What Matters? Exploring Drivers of Basic and Complex Adjustments to Tornadoes among College Students

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ABSTRACT: Scholars have produced several theories and models to explain why individuals adjust to hazards. While findings from these studies are informative, studies have not considered how threat and coping appraisals may have differential effects on varying types of hazard adjustments, or how these findings may generalize to vulnerable populations. This study expands on the protection motivation theory to explore the factors that shape hazard adjustment intentions among college students, a population traditionally defined as vulnerable, in response to tornado risk. An online survey was administered to college students ($n = 377$) at Oklahoma State University, situated in a region that experiences considerable tornado risk. While the correlations between threat appraisal and tornado hazard adjustment intentions are smaller than the correlations between coping appraisal and tornado hazard adjustment intentions, findings suggest that threat appraisals become more important for influencing college students' adjustment intentions when adjustment activities are complex (e.g., tornado shelter, home insurance) rather than basic (e.g., flashlight, first-aid kit). This suggests that while both threat appraisals and coping appraisals are important for complex hazard adjustment intentions, basic hazard adjustment intentions are almost exclusively determined by coping appraisals. These findings have several practical implications for emergency management and provide new avenues for future hazard adjustment studies.

KEYWORDS: Emergency preparedness; Tornadoes; Planning

1. Introduction

While there is a vast body of research on response to tornado warnings (Lindell et al. 2016; Mason et al. 2018; Nagele and Trainor 2012), few studies have explored the factors that influence mitigation and preparedness efforts related to tornadoes (Simms et al. 2013). This is particularly true when considering college students, who represent a population understudied in response to hazards and that suffer from increased vulnerability to hazard impacts when compared to the general public (Greer et al. 2018; Lovekamp and Tate 2008). College students, as a population, are more transient than the general public, typically do not own homes, have limited financial resources, are generally unfamiliar with the local neighborhoods and communities, and lack local hazard knowledge (Jauernic and Van Den Broeke 2017; Rohli et al. 2018; Simms et al. 2013; Wu et al. 2017). Likewise, other research has found that undergraduate students often underestimate their risk, an optimism bias that carries across hazard types (Klaczynski 2017; Kuhn 2001; Weinstein 1980), and underestimate their own agency to address their vulnerability, leading to lower levels of preparedness when compared with the general public (Lovekamp and Tate 2008). These conditions and characteristics make college students vulnerable to and underprepared for hazards (Lovekamp and Tate 2008; Tkachuck 2016).

To understand how college students consider adjusting to tornadoes, we deployed a survey to college students at Oklahoma State University. This is an ideal site for this study because Oklahoma is often associated with risk for tornadoes and other severe weather and has suffered from significant tornadoes in the past, such as the May 1999 F5 Bridge Creek tornado and the May 2013 EF5 Moore tornado (Dixon et al. 2011). Oklahoma also sees a majority of their tornadoes from April to May, during the spring semester for students (Dekker 2020). This creates an environment with a history of disaster events and a vulnerable population that is present during the riskiest time of the year for tornadoes.

Relying on the theoretical foundation provided by the protection motivation theory (PMT), we asked respondents about their threat and coping appraisals related to tornadoes and adjustments they intended to undertake to address the tornado threat in the area (Rogers 1975). We focus on intention instead of actual adoption of measures for two reasons. First, as noted above, college students often lack funding and perceived agency to undertake adjustments. Second, undertaking such adjustments, such as installing a storm shelter, should reduce risk perceptions and mask causal effects (Seebauer and Babcicky 2021). To expand upon the PMT, we also included measures of hazard salience and negative emotions felt regarding tornadoes to see how these factors shape adjustment intentions, defined as adjustments that college students indicate they are likely to undertake. Moreover, we assess the PMT variables as predictors of adjustment intentions across two categories of mitigation activities (basic vs complex), which addresses important questions in the literature about coping appraisals and threat appraisals, and when they matter most for hazard adjustment intentions. This research can also help emergency managers understand the factors driving adjustment intentions among a vulnerable population across the

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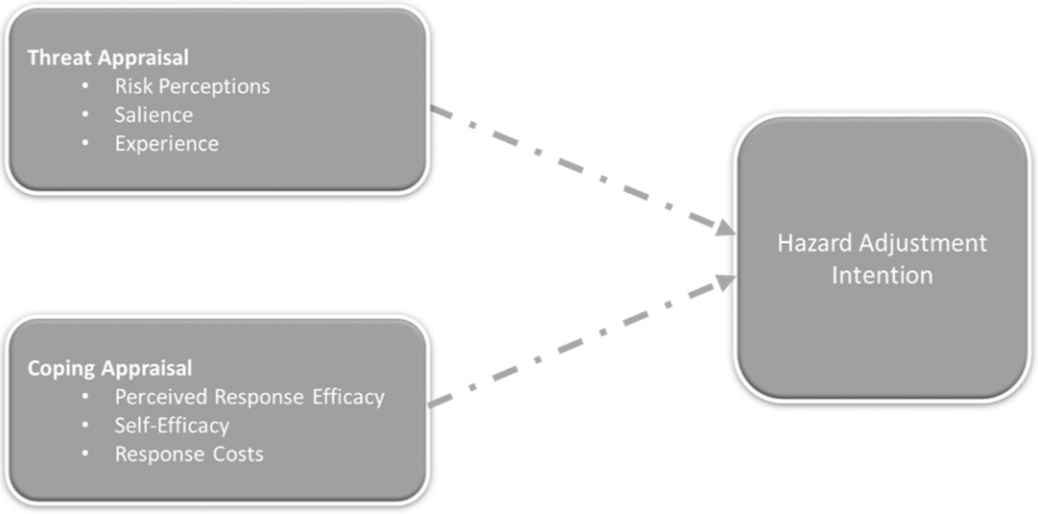

FIG. 1. Protection motivation theory (adopted from Floyd et al. 2000; Rogers 1975).

state. As such, the findings will inform practitioners with specific communication strategies that help them motivate vulnerable populations to engage in protective behaviors in preparation for tornado threats.

This paper progresses as follows: section 2 outlines the extant literature regarding the PMT and past studies exploring adjustment among college students. Section 3 outlines the study methodology and measures used. Subsequent sections outline our results, discussion of the results in the context of existing literature, study limitations, and future research recommendations.

2. Review of the literature

a. Hazard adjustment models and theories

Disaster and risk researchers have developed a few theories and models that attempt to explain how and why individuals adjust their behaviors to reduce their disaster risk (Fishbein and Ajzen 1975; Lindell and Perry 2012; Mulilis and Duval 1995; Witte 1992). For example, the theory of reasoned action (TRA) and the theory of planned behavior (TPB) suggest that factors such as individuals' emotions, demographics, and hazard experience along with their behavioral, normative, and control beliefs determine whether individuals undertake hazard adjustment behaviors (Ajzen 1985; Fishbein and Ajzen 1975, 2011). The protective action decision model (PADM) explains that individuals receive risk information and go through a predecisional process and a decision making process to decide how they want to adjust to risks (Lindell and Perry 2004). The extended parallel process model (EPPM) suggests that perceived threat, efficacy (ability to address a threat), and fear can explain adjustment to hazards, and that fear can lead to maladaptive responses (such as intentionally undertaking risky behaviors).

In recent years, several disaster studies have employed the PMT (see Fig. 1) when investigating hazard adjustment behaviors (Bockarjova and Steg 2014; Greer et al. 2020; Grothmann and Reusswig 2006; Keshavarz and Karami 2016; Mulilis and Lippa 1990; Westcott et al. 2020). Unlike TRA, TPB, or PADM, the PMT focuses on examining how two cognitive processes, threat and coping appraisals, shape hazard adjustment behaviors (Floyd et al. 2000; Maddux and Rogers 1983; Rogers 1975; Rogers and Prentice-Dunn 1997). Based on PMT, threat appraisals capture variables such as risk perceptions (the likelihood of a given hazard affecting an individual's household and their community), hazard salience (how often an individual thinks about a given hazard), and experience (their history with a given hazard).

Coping appraisal variables includes individuals' perceived response efficacy (how well individuals believe a given hazard adjustment activity can protect them), self-efficacy (the ease at which individuals feel they can undertake a given hazard adjustment activity), and response costs (the financial investment necessary to implement a given hazard adjustment activity). Unlike TRA, TPB, and PADM (which focus more on threat beliefs), PMT provides clear definitions for threat appraisals and accounts for the role of coping appraisal variables. While the EPPM does provide an iteration of the PMT that adds fear as a potential response, denial is the primary maladaptive response to tornadoes, which equates to inaction in this context. These two cognitive processes lay the groundwork for investigating hazard adjustment behaviors and therefore this study is guided by PMT.

b. PMT studies

While no studies have used the PMT to measure adjustment to tornadoes (for exception, see Weinstein et al. 2000), existing studies provide some insights into using the PMT to study adjustment to other natural and technological hazards. In general, most of the cross-sectional PMT studies have concluded that coping appraisal variables are better predictors when compared to threat appraisal variables (Bubeck et al. 2012;

Greer et al. 2020; Milne et al. 2000). Tang and Feng (2018) used the PMT to explore adjustments following an earthquake in southern Taiwan and found that self-efficacy and response costs were the main factors influencing disaster preparedness. Likewise, Babcicky and Seebauer (2019), when employing the PMT to explore flood adjustment among households across Austria, found that coping appraisals, not threat appraisals, were related to adjustment behavior. Westcott et al. (2020) used a qualitative approach to study bushfire preparedness and found that rewards that reduce response cost increased bushfire hazard adjustment behaviors. In addition, preparedness culture initiatives, training, and education could increase people's perceived response efficacy and self-efficacy, which in turn encouraged the adoption of hazard adjustments (Westcott et al. 2020). Similarly, Bockarjova and Steg (2014) also found that response costs play a major role in predicting hazard adjustment intentions (proenvironmental behaviors) and, while the effect was weak, the perceived severity of environmental risk was also a significant predictor. In contrast, in an experimental study, Mulilis and Lippa (1990) found that study participants increase their earthquake hazard adjustment intentions when they are assigned to a scenario that uses a negative, threat-inducing communication strategy to stage the experiment condition (higher threat appraisal condition). Finally, Weinstein et al.'s (2000) study on protective action for tornado hazards found that numerous threat appraisal variables instead produce positive and significant relationships with delayed protective behavior.

Some studies focused on meteorological hazard adjustment activities using other theories and models. Chaney et al. (2013) conducted a PADM survey study in Alabama that investigated household tornado preparedness levels; the study concluded that the significant predictors of tornado preparedness are demographic variables such as household member composition and income level. Threat appraisal variables were not included in the model since it was found nonsignificant in the literature (Chaney et al. 2013). Keul et al. (2018) found risk perceptions, while correlated, were not a significant predictor of multihazard weather preparedness activities in a cross-national study.

While the findings show some consistency, researchers have measured threat appraisal in several different ways. These variables include perceived vulnerability (Bockarjova and Steg 2014; Keshavarz and Karami 2016), perceived severity (Bockarjova and Steg 2014; Grothmann and Reusswig 2006; Keshavarz and Karami 2016; Mulilis and Lippa 1990; Scarpa and Thiene 2011), hazard exposure (Grothmann and Reusswig 2006), perceived probability of hazard event occurrence (Grothmann and Reusswig 2006; Mulilis and Lippa 1990), and fear (Grothmann and Reusswig 2006; Scarpa and Thiene 2011). As for coping appraisal variables, most of the studies measured all three variables: self-efficacy, response efficacy, and response costs (e.g., Bockarjova and Steg 2014; Keshavarz and Karami 2016; Scarpa and Thiene 2011). There are, however, some exceptions. For example, Mulilis and Lippa (1990) did not measure response costs in their earthquake preparedness study. Westcott et al. (2020) measured the effects of adaptive rewards, an incentive meant to positively influence coping appraisals, when studying bushfire preparedness.

c. *Advancing the PMT*

Some studies have tried to advance the existing PMT by introducing additional variables that have been previously included in other hazard adjustment theories and models. Grothmann and Reusswig (2006) included nonprotective response variables (fatalism, denial, and wishful thinking) in their modified PMT model when studying flood preparedness. They found these variables improved their model by explaining an additional 1%–10% variance and the nonprotective response variables had negative coefficients. Scarpa and Thiene (2011) included information source variables (communication, observational learning, experience, personality) in their modified two-stage PMT model and found these variables influenced both threat and coping appraisal variables.

While findings from these studies employing the PMT are informative, no studies have compared the appraisal variables that influence the intention of adopting *different* hazard adjustment actions using the PMT framework. Studies such as Wu et al. (2017) shed light on this issue by suggesting the earthquake hazard adjustment actions that can also address other hazard risks are more likely to be adopted, but the study failed to systematically explain why some hazard adjustment actions are more likely to be adopted when compared to others. In the present study, we argue that individuals intend to adopt hazard adjustments at variable rates depending on the extent to which the actions are more basic or more complex, and that different factors likely drive these different adjustments. Therefore, this study focuses more on improving the efficacy of the PMT by identifying the basic and complex adjustment behaviors and how the appraisal variables affect them.

To illustrate, basic hazard adjustment actions reflect various activities that are fundamental to any form of household hazard preparedness, often referred to as having basic disaster supplies. Such activities include having a flashlight, fire extinguisher, first-aid kit, first-aid training, and a three-day food and water supply (Wu et al. 2017). Complex hazard adjustment actions, alternatively, provide a substantial layer of preparedness and protection against tornadoes, which include signing up for a smart phone tornado alert system, installing a tornado shelter, having a weather radio, purchasing homeowner's insurance, and developing a household emergency plan (Federal Emergency Management Agency 2020). In the present study, we argue that while adopting basic hazard adjustment activities are almost exclusively dependent upon coping appraisal variables, adopting complex hazard adjustment activities should instead be viewed as being dependent upon both coping appraisal and threat appraisal variables. For example, basic hazard adjustment actions require only a *minimal* investment (particularly for students) and can be used for a range of hazard types. Complex hazard adjustment actions, on the other hand, require a *substantial* and *specific* investment in activities that have limited use for other hazards. We suggest that while coping appraisals are important for both basic and complex hazard adjustment actions, students should be motivated

enough to invest in complex adjustment actions only when they also demonstrate some combination of negative emotion toward tornadoes, increased tornado salience, and/or have experience with tornadoes.

Variables such as hazard salience or emotional responses to hazards are not included in most PMT studies. Salience has been identified as one of the factors that correlates with protective actions in PADM studies (Lindell et al. 2009; Lindell and Whitney 2000). Variables that measure negative emotion toward a disaster, such as fear or anxiety, are also identified as factors that influence people's hazard adjustment intentions in the model of information meaning making, TRA, EPPM, and social cognitive preparation (Becker et al. 2012; Fishbein and Ajzen 2011; Paton 2003; Witte 1992). Finally, the PMT studies mentioned in the previous section all recruited households as their study participants. While this sampling approach provides research findings with greater generalizability, it excludes a group of people with increased vulnerability to hazards: college students.

To address these gaps in the literature, this study uses the PMT as its theoretical lens to examine Oklahoma college students' tornado hazard adjustment intentions and address the following research questions (RQs):

RQ1: What are the correlations between students' basic hazard adjustment intentions, threat appraisal variables, coping appraisal variables, and demographic characteristics?
RQ2: What are the correlations between students' complex hazard adjustment intentions, threat appraisal variables, coping appraisal variables, and demographic characteristics?
RQ3: What threat appraisal variables, coping appraisal variables, and demographic characteristics best explain students' basic hazard adjustment intentions?
RQ4: What threat appraisal variables, coping appraisal variables, and demographic characteristics best explain students' complex hazard adjustment intentions?

By testing the above RQs, this study aims to integrate the PMT with additional key variables (salience and negative emotion) that are mentioned in other hazard adjustment models and theories. Since these variables are conceptually related to threat appraisal variables, this study considers salience and negative emotion to be additional dimensions of threat appraisal. Moreover, the categorization of adjustment actions and intentions as basic and complex aims to help explain when and why threat appraisal variables, broadly and specifically, are necessary to motivate protective behaviors for some adjustment activities (complex) but not others (basic).

3. Methods

a. Sample

Data for this study were collected via a random sample of 5000 Oklahoma State University (OSU) students in spring 2019. The OSU Office of Institutional Research and Information Management provided the student email list. Following the internet survey approach proposed by Dillman et al. (2014), an invitation and a cover letter were attached to the simulation link and initially was sent to each of the 5000 randomly selected emails on 2 May 2019 (wave 1). Follow-up emails were sent on 9 May 2019 (wave 2) and 16 May 2019 (wave 3), and the final follow-up emails were sent on 23 May 2019 (wave 4). Identifying information was not collected or retained for respondents. This study included completed responses from 377 participants for a total response rate of 7.54%. While this response rate is lower than typically seen with student samples (Fosnacht et al. 2017), there is some evidence that public university students are less likely to respond to web-based surveys than private university students (Porter and Umbach 2006); 79% of the sample were undergraduates, while 21% were graduate students. The survey took approximately 15 min to complete. Ten $50 Amazon gift cards were randomly drawn for study participants as an incentive for successful completion of the tornado simulation project. Entry into this prize contest required respondents to opt into the drawing by providing contact information in the form of an email address.

b. Measures

The online questionnaire included 48 questions that were largely based on previous surveys conducted by Greer et al. (2020) and Lindell and Whitney (2000) with measures added to modernize the instruments and capture negative emotions. Questions were revised and new questions were added to be relevant for the tornado context. Cronbach's alpha levels are provided for applicable (multiitem) measures. In the survey, respondents were first asked to report their *negative emotions* (e.g., fear, anger, disgust) toward tornadoes and their impacts (from 1 = no negative emotion to 5 = high negative emotion). Then, *tornado experience* was measured by asking respondents to report their experience of property damage from local tornadoes in the past few years (from 1 = no damage to 5 = total collapse of home). *Hazard salience* was measured via how often they think about tornadoes (from 1 = never to 5 = daily). *Tornado risk perceptions* was captured in regard to potential damage to their homes or properties, injuries, job disruptions, and daily activity ($\alpha = 0.85$; from 1 = not at all likely to 5 = almost a certainty). Taken together, these variables assess different aspects of respondents' *threat appraisals*.

The 11 tornado adjustment activities captured in the survey were separated into two groups (and hence formed two separate dependent variables for adjustment intentions). The first group includes six *basic mitigation adjustment activities* (having a flashlight, fire extinguisher, first-aid kit, first-aid training, three-day food supply, and three-day water supply) while the second group includes five *complex mitigation adjustment activities* (signing up for a smart phone tornado alert system, installing a tornado shelter, having a weather radio, homeowner's insurance, and household emergency plan). Respondents were first asked to report their *coping appraisals,* or their perceived attributes of these separate adjustment activities via seven questions (from 1 = not at all to 5 = to a very great extent), including two items for the perceived *response efficacy* (the activity protects persons or property very effectively), three items for the perceived *self-efficacy* (the activity requires specialized knowledge, and a lot of cooperation and effort), and two items for the perceived response cost (the extent of

the activities' monetary costs and its usefulness for other hazards). We measure and assess each of these seven items as specific aspects of *response efficacy*, *self-efficacy*, and *response cost* (and ultimately, *coping appraisals*) separately, relative to the basic and complex activity categorization. We chose to measure the appraisal variables individually, rather than a combined average, primarily because doing this will provide relevant, in-depth insights in to which aspects of *self-efficacy*, *response efficacy*, and *response cost* are most important for influencing the adjustment intentions categories. Doing this can provide unique, actionable insights for emergency managers and researchers. One natural consequence of this approach, however, involves the predictors being strongly correlated in some instances. Thus, we address potential concerns about multicollinearity by conducting variation inflation factor (VIF) tests. Acceptable VIFs, according to Hair et al. (2011), fall in between 1 and 5. Our results showed that VIFs never exceeded 1.69, so we do not assume multicollinearity is present in the data used for regression analysis.

Next, the perceived likelihood of adopting each of these 11 hazard adjustment activities (adjustment intentions) was captured (from 1 = not at all to 5 = to a very great extent) and were combined to form two separate dependent variables. The hazard adjustment intentions for the six basic activities were then combined to form the first dependent variable, *basic hazard adjustment intentions* ($\alpha = 0.74$). Then the hazard adjustment intentions for the five complex activities (signing up for a smart phone tornado alert system, installing a tornado shelter, having a weather radio, homeowner's insurance, and household emergency plan) were combined to form the second dependent variable, *complex hazard adjustment intentions* ($\alpha = 0.61$). Following Clark and Watson (1995), a Cronbach's alpha greater than 0.60 is commonly characterized as good. Last, we asked respondents to report their demographic and household information, including their sex (female = 1), duration in Oklahoma (years), and whether they rent or own their home (renter = 1). According to the PADM, personal characteristics (demographics) such as age, sex, race, education level, income level, homeownership, and tenure of residence in the state are the variables that could influence protective action decisions (hazard adjustment in this case) (Lindell and Perry 2004). Since our sample is OSU college students, we exclude race, education level, and income level because these variables do not have enough variation to detect any meaningful effects (Lindell and Perry 2004).

c. *Analysis approach*

We conducted separate analyses for each approach detailed below using one of the two dependent variables (basic hazard adjustment intentions and complex hazard adjustment intentions) entered as the primary outcome variable, along with their corresponding *coping appraisal* assessments.

To test the research questions, Pearson's (r) correlations were first computed. In a second step, we performed a stepwise multiple regression to assess the explanatory power of the threat appraisal variables, as compared to the coping appraisal variables, along with the demographic variables, on respondents' adjustment intentions.[1] At each stage, stepwise regression uses the probability of F for each variable in the regression equation to provide a judgement on the contribution made by each predictor variable; one predictor variable is either included or removed at each step until the most appropriate regression model is determined (Pasha 2002). The stepwise approach thus shows which group of predictor variables constitute the best-fitting model for each form of adjustment intentions, or which factors have the most explanatory power for *basic hazard adjustment intentions*, and *complex hazard adjustment intentions*, specifically.

4. Results

Tables 1 and 2 present descriptive statistics (mean and standard deviation) scores and correlations for all measures, including the control variables. Table 1 displays the descriptives and correlation matrix for the *basic hazard adjustment intentions* grouping, while Table 2 displays the descriptives and correlation matrix for the *complex hazard adjustment intentions* grouping. The majority of respondents were female (62%) and home renters (71%), who, on average, had lived in Oklahoma (OK) for 14 years. As shown in Tables 1 and 2, on average, the coping appraisal measures for both basic hazard adjustment actions and complex hazard adjustment actions were rated highest for their ability to protect persons effectively ($M = 4.05$; $M = 3.86$, response efficacy) and to be useful for other purposes other than tornado protection ($M = 4.23$; $M = 3.74$, response cost). On average, the adjustment intentions of students for basic adjustment items ($M = 3.90$) were slightly higher than complex adjustment items ($M = 3.61$).

RQ1 addresses the correlations between students' basic hazard adjustment intentions, threat appraisal variables (negative emotion, hazard experience, hazard salience, risk perceptions), coping appraisal variables (response efficacy, self-efficacy, response cost) and demographic characteristics (sex, OK residency, home renter). As shown in Table 1, students' risk perceptions ($r = 0.13$, $p < 0.01$) is significantly and positively correlated with their basic hazard adjustment intentions, along with the ability of such adjustment actions to protect persons ($r = 0.44$, $p < 0.01$) effectively, require a lot of effort (negative sign, $r = -0.11$, $p < 0.05$) and be useful for purposes other than tornado protection ($r = 0.52$, $p < 0.01$). None of the remaining threat appraisal variables, coping appraisal variables, or demographic characteristics significantly correlate with basic hazard adjustment intentions. Negative emotions, on the other hand, again shows significant and positive correlations with hazard salience ($r = 0.16$, $p < 0.01$), risk perceptions ($r = 0.24$, $p < 0.01$), the response efficacy (property, $r = 0.13$, $p < 0.01$) of basic hazard adjustment actions, and both sex and renting a home.

RQ2 addresses the correlations between students' complex hazard adjustment intentions, threat appraisal variables (negative emotion, hazard experience, hazard salience, risk perceptions),

[1] Sex was not included in the stepwise regression due to nonsignificant correlations.

TABLE 1. Correlation matrix for basic hazard adjustment intentions and coping appraisals. Two asterisks (**) with bold font indicate the correlation is significant at the 0.01 level (two tailed), and one asterisk (*) with bold font indicates the correlation is significant at the 0.05 level (two tailed); $N = 371$. Basic adjustment intentions (adj int; flashlight, fire extinguisher, first-aid kit, first-aid training, three-day food, three-day water). Coping appraisal variables: response efficacy (protect persons and property very effectively), self-efficacy (require specialized knowledge and skill, require a lot of effort and cooperation from others), and response cost (useful for purposes other than tornado protection and monetary cost) are perceptions of fundamental adjustment intentions, specifically.

	M	SD	Basic adj int	Negative emotion	Hazard experience	Hazard salience	Risk perception	Response efficacy (person)	Response efficacy (property)	Self-efficacy (knowledge)	Self-efficacy (effort)	Self-efficacy (cooperation)	Response cost (useful)	Response cost (monetary)	Gender (female = 1)	Duration in OK (years)	Home ownership (renter = 1)
Basic adj int	3.90	0.76	—														
Negative emotion	2.84	1.10	0.05	—													
Hazard experience	1.25	0.56	0.02	0.00	—												
Hazard salience	2.57	0.84	0.05	**0.16****	**0.11***	—											
Risk perception	2.31	0.78	**0.13***	**0.24****	**0.13***	**0.19****	—										
Response efficacy (person)	4.05	0.86	**0.44****	0.09	−0.06	0.10	**0.20****	—									
Response efficacy (property)	2.32	0.98	0.07	**0.13****	−0.09	0.00	**0.24****	**0.24****	—								
Self-efficacy (knowledge)	2.38	0.70	−0.04	0.02	−0.01	−0.03	**0.16****	0.05	0.39**	—							
Self-efficacy (effort)	2.41	0.74	**−0.11***	0.04	−0.04	−0.06	**0.14****	−0.05	0.27**	**0.73****	—						
Self-efficacy (cooperation)	2.14	0.81	−0.07	0.06	−0.07	−0.05	**0.20****	−0.03	0.37**	**0.70****	**0.75****	—					
Response cost (useful)	4.23	0.82	**0.52****	0.10	−0.02	0.10	**0.12***	**0.65****	0.01	−0.08	**−0.12***	**−0.18****	—				
Response cost (monetary)	2.41	0.72	−0.08	0.01	0.01	−0.01	**0.13***	−0.07	0.24**	**0.55****	**0.66****	**0.54****	**−0.12***	—			
Sex (female = 1)	0.62	0.49	−0.03	**0.19****	0.06	−0.06	0.02	0.04	−0.04	−0.04	0.06	0.02	0.10	−0.03	—		
Duration in OK (years)	14.11	9.61	−0.07	−0.04	0.08	**0.11***	0.06	0.05	−0.10	−0.06	−0.01	−0.04	0.08	0.00	**0.14****	—	
Home ownership (renter = 1)	0.71	0.45	−0.04	**0.12***	−0.03	0.03	0.03	0.01	0.07	0.03	0.01	−0.03	0.01	0.02	−0.06	**−0.15****	—

TABLE 2. Correlation matrix for complex hazard adjustment intentions and coping appraisals. Two asterisks (**) with bold font indicate the correlation is significant at the 0.01 level (two tailed), and one asterisk (*) with bold font indicates the correlation is significant at the 0.05 level (two tailed). Listwise $N = 371$. Complex hazard adjustment intentions: smart phone tornado alert system; installing a tornado shelter; having a weather radio, household emergency plan, homeowner's insurance. Coping appraisal variables: response efficacy (protect persons and property very effectively), self-efficacy (require specialized knowledge and skill, require a lot of effort and cooperation from others), and response cost (useful for purposes other than tornado protection and monetary cost) are perceptions of advanced mitigation adjustment intentions, specifically.

	M	SD	Complex adj int	Negative emotion	Hazard experience	Hazard salience	Risk perception	Response efficacy (person)	Response efficacy (property)	Self-efficacy (knowledge)	Self-efficacy (effort)	Self-efficacy (cooperation)	Response cost (useful)	Response cost (monetary)	Gender (female = 1)	Duration in OK (years)	Home ownership (renter = 1)
Complex adj int	3.61	0.80	—														
Negative emotion	2.84	1.09	0.06	—													
Hazard experience	1.25	0.56	**0.13***	0.00	—												
Hazard salience	2.58	0.84	**0.18****	**0.16****	**0.12***	—											
Risk perception	2.31	0.77	**0.21****	**0.24****	0.13*	0.19**	—										
Response efficacy (person)	3.86	0.68	**0.49****	**0.13***	−0.05	0.18**	0.17**	—									
Response efficacy (property)	2.88	0.91	**0.16****	**0.12***	−0.06	0.07	0.15**	0.45**	—								
Self-efficacy (knowledge)	2.44	0.73	−0.04	0.08	−0.07	−0.04	0.11*	0.07	**0.40****	—							
Self-efficacy (effort)	2.54	0.61	**−0.13***	**0.11***	−0.09	−0.04	0.05	−0.01	**0.20****	**0.66****	—						
Self-efficacy (cooperation)	2.67	0.66	0.02	**0.13****	−0.02	−0.02	0.16**	0.09	**0.25****	**0.66****	0.65**	—					
Response cost (useful)	3.74	0.74	**0.47****	**0.15****	0.05	0.14**	0.16**	0.54**	**0.29****	0.03	0.01	**−0.17****	—				
Response cost (monetary)	2.65	0.48	**−0.15****	0.07	−0.06	0.03	0.10*	0.00	**0.11***	**0.45****	0.56**	**0.48****	0.04	—			
Sex (female = 1)	0.62	0.49	0.02	**0.19****	0.06	−0.06	0.02	0.10	−0.01	−0.02	−0.01	−0.02	0.09	−0.02	—		
Duration in OK (years)	14.12	9.59	**0.13***	−0.05	0.08	**0.10***	0.06	0.07	**−0.16****	**−0.14****	**−0.18****	**−0.13***	−0.01	**−0.13****	**0.13****	—	
Home ownership (renter = 1)	0.71	0.45	**−0.18****	**0.12***	−0.03	0.03	0.03	**−0.11***	0.02	0.08	0.04	0.00	−0.08	0.04	−0.07	**−0.15****	—

coping appraisal variables (response efficacy, self-efficacy, response cost), and demographic characteristics (sex, OK residency, home renter). As shown in Table 2, students' tornado hazard experience ($r = 0.13, p < 0.05$), salience ($r = 0.18$, $p < 0.01$), and risk perceptions ($r = 0.21, p < 0.01$) are significantly and positively correlated with their complex hazard adjustment intentions, along with the ability of such adjustment actions to protect persons ($r = 0.49, p < 0.01$) and property ($r = 0.16$, $p < 0.01$) effectively, require a lot of effort ($r = -0.13, p < 0.05$), be useful for purposes other than tornado protection ($r = 0.47$, $p < 0.01$), and cost a lot of money ($r = -0.15, p < 0.01$); both duration of living in Oklahoma ($r = 0.13, p < 0.05$) and renting a home ($r = -0.13, p < 0.05$) are also significantly correlated to such adjustment intentions, with the former showing a positive sign and the latter showing a negative sign. However, negative emotion toward tornadoes, adjustment actions requiring specialized knowledge and skill, requiring cooperation from others, and sex are nonsignificant. Negative emotions toward tornadoes are also significantly and positively correlated to the threat appraisal variables of hazard salience ($r = 0.16, p < 0.01$), and risk perceptions ($r = 0.24, p < 0.01$), along with numerous coping appraisal variables (persons, property, effort, cooperation, useful) and demographic characteristics (sex, renting a home).

Stepwise multiple regression was performed next to test RQ3 and RQ4, which seeks to find the particular set of threat appraisal variables, coping appraisal variables, and demographic characteristics that best explain students' basic hazard adjustment intentions (RQ3) and complex hazard adjustment (RQ4). Only variables that had significant zero-order relationships with the adjustment intentions were included in the stepwise multiple regression analysis.

As shown in Table 3's model 1, three variables met the minimum inclusion criteria resulting in a significant prediction equation [$F(3, 370) = 54.005, p < 0.001$] that explained 30% of the variance in basic hazard adjustment intentions (adj. $R^2 = 0.30$), specifically. Here, no threat appraisal variables remained in the final model. Rather, protecting persons effectively (response efficacy) ($b = 0.18$, $p < 0.001$) and being useful for purposes other than tornado protection (response cost) ($b = 0.37$, $p < 0.001$) are the two coping appraisal variables, along with duration living in Oklahoma ($b = -0.01, p < 0.05$), that produce the best-fitting model for basic hazard adjustment intentions.

As shown in Table 3's model 2, six variables instead met the minimum inclusion criteria resulting in a significant prediction equation [$F(6, 372) = 37.905, p < 0.001$] that explained 37% of the variance in complex hazard adjustment intentions (adj. $R^2 = 0.37$). Tornado hazard experience ($b = 0.17, p < 0.05$) and risk perceptions ($b = 0.11$, $p < 0.05$) were the only threat appraisal variables to remain in the final model, while protecting persons effectively (response efficacy) ($b = 0.37$, $p < 0.001$), being useful for purposes other than tornado protection (response cost) ($b = 0.31$, $p < 0.001$), and costing a lot of money (response cost) ($b = -0.25$, $p < 0.001$) were the only coping appraisal variables, along with the demographic characteristic of renting a home ($b = -0.21, p < 0.05$). However, adding the two threat appraisal variables (experience and risk perceptions) and the demographic characteristic (renting and home) only improves the adj. R^2 of the model by 6%, as the three coping appraisal variables alone explain 31% of the variance in complex hazard adjustment intentions (adj. $R^2 = 0.31$).

TABLE 3. Stepwise regression results: best-fitting models of two types of mitigation measures. Note: Unstandardized regression coefficients are shown. Here, three asterisks (***) indicate $p < 0.001$, two asterisks (**) $p < 0.01$, and one asterisk (*) $p < 0.05$. Standard errors are in parentheses. Model 1: Basic hazard adjustment intentions (flashlight, fire extinguisher, first-aid kit, first-aid training, three-day food, three-day water) as dependent variable (DV). Model 2: Complex hazard adjustment intentions (smart phone tornado alert system; installing a tornado shelter; having a weather radio, homeowner's insurance, household emergency plan) as DV.

	Outcome variable	
	Basic adj int	Complex adj int
Predictor variables	Model 1	Model 2
Negative emotion		
Hazard experience		0.17 (0.06)**
Hazard salience		
Risk perception		0.11 (0.04)**
Response efficacy (person)	0.18 (0.05)***	0.37 (0.06)***
Response efficacy (property)		
Self-efficacy (knowledge)		
Self-efficacy (effort)		
Self-efficacy (cooperation)		
Response cost (useful)	0.37 (0.05)***	0.31 (0.05)***
Response cost (monetary)		−0.25 (0.07)***
Sex (female = 1)		
Duration in OK (years)	−0.01 (0.00)*	
Home ownership (renter=1)		−0.21 (0.07)**
F	54.005***	37.905***
Degrees of freedom	3	6
Adj. R^2	0.30	0.37
Obs	373	378

5. Discussion

The results of this study complement PMT literature that addresses factors influencing adjustment intentions in response to hazards. The correlation matrixes illustrate the basic relationships among tornado hazard adjustment intentions, threat appraisal, coping appraisal, and demographic variables. Similar to the previous studies on flood adjustment and proenvironmental behaviors (Babcicky and Seebauer 2019; Bockarjova and Steg 2014), this study found that, in general, the correlations between threat appraisal and tornado hazard adjustment intentions are smaller than the correlations between coping appraisal and tornado hazard adjustment intention. This is true for both basic and complex tornado hazard adjustment intentions. We included measures of hazard experience and salience based on PADM findings (Lindell 2018) and they do have significant, positive correlations with complex hazard (but not basic) adjustment intentions based on the Oklahoma State University student sample. In contrast, while we included measures of negative emotion based on the TRA

studies (Ajzen 1985; Fishbein and Ajzen 1975, 2011), we did not find significant correlations with hazard adjustment intentions.

Consistent with the findings from Westcott et al. (2020), the perceived response efficacy of protecting persons is highly correlated with hazard adjustment intentions, as outlined in Tables 1 and 2. Correlations between perceived response efficacy of protecting property and hazard adjustment intention, on the other hand, are much smaller in both correlation matrixes. This is especially true for the basic hazard adjustment activities since most of the activities in this category focus more on adjustment actions that address survival (e.g., first-aid kits, food, and water supply). The correlations among self-efficacy variables and tornado hazard adjustment intentions are small in both correlation matrixes. This finding is somewhat different from other studies (Tang and Feng 2018; Westcott et al. 2020) and could be occurring for a couple of reasons. First, this difference could relate to the populations studied. As noted above, college students have lower levels of perceived self-efficacy and show little confidence in their ability to address their vulnerability (Lovekamp and Tate 2008). Second, the differences could relate to hazard type: while our study focused on tornadoes, other studies have explored adjustment in relation to earthquakes and bushfires.

One of the response costs variables, utility for other hazards, is highly, positively correlated with tornado hazard adjustment intentions. This result is similar to the literature (Bockarjova and Steg 2014; Tang and Feng 2018; Westcott et al. 2020; Wu et al. 2017) and is especially true for the basic hazard adjustment intentions. This also helps to explain why students reported greater intentions to adopt basic hazard adjustment actions, as compared to complex hazard adjustment actions. Finally, longer tenure in Oklahoma (positive) and being a renter (negative) are correlated with complex hazard adjustment intentions, but not basic adjustment intentions. This is likely because students would not consider large investments in complex hazard adjustment activities, particularly tornado storm shelters, without established residency and homeownership (so they can keep their investment); whereas the same variables do not explain variance in adopting basic activities, such as flashlights and food supplies, as they are easily acquired and transferable to new locations.

The most intriguing findings from this study comes when addressing RQs 3 and 4. As mentioned earlier, prior PMT studies did not specifically address how appraisal variables affect distinct types of hazard adjustment actions differently. Our results imply that to lead an individual to intend to adopt basic tornado hazard adjustment activities, one only needs to value the response efficacy of protecting persons and understand how a given tornado hazard adjustment action can be used for other hazards. Based on this college student sample, however, to trigger complex tornado hazard adjustment actives, students need more appraisal variables to contribute to the effect. These appraisal variables include hazard experience, risk perceptions, the response efficacy of protecting persons, and both response cost variables (monetary). These findings are important for disaster science theories and emergency managers that serve college student populations. We expand on this in the next section.

6. Conclusions

College students are generally defined as vulnerable and unprepared for hazards (Rohli et al. 2018: Greer et al. 2018; Jauernic and Van Den Broeke 2017; Wu et al. 2017; Tkachuck 2016; Simms et al. 2013; Lovekamp and Tate 2008). While existing research has provided important insights, much remains to be discovered about the factors that influence college students' adjustment intentions in response to tornado threats. For example, most PMT studies conducted using other types of samples have concluded that coping appraisal variables are better predictors of adjustment intentions than threat appraisal variables (e.g., Greer et al. 2020), although it is unclear whether these findings generalize to college students, who often do not own a home, know much about hazards, or have a permanent job with a steady income (Jauernic and Van Den Broeke 2017). Likewise, these studies have not considered how threat and coping appraisals may have differential effects on varying types of hazard adjustments. Moreover, previous studies employing PMT models have not considered negative emotion (exception, Weinstein et al. 2000) and hazard salience as important components of threat appraisal, which can help explain when individuals such as college students become more motivated to engage in protective action.

Using a sample of college students from a major university in Oklahoma, situated in a region that experiences severe tornado risk, the present study used an expanded PMT model to better understand when students are more likely to engage in tornado mitigation and preparedness measures. Our findings suggest that threat appraisals become more important for influencing college students' adjustment intentions when the hazard adjustment activities are complex (e.g., tornado shelter, home insurance), rather than basic (e.g., flashlight, first-aid kit), particularly due to the influence of hazard salience, hazard experience, and risk perceptions on complex adjustment intentions. Specifically, the present study adds to PMT theory and the existing literature by 1) considering negative emotion and hazard salience as additional dimensions of threat appraisal, and 2) explaining when and why some hazard adjustment activities (basic vs complex) are more likely to be adopted than others.

The results support our overall argument and suggest that while both threat appraisals *and* coping appraisals are important for complex hazard adjustment intentions, basic hazard adjustment intentions are almost exclusively determined by coping appraisals. These findings have several implications for emergency management and the academic literature. First, threat appraisals help provide the necessary motivation for college students to invest in *complex* adjustment intentions. To make such a large investment, in addition to coping appraisals, college students must either have high risk perceptions toward the hazard itself, have high hazard salience, or experience with the hazard (experience and risk perception being the most influential here). While emergency managers can help most of the student population during their college experience with

education for basic adjustments, this suggests that they must expend efforts communicating a heightened level of importance about tornado risk in order to influence students' intentions for complex adjustments. Despite few students being able to adopt some of the complex adjustments (tornado shelter, insurance) during their actual college experience, emergency managers can nonetheless motivate them to secure others (e.g., smart phone alert system, emergency management plan) and help ensure their safety postgraduation. Educating students while in college on the importance of homeowner's insurance and the value of shelters can help positively influence long-term adjustment behaviors. Basic adjustment activities, on the other hand, do not require heightened risk perceptions, experience, or salience, because they are adjustments that require minimal financial investment, little effort, and individuals know that such supplies can be useful for hazards ranging from tornadoes to pandemics.

Second, these findings suggest that previous studies on adjustment intentions, which find that coping appraisals are more important than threat appraisals, should be reexamined by parsing potential adjustments and with a broader population and/or different hazards. For example, if measures of adjustment activities are predominately reflecting basic activities, this would explain why coping appraisal variables have received consensus on being the most important for adjustment intentions. Our findings suggest that threat appraisal variables should only matter in relation to more complex adjustment activities, as these require more investment, effort, and are dependent upon factors such as home ownership and duration living in the areas.

a. Future research

There are several avenues for future research. First, the same approach above can be used to reexamine previous studies and for future studies that assess adjustment activities for other hazards, such as earthquakes, which can be categorized as basic (e.g., cabinet locks or latches) or complex (purchasing insurance). Second, many of the determinations regarding the importance of coping appraisals have been made without the use of appropriate analytical procedures such as stepwise regression, which can determine the most important set of appraisal predictors along a number of criteria. Future research on PMT and adjustment intentions, or replication studies, should use multivariate tools such as stepwise regression (or others) in conjunction with correlation analysis to make valid claims about the importance of variables. Third, there is likely a larger ladder to consider in the categorization of adjustment activities, as a group of activities may fit between basic and complex to form three groups, or even four. That is, while our categorization of adjustment activities included two levels, or two steps from the most basic to most complex, there may be additional activities or categorizations that expand the number of levels (e.g., basic, moderate, complex). Fourth, we did not ask respondents when they intended to undertake a given adjustment, only whether or not they intended to undertake said adjustment. The time horizon between adjustment intentions and actual adoption might be long in the case of complex adjustments, such as acquiring homeowner's insurance or installing a storm shelter. This is particularly true for populations such as college students that often lack agency to undertake said complex adjustments but may intend to when they own a home. To increase granularity and practical utility of study findings, future studies should bound adjustment intentions temporally (next year, next five years, never, etc.) to better understand temporality. Fifth, future research should aim to confirm our findings in other types of samples, as the unique conditions and characteristics of a student sample may also best explain the impact of threat appraisals. Overall, the additions/improvements to the PMT suggested and tested within this study are an important foundation but need to be replicated and expanded to a broader population. This is discussed further below.

b. Limitations

The present study has some important limitations inherent in its design. Foremost, our sample was specific to Oklahoma college students, who are often young renters with minimal resources, and consequently do not adopt mitigation measures as frequently as the broader population. Thus, the generalizability of our findings is limited to this traditionally defined vulnerable group. Future research is needed to confirm these findings in the broader Oklahoma population and even additional geographic regions. For example, it could be that threat appraisals are important for the consideration of complex hazard adjustment activities among college students *because* of the characteristics that make them vulnerable (requiring extra motivation), while coping appraisal variables might suffice alone for the same activities among the general population, as they are generally better equipped to make such decisions. A more representative sample design is needed to assess these potential research questions, along with refined analytic procedures to address them (e.g., moderation or moderated mediation).

Second, our study did not include many demographic variables that previous works have noted important to consider, such as age and being married. While our survey captured many of these variables, most were not included in the analysis because they did not have enough variation to identify strong correlations with hazard adjustment intentions. Being a student sample, it shows little variance in age and marital status since most students are relatively young and not married. For example, in our sample, 79.7% of respondents were between 18 and 24 years old, and 91.3% were not married. Likewise, some of our questions might not be well suited to college students. When asking about household income, for example, college students might list their parents' income instead of their own. When asking about homeownership or adjustment intentions, they might indicate they own their home while living with parents or be thinking of their ability to exert influence on their parents (and thus leverage their resources) to undertake adjustments. While we recognize that college students cannot engage in some of the adjustment activities (particularly complex adjustments related to homeownership), we asked respondents about their adjustment *intentions,* which captures what they are likely to do in the future.

Third, stepwise regression can sometimes fit the data well in sample but poorly out of sample due to nuisance variables (rather than explanatory variables that have causal effects on the outcomes variable) producing significant results (Smith 2018). However, since these issues typically arise when a larger number of predictors are included, we assume stepwise regression is useful to select the most useful explanatory variables in this study. Fourth, we assessed the coping appraisals individually, and thus could not conduct more complex analytical procedures such as structural equation modeling (SEM). Single-item measures often present identification and convergence issues in SEM (Petrescu 2013), and, given the high number of single items we use to capture both our latent variables and demographic variables, we assumed these issues would manifest easily with its use. Finally, as mentioned in the previous section, additional research is needed to confirm the validity of our approach for grouping adjustment intentions (basic vs complex) using different samples and consideration of additional levels.

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