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Pre-Post Tornado Effects on Aggressive Children's Psychological and Behavioral Adjustment Through One-Year Postdisaster

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Abstract

Objective—Using a risk-resilience framework, this study examined how varying levels of exposure to a natural disaster (EF-4 tornado) and children's characteristics (sex; anxiety) influenced the behavioral and psychological adjustment of children who shared a common risk factor predisaster (elevated aggression) prior to exposure through one-year postdisaster.

Method—Participants included 360 children in 4th–6th grades (65% male; 78% African American) and their parents from predominantly low-income households who were already participating in a longitudinal study of indicated prevention effects for externalizing outcomes when the tornado occurred in 2011. Fourth-grade children who were screened for overt aggressive behavior were recruited in three annual cohorts (120 per year, beginning in 2009). Parent-rated aggression and internalizing problems were assessed prior to the tornado (Wave 1), within a half-year after the tornado (Wave 2), and at a one-year follow-up (Wave 3). Children and parents rated their exposure to aspects of tornado-related traumatic experiences at Wave 3.

Results—Children displayed less reduction on aggression and internalizing problems if the children had experienced distress after the tornado or fears for their life, in combination with their pre-tornado level of anxiety. Higher levels of children's and parents' exposure to the tornado interacted with children's lower baseline child anxiety to predict less reduction in aggression and internalizing problems one year after the tornado.

Conclusion—Higher levels of disaster exposure negatively affected at-risk children's level of improvement in aggression and internalizing problems, when life threat (parent- and child-reported) and child-reported distress after the tornado were moderated by baseline anxiety.

Keywords

disaster; internalizing; aggression; children; prevention

On April 27, 2011, four tornadoes struck Tuscaloosa County, Alabama. One of these, an EF-4 tornado with winds up to 200 miles per hour, was the most destructive tornado in a series of tornadoes that swept across the South that day. The EF-4 tornado tore a 5.9 mile

long, mile-wide gash through the city of Tuscaloosa, leaving 41 people dead and over 950 injured. In the storm's aftermath, over 750,000 cubic yards of debris littered the city, in part, from the over 7,000 residential homes, three elementary schools, and one middle school that were damaged or destroyed. (2,349 residential homes were severely damaged and 2,375 were completely destroyed.) This long-track tornado continued on its path on the ground through Tuscaloosa County areas as well. In the days that followed, over 600 people sought shelter with the American Red Cross, and 11,665 applications for recovery aid were submitted to FEMA (Jones, 2011; Rupinski, 2011).

The research base for understanding the immediate and longer-term behavioral and psychological effects of highly destructive natural disasters such as tornadoes on children has increased steadily over the past few decades (Bonanno, Brewin, Kaniasty, & La Greca, 2010; Masten & Narayan, 2012). This body of research thus far indicates that these effects are likely diverse, highlighting the importance of understanding the impact of disaster exposure on multiple dimensions of psychological and behavioral adjustment, including aggression and internalizing problems as addressed in this study. Conceptual models based in risk and resilience and ecological needs-based perspectives predict that the effects of disasters on adjustment will be relatively subtle in many instances because they are influenced by a combination of risk and resilience factors that operate in an additive or, in some instances, interactive manner (Bonanno et al., 2010; Masten & Narayan, 2012; Weems & Overstreet, 2008).

The current study focuses on understanding how proximal and distal disaster exposure may affect aggression and internalizing problems among children with a shared predisaster risk factor (elevated levels of childhood aggression). This is one of the few studies conducted with children and their caregivers to offer predisaster-postdisaster comparison data on both aggression and internalizing problems. By carefully measuring disaster exposure from both child and caregiver perspectives, the study also examines whether personal characteristics thought to influence reactions to stress and adversity (sex, predisaster anxiety) may moderate relations between disaster exposure and aspects of adjustment. The study also assesses how these moderating effects may differ depending on the domain of adjustment being studied (i.e., internalizing problems, aggression).

Conceptual Framework Accounting for Effects of Disasters

Conceptual models for understanding the effects of disasters on children's adjustment emphasize the importance of assessing various aspects of disaster exposure during and after the actual disaster event (La Greca, Silverman, Vernberg, & Prinstein, 1996). Exposure experiences have typically been found to vary considerably within a disaster-affected communities, and research based on risk and resilience perspectives emphasizes the need to measure disaster exposure carefully in order to understand how the adjustment of children with comparable levels of risk (i.e., disaster exposure) may be differentially affected due to personal or environmental characteristics (Weems & Graham, 2014).

One important focus of the current study is to better understand how child and parent perceptions of proximal and distal disaster exposure might affect aggression and

internalizing problems. *Proximal exposure* refers to events and experiences that occur during the disaster itself, and *distal exposure* refers to events and consequences of the disaster that become apparent in the aftermath (Bonanno et al., 2010). A primary characteristic of proximal exposure is the degree of exposure to objective events that signal bodily harm, life threat, and loss (McKnight, Compton, & March, 2004; Vernberg, La Greca, Silverman, & Prinstein, 1996). Subjective experience during disasters, especially fear of imminent death or serious harm, is also an important component of proximal exposure (Bonanno et al., 2010; Vernberg et al., 1996; Yelland et al., 2010). Distal exposure encompasses losses and disruptions that follow a disaster, such as economic and material losses, disruptions of social relationships and routines, and ongoing exposure to reminders of destruction and damage caused by the disaster. For the current study, we conceptualize subjective feelings of emotional distress in the first few weeks following the disaster as an important component of distal exposure, although some research has interpreted disaster exposure and disaster distress as separate constructs (Scott, Lapre, Marsee, & Weems, 2014).

Children and their families had a wide range of proximal and distal disaster exposure from the Alabama tornado on April 27, 2011. Unlike hurricanes or other natural disasters that can have broad impact across many miles, a tornado has a devastating impact on homes and schools in its immediate path and causes moderate damage in adjacent areas along the path. Individuals who were several miles from the tornado's direct path may have had relatively little direct disaster exposure. Within a family, a parent and a child may have different levels of proximal and distal exposure because they were not necessarily together during the disaster and do not share all of the same types of experiences following the disaster. Even when together, parents and children may have different subjective experiences during and after a disaster. The current study measured proximal and distal exposure from the perspectives of both the child and parent, providing a unique opportunity to examine how these perceptions of exposure relate to changes in psychological and behavioral adjustment from predisaster to postdisaster.

Specific aspects of disaster exposure potentially affect both aggression and internalizing problems. Proximal disaster exposure may activate intense and acute stress and fear reactions that involve intense negative emotions, dissociative experiences, and extreme arousal or aggression related to fight-or-flight responses. Distal exposure may produce more chronic stress responses associated with basic human needs for safety, self-worth, control, and sense of social relatedness (Weems & Overstreet, 2008).

Disaster exposure and aggression

Although there are very few predisaster-postdisaster studies on children's aggression, some research has examined how disaster exposure may affect aggression among children and adolescents (Marsee, 2008; Scott et al., 2014; Vigil, Geary, Granger, & Flinn, 2010). This research to date has supported the perspective that disaster exposure may contribute to problems with emotion regulation and irritability, which in turn contributes to increased aggression in response to relatively mild interpersonal provocation as part of a heightened activation of the stress-response system (Kunimatsu & Marsee, 2012; Marsee, 2008; Scott et al., 2014).

The current study contributes to this growing body of research on possible linkages between disaster exposure and aggression in several ways. This is the one of the first to include predisaster and postdisaster measures of aggression. The multi-informant set of measures includes behavioral measures of aggression provided by caregivers rather than the children themselves. This is also the first to study potential connections between disaster exposure and aggression prospectively with children who were at risk for aggression prior to disaster exposure. The study design allows a more stringent assessment of child characteristics that possibly moderate the impact of disaster exposure on aggression within an at-risk group. For example, Vigil and colleagues (2010) found lower levels of aggression among at-risk adolescent boys with high levels of disaster exposure from Hurricane Katrina compared to matched controls who did not experience the disaster. This effect was not found for girls, possibly reflecting sex differences in the adaptive value or costs of aggression under conditions that decrease social status or the ability to protect oneself (Vigil et al., 2010).

Disaster exposure and internalizing problems

Increases in internalizing problems have often been found among children after natural disasters (Bonanno et al., 2010; Felix et al., 2011; Goenjian et al., 2001; Goenjian et al., 2005; La Greca, 2006; Thienkrua et al., 2006). Posttraumatic stress symptoms represent one specific form of internalizing problems arising following disasters, but internalizing problems and disorders overall appear to increase among disaster-exposed children and adolescents (Rubens, Vernberg, Felix, & Canino, 2013). Several predisaster-postdisaster studies on children's symptoms of depression and anxiety have been conducted. Children's degree of exposure to Iowa floods in 1993 produced small but significant increases in depression (Ginexi, Weihs, Simmens, & Hoyt, 2000). After a Dutch fireworks disaster, family practitioners reported that younger children had more sleep problems and adolescents had more anxiety problems following the disaster than before (Dirkzwagger, Kerssens, & Yzermans, 2006). Children also reported more generalized anxiety symptoms postdisaster (compared to predisaster) in the early months following exposure to severe hurricanes (LaGreca, Silverman, & Wasserstein, 1998; Weems et al., 2007). Most of this research has used non-selected convenience samples rather than specific at-risk groups.

Moderators of the Effects of Disaster Exposure on Aggression and Internalizing Problems

The emergence, persistence, and nature of behavioral and psychological reactions to disaster exposure are thought to be affected by a variety of moderators (Masten & Narayan, 2012; Vigil et al., 2010). Moderators can involve characteristics of the disaster itself, contextual qualities of social relationships and resources, and characteristics of the children themselves. The current study focuses on how the severity and duration of disaster exposure and loss are moderated by two child characteristics (sex and pre-exposure anxiety) that appear to shape responses to chronic and acute stress (Bonanno et al., 2010; La Greca et al., 1998).

Sex

Sex differences in psychological and behavioral reactions to disaster exposure have been found in a number of studies utilizing diverse convenience samples. Most often, girls,

compared to boys, report greater levels of internalizing problems and subjective distress during and after disaster exposure (Bonanno et al., 2010). These findings have been attributed to normative sex-related differences in biological, social, and behavioral concomitants of stress responses (Klimes-Dougan, Hastings, Granger, Usher, & Zahn-Waxler, 2001; Natsuaki et al., 2009; Vigil et al., 2010). The current study offers an opportunity to examine whether these sex differences occur among children who are at risk due to elevated aggression.

Pre-exposure anxiety

A similar opportunity arises to examine the potential role of predisaster level of anxiety in moderating the effects of disaster exposure on internalizing problems and aggression among at-risk aggressive children. Among nonselected samples, higher trait anxiety prior to disaster exposure has been generally thought to increase the risk of developing or intensifying pre-existing internalizing problems and aggression following disaster exposure due to a lower threshold for the activation of stress reactions in the presence of acute and chronic stress (La Greca et al., 1998; Weems et al., 2007). Prolonged activation of stress responses potentially contributes to poorer emotion regulation and heightened perceptions of fear and threat (Scott et al., 2014).

At the same time, research on children with disruptive behavior and conduct problems has sometimes found that anxiety may influence adjustment following adverse environmental events, in that anxiety may suppress approach behavior under conditions of threat (Neuhaus & Beauchaine, 2013; van Goozen et al., 1998). Among children who have developed significant externalizing problems, anxiety may represent more responsiveness of behavioral inhibition system functions, which may protect against developing more severe antisocial behavior by increased recognition or concern for the negative effects of antisocial acts on others (Neuhaus & Beauchaine, 2013). Among children with externalizing problems, anxiety may reflect greater awareness and acknowledgment of conflicting emotions, and some evidence suggests that youth who have predominantly externalizing problems have less complex understanding or awareness of their emotional responses to stress, even though their behavior may be affected by these responses (Cole, Hall, & Hajal, 2013).

Summary of Planned Study

Changes in at-risk children's behavioral and psychological adjustment were assessed from baseline pre-tornado levels through their functioning one year after the disaster. A unique aspect of our study is that children were involved in a preventive intervention for aggressive children. Thus, this study helps us to understand how major trauma exposure affects children who had been screened to participate in school-based preventive interventions based on their high teacher-rated levels of aggressive behavior.

Our first hypothesis was that greater exposure to the tornado, as reported by children and parents, would produce relatively higher levels of parent-rated aggression from baseline through a one-year follow-up. Similarly, a second hypothesis proposed that greater exposure to the tornado would elevate the slope of children's internalizing problems. We also examined whether changes from predisaster to postdisaster in child functioning were

moderated by child characteristics (sex, baseline child anxiety). Because many of our measures involved parent report, we controlled for parental depression symptoms given past research supporting an association between parental depression and parent-reported child functioning (Youngstrom, Izard, & Ackerman, 1999)¹. Because the sample had been involved in a prevention study across three annual cohorts, we conducted secondary analyses to examine cohort effects on the tornado exposure effects. However, age and intervention timing were confounded for the purposes of the present analyses, making this secondary analysis exploratory in nature. The first cohort had the oldest children at the time of the tornado but they also had received the intervention two years before the tornado; the second cohort was a year younger than Cohort 1 and a year older than Cohort 3, and received preventive intervention immediately before the tornado; and the third cohort was the youngest and received intervention after the tornado.

Method

Participants

Data for the present study were collected as part of a longitudinal study examining the relative effectiveness of two versions of a prevention program for children with aggressive behavior problems (see Lochman et al., 2015). The main study recruited six students each year from each of 20 public elementary schools in urban and rural locations in the United States during the 2008–2009, 2009–2010, and 2010–2011 academic years, resulting in a total sample size of 360 children.

A two-gate screening procedure was used to identify children eligible for participation. In the first gate, fourth-grade teachers completed a 6-item measure of aggression (Dodge, Lochman, Harnish, Bates, & Pettit, 1997) on each of their students. Across all students rated, a cutoff score corresponding to the 75th percentile was determined, and children whose scores fell at or above the cutoff score were considered to have passed the first screening gate. At each school, the names of students with scores at or above the 75th percentile were placed in random order and, using the randomized lists, families were contacted and invited to participate. Parents and children completed separate assessment interviews, and the assessment interview with parents included a second gate screening from the BASC Aggression scale (Reynolds & Kamphaus, 1992). Children whose parents rated their level of aggression in the average range or higher were considered eligible and were enrolled in the project. During each of the three intervention years, families were contacted and assessed in this manner until six children were enrolled at each of the participating schools (120 students each year).

At the time of recruitment, children ranged in age from 9.17 to 11.79 years (Mean = 10.17). The sample included boys (65%) and girls (35%), who identified as African American (78.1%), Caucasian (20.3%), Hispanic (1.4%), and “Other” (0.3%). Five percent of families

¹The growth curves were rerun without parental depression in as a covariate. Because caretaker depression is related to child psychopathology as well as potentially marking biased reporting, the inclusion of the term might artificially deflate the predictive role of tornado exposure. When caretaker depression was removed, the same statistically significant results were found in the growth curve analyses as when caretaker depression was in the model, indicating that it had not confounded the interpretation of the effects of degree of exposure.

reported no income, 24.9% less than \$15,000, 31.8% between \$15,000 and \$29,999, 20.5% between \$30,000 and \$49,999 and 17.6% greater than \$50,000.

Children participated in the Coping Power program (Lochman, Wells, & Lenhart, 2008), during the second semester of fourth grade and both semesters of fifth grade. Ten of the participating schools were randomly assigned to a group intervention format (Group Coping Power, GCP), and the remaining 10 schools were assigned to an individual administration format (Individual Coping Power, ICP); thus, all students received the intervention. Both intervention conditions involved 32 weekly sessions in which children were taught to use cognitive-behavioral strategies for goal setting, emotion regulation, social problem solving, and peer pressure resistance. More details about the intervention procedures are provided in Lochman et al. (2015). At GCP schools, the six participating students attended weekly group meetings together; at ICP schools, each student attended one-on-one meetings with a Coping Power clinician. Overall, students participated in an average of 28.75 sessions (range = 0 to 34); GCP students participated in an average of 28.54 sessions (range = 0 to 34), while the mean number of sessions attended for ICP students was 28.96 (range = 3 to 34). The three annual cohorts received intervention in three successive years (Cohort 1 received intervention the year before the tornado, Cohort 2 completed intervention just before the tornado, and Cohort 3 received the intervention in the year after the tornado). Lochman et al. (2015) examined whether intervention effects for the two conditions varied by cohort (timing relative to the tornado) and no significant differences were found.

Procedure

Data were collected from parents and children in three waves. Wave 1 data were collected before the April 27, 2011 tornado (approximately May to October of 2010 for the first two cohorts; approximately January to April of 2011 for the third cohort), Wave 2 data were collected in the half-year following the tornado for all three cohorts, and Wave 3 data were collected 12 to 18 months after the tornado (approximately May to October of 2012 for all three cohorts). The mean number of days after the tornado that W2 (W denotes Wave) was collected was 69.5 days, with a standard deviation of 22.5 days. Eighty-nine percent of the participants were assessed within 90 days after the tornado; the longest period for the W2 follow-up was 201 days, and the next longest was 154 days. Although one case was thus beyond a half-year after the tornado, for the purposes of this paper, we describe the W2 assessment as being within a half-year after the tornado. Children's ages varied systematically by cohort, with the average ages at W1 being 11.9 years ($SD = 0.6$) for Cohort 1, 10.9 years ($SD = 0.5$) for Cohort 2, and 9.9 years ($SD = 0.6$) for Cohort 3. At W1, prior to the tornado, 32% of the children were in the clinically at-risk range according to parents' ratings of children's Aggression on the BASC (T score at or above 60). Parents and children completed assessment measures in separate interviews with project staff, typically in their homes, but occasionally in another location of their choice (e.g., public library, restaurant). Parents received \$50 for completing measures at each wave, and children received \$10.

Measures

Tornado-related proximal and distal exposure—Trauma exposure during the tornado (proximal exposure) and loss, disruption, and overall distress in the first few weeks after the tornado (distal exposure) were measured using the Tornado-Related Traumatic Experiences (TORTE) questionnaire, which was adapted from a measure previously used to assess hurricane-related traumatic experiences among children and adolescents (Vernberg et al., 1996). Proximal exposure was measured with seven yes/no items. One item represented *perceived life threat* (“At any time, did you think you might die during the tornado?”) and six items represented *traumatic events during the tornado* (e.g., windows or doors broke, saw someone get hurt badly, hit by something falling or flying during the tornado). Distal exposure was assessed with 10 yes/no items regarding *loss and disruption after the tornado* (e.g., home badly damaged or destroyed, clothes or toys ruined) and one item measuring *distress after the tornado* (“Overall, how upset about things were you during the first few weeks after the tornado?”), which was rated on a 4-point scale (not at all, a little, a lot, a whole lot). Parents and children reported on their own experiences during and soon after the tornado, thus providing perceptions of personal experiences during and after the tornado from both perspectives.

Consistent with prior research, proximal trauma exposure was represented in analyses by two variables: *perceived life threat* (single item coded 0, 1), and *traumatic events during the tornado*. For the current sample, the total number of traumatic events during the tornado fell between zero and two for 96% of respondents. To reduce skewness, this variable was coded as 0, 1, 2 (for 2 or more traumatic events). Similarly, distal exposure in the first few weeks after the tornado was represented by two variables: *distress after the tornado* (single item coded 0, 1, 2, 3) and *loss and disruption after the tornado*. Most respondents (90%) reported zero to three of the 10 TORTE items regarding loss and disruption after the tornado, so this variable was coded 0, 1, 2, 3 (for 3 or more loss-disruption items) to reduce skewness for analyses.

Child psychological and behavioral adjustment—The Behavior Assessment System for Children (BASC; Reynolds & Kamphaus, 1992) is a comprehensive behavior checklist covering a range of child behavior problems including aggression and internalizing problems (anxiety, depression, somatization). Respondents rated each item on a 4-point scale (“Never,” “Sometimes,” “Often,” “Almost Always”). The BASC has demonstrated strong reliability (Chronbach’s alpha of .80–.89) and construct validity (Doyle, Ostrander, Skare, Crosby, & August, 1997; Reynolds & Kamphaus, 1992) in prior research. For the present study, the BASC was completed by children’s parents. The Internalizing Composite and Aggression Scale scores across all waves were used in analyses. The internal consistency for these two outcome scales at W1 for this sample was .84 for Aggression and .89 for Internalizing Problems. The baseline Anxiety scale was used as a child characteristic that could moderate tornado exposure, and this scale’s internal consistency for this sample was .78.

Parental depression—The Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) is a depression screening questionnaire consisting of 21 items.

Respondents used a 4-point scale to rate each item, and a total score was calculated with higher scores indicating a greater degree of depressive symptoms. A meta-analysis conducted on 25 years of research established internal consistencies of .86 for psychiatric populations and .81 for nonpsychiatric populations (Beck, Steer, & Garbin, 1988). The internal consistency of the W1 BDI score for the sample of caretakers in the present study was .84. Correlations of the BDI with another self-report measure of depression have been reported to be .73 and .74 for psychiatric and nonpsychiatric populations, respectively (Beck et al., 1988).

Analytic Plan

A 3-level Growth Curve Model was conducted using HLM 7.01 and children's Aggressive Behavior and Internalizing Problems as dependent variables. HLM analyses used data from three time points at level-1 (Wave 1 [W1] prior to the tornado, Wave 2 [W2] immediately after the tornado (completed in the half-year after the tornado), Wave 3 [W3], one year after the tornado); time was included as a continuous variable in analyses, as there were variations between participants in the number of days between assessments. The children are at level-2, and they are nested within their school and cohort at level-3. FIML was used to estimate missing outcome data. All intercept models at level-2 included child baseline anxiety, sex, and caretaker depression¹ as predictors, and all time slope models at level-2 included those three predictor variables plus the eight TORTE predictor variables (child report and parent report of the four TORTE constructs), and the interactions among the child characteristics (sex; anxiety) and the TORTE variables. Terms were retained in the models and reported in the Tables only if they had significant or trend effects, or if they were a component variable for an associated interaction effect. Two growth curve analyses were conducted, as indicated below.

Secondary analyses were conducted to examine cohort effects on the tornado exposure effects. However, age and intervention timing were confounded for the purposes of the present analyses, making this secondary analysis exploratory in nature.

Results

Associations among Predictor Variables and among Outcome Variables

The associations among the continuous scored TORTE variable for children's and parents' reports of traumatic events experienced during the tornado, their degree of loss and disruption in the half-year after the tornado, and their level of being distressed in the half-year after the tornado are indicated in Table 1, along with the means and standard deviations for these variables (skewness and kurtosis for these variables were within acceptable limits). Although there were significant correlations for all but one of the associations between TORTE variables, the strength of the statistically significant correlations was generally modest (most in the .1 to .3 range). The TORTE variables indicating whether the child and the parent feared that they might die during the tornado (perceived life threat) were scored as dichotomous variables (0, 1), and the relations among these dichotomous TORTE variables and the continuous TORTE variables are also included in Table 1. Forty-four percent of the children and 43% of parents endorsed that they had feared for their life during the tornado.

Parent and child reports of perceived life threat were significantly associated in a Chi Square test, $\chi^2(1, N = 594) = 13.92, p < .001$. Table 1 also includes the relations between children's baseline level of anxiety and the TORTE measures of tornado exposure; higher baseline parent-rated child anxiety was also found to be related to parents' fears that they might die during the tornado, $t(296) = -3.02, p < .01$. When associations with children's sex were examined, at-risk boys were more likely to have higher parent-rated anxiety than at-risk girls, $t(296) = -2.28, p < .05$, but there were no other associations between children's sex and the TORTE predictor variables.

Examining associations between the two outcome variables at W3, parent-rated BASC Aggression was strongly and positively correlated with parent-rated BASC Internalizing Problems, $r(296) = .58, p < .001$. The patterns of associations between the two outcome variables at W1 and W2 were very similar to the patterns noted at W3. When the stability of the outcome variables across time was examined, BASC Aggression at W3 was strongly correlated with Aggression scores at W1, $r(289) = .69, p < .001$, and at W2, $r(290) = .76, p < .001$, and W2 was strongly correlated with W1, $r(284) = .74, p < .001$. Similarly, Internalizing Problems at W3 were strongly correlated with Internalizing Problems at W1, $r(291) = .76, p < .001$, and at W2, $r(292) = .80, p < .001$, and W2 was strongly correlated with W1, $r(286) = .73, p < .001$.

HLM Growth Curve Analyses

Children's aggressive behavior outcomes (Hypothesis 1)—Table 2 and Figures 1a–b indicate the results from the HLM analysis conducted with parent-rated Aggression as the outcome across time. This analysis used the child-reported and parent-reported TORTE variables indicating proximal exposure (perceived life threat, number of traumatic events during the tornado), and distal exposure (degree of loss and disruption, feeling distressed after the tornado). Children's parent-rated Aggression significantly declined across this time period for the overall sample. Children's and parents' self-reported tornado exposure did not have simple main effects on Aggression across time. However, in this growth curve analysis, two of the eight interaction effects involving baseline BASC Anxiety and TORTE variables were significant. Children had the greatest decline in slopes of Aggression if they had high levels of baseline Anxiety in combination with the children having low exposure to the tornado. However, it was clear that higher levels of baseline Anxiety were associated with higher levels of Aggression at baseline, and that despite the greater decline in Aggression for children with higher baseline Anxiety, they still had higher levels of Aggression at the one-year follow-up than did children with lower levels of baseline Anxiety. Low exposure was evident in the children not fearing they would die in the tornado (Figure 1a), and the children not feeling distressed in the half-year immediately after the tornado (Figure 1b). In contrast, children who had the least declines in Aggression over time were children who were low in baseline Anxiety and who had high tornado exposure (children who feared for their lives during the tornado, Figure 1a, and who were distressed about the tornado in the half-year after the tornado, Figure 1b).

Children's internalizing behavior outcomes (Hypothesis 2)—Table 3 and Figure 2 indicate the results from the HLM analysis conducted with parent-rated Internalizing

Problems as the outcome across time, and using the child-reported and parent-reported TORTE variables indicating exposure during (perceived life threat, traumatic events) and after (loss/disruption, distress) the tornado. Children's parent-rated Internalizing Problems significantly declined across this time period for the overall sample, and Internalizing Problems declined significantly more for boys than for girls. Children's and parents' self-reported trauma exposure did not have main effects on children's Internalizing Problems across time. However, one of the eight interaction effects involving children's baseline BASC Anxiety and TORTE variables was significant. Children had the greatest decline in slopes of Internalizing Problems if they had high levels of baseline Anxiety in combination with low exposure to the tornado. Consistent with the findings for Aggression, it was clear that higher levels of baseline Anxiety were associated with higher levels of Internalizing Problems at baseline, and that despite the greater decline in Internalizing Problems for children with higher baseline Anxiety, they still had higher levels of Internalizing Problems at the one-year follow-up than did children with lower levels of baseline Anxiety. Low exposure was evident in the parents not fearing they would die in the tornado (Figure 2). In contrast, children who had the least declines in Internalizing Problems over time were children who were low in baseline Anxiety and whose parents thought they might die during the tornado (Figure 2b).

Because the Anxiety scale was one of the three subscales within the Internalizing composite score, a secondary analysis was conducted to determine whether the effects of baseline Anxiety as a predictor of Internalizing scores over time may have been due to regression to the mean related to the Anxiety subscale. In this secondary analysis, the Internalizing composite was recomputed to include only the Depression and Somatization subscales, and not the Anxiety subscale. The same pattern of findings on the change rates in the model were obtained with the recomputed Internalizing score as with the full Internalizing score².

Secondary Analyses of Cohort Effects

We also reran the above two HLM analyses with cohort as a predictor. Cohort indicated both developmental differences (as each cohort was one year younger than the prior cohort) and differences in intervention timing as part of the original study (Cohorts 1 and 2 had received a cognitive-behavioral intervention for aggressive behavior, Coping Power, prior to the tornado and Cohort 3 received the intervention in the year after the tornado). Children's Aggression and Internalizing Problems were predicted by cohort (greater slope declines for Cohort 3 in comparison to Cohort 1).

The Cohort 3 effects may have been due to children and parents experiencing most improvement if the intervention followed the tornado, or may have been a simple intervention effect due to greater change during the intervention year (the year after the

²The growth model results for the recomputed Internalizing score (retaining Depression and Somatization, but dropping Anxiety) indicated there was a significant overall decline in the modified Internalizing score, $t(59) = -5.22, p < .001$, a significant effect of Sex on the change rate, $t(164) = -2.46, p < .02$, a significant effect of child anxiety on the slope, $t(164) = -3.38, p < .01$, and a significant effect for parents' TORTE Life Threat score interacting with children's baseline Anxiety, $t(164) = 2.79, p < .01$. This pattern of effects precisely parallels the pattern found in Table 3 for the full Internalizing score, and the effects are in the same directions, indicating that the Internalizing results are not simply due to the effects of the Anxiety score being a baseline predictor and being a part of the Internalizing composite over time.

tornado for Cohort 3; years prior to the tornado for Cohorts 1 and 2). To clarify the intervention's role in the cohort effects, we conducted additional HLM analyses. The secondary analyses examined whether cohort predicted change on our dependent variables over the three time points before, during, and just after each cohort received the intervention (for Cohort 1, the intervention baseline was two years before the tornado, and for Cohort 2, the intervention baseline was one year before the tornado). The means for these variables during the intervention periods are in Lochman et al. (2015). There were no significant effects of the comparisons between Cohort 3 and the other cohorts on the slope for Aggression, $t(236) = -1.75$, $p = .08$, or on the slope for Internalizing Problems, $t(236) = -1.35$, $p = .18$, thus indicating that the cohort effects favoring Cohort 3 in the tornado exposure analyses were due to the typical reduction in behavioral and emotional problems that occurred during the intervention period.

Discussion

This study provided a unique opportunity to examine how children's and parents' exposure to a major natural disaster, an EF-4 tornado that destroyed 12% of Tuscaloosa in April 2011, affected changes, from pre-tornado levels, in children's internalizing and aggressive behaviors. Addressing limitations in recent reviews (Bonanno et al., 2010; Masten & Narayan, 2012), this is the first study to examine changes through a one-year follow-up of at-risk children's aggressive and internalizing functioning following a natural disaster, while using pre-tornado data as a baseline. In the absence of predisaster information, it is not possible to examine the extent to which postdisaster patterns of adjustment reflect the impact of disaster-related experiences rather than a continuation of patterns of adjustment that were evident prior to the disaster. The use of external parental reports of children's outcome functioning, and of child and parent report of disaster exposure, are strengths of the study, in comparison to prior studies that have relied on youth self-report only. It is notable that the study took place with a carefully selected at-risk initially aggressive sample who could have been especially vulnerable to the effects of the disaster. Thus, the study used a "natural experiment" design (Costello, Compton, Keeler, & Angold, 2003) in which children who shared a common risk factor prior to the disaster were exposed to varying degrees of tornado-related trauma exposure due to the sudden and unpredictable path of the Tuscaloosa County tornado.

Partially supporting the study's two hypotheses, the results indicate that a greater degree of exposure to the tornado predicted relatively poorer slopes for children's aggressive behavior and internalizing behaviors across time, especially for children with certain characteristics. The key child characteristic which moderated the impact of degree of tornado exposure for these at-risk children was children's pre-tornado levels of anxiety. The findings of this study illustrate the complex and dynamic effects of a natural disaster in increasing children's risk for reductions in their behavioral and emotional functioning, particularly in the context of children's enrollment in a school-based preventive intervention.

Natural disasters vary considerably in the degree to which they affect members of a community. Large-scale weather systems like hurricanes can create physical damage across a wide geographic area, thus inflicting physical damage on entire communities. Tornadoes,

in contrast, can create extremely strong physical damage in the path of the tornado, but neighborhoods blocks away from the path may have little or no physical damage. However, both tornadoes and hurricanes have the potential to have wide-ranging psychological impact, due to the trauma created by knowing people who were hurt, and by viewing the damage caused by the tornado both in person, and repeatedly through media coverage. In addition, both tornadoes and hurricanes can lead to strong supportive help provided to a community by disaster relief agencies and by internal humanitarian efforts within the community itself. Churches and social groups mobilize to provide physical and psychological support to other members of their community, and teachers and parents can change how they attend and respond to the children in their care.

So, a first question that arises is: How do at-risk aggressive children and their families within an overall community fare, regardless of the degree of physical damage each of them receive? What is evident in Tuscaloosa is that at-risk aggressive children who were exposed to the tornado did not necessarily have worse outcomes than at baseline, but they did not show the improvement in functioning evident among their less-exposed peers. How could these child improvements occur among low-exposed children? In our sample, the general improvements could be partially due to children's exposure to an intervention for their aggressive behavior, but could also be partly due to the community's responses after the tornado.

After disasters, children may experience coping assistance from parents and friends (Prinstein, La Greca, Vernberg, & Silverman, 1996). In the case of the Tuscaloosa tornado, this likely extended to children's teachers as well, as teachers appeared to take the last weeks of the school year, following the tornado, to explore children's feelings in supportive ways and to assist their coping. In the school context, school personnel in prior research have been overwhelmingly interested in helping children deal with the psychological and emotional aftermath of a traumatic event (Felix et al., 2010). This has led to individualized, supportive time with school staff and to trauma-focused intervention activities (Smilde-van den Doel, Smit, & Wolleswinkel-van den Bosch, 2006).

Child Outcomes and Tornado Exposure

Partially supporting the study's hypotheses, the current results indicate that the degree of exposure to the tornado that children experience negatively influences at-risk children's emotional adjustment through the one-year follow-up. Although not all indicators of disaster exposure emerged as significant predictors, several aspects of exposure did predict behavioral and emotional outcomes in the growth analyses. Thus, children who feared for their lives during the tornado had relatively weaker declines in aggression problems. In addition, children's reports of being distressed in the half-year after the tornado also affected children's aggression, and parents' reports of fearing for their lives predicted the course of internalizing outcomes. However, these three exposure variables were found to operate in combination with the child characteristics described below.

It is interesting that the most important aspects of exposure to the tornado, across the two outcomes, involved perceived life threat during the tornado and stronger feelings of distress in the half-year period after the tornado. It appears that the specific affective reactions

related to intense fear that one's life was at stake during the tornado and to the resultant ongoing feelings of being very upset for days or weeks afterwards are key triggers for children's relatively poorer emotional and behavioral functioning during the ensuing year. The source (parent versus child) of the affective reaction related to the tornado appeared to be important. It was children's perceptions of their own life threat and distress, and not parents' perceptions of their own affective reactions, that predicted the course of children's aggression over time. Consistent with prior reports that disaster exposure may lead to problems with emotional regulation and irritability (Kunimatsu & Marsee, 2012; Marsee, 2008; Scott et al., 2014), the emotional dysregulation stimulated by children's own tornado exposure in the present study may have led to their less regulated aggressive behavior across time. In contrast, parents' fears of their death predicted children's internalizing outcomes. Parents' intense emotional reactions may make children more vulnerable to expressing their own signs of anxiety and depression. In sum, children's best emotional and behavioral outcomes occurred with *low exposure*, especially when low exposure to the tornado occurred in interaction with certain child characteristics.

Consistent with prior conceptualizations of disaster effects which suggested that disaster exposure may have varied effects depending on children's characteristics (Weems & Graham, 2014), children's pre-tornado anxiety level was found to moderate their experience of degree of exposure to the disaster. When children had high baseline anxiety *and* they had not been afraid of dying during the tornado, they were likely to have greater declines in parent-rated aggressive and internalizing behavior outcomes across time. Likewise, if children experienced lower levels of distress in the days after the tornado *and* they had high levels of baseline anxiety, they were likely to have greater declines in aggressive behavior problems across time.

Baseline levels of child anxiety were related to children's behavioral and emotional adjustment in complex ways. At baseline, higher levels of child anxiety served as a risk factor, predicting higher levels of child aggressive and internalizing behaviors. However, children's baseline anxiety served a markedly different function in interaction with exposure to tornado effects in predicting changes in children's problems across time.

Higher baseline child anxiety among this at-risk group of aggressive children may predict more concern with consequences to their behavioral problems and potentially predict more orientation to others, which may have then allowed them to take advantage of the extra support provided by community members in the aftermath of the tornado. Children's baseline anxiety, in this type of sample, thus appeared to help children to handle more resiliently the stressors related to tornado exposure (Bonanno, 2005; Linley & Joseph, 2004). Baseline anxiety could have partially counteracted these at-risk children's typical inhibition deficits and impulsivity, consistent with the role for anxiety suggested by Schatz and Rostain (2006) in their review of comorbid anxiety and ADHD. In a related way, high levels of baseline anxiety (Ollendick et al., 2015) and of baseline depression (Jarrett et al., 2014) have predicted greater reductions in externalizing problems following intervention among ADHD and aggressive children. However, if children were highly anxious before the tornado and then experienced significant exposure to the disaster, then they may have perceived that their high baseline anxiety was in some sense confirmed, and their overall

anxiety may not have decreased to a level that permitted them to cope with the stress they experienced after the tornado. Even with the noted declines in behavioral and emotional problems for children with higher levels of anxiety prior to the tornado, the ultimate level of behavioral and emotional problems for these children was still higher than for initially low anxious children. The combination of children having higher anxiety and receiving a lower dose of exposure to the tornado appeared then to serve as a protective factor in predicting relative changes in behavior, but not in absolute levels of outcomes at the one-year follow-up.

Limitations

First, although a unique strength of this study is that it permitted a rigorous assessment of how at-risk aggressive children involved in an ongoing intervention study changed in their behavioral and emotional functioning from before to after the Tuscaloosa tornado, the results do not inform us about how non-risk children or children not involved with intervention react to natural disaster. At the same time, our results do generalize to those at-risk children who are involved in intervention when a disaster strikes. Second, a limitation to the generalization of the tornado-exposure results is that it is not clear if they indicate how children and parents might react if a natural disaster creates large-scale physical damage across an entire community, such as during a hurricane. Third, it would be useful for future research to obtain children's self-report of baseline anxiety, in addition to the parent report obtained for this study. Fourth, the measure of parents' and children's exposure to the tornado was collected retrospectively. More immediately assessed perceptions and collection of objective measures of exposure may have yielded different results. Fifth, it would have been useful to have followed up the sample over a longer period of time so that quadratic, as well as linear, patterns of behavioral change could be assessed. There may be more change immediately after the disaster rather than several years later. Sixth, the cohort effects are merely suggestive of the effects of intervention timing. The three cohorts were also different in age (each successive cohort was one year younger than the prior one). However, the secondary analyses on the cohort effects indicated that the cohort effects favoring Cohort 3 in the tornado exposure analyses were simply due to the typical reduction in behavioral and emotional problems that occurred during the intervention period, and were not due to age differences between cohorts or to whether the intervention had magnified effects if delivered after the tornado.

Summary

The present findings indicate that at-risk aggressive children and their parents have nuanced effects emanating from a natural disaster such as the Tuscaloosa tornado. Because pre-tornado data existed on these children, it was possible to determine how much change occurred for them in the time between a baseline assessment wave prior to the tornado and the time one year after the tornado. Children's behavioral and emotional functioning in the year after the tornado was moderated by the degree of exposure to the tornado that the children experienced. If the children had higher proximal and distal exposure to the tornado, they had less reduction in their internalizing problems and aggression in comparison to their peers, especially if they exhibited the lowest rates of anxiety prior to the tornado. These negative effects of the tornado exposure on some children may have been even worse if the

tornado exposure had not stimulated parents to provide more positive parenting practices in the year after the tornado. Thus, the overall positive improvements among children after the tornado were evident primarily among those children who had less direct exposure to the tornado.

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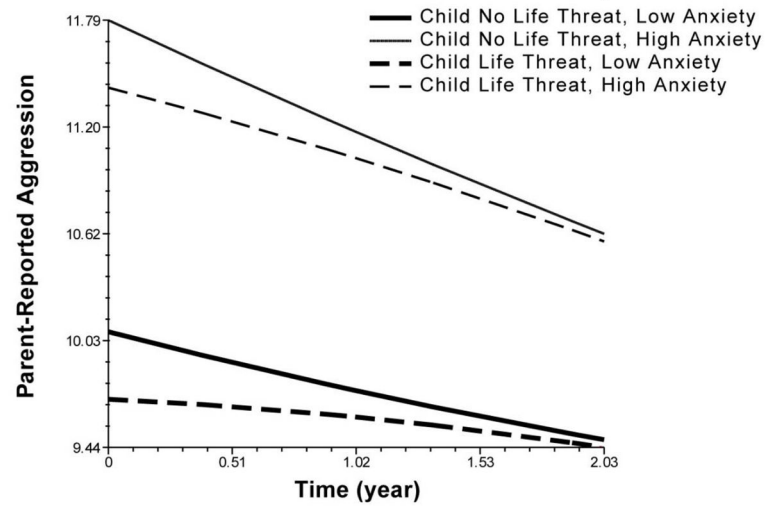
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Clinical Implications

The results also suggest that children who are currently involved or recently involved with psychological intervention for aggressive problems may continue to benefit from the intervention effects even in the context of a disaster. As noted earlier, high baseline child anxiety in combination with low tornado exposure was associated with the greatest reduction in aggressive problems. In contrast, children with low baseline anxiety and high exposure showed the least improvement on aggression problems and internalizing problems, suggesting that children with these characteristics might need additional therapeutic assistance in the face of disaster to maximize the benefits of psychological treatment for aggression problems.

1a. Child TORTE Fear for Life BY Children's Baseline Anxiety



1b. Child TORTE Distress BY Children's Baseline Anxiety

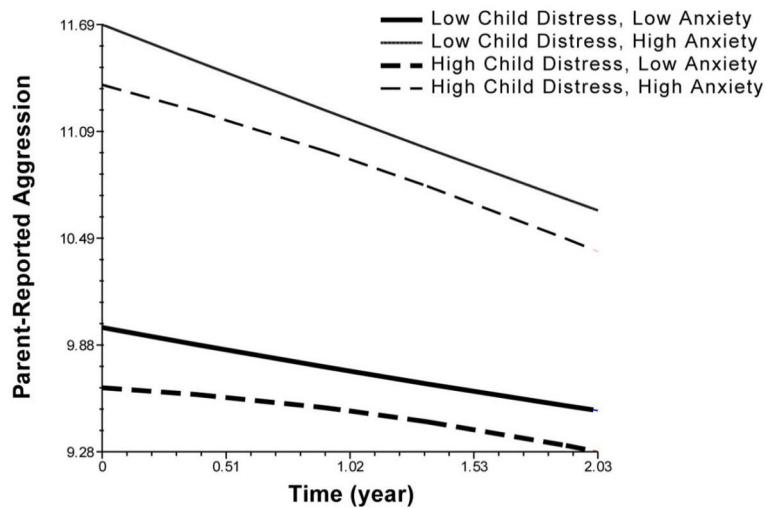


Figure 1.
Aggression Outcomes Predicted by Tornado-Related Traumatic Experiences (TORTE)
Note: Time is modeled as a continuous variable within these analyses.

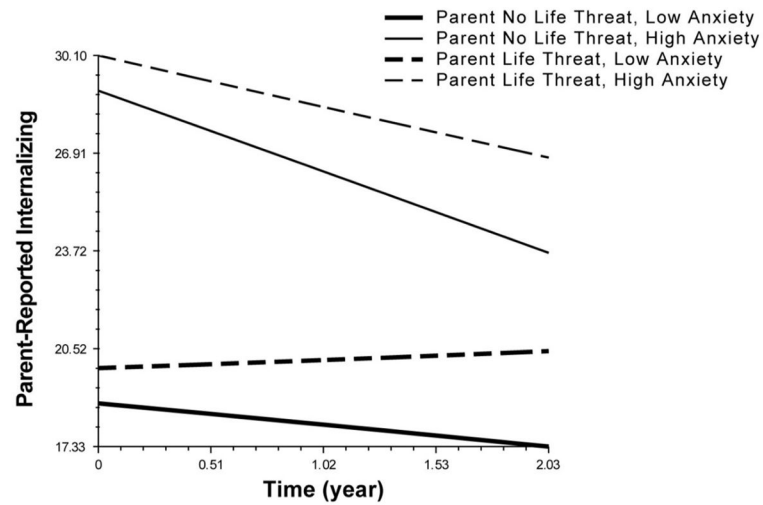


Figure 2.

Internalizing Outcomes Predicted by Tornado-Related Traumatic Experiences (TORTE):
Parent TORTE Fear for Life BY Children's Baseline Anxiety

Note: Time is modeled as a continuous variable within these analyses.

Table 1

Means, Standard Deviations, and Pearson Correlation Coefficients for Associations Among Child- and Parent-rated Exposure During and After the Tornado (TORTE)

Exposure and Anxiety Variables	Child-rated TORTE (N=296)			Parent-rated TORTE (N=298)		
	Traumatic Events during tornado	Loss and disruption after tornado	Distressed after tornado	Traumatic Events during tornado	Loss and disruption after tornado	Distressed after tornado
Pearson Correlation Coefficients						
Child-rated TORTE						
Traumatic Events during tornado		.27***	.12*	.28***	.24***	.12*
Loss and disruption after tornado			.23***	.24***	.44***	.17**
Distressed after tornado				.05	.19**	.15**
Parent-rated TORTE						
Traumatic Events during tornado					.34***	.11*
Loss and disruption after tornado						.31***
Children's Parent-rated Baseline Anxiety	.11	.10	.06	.07	.12*	.17**
t-tests Between Dichotomous TORTE Variables and TORTE Continuous Variables						
Child-rated Perceived Life Threat	-2.71**	-5.75***	-4.43***	-1.56	-2.23*	-3.76***
Parent-rated Perceived Life Threat	-3.44***	-4.74***	-2.55*	-2.50*	-6.28***	-4.74***
Means and Standard Deviations of TORTE Continuous Variables						
Mean	0.55	.59	1.19	0.68	.77	1.81
SD	0.69	.76	0.90	0.70	.79	0.97

Note: TORTE refers to Tornado-Related Traumatic Experiences. The fourth variable from the TORTE assessed children's and parents' perceived life threat, and was scored as present or absent (0 or 1). The relations between that variable and the other TORTE variables are reported using t-test analyses.

p < .001;

**
p < .01;

*
p < .05.

Table 2
Tornado Exposure Predicting Parent-Reported Child Aggressive Behavior Problems

	Fixed Effect				p-value	Level-3 (between Group) Variance	Random Effect		Level-1(Random Error) Variance
	Coef.	SE	T-ratio	DF			Level-2 (Student within Group) Variance		
Mean of Initial Status	10.81	0.36	29.64	59	<.001***	Initial Status in Model 2.91*	18.10*		8.05
Sex (1=Boy 0=Girl)	2.05	0.69	2.99	164	.003**				
Caretaker Depression	0.09	0.05	1.68	164	.096				
Child Anxiety	0.29	0.07	4.13	164	<.001***				
Child TORTE Life Threat	-0.37	0.69	-0.54	164	.592				
Child TORTE Distressed	-0.34	0.38	-0.91	164	.365				
Mean of Change Rate	-0.37	0.14	-2.62	59	.011*	Change Rate in Model 0.03	0.53*		
Sex (1=Boy 0=Girl)	-0.79	0.33	-2.40	164	.018*				
Caretaker Depression	0.03	0.03	1.31	164	.191				
Child Anxiety	-0.05	0.03	-1.37	164	.172				
Child TORTE Life Threat	0.28	0.34	0.84	164	.400				
Child TORTE Distressed	0.18	0.19	0.95	164	.346				
Child TORTE Life Threat BY Anxiety	-0.17	0.08	-2.13	164	.035*				
Child TORTE Distressed BY Anxiety	0.11	0.04	2.57	164	.011*				

Note: TORTE refers to Tornado-Related Traumatic Experiences.

 $p < .001$;

**
 $p < .01$;

*
 $p < .05$.

Table 3
Tornado Exposure Predicting Parent-Reported Child Internalizing Behavior Problems

	Fixed Effect				p-value	Random Effect		
	Coef.	SE	T-ratio	DF		Level-3 Variance	Level-2 Variance	Level-1 Variance
	Model for Initial Status							
Mean of Initial Status	24.53	0.62	39.28	59	<.001***	14.27*	22.44*	26.57
Sex (1=Boy 0=Girl)	1.21	0.91	1.33	164	.186			
Caretaker Depression	0.14	0.07	2.03	164	.043*			
Child Anxiety	1.70	0.09	18.35	164	<.001***			
Child TORTE Life Threat	-1.10	0.91	-1.21	164	.228			
Parent TORTE Life Threat	1.19	0.91	1.30	164	.194			
	Model for Change Rate							
Mean of Change Rate	-1.34	0.25	-5.29	164	<.001***	0.04	1.47*	
Sex (1=Boy 0=Girl)	-1.18	0.60	-1.99	164	.049*			
Caretaker Depression	0.05	0.05	1.01	164	.312			
Child Anxiety	-0.36	0.07	-5.55	164	<.001***			
Child TORTE Life Threat	0.83	0.60	1.38	164	.169			
Child TORTE Life Threat BY Anxiety	-0.25	0.14	-1.75	164	.082			
Parent TORTE Life Threat	0.96	0.60	1.58	164	.117			
Parent TORTE Life Threat BY Child Anxiety	0.29	0.13	2.27	164	.025*			

Note: TORTE refers to Tornado-Related Traumatic Experiences.

 $p < .001$;

**
 $p < .01$;

*
 $p < .05$.