

## RAINSTORM EXPERIENCES AND PTSD

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### The Role of Perceived Severity of Disaster, Rumination, and Trait Resilience in the Relationship Between Rainstorm-related Experiences and PTSD among Chinese Adolescents Following Rainstorm Disasters

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### Abstract

This study examined the mediating role of perceived severity of trauma and rumination in the relationship between traumatic experiences and PTSD, and assessed the moderated role of resilience in this mediating process. Nine hundred and fifty-one adolescents were selected to complete a self-report questionnaire involving rainstorm-related experiences, perceived severity of trauma, rumination, resilience, and PTSD. The results found that rainstorm-related experiences had a positive effect on PTSD by perceived severity of disaster, or by rumination via perceived severity of disaster. Resilience buffered the relationship between rainstorm-related experiences and PTSD, but did not buffer the relation of rainstorm-related experiences to perceived severity of disaster and rumination. These findings indicated that rainstorm-related experiences may have an indirect effect on PTSD via cognitive activities, and these indirect paths were not buffered by resilience. A buffering effect only occurred in the direct paths from rainstorm-related experiences to PTSD.

**Key words:** rainstorm-related experiences, perceived severity of disaster, rumination, resilience, PTSD

It has been documented that posttraumatic stress disorder (PTSD) is a common negative outcome amongst individuals following traumatic experiences. Studies have found that the prevalence of PTSD in a traumatized population following natural disasters ranges from 5% to 60% (Galea, Nandi, & Vlahov, 2005). In China, these rates have been found to range from 6.5%~82.6% (Cao, Wang, Cao, & Zhang, 2015). Of particular importance is the finding that adolescents may report more severe PTSD symptoms than adults because of their susceptibility to trauma (Eth, 2008). For example, Ying et al.' (2015) study on adolescents following the Wenchuan earthquake found that 8.4% of individual's showed signs of PTSD. A study on adolescents who experienced a flood in southwestern Poland found that 18% of the participants met full diagnostic criteria for PTSD (Bokszczanin, 2007). Agustini, Asniar and Matsuo (2011) found that very severe to moderate PTSD symptoms occurred in 63.1% of 482 adolescent participants after the tsunami in Aceh.

These higher prevalence rates of PTSD have led to a recent interest amongst researchers to examine the risk factors for PTSD. Two meta-analyses have found that there are many risk factors for PTSD in adolescents such as traumatic exposure, perceived life threat, and other post-traumatic factors (Furr, Comer, Edmunds, & Kendall, 2010; Trickey, Siddaway, Meiser-Stedman, Serpell, & Field, 2012), wherein traumatic experiences might be a prerequisite for PTSD (Freedy, Resnick, & Kilpatrick, 1992; Janoff-Bulman, 2010). Theoretically, traumatic experiences may challenge an individual's existing and stable belief system, leading them to form negative assumptions about their posttraumatic world and, in turn, elicit PTSD (Janoff-Bulman,

2010). Studies have also suggested that the differences in the prevalence rates and severity of PTSD symptoms may depend on the degree of exposure to the traumatic experiences (Grubaugh, Zinzow, Paul, Egede, & Frueh, 2011). Furthermore, several studies have found that traumatic experiences have positive effect on PTSD (Fan, Zhang, Yang, Mo, & Liu, 2011; Ma et al., 2011).

Nevertheless, other studies have found that traumatic experiences do not necessarily directly lead to PTSD (Nygaard & Heir, 2012; Zhou, Wu, Yuan, Chen, & Chen, 2015), and therefore not all individuals who experience a trauma will necessarily develop PTSD following traumatic events (Wu, Zhou, Lin, & Chen, 2015). A potential reason for these mixed findings may be attributed to the cognitive activities following a traumatic experience (Bomyea & Lang, 2016; Janoff-Bulman, 2010; Joseph, Williams, & Yule, 1997; Park, 2010; Ponnampereuma & Nicolson, 2016). Studies on PTSD have found that the perceived severity of a trauma and rumination may be two important cognitive factors that lead an individual to experience distress (Blanchard et al., 1995; Cernvall et al., 2016; Delahanty, Raimonde, Spoonster, & Cullado, 2003; Zhou & Wu, 2016). Therefore, the aim of this study was to assess the role of perceived severity of disasters and levels of rumination in relationship between traumatic experiences and PTSD, and to elucidate the underlying cognitive processes of the occurrence of PTSD amongst adolescents after a rainstorm disaster.

### **Perceived severity of disaster, Rumination, and PTSD**

The perceived severity of disasters involves the appraisal and associated cognitions regarding the severity of the disaster outcomes (e.g., evaluating the

economic and health consequences following a natural disaster). The cognitive theory of stress and coping suggests that an individual's cognitive appraisal and coping process plays an important role in the resulting psychological outcomes ([Lazarus & Folkman, 1984](#)). Based on this theory, the experience of a traumatic event can activate an individual's appraisal system, wherein people are primarily focused on the potential harm associated with a traumatic experience. When individual who has recently suffered a trauma evaluates and perceives the traumatic experience as being threatening, they may show more fear or worry than an individual who does not. This can lead to a conditioned fear of trauma-related cues ([Jovanovic et al., 2009](#)), wherein traumatic events may easily intrude into peoples' cognitive worlds (Fani et al., 2012) and elicit PTSD symptoms, particularly those related to re-experiencing the event(s). Thus, studies have reported that having a greater perceived severity of an experienced trauma was associated with more symptomatology associated with PTSD ([Besser, Neria, & Haynes, 2009](#); [Girelli, Resick, Marhoefer-Dvorak, & Hutter, 1986](#); [Kemp, Rawlings, & Green, 1991](#); [Lee, Ahn, Jeong, Chae, & Choi, 2014](#); [Solomon, Mikulincer, & Hobfoll, 1987](#)). Taken together, it may be that the perceived severity of trauma may mediate the relationship between traumatic experiences and PTSD.

Another important predictive factor of PTSD is rumination, which refers to a mode of responding to distress that involves repetitively and passively focusing on symptoms of distress and on the possible causes and consequences of these symptoms ([Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008](#)). [Janoff-Bulman \(2010\)](#) claimed that the shattered world assumption, led by trauma severity, caused substantial internal

disequilibrium before and after a trauma and, in turn, could cause a traumatized individual to immerse him/herself into the traumatic events and ruminate on them. Furthermore, rumination on traumatic events causes individuals to focus on the negative outcomes of traumatic events and, in turn, increases negative emotions ([Blackburn & Owens, 2016](#)), which may ultimately lead to PTSD (Borders, Rothman, & McAndrew, 2015; Chuen Yee Lo, Lau, Cheung, & Allen, 2012). Thus, it was proposed that traumatic experiences may be indirectly associated with PTSD via rumination.

Although traumatic experiences may lead to more PTSD symptoms via the activation of one's perceptions of trauma severity or rumination, the complimentary role of the perceived severity of a disaster and rumination has seldom been examined. In fact, Lazarus and Folkman (1984) suggested that the appraisal of traumatic experiences might be associated with cognitive coping. That is, the perceived severity of trauma may be related to rumination because rumination can be considered as a way of coping following a traumatic event ([Baschnagel, Gudmundsdottir, Hawk, & Beck, 2009](#)). Specifically, when traumatized people perceive a trauma as being of a higher severity, they also tend to perceive more psychological stress which, in turn, undermines their emotional ability to self-regulate, or the capacity to engage in self-control over one's behavior ([Baumeister, Gailliot, DeWall, & Oaten, 2006](#)). This may lead traumatized individuals to focus their attention on negative thoughts and feelings, which can lead to the formation of negative self-schemas based on their traumatic experiences, and increase the likelihood of rumination (Michl, McLaughlin, Shepherd, & Nolen-

Hoeksema, 2013; [Scher, Ingram, & Segal, 2005](#)). Taken collectively, it is likely that traumatic experiences may also have indirect effects on PTSD based on an individual's perceived severity of the trauma via rumination.

Nevertheless, it has been noted when examining the predictive factors of PTSD, individual characteristics and traits should not be ignored ([Bonanno, 2004](#)). The diathesis–stress model emphasizes that exposure to traumatic events interacts with individual characteristics and traits to produce trauma-related outcomes ([McKeever & Huff, 2003](#)), wherein trait resilience may be an important individual characteristic ([Besser & Priel, 2010](#); [Wagnild, 2009](#)). Furthermore, studies have indicated that resilience may buffer the role of traumatic experiences in PTSD ([Fincham, Altes, Stein, & Seedat, 2009](#); [Lee et al., 2014](#)), but it is still unclear as to whether resilience buffers the underlying cognitive processes of PTSD following a traumatic event. Therefore, this study further assessed the potential moderating role of resilience in paths from traumatic experiences to PTSD.

### **Moderated Role of Resilience**

Trait resilience refers to a positive personality trait that enables individuals to recover from adversity and to adapt, thrive and mature in the face of difficult or challenging circumstances ([Friborg, Hjemdal, Rosenvinge, & Martinussen, 2003](#); [Liu, Wang, Zhou, & Li, 2014](#)). Resilient individuals are more likely to be hardy ([Bonanno, 2005, 2008](#)), wherein they tend to view potentially stressful situations as meaningful, have a continued commitment to their values and goals of life after stressful situations, believe that they have some control over their stressors, appraise stressors as changeable,

and see change as a normal aspect of life ([Jakšić, Brajković, Ivezić, Topić, & Jakovljević, 2012](#); Nabizadeh & Mahdavi, 2016). Therefore, after traumatic experiences, individuals with greater resiliency may perceive a traumatic event as being less severe. In contrast, individuals with lower resiliency may be inclined to perceive a traumatic event as being more severe.

In addition to hardiness, features of resilience include self-improvement, positive impact, coping and a sense of coherence ([Tedeschi & Calhoun, 2004](#)). Resilient individuals have been found to be more likely to use creative exploration, relaxation, and optimistic thinking as ways of coping ([Tugade & Fredrickson, 2004](#)). More importantly, Calhoun and Tedeschi's (2006) theory suggests that resilient individuals may look at traumatic experiences as being less aversive, and thus their beliefs may challenge less. The result being that individuals ruminate less in response to traumatic cues ([Tedeschi & Calhoun, 2004](#)). Therefore, it is more likely highly resilient adolescents may engage in less rumination, than less resilient adolescents following a traumatic experience. That is, resilience may also buffer the role of traumatic experiences with respect to rumination.

Additionally, resilient trauma survivors show other characteristics such as self-esteem and optimism ([Bonanno, 2005, 2008](#)), this may permit people to persist in normal functioning despite a traumatic exposure ([Bensimon, 2012](#)), such that resilient individuals remain stable before, during and after their exposure to trauma (Bonanno, 2008). Therefore, higher resilience could protect traumatized individuals from posttraumatic negative outcomes, and reduce susceptibility to negative psychological



outcomes ([Pietrzak, Johnson, Goldstein, Malley, & Southwick, 2009](#); [Wingo et al., 2010](#)), whereas individuals with comparatively low resiliency may be more inclined to perceive more distress. In other words, resilience may also buffer the role of traumatic experiences in PTSD ([Dai et al., 2014](#); [Lee et al., 2014](#)).

### **Current study**

The literature reviewed above suggests that the unique role of traumatic experiences, perceived severity of trauma, rumination, and resilience in predicting the onset of PTSD, but no studies have assessed their combined role in producing the symptoms of PTSD. In addition, theoretically, both perceived severity of trauma and rumination may mediate the relationship between traumatic experiences and PTSD, but the predictive utility of such relationships has not yet been evaluated in adolescent survivors of natural disasters. Moreover, the complimentary role of perceived severity of disasters and rumination in the relationship between traumatic experiences and PTSD has seldom been examined, which further limits our understanding of the underlying processes of PTSD. More importantly, although the potential moderating role of resilience in the relationship between traumatic experiences and PTSD had been identified ([Ying, Wu, Lin, & Jiang, 2014](#)), the role of resilience in the relationship between traumatic experiences and cognitive factors (e.g., perceived severity of trauma, rumination) is still unclear. Finally, natural disasters, which are both unpredictable and uncontrollable traumatic events, may seriously destroy a victim's cognitions and beliefs ([Ehlers & Clark, 2000](#)), such that a better understanding of the mediating and moderating factors represents a pressing need in terms of both decreasing PTSD and

promoting adjustment amongst survivors following natural disasters.

Given this backdrop, the current study examined how traumatic experiences, perceived severity of trauma, rumination, and resilience were associated with PTSD amongst adolescents following a severe rainstorm. Specifically, a moderated serial multiple mediation model is hypothesized wherein rainstorm-related experiences may have an indirect effect on PTSD via the perceived severity of the disaster, or via rumination. We also predicted that the traumatic experiences may have an indirect effect on PTSD by the perceived severity of the disaster via rumination, and that resilience may moderate the paths from the rainstorm-related experiences to the perceived severity of trauma, rumination, and PTSD (see figure 1 for the theoretically hypothesized model)

--Insert Figure 1--

### **Method**

#### **Participants and Procedures**

This study was approved by the Research Ethics Committee of Anhui Normal University and conducted with the permission of the principals of the participating schools. To recruit participants, we first chose the areas where rainstorms frequently occur in China, with total rainfall amounting to more than 200 mm in 24 hours according to the Chinese Meteorological Administration. Then, we selected several cities, such as Nanjing, Huainan, and Huangshan, in the middle-lower reaches of the Yangtze River and the Huai River in China (i.e., areas that have relatively high occurrences of rainstorm disasters). Next, we selected several middle schools in these

areas with the approval of the principals of the participating schools. We then randomly selected several classes within these schools. In the selected classes, everyone who attended school on the date of the survey was recruited to participate. There were no exclusion criteria. Compensation was not provided. The purpose of the study and the voluntary nature of students' participation were highlighted before the survey, and written consent forms that emphasized the right of each participant to withdraw from the survey at any time were provided to participants. The researchers administered the questionnaire packets in the classroom settings without the teachers' presence. The participants first provided demographic information that included gender and age. They were then asked to complete measures that assessed rainstorm-related experiences, rumination, social support, and PTSD. After the questionnaire packets were completed, the participants were told that school psychologists or teachers were available to provide any psychological/counseling services that they might need. In this study, 951 middle school students participated in this investigation. 453 (47.6 %) were male and 490 (51.6%) were female, and 8 (0.8%) participants did not report gender. The mean age was 14.78 (SD=1.70) years old, with a range from 12.0 to 19.0.

### **Measures**

***Rainstorm-related experiences.*** Adolescents' rainstorm-related experiences were assessed by using our self-developed questionnaire. To date, there is no well-established measure for rainstorm-related experiences, so we developed one by referring to the developing process of the Hurricanes-related Traumatic Experiences Questionnaire (Vernberg, La Greca, Silverman, & Prinstein, 1996). We also carried out qualitative interviews with some of the adolescent participants who were severally

affected by the rainstorms. Based on the adolescents' responses and relevant psychological assessment, the questionnaire items were developed. Seven items constituted the formal questionnaire (e.g., *the house was damaged by the rainstorm*), and were rated on a 5-point Likert scale that ranged from 0 (*completely disagree*) to 4 (*completely agree*). Each student evaluated their exposure to daily life-threatening experiences or to disruption-loss in the week following the latest rainstorm. In this study, the questionnaire had a good internal reliability (Cronbach's  $\alpha=0.83$ ).

***Perceived severity of disaster.*** Adolescents' perceived severity of disaster was assessed using our self-developed questionnaire according to the following procedures. First, according to the contents of the assessed perception of risk involving the perceived severity of extreme events (Slovic, 1992) and the items of risk perception questionnaire related to climate change (Fu, Yang, Qin, & Lai, 2014), we developed several items (e.g., *rainstorms threaten my daily life*). Next, we carried out qualitative interviews with some of the adolescent participants who were severally affected by the rainstorms according to these developed items. Based on the participants' responses and relevant psychological assessment, we changed and re-worded the items and finally developed the perceived severity of disaster questionnaire. Nine items constituted the formal questionnaire (e.g., *rainstorms brought me and my family loss*), and were rated on a 5-point Likert scale that ranged from 0 (*completely no impact*) to 4 (*extremely serious impact*). Each student evaluated their exposure to daily life-threatening experiences or to disruption-loss in the week following the latest rainstorm. In this study, the questionnaire had a good internal reliability (Cronbach's  $\alpha=0.80$ ) and validity [ $\chi^2/df=4.56$ , CFI=0.95, TLI=0.92, RMSEA (90%CI) =0.061 (0.050-0.073), SRMR=0.033].

***Rumination.*** Rumination was assessed by the subscale of cognitive emotion regulation

questionnaire (Chinese revised version; Zhu, Luo, Yao, Auerbach, & Abela, 2007). The cognitive emotion regulation questionnaire was a 36-item instrument designed to measure the following cognitive coping strategies: (1) Self-blame, (2) Acceptance, (3) Rumination, (4) Positive Refocusing, (5) Refocus on Planning, (6) Positive Reappraisal, (7) Putting things into Perspective, (8) Catastrophizing, and (9) Other-blame (Garnefski, Teerds, Kraaij, Legerstee, & van den Kommer, 2004). All of the items were rated on a 5-point Likert scale that ranged from 0 (*completely disagree*) to 4 (*completely agree*). This questionnaire has good stability and reliability in Chinese samples (Zhu et al., 2007), and it had a good internal reliability in the current study (Cronbach's  $\alpha=0.89$ ). This questionnaire showed good reliability and validity in adolescents' sample following natural disaster (Zhen, Quan, Yao, & Zhou, 2016). Considering applicability for adolescents who were severally affected by rainstorms, we carried out an interview based on the items of this questionnaire, and then reworded some of the items according to these interview results in order to ensure that all of the adolescents could understand all of the item meanings. In this study, this questionnaire also demonstrated good reliability (Cronbach's  $\alpha=0.89$ ) and validity [ $\chi^2/df=3.25$ , CFI=0.91, TLI=0.90, RMSEA (90%CI) =0.049 (0.046-0.051), SRMR=0.066]. We only used the rumination subscale based on our research needs, and the internal reliability of rumination subscale was acceptable here (Cronbach's  $\alpha=0.71$ ).

**Resilience.** Resilience was assessed using the Chinese version of the CD-RISC (Yu & Zhang, 2007), a 25-item instrument that assesses the ability to cope with stress and adversity. The items are rated on a 5-point Likert scale ranging from 0 (not true at all) to 4 (true nearly all of the time). Higher scores indicate higher levels of trait resilience. A previous study demonstrated that the scale has good psychometric properties in both the general population and patient samples (Connor & Davidson, 2003). The Chinese

version of the CD-RISC was first translated and used by Yu and Zhang (2007) and was found to have good internal consistency, convergent validity, and discriminant validity. This scale also showed good psychometric properties in adolescents following Wenchuan earthquake (Ying, Wang, Lin, & Chen, 2016; Ying et al., 2014). In order to assess its applicability for adolescents who were severally affected by rainstorms, we carried out an interview based on the items of this questionnaire, and then reworded some of the items according to the interview results. This scale in the present study demonstrated good reliability (*Cronbach's*  $\alpha=0.93$ ) and validity [ $\chi^2/df=4.36$ , CFI=0.91, TLI=0.90, RMSEA (90%CI) =0.059 (0.056-0.063), SRMR=0.042].

**PTSD.** PTSD was assessed using the PTSD Checklist for DSM-5 (Weathers, 2013). This measure is a 20-item self-report scale that was designed to assess the occurrence and frequency of PTSD symptoms according to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, in relation to the most distressing event experienced by an individual. In the present study, all of the items were translated into Chinese. Next, we carried out an interview based on the items of this questionnaire, and then reworded some of the items according to the interview results. The respondents rated the frequencies of the symptoms during the most recent two weeks on a 4-point Likert scale that ranged from 0 (*not at all/only once*) to 3 (*almost always or more than 5 times a week*). The scale had four subscales: (1) re-experiences, (2) negative cognitions and emotion alteration, (3) avoidance, and (4) hyper-arousal. An overall severity score is generated by summing the scores of the four symptom types. This scale has been previously identified as being applicable to adolescents following a natural disaster (Liu et al., 2014; Wang et al., 2015). In this sample, the scale demonstrated good reliability (*Cronbach's*  $\alpha=0.90$ ) and validity [ $\chi^2/df=4.08$ , CFI=0.92, TLI=0.91, RMSEA (90%CI) = 0.057 (0.052-0.061), SRMR=0.047].

**Data Analysis Strategies**

Descriptive analyses were conducted for all of the measures administered. Correlations were calculated to examine the associations between major variables. Statistical analyses were conducted using Mplus 7.0 software. Before statistical analyses, we conducted an analysis of missing data on cases and variables for the main measures, respectively, and found that all of the missing rates on cases were less than 30.3 %, and on variables less than 0.8 %. Moreover, to establish the type of missing data, we used Little's Missing Completely at Random (MCAR) test. The results revealed that the data were missing at random on each of the main measures [MAR,  $\chi^2(27) = 28.76, p = 0.373$ ]. In addition, we examined the distribution of scale scores and found that skewness and kurtosis were 1.16 and 1.65 for rainstorm-related experiences, -0.14 and -0.32 for perceived severity of disasters, -0.18 and -0.07 for rumination, -0.05 and -0.14 for resilience, and 0.84 and 0.80 for PTSD. These results indicated that the scores did not substantially deviate from a normal distribution, we therefore adopted ML to handle missing data.

To evaluate the model fit, we used chi-square values, the comparative fit index (CFI), Tucker-Lewis index (TLI), normed fit index (NFI) and the root mean square error of approximation (RMSEA). A non-significant chi-square value indicated a good fit between the model and the data. The general cutoffs for accepting a model are NFI, CFI and TLI equal to or greater than 0.90, and a RMSEA of equal to or less than 0.08 (Wen, Hau, & Marsh, 2004).

In the moderated serial multiple mediation model examination, all independent variables were first centered on their respective means to reduce multicollinearity between main effects and interaction terms, and to increase the interpretability of the coefficients on interaction terms (Cohen, Cohen, West, & Aiken, 2013). Then, we

followed the moderated serial multiple mediation model analysis procedures recommended by Hayes (2015) and Preacher, Rucker and Hayes (2007), and built a structure equation model (see Figure 2). Wherein, rainstorm-related experience had a direct prediction on PTSD, and an indirect prediction via perceived severity of disaster, as well as via rumination through perceived severity of disaster. Resiliency predicted perceived severity of disaster, rumination, and PTSD and the interaction term between rainstorm-related experiences and resilience also predicted perceived severity of the disaster, rumination, and PTSD.

Next, to test the significance of the indirect effect of rainstorm-related experiences on PTSD via rumination, we conducted a bias-corrected bootstrap test with a 95% confidence interval (Gootzeit & Markon, 2011). Also, we used a simple slope test to further examine the significance of the interaction terms.

## **Results**

### **Descriptive statistics and correlations among main measures**

Descriptive statistics and the correlations among the various measures are shown in Table 1. The mean levels of rainstorm-related experiences, perceived severity of disasters, rumination, resilience, and PTSD were 0.62, 2.73, 2.37, 2.34 and 0.86, respectively. Based on the diagnostic algorithm of at least one intrusion symptom, one avoidance symptom, two negative alterations in cognition and mood symptoms, and two arousal symptoms endorsed as 2 or greater, a total of 145 (15.2%) participants were identified as probable PTSD cases. Next, Pearson correlations among the main variables were calculated. These analyses found that sex had a significant relation to rainstorm-related experiences and perceived severity of the disaster, but was not related to the other variables. Only age was associated significantly with rainstorm-related experiences and resilience. Rainstorm-related experiences were significantly,



positively related to perceived severity of the disaster, rumination and PTSD, but was not associated with resilience. Perceived severity of the disaster was positively associated with rumination and PTSD, negatively associated with resilience. Additionally, rumination was positively related to resilience and PTSD, and resilience was negatively related to PTSD.

--Insert Table 1--

### **Moderated serial multiple mediation analysis**

Before the moderated serial multiple mediation analysis, we carried out an examination of the direct effect of the rainstorm-related experiences on PTSD and found that the direct model fit the data better [ $\chi^2/df=1.46$ , CFI=0.99, TLI=1.00, RMSEA (90%CI) =0.022 (0.000-0.057), SRMR=0.009]. Wherein, rainstorm-related experiences positively and significantly predicted PTSD ( $\beta=0.15$ ,  $p<0.001$ ). Next, employing a moderated serial multiple mediation analysis (see Figure 2), we found that this model fit the data better [ $\chi^2/df=4.30$ , CFI=0.97, TLI=0.95, RMSEA (90%CI)=0.059 (0.045-0.073), SRMR=0.020]. The results of path analyses found that rainstorm-related experiences only had a significant positive prediction on the perceived severity of the disaster, but had a non-significant relation to the other variables. The perceived severity of the disaster positively predicted rumination and PTSD, and rumination positively predicted PTSD. Resilience positively predicted rumination and negatively PTSD, but demonstrated a non-significant relation with perceived severity of the disaster. The interaction term between rainstorm-related experiences and resilience negatively predicted PTSD, whereas it had a non-significant association with resilience and perceived severity of the disaster. Overall, 21% of the variance in PTSD could be explained by this model. These results indicated that rainstorm-related experiences might have a positive effect on PTSD based on one's

perceived severity of the disaster, or by rumination via one's perceived severity of the disaster. In addition, resilience moderated the relationship between rainstorm-related experiences and PTSD, but did not moderate the relation of rainstorm-related experiences to perceived severity of the disaster and rumination.

--Insert Figure 2 --

We conducted bias-corrected bootstrap tests with a 95% confidence interval ([Gootzeit and Markon, 2011](#)) to evaluate the significance levels of the indirect effects of rainstorm-related experiences and resilience on PTSD, and the direct effects of the interaction term between rainstorm-related experiences and resilience on perceived severity of the disaster, rumination, and PTSD, in Figure 2. Five thousand bootstrap samples were created from the original data set using random samples with replacement. The model in Figure 2 was then constructed 5000 times with these samples, to yield 5000 estimations of each indirect path coefficient. If the 95% confidence interval of an indirect path coefficient does not include 0, it is suggested that the indirect path is indeed significant.

Table 2 shows the bias-corrected bootstrap test results. The 95% confidence intervals for the direct paths from the interaction term between rainstorm-related experiences and resilience to perceived severity of disaster and rumination included 0, and from rainstorm-related experiences to PTSD also included 0, whereas from resilience and the interaction term between rainstorm-related experiences and resilience to PTSD did not include 0. The 95% confidence interval for the indirect paths from rainstorm-related experiences to PTSD via perceived severity of disaster, from rainstorm-related experiences to PTSD through perceived severity of disaster via rumination, and from resilience to PTSD via rumination did not include 0. Conversely,

the 95% confidence intervals for the other indirect path coefficients did include 0. These results further supported the paths in Figure 2.

--Insert Table 2--

Similarly, we used a simple slope test to further examine whether the moderating effect of resilience on the relationship between rainstorm-related experiences and PTSD was significant or not. We graphed the relation between rainstorm-related experiences and PTSD for participants whose levels of resilience were 1 SD above or below the mean (see Figure 3). For participants 1 SD above the mean of resilience, increased rainstorm-related experiences were not significantly associated with change in PTSD symptoms (*simple slope*=0.12,  $t=1.32$ ,  $p=0.187$ ). In contrast, for participants 1 SD below the mean, increased rainstorm-related experiences were associated with a significant increase in PTSD symptoms (*simple slope*=0.45,  $t=4.70$ ,  $p<0.001$ ).

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-Insert Figure 3 approximately here

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### **Discussion**

To our knowledge, this is first study to examine the combined role of rainstorm-related experiences, perceived severity of disasters, rumination, and resilience in PTSD amongst adolescents following a rainstorm disaster. By using moderated serial multiple mediation analysis, the findings indicated that perceived severity of disasters and rumination fully mediated the relation of rainstorm-related experiences to PTSD, and resilience moderated the direct association between rainstorm-related experiences and PTSD.

Specifically, the findings suggest that there is a direct effect of rainstorm-related experiences on PTSD before inserting the mediators (i.e., perceived severity of

disasters and rumination). Our findings support the shattered world assumption (Janoff-Bulman, 2010), and are also consistent with the findings of previous studies that have found that traumatic experiences have a direct and positive effect on PTSD ([Bokszczanin, 2007](#); [Chen et al., 2015](#); [Dixon, Shochet, & Shakespeare-Finch, 2015](#)). Furthermore, after inserting perceived severity of disasters and rumination into the relationship between rainstorm-related experiences and PTSD, the prior significant, direct association between them disappeared, which suggested that a complete mediational role in the relation of rainstorm-related experiences and PTSD. More importantly, this finding further supported our studies on PTSD amongst adolescents after the Ya'an earthquake ([Wu et al., 2015](#); [Zhou et al., 2015](#)), and indicated that rainstorm-related experiences provide a potential predictor for PTSD. Additionally, a more important predictor or process of PTSD may be the perceived severity of disasters and the rumination following rainstorm-related experiences.

Here, we found that rainstorm-related experiences might have a one-step, indirect effect on PTSD via one's perceived severity of the disasters, which is consistent with previous studies ([Besser et al., 2009](#); [Lee et al., 2014](#); [Lee, Joo, & Choi, 2013](#); [Pedrelli, Feldman, Vorono, Fava, & Petersen, 2008](#)) and Lazarus and Folkman's (1984) theory. That is, a stressor typically triggers a stress reaction if the stressor is perceived as a threat or if an individual feels incapable of meeting the perceived demands of a given situation (Lazarus & Folkman, 1984). Based on this theory, we believe that the rainstorm-related experiences may have elicited the adolescent participants' negative perceptions of the disaster or that they perceived the disasters as being particularly severe because it was uncontrollable ([Zhou et al., 2015](#)). The adolescents may have been more likely to perceive the rainstorm as being more threatening, and thus they felt unsafe. This loss could lead to a heightened sensitivity to threat—even minor threat,

and in turn may have triggered a sequence of physical, emotional, and cognitive emergency responses - a state termed chronic hyperarousal (Van der Kolk, Greenberg, Orr, & Pitman, 1988), which can cause individuals to fail to modulate their emotions and hence lead to PTSD ([Bloom & Farragher, 2010](#)). Moreover, a greater perceived severity of the natural disaster may have also added to the adolescents' fear and worry, thus eliciting more intrusive symptoms (Fani et al., 2012) and ultimately resulting in PTSD.

Additionally, we also found a significant multiple indirect path to PTSD from rainstorm-related experiences to perceived severity of disasters via rumination, which was consistent with our hypothesis and supported Janoff-Bulman's (2010) theory. Our results found that a higher degree of exposure to traumatic experiences led to a greater perceived severity of the disasters. Calhoun and Tedeschi (2006) suggested that for individuals who view a disaster as being more aversive, their belief system about the world as being a safe place and their sense of self-efficacy may be shattered, leading to the individuals' cognitive disequilibrium. To relieve this disequilibrium, individuals need to repeatedly think about or ruminate over the traumatic events ([Janoff-Bulman, 2010](#)). Furthermore, as rumination involves repeatedly replaying the course of an experience in one's mind, focusing on how unpleasant it was ([Hu, Koucky, Brown, Bruce, & Sheline, 2015](#)), this behavior can present traumatic cues to a traumatized individual's cognitions and, thereby, increase their intrusive symptoms, ultimately leading to PTSD. In addition, rumination may impede changes in negative appraisals of traumatic events (Ehlers, Mayou, & Bryant, 1998), this may lead traumatized individuals to focus on the negative effects of the traumatic experiences, and thus may increase the symptoms PTSD.

Nevertheless, we did not find a one-step, indirect effect of rainstorm-related experiences on PTSD via rumination. One possible explanation might be attributed to the non-significant, direct relation between rainstorm-related experiences and rumination, which was not consistent with previous studies (Borders et al., 2015; Chuen Yee Lo et al., 2012), but supported the findings from Zhou et al.' (2015) studies on adolescents. Here, previous studies considered rumination following a trauma as being a negative coping strategy that traumatized individual frequently use (Baschnagel et al., 2009). However, for adolescents with rainstorm-related experiences in this study, family and social groups may have been able to provide more support, which may have helped them to use more positive strategies to cope with the traumatic event. Thus, they may have been less likely to ruminate as their main coping strategy, which may explain why we found the non-significant and direct relationship between rainstorm-related experiences and rumination.

This study also found that resilience had a directly negative effect on PTSD, which was consistent with previous studies (Bonanno, 2005; Connor & Davidson, 2003; Dai et al., 2014; Lee et al., 2014). It may be that resilience enables individuals to bounce back from adversity, and to adapt, thrive and mature in the face of adverse circumstances (Friborg, Hjemdal, Rosenvinge, & Martinussen, 2003; Liu, Wang, Zhou, & Li, 2014), and thus can protect traumatized people from PTSD (Ying et al., 2014). Nevertheless, an unexpected but interesting finding was the significantly positive association between resilience and rumination. This was inconsistent with previous studies (Calhoun & Tedeschi, 2006; Thanoi, Phanchaoenworakul, Thompson, Panitrat, & Nityasuddhi, 2010; Tugade & Fredrickson, 2004). A potential explanation may be that adolescents have immature cognitive and emotional capabilities., Although resilience can lead to more optimistic thinking (Tugade & Fredrickson, 2004), when

this thinking focuses on traumatic experiences, traumatic cues may also intrude into the cognitive world of the traumatized individuals, and thus may result in intrusive rumination.

Consistent with previous studies (Dai et al., 2014; Lee et al., 2014), we found that resilience could buffer the effect of rainstorm-related experiences on PTSD, but resilience only moderated the direct association between rainstorm-related experiences and PTSD. Specifically, for participants in the higher resiliency group, increased rainstorm-related experiences were not significantly associated with a change in PTSD symptoms. In contrast, for participants in the lower resiliency group, increased rainstorm-related experiences were associated with a significant increase in PTSD. Resilient adolescents displayed a greater hardiness, as well as higher rates of self-esteem, optimism, and self-enhancement than adolescents with lower levels of resiliency (Bonanno, 2005, 2008). Resilient adolescents displayed greater resistance to the negative effects of adversity (Benight & Bandura, 2004), and had more optimistic attitudes in the face of adversity (Liu et al., 2014). Some of the participants even considered the adversity to be a normal life event, such that their reactions remained stable during and after their exposure to the trauma (Bonanno, 2008), and in this way the rainstorm-related experiences may have non-significant effects on developing PTSD. For adolescents with less resilience, they displayed lower levels of optimism, self-esteem, and hope at baseline (Besser, Zeigler-Hill, Weinberg, Pincus, & Neria, 2015), thereby making them more likely to be susceptible to the effects of the traumatic experiences (Pietrzak et al., 2009). Once they experienced a highly stressful event, (i.e., the rainstorm disaster), this experience may have further reduced their levels of self-esteem, hope, and aggravated their negative attitude, leading to even higher levels of distress.

Several design and measurement limitations must be acknowledged. First, the participants were not randomly selected but rather represent a convenience sample due to the nature of the investigation. As a result, one cannot eliminate the possibility of a sampling bias. Second, all variables were measured by self-report, and so associations between the main measures might be affected by common-method variance. Third, the study was conducted with a sample of adolescents after the rainstorm in China, so generalizations to other individuals with different traumatic experiences must be done with caution. Additionally, the rainstorm-related experiences and perceived severity of the disaster were assessed by using our own self-developed questionnaire. While the developing process of these two questionnaires was based on previous studies and interviews with adolescents, it still lacked the standardized and strict procedures typically used in building a questionnaire with good reliability and validity. Therefore, further development of standardized questionnaires to carry out further research on this topic would be recommended.

Despite these limitations, this study indicated that the effect of traumatic experiences on PTSD may be realized via multiple indirect paths, further suggesting that exposure to a trauma is a very objective experience, and its impact on individuals' posttraumatic reactions largely depends on their own cognitive and emotional processes of the traumatic events and their consequences (Zhou et al., 2015). In addition, this study suggests that although resilience in adolescents can buffer PTSD following traumatic exposure, resilient adolescents may also engage in rumination because of their immature cognitive and emotional capability. Our results may, therefore, contribute to the theoretical and empirical studies on PTSD following trauma and resilience amongst adolescents. From an intervention and health-enhancement perspective, this study also highlights important implications for adolescents after a



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traumatic rainstorm. Clinical efforts should focus on decreasing their perceived severity of the event and the levels of post-traumatic rumination, thereby helping to distract their focus from negative aspects of the rainstorm. Additionally, school psychologists or parents should focus on the cultivation of hardiness, self-esteem, and self-enhancement amongst adolescent children, and encourage them to acknowledge any reminders of the traumatic event and any negative emotions they may experience to others in order to mitigate the possible negative effects of the trauma.

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*Table 1 Means, standard deviations, and correlations among main variables*

	M±SD	1	2	3	4	5	6
1. Sex	--	1.00					
2. Age	14.78±1.70	0.04	1.00				
3. Rainstorm-related experiences	0.62±0.61	0.14**	0.05	1.00			
4. Perceived severity	2.73±0.73	0.07*	0.15**	0.43**	1.00		
5. Rumination	2.37±0.85	-0.01	0.04	0.07*	0.09**	1.00	
6. Resilience	2.34±0.67	-0.01	-0.11**	-0.05	-0.07*	0.23**	1.00
7. PTSD	0.86±0.52	-0.02	-0.04	0.15**	0.25**	0.28**	-0.13**

**Note:** Perceived severity=perceived severity of disaster.

\*\* . Correlation is significant at the 0.01 level (2-tailed);

\* . Correlation is significant at the 0.05 level (2-tailed).

**Table 2** Bias-corrected Bootstrap test

Paths	Standardized $\beta$ (SE)	Standardized 95%	
		Low	High
<b>Direct paths</b>			
Experiences-PTSD	0.03(0.04)	-0.03	0.09
Resilience-PTSD	-0.21 (0.04) ***	-0.28	-0.15
Interaction term -PTSD	-0.09(0.05) *	-0.16	-0.01
Interaction term - perceived severity	0.03(0.04)	-0.03	0.08
Interaction term - rumination	-0.01(0.03)	-0.07	0.04
<b>Indirect paths</b>			
Experiences-perceived severity -PTSD	0.09(0.02) ***	0.07	0.12
Experiences-rumination -PTSD	0.02(0.01)	-0.01	0.04
Experiences-perceived severity-rumination -PTSD	0.01(0.006) *	0.003	0.02
Resilience-perceived severity -PTSD	-0.01(0.01)	-0.02	0.002
Resilience -rumination -PTSD	0.08(0.02) ***	0.06	0.10
Resilience -perceived severity-rumination -PTSD	-0.001(0.04)	-0.003	0.001

**Note:** Experiences= Rainstorm-related experiences, perceived severity=perceived severity of disaster, Interaction term= Interaction term between rainstorm-related experiences and resilience.

\*\*\*. Path is significant at the 0.001 level (2-tailed);

\*\* . Path is significant at the 0.01 level (2-tailed);

\*. Path is significant at the 0.05 level (2-tailed).

**Figure 1.** The concept figure of proposed moderated serial multiple mediation model

**Note:** Experiences represent rainstorm-related experiences, perceived severity represents perceived severity of disaster.

**Figure 2.** Moderated serial multiple mediation model

**Note:** Experiences and Exper represent rainstorm-related experiences, perceived severity represents perceived severity of disaster, NCAEA represents negative cognition and emotion alteration of PTSD;

\*\*\*. Path is significant at the 0.001 level (2-tailed);

\*\*. Path is significant at the 0.01 level (2-tailed);

\*. Path is significant at the 0.05 level (2-tailed).

**Figure 3.** Relationship between rainstorm-related experiences and PTSD at different levels of resilience

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