, particularly those that are more extreme, should make weather more relevant and salient to the individuals who are affected by them and make the participants more motivated to process future information. Johnson (1997) found that the level of participants’ direct experience with a disease was related to their need for information and subsequent information-seeking behaviors. Wang (2017) showed that perceived direct experience was positively related to climate-related media behaviors.

Taken together, individuals form judgment about weather events (e.g., whether the weather they experience is unusual) when they personally experience a weather event. Those who experienced or are about to experience an unusual weather event will be more interested in and subsequently seek more information through the media. They may be more motivated to process information related to weather and climate and more likely to understand weather patterns and changes. Thus, we propose the following hypotheses:

H1: Direct experience of a major weather event (e.g., Typhoon Fitow) increases individuals’ (i) perceptions of unusual weather and (ii) climate- and weather-related media use.

H2: Direct experience of a hot summer increases individuals’ (i) perceptions of unusual weather and (ii) climate- and weather-related media use.

A number of global warming-related beliefs were investigated by various scholars and organizations, for example, belief certainty about global warming, concerns about the effects of global warming, and attitudes toward...
mitigation behaviors (Saad and Jones 2016; Wang 2017). Social psychological research on accessibility states that people form judgments based on the most accessible information or experiences (Schwarz 1998). An unusual weather event, in general, is highly accessible to individuals and may be used to form judgments about global warming. For example, the March 2016 Gallup survey found that after the warm winter in 2015 in the United States, the percentage of Americans who believed that the effects of global warming had already manifested increased to 59%, which was slightly higher compared with years since 2009 (Saad and Jones 2016). The Gallup survey indicates that these beliefs may be influenced by an actual weather event. On the other hand, Schuldt and Roh (2014) found that the participants who were interviewed shortly after a snowfall in spring (vs not) were less likely to believe that global warming occurred. In addition, Spence et al. (2011) found that for a U.K. sample, self-reported experience of flooding was negatively related to global warming uncertainty and positively related to global warming concerns. Global warming concerns, but not uncertainty, were then positively related to preparedness to reduce energy use. Hamilton and Stampone (2013) found that the independents (i.e., those without a party affiliation) were more likely to agree that global warming was happening when they were interviewed on a warm day than on a cool day, indicating that short-term temperature may influence beliefs about global warming.

Belief certainty that global warming has already occurred can be particularly important for global warming mitigation and adaptation education. If the public does not believe that global warming has occurred or will occur, the public would be less likely to consider actions to alleviate global warming. In other words, the public would not consider or evaluate actions to alleviate global warming if they do not believe that global warming would happen. That is, the initial belief regarding when global warming would occur would act as a gateway belief to a number of other beliefs and considerations. For example, Li et al. (2011) found that those who thought the temperature was warmer than usual were more likely to donate money to charity to mitigate global warming. Thus, we forward the following hypotheses:

H3: Actual weather events (typhoon and hot summer) positively influence participants’ perceptions of when global warming would happen.

H4: Actual weather events (typhoon and hot summer) positively influence participants’ attitudes toward actions to alleviate global warming.

Finally, we examine how perceived weather patterns and belief certainty would mediate the relationships between the actual weather events and attitudes toward actions to alleviate global warming.

3. Method

This research was conducted in China in November 2013. Many Chinese cities observed a very hot summer in 2013 (Sun et al. 2014). For example, the averages of the highest daily temperatures in Beijing, Chongqing, Shanghai, Tianjin, Hangzhou, and Ningbo were 0.6°, 3.9°, 2.6°, 1.2°, 2.8°, and 2.9°C higher than the average of the highest, daily summer temperatures between 1981 and 2010. Four coastal provinces and the city of Shanghai were hit by Typhoon Fitow in October 2013. Typhoon Fitow was “the strongest typhoon that has landed in mainland China in October since 1949” (ESCAP/WMO Typhoon Committee 2013, p. 15). A total of 12.2 million people were affected, and 11 died. The direct loss was $10 billion (U.S. dollars; ESCAP/WMO Typhoon Committee 2013).

An online survey was conducted using a consumer panel in China, purchased from sojump.com, a Chinese online survey provider. A total of 569 participants completed the online survey after 117 completions were automatically removed from the final sample by the survey website because these participants failed an attention filter question. An additional six cases were removed because they had non-Chinese IP addresses or missed other information. Participants’ IP addresses were used to track the locations where they lived at the time of survey completion.

Among the final sample of 563 participants, 47 were from Zhejiang Province, 76 were from Shanghai, 20 were from Fujian, 9 were from Jiangxi, and 35 were from Jiangsu where Typhoon Fitow hit at least part of the province or the city. The rest were from Beijing, Tianjin, Chongqing, Henan, Sichuan, Shandong, and several other provinces. There were more females than males (55.1% vs 44.9%). The average age, annual income, years of education, and political philosophy are presented in Table 1. Almost all were employees or managers in companies, software designers/information technology, nurses or doctors, and those working in marketing/sales. Only five participants self-reported as a farmer or free occupation. College and postgraduate students represented 12.2% of the total sample.

The average of the 3 summer months’ highest daily temperatures (June–August 2013) was also computed for a specific location based on participants’ IP addresses and recorded weather data for the location obtained from tianqi.com (Chinese romanization for weather). In summer 2013, many provinces, particularly those in the southern part of the country, experienced a hot summer. Among all cities, Chongqing had the highest 3-month average (35°C or 95°F).
We searched Baidu Encyclopedia (https://baike.baidu.com) for recorded weather information of Typhoon Fitow. Based on the categorical warnings that were issued by local weather authorities, cities and towns were assigned a value of 2–5, whereby 5 was the highest and most severe category. The cities and towns in the same provinces where Typhoon Fitow hit but were issued a storm warning were assigned a value of 1, whereas the rest of the country was assigned a value of 0.

The questionnaire contained a number of questions. Only part of the dataset was used in this manuscript. All questions were in Chinese. Some of the questions were adapted from their English versions. For these questions, questionnaire equivalency was established through back translation.

Perceived experience of unusual weather was measured by three items: “in the past 12 months, I felt the weather was warmer than usual,” “I experienced some unusual weather myself (e.g., severe typhoon),” and “my family or friends experienced some unusual weather (e.g., severe typhoon).” Alpha coefficient was 0.76 (or 0.86 with two items).

Participants’ use of climate and environment-related media was measured by the following items: “in the past month, how many times did you read or watch...” followed by “news about climate or environment on TV,” “news about climate or environment in newspapers,” “news about climate or environment on the Internet,” “films/documentaries related to climate or environment,” “blogs about climate or environment,” and “other sources of information related to climate or environment (e.g., books).” Participants selected a preset number ranging from 0 to 11+ times. The choice (11+ times) was recoded as 11. Alpha coefficient was 0.86.

Belief of when global warming would happen was measured by a question. Responses were “now (already happened),” “in 25 years,” “in 50 years,” “in 75 years,” “in 100 years,” “in 125 years,” and “never.” These responses were coded as 7 to 1, respectively.

Attitudes toward global warming were measured by the following item: “taking actions to alleviate global warming is...” followed by “good,” “wise,” and “necessary.” Responses ranged from 1 (strongly disagree) to 7 (strongly agree).

Participants’ gender (1 = male, 2 = female), age, annual income [1 = RMB 10,000 or $1,517 (U.S. dollars)], ethnicity, years of education, and political philosophy (1 = conservative, 7 = liberal) were measured toward the end of the questionnaire.

4. Results

The present research adopted hierarchical multiple regression in analyzing the influence of actual weather patterns on climate-related perceptions and media behaviors. The use of hierarchical multiple regression can estimate the predictive power of the weather variables while controlling for the influence of other variables (e.g., demographic variables). In general, demographic variables were entered in the first step and actual weather events were entered in the second step. Means and standard deviations are presented in Table 1. We entered the independent variables (IV) using the following order: demographic characteristics of the participants and

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<td>Political philosophy</td>
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<td>Typhoon Fitow</td>
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<td>Average of highest daily temperature June–August 2013 (°C)</td>
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<td>Perceived experience of unusual weather</td>
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<td>Climate/environment news</td>
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<td>Belief when global warming occurs</td>
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<td>Attitude toward mitigation behaviors</td>
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<td>Means</td>
<td>1.55</td>
<td>31.15</td>
<td>7.34</td>
<td>15.44</td>
<td>5.16</td>
<td>0.68</td>
<td>32.09</td>
<td>5.51</td>
<td>4.58</td>
<td>5.56</td>
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<tr>
<td>SD</td>
<td>0.50</td>
<td>7.43</td>
<td>5.23</td>
<td>2.19</td>
<td>1.07</td>
<td>1.10</td>
<td>1.83</td>
<td>1.28</td>
<td>2.46</td>
<td>1.06</td>
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</table>

*p < 0.05
**p < 0.01.
political philosophy, weather events, and climate and weather media use and perceived experience. This order reflects the principle that “no IV entering later should be a presumptive cause of an IV that has been entered earlier” (Cohen et al. 2003, p. 158). This approach will also allow us to estimate the amount of additional variance added to a model by the variables of interest. Regression models are presented in Table 2, which also showed whether demographic variables predicted perceived experience, beliefs in global warming, and climate- and environment-related media behavior. For the results reported below, standardized regression coefficients range from −1 to 1. A coefficient of 1 means a perfect correlation between two variables, whereas a coefficient of −1 means perfect, negative correlation between two variables. For social science research, a coefficient of 0.4 or above indicates a strong correlation, 0.2–0.4 indicates a moderate relationship, and below 0.2 indicates a weak relationship (Cohen et al. 2003).

For H1, Typhoon Fitow influenced the participants’ perceived personal experience of weather events (β = 0.14, p = 0.002) but did not influence one’s climate- and environment-related media use (β = −0.01, p = 0.858).

For H2, the average daily temperature of June to August 2013 only marginally influence one’s perceived experience of unusual weather (β = 0.08, p = 0.072) but did not influence one’s climate- and environment-related media use (β = 0.03, p = 0.434).

For H3 and H4, Table 2 shows that for neither Typhoon Fitow nor the average of highest daily summer temperature predicted the participants’ beliefs of when global warming would occur (β = 0.00, p = 0.973 and β = 0.03, p = 0.484, respectively) or their attitudes toward global warming mitigation behaviors (β = −0.04, p = 0.426 and β = 0.04, p = 0.394, respectively). Thus, H3 and H4 were not supported.

Further path analysis was conducted to examine the interrelationships among actual weather events, climate-related perceptions, and media behaviors. Unlike multiple regression where only one dependent variable is included in a model, path analysis allows multiple dependent variables in a model and the dependent variables can also act as independent variables (Hair et al. 1998). Path analysis allows us to examine the indirect effects of exogenous variables and is an extension of multiple regression. Most nonsignificant relationships were dropped from the final

### Table 2. Hierarchical multiple regression analysis of the effects of Typhoon Fitow and average of the highest daily summer temperatures on global warming perceptions and media behavior. Responses for belief about when global warming occurs ranged from 1 (never) to 7 (now/already occurred).

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Perceived experience of unusual weather</th>
<th>Climate-related media use</th>
<th>Belief: When global warming occurs</th>
<th>Attitudes toward mitigation behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-0.01 0.11 0.00</td>
<td>0.18 0.21 0.04</td>
<td>0.07 0.09 0.03</td>
<td>0.21 0.07 0.13***</td>
</tr>
<tr>
<td>Age</td>
<td>-0.01 0.01 -0.07*</td>
<td>0.01 0.01 0.04</td>
<td>0.00 0.01 -0.03</td>
<td>0.02 0.00 0.17***</td>
</tr>
<tr>
<td>Annual income</td>
<td>0.05 0.01 0.20***</td>
<td>0.10 0.02 0.22***</td>
<td>0.01 0.01 0.03</td>
<td>0.00 0.01 -0.02</td>
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<tr>
<td>Years of education</td>
<td>0.01 0.02 0.02</td>
<td>0.02 0.05 0.01</td>
<td>-0.03 0.02 -0.06</td>
<td>0.01 0.02 0.03</td>
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<tr>
<td>Political philosophy</td>
<td>0.22 0.05 0.19***</td>
<td>0.45 0.10 0.20***</td>
<td>-0.06 0.04 -0.06</td>
<td>0.08 0.03 0.10***</td>
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<td>(1 = conservative, 7 = liberal)</td>
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**Step 2**

<table>
<thead>
<tr>
<th>Experience: Typhoon Fitow</th>
<th>Average highest daily temperature June–August 2013</th>
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<tbody>
<tr>
<td>0.16 0.05 0.14***</td>
<td>0.05 0.03 0.08*</td>
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**Step 3**

<table>
<thead>
<tr>
<th>Perceived experience of unusual weather</th>
<th>Climate-related media use</th>
<th>Belief: When global warming occurs</th>
<th>Attitudes toward mitigation behaviors</th>
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<td>0.16 0.04 0.19***</td>
<td>0.00 0.02 0.01</td>
<td>0.15 0.03 0.22***</td>
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<table>
<thead>
<tr>
<th>Step 1 Model Statistics</th>
<th>R² = 0.089, F(5, 540) = 9.3</th>
<th>R² = 0.102, F(5, 540) = 12.3</th>
<th>R² = 0.007, F(5, 540) = 0.8</th>
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<tbody>
<tr>
<td>Step 2 Model Statistics</td>
<td>ΔR² = 0.033, F(2, 538) = 0.3</td>
<td>ΔR² = 0.001, F(2, 538) = 0.086</td>
<td></td>
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<tr>
<td>Step 3 Model Statistics</td>
<td>ΔR² = 0.033, F(2, 536) = 27.6</td>
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*p < 0.10
**p < 0.01.
***p < 0.001.
model to improve the presentation of the results. Significant demographic variables were controlled for. The normalized Mardia's coefficient (=21.1) showed that the data did not conform to multivariate normality. The robust maximum likelihood estimate was used. The final path model showed a good fit to the data: Satorra–Bentler (S–B) $\chi^2 (10, N = 563) = 28.70, p = 0.001$, RMSEA = 0.058, 90% CI of RMSEA [0.034, 0.083], CFI = 0.94, and SRMR = 0.036. Solid lines indicate $p < 0.05$; dashed lines indicate $p > 0.05$. Responses for belief about when global warming occurred were based on a scale from 1 (never) to 7 (now/already occurred), with 25 years as an interval of 1.

Previous research stated that if individuals personally experience certain weather events, they are more likely to have stronger belief certainty toward global warming. However, many of these studies relied on cross-sectional surveys and participants’ self-reports (Spence et al. 2011; Wang 2017). It is argued that it is possible that the direction of the relationships can be the opposite such that those who had more firm beliefs that global warming is happening are more likely to pay attention. That is, reverse causality is possible. In our analysis, we used objective weather patterns that cannot be influenced by one’s perception of whether global warming is happening. Thus, reverse causality is not possible.

We found that the correlation between Typhoon Fitow and participants’ perception of unusual weather was 0.18 after controlling for the demographic variables, indicating that the real weather event and public perceptions were only weakly correlated. The average of the highest daily temperatures in different cities in summer 2013 were not related to perceived unusual weather; that is, those living in a hotter city (vs cooler city) did not perceive that they experienced more unusual weather. There are a number of reasons for this: First, there can be errors related to participants’ own recall when responding to survey questions. Second, it is possible that participants do not consider such weather patterns (e.g., Typhoon Fitow or hot weather) extremely unusual considering that they might have experienced such, although to a lesser degree, in previous years. The third explanation for the weak effect could be that individuals living in different regions were all exposed to weather media and might have vicariously lived through the incidents. Thus, those who did not personally experience these events may modify their perceptions of weather change based on the weather media.

Regarding the mediating relationships, Typhoon Fitow, but not the average daily temperature, predicted self-reported experience of unusual weather, which in turn predicted belief certainty about global warming (indirect effect: $\beta = 0.03, p = 0.009$) and attitudes toward mitigation and adaptation behaviors (indirect effect: $\beta = 0.03, p = 0.008$).

5. Discussion

This research examined various predictors of climate change–related perceptions and beliefs, particularly the impact of two actual weather events (e.g., Typhoon Fitow and hot summer). The use of actual weather events can allow us to establish cause and effect between weather events and public perceptions.
either. However, we found that the perceived experience of unusual weather was a predictor of belief certainty and attitudes. Thus, the effects of Typhoon Fitow on belief certainty and attitudes were mediated by perceived experience of unusual weather, although the effects were rather small. Because weather fluctuates and changes, individuals may become accustomed to it or may not associate them with global warming. Although some weather events are not the result of climate change, many extreme weather events are. Thus, it might be worthwhile to link these extreme weather events to global warming by showing the connection between these weather events and perceived personal experience (left panel of Fig. 1) and the connection between perceived experience and attitudes and belief certainty (right panel of Fig. 1) to the potential target audience either through the media or interpersonal communication. That is, for environmental educators, the task is to try to establish the link between weather events and global warming through a mediator (i.e., perceived experience of unusual weather). The efficacy of this approach should be dealt with in future research.

It might also be important if future research asks participants to provide more specific information about the weather events they experience and the reasons why they connect or do not connect such events with global warming. It might also be important to analyze the Chinese media regarding how these events were reported: whether the focus is on the public preparedness for an actual weather event (e.g., Typhoon Fitow), the economic or human impact of Typhoon Fitow, or the causes of Typhoon Fitow (i.e., global warming). For example, if the Chinese media reports on the connection between the intensity of typhoons and climate change, the public may be more likely to consider the connection between the two. Such information may help provide a better understanding of why actual weather events only account for a very small variation in perceived experience and why perceived experience is only weakly associated with global warming beliefs and attitudes. Although that would be a very difficult undertaking and is subject to recall errors and subsequent human reading/coding of the data, it can still be accomplished. Furthermore, our analysis of the impact of summer temperatures was to compare the perceived perceptions between participants in hotter versus cooler cities or places. Future research might need to consider using the changes in summer temperatures compared with previous years in the same locations (i.e., temperature variations). Again, our results indicate that the actual event of Typhoon Fitow influenced one’s perception or recall of weather patterns and indirectly influenced belief certainty when global warming would occur. There is room for improving the relationships between actual weather events (e.g., Fitow), perceived experience, media use, and global warming beliefs.

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