



Recalling a Devastating Tornado: Qualities of Child Recollections and Associations with Mental Health Symptoms

Erin P. Hambrick¹ · Eric M. Vernberg² · Andrea F. Greenhoot³ · Michelle L. Hendrickson^{2,4}

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Abstract

Trauma recollections often contain trauma-related cognitive and emotional processing. Research examining indicators of such processing in children's trauma recollections and their association with mental health symptoms is limited. Fifty 8 to 12-year-old children provided two open-ended recollections about (1) challenging/"bad" things and (2) positive/"good" things that happened to them 1-year post experiencing an EF-5 tornado. Children completed exposure and mental health symptom measures (PTSD, anxiety, depression). Transcripts were coded for indicators of processing: coherence, positive and negative emotion terms, and resolutions. Age, gender, SES, family tornado-related discussion frequency, verbal ability, tornado-specific psychotherapy receipt, and exposure were controlled. Coherence and positive emotion were positively associated and resolutions were negatively associated with mental health symptoms when children discussed the "bad" things. Children's processing and mental health symptoms were unrelated when children discussed the "good" things. The measured indicators of children's processing may reflect children's meaning-making efforts and have implications for adjustment.

Keywords Natural disaster · Children · Meaning-making · Trauma · Recollections · Cognitive processing · Emotional processing · Mental health

Trauma exposure typically prompts cognitive and emotional processing (Cromer and Smyth 2010), even in children (Bronfman et al. 1998). Cognitive processes, such as how one interprets the trauma, are associated with post-trauma adjustment in children and adolescents, explaining variance in psychological symptoms that exposure alone cannot (Srinivas et al. 2015). Understanding how children think about, feel about, and reflect on trauma can inform the creation and adaptation of trauma intervention strategies (Simon

et al. 2010). Identification of adaptive and maladaptive ways of processing trauma is a step toward creating strategies to prevent or reduce impairment following trauma exposure. The goal of this study was to explore links between indicators of children's cognitive (coherence and resolutions) and emotional (emotion expression) processing of trauma in recollections about a devastating tornado and concurrent mental health symptoms.

Evidence of cognitive and emotional processing (henceforth "processing") is evident in children's trauma recollections (Fivush and Baker-Ward 2005), and includes use of language that reflects their thoughts and feelings (Legerski et al. 2015). Research suggests that such language mirrors a child's "thinking about and reflecting on [their own] experience" (Fivush and Baker-Ward 2005, p. 456). In addition, children provide longer, more coherent, and more emotionally expressive recollections about negative events than positive events (Fivush et al. 2003), suggesting that negative experiences spur efforts to process what happened. Moreover, studies suggest that children may attempt to engage in meaning making in the aftermath of trauma, which involves "reappraisal of cognitions and emotional reactions to trauma that undermine well-being

✉ Erin P. Hambrick
hambricke@umkc.edu

¹ Department of Psychology, University of Missouri-Kansas City, 309 Cherry Hall, 5030 Cherry Street, Kansas City, MO 64110, USA

² Clinical Child Psychology Program, Departments of Psychology and Applied Behavioral Science, University of Kansas, Lawrence, KS, USA

³ Center for Teaching Excellence and Department of Psychology, University of Kansas, Lawrence, KS, USA

⁴ Department of Psychology, Jackson Behavioral Health Hospital, Jackson Health System, University of Miami, Miami, FL, USA

and constructing more adaptive meaning” (Simon et al. 2010, p. 229).

However, little research has been conducted on how indicators of processing, when present in children’s trauma recollections, are associated with post trauma adjustment. The goal of this project was to examine whether and how potential indicators of children’s processing, such as coherence, emotion expression, and resolutions (Fivush and Baker-Ward 2005; Fivush et al. 2003; Legerski et al. 2015), when found in children’s tornado recollections, were associated with post-trauma functioning. Extant literature on children’s processing and how it relates to post-trauma adjustment is reviewed below.

Coherence

Coherence has long been considered important in the study of post-trauma adjustment. Fractured recollections, which do not follow a logical timeline or that focus on peripheral versus central trauma details, are hypothesized to be associated with poor post-trauma functioning (Ehlers and Clark 2000). Inability to remember key aspects of the trauma is a cognitive symptom of Posttraumatic Stress Disorder (PTSD) in the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association 2013). Further, adult trauma survivors often exhibit improvements following treatment during which their trauma recollections become more coherent through expressive writing (Smyth and Helm 2003). Yet, emerging experimental research with adults suggests that trauma recollections provided by individuals diagnosed with PTSD, for example, are as coherent as trauma recollections provided by individuals without PTSD (Rubin 2011; Rubin et al. 2016).

Similar to findings from adult studies, findings are mixed in the limited research on coherence and post-trauma functioning in children. In a study of children ages 2 to 13 who experienced an injury requiring emergency medical treatment, children whose parents rated them as highly distressed provided less coherent accounts of their injury (Peterson and Biggs 1998). In a study of 8 to 16-year-olds receiving trauma treatment due to exposure to various traumatic events (Berliner et al. 2003), participants rated their trauma memories as having fewer sensory details, an indicator of coherence, than their positive memories. Yet, no linkages between aspects of memory coherence and mental health symptoms were found. The authors suggested that the null findings may have been due to the small sample size ($N=30$) and to the wide variation of age and trauma type. Given the range of findings in previous studies, there is a need for additional research

on the association between coherence and mental health problems, particularly in more homogenous samples.

Emotion Expression

There has also been a longstanding interest in emotion expression in trauma recollections, and the association between emotion expression and post-trauma adjustment. Research from expressive writing paradigms with adults and adolescents suggests that expressing emotion while writing about trauma can improve adjustment over time (e.g., Smyth and Pennebaker 2008). Yet, other research from adult populations suggests that the role of emotion expression in adjustment is highly complex, often playing different roles across individuals (Kennedy-Moore and Watson 2001). Moreover, emotion expression may be a way of communicating distress, and it also may be a way of coping with and resolving distress.

Research on associations between emotion expression in children’s trauma recollections and their post-trauma adjustment is also unclear. Following exposure to Hurricane Andrew, 3 and 4-year-old children whose oral recollections contained more positive emotion terms immediately after the hurricane had fewer symptoms of PTSD at a 6-year follow-up, but not concurrently (1-month post hurricane; Sales et al. 2005). Children’s use of negative emotion terms was unrelated to PTSD. In another Hurricane Andrew study, 7 to 12-year-old children’s expression of negative emotion terms in written recollections of “the worst things” that happened to them because of the hurricane was associated with increased PTSD symptoms, both 3 and 7 months post-hurricane (Legerski et al. 2015). Thus, it may be that age, valence (positive or negative) of emotion expression, and time since the event all matter in terms of how emotion expression relates to post-trauma mental health symptoms. How these dimensions of emotion expression matter, however, remains unknown.

Resolutions

One important aspect of trauma recovery is the ability to focus on the present instead of dwelling on the trauma (Classen et al. 2011). Resolutions in trauma narratives are thought to reflect a person’s present-focus (Greenhoot et al. 2013). Yet, little research has been conducted on how a person’s mention of having resolved trauma-related problems relates to psychological symptoms. One study with a young adult sample found that the presence of resolutions in written trauma recollections was positively associated

with PTSD (Greenhoot et al. 2013). Authors concluded that discussing trauma may trigger on-the-spot efforts to manage distress in those who are still psychologically struggling with the impact of the trauma. To date, similar studies have not been conducted on resolutions and post-trauma or disaster adjustment in children.

Methodological Issues in Research on Children's Trauma Processing

One reason for limited consensus on how children's cognitive and emotional processing in the aftermath of trauma relates to psychological adjustment is the methodological challenges inherent in conducting this type of research (blinded reference). Trauma-exposed children are difficult to recruit into studies due to the ongoing adversity they may experience post-trauma, and many ethics boards limit the types of data that can be collected from children regarding their trauma experiences. Thus, existing studies have contained wide age ranges, often finding disparate results across age groups (Peterson and Biggs 1998; Berliner et al. 2003). Time since trauma has also varied, as has trauma type (Peterson and Biggs 1998; Berliner et al. 2003). Methods of data collection and analysis also differ, with some studies using verbatim transcripts to code indicators of processing (e.g., Legerski et al. 2015), and others using child ratings of how their memories feel (e.g., Berliner et al. 2003). Thus, there is a need for more research on children's processing and the relation between processing and post-trauma adjustment in more homogenous samples. Studying children's processing and the associations between processing and mental health symptoms in the context of a disaster may provide some methodological advantages, as all participants are impacted simultaneously by the same disaster.

Disaster Exposure and Children

High intensity exposure to trauma and loss experiences during and after natural disasters causes short-term distress in most children (e.g., Vernberg and Varela 2001). These reactions, which include re-experiencing phenomena, psychic numbing, and hyperarousal, typically subside over the course of a year. Reactions rarely persist at clinically significant levels for more than 30% of disaster-exposed children 1 year post-disaster (Bonanno et al. 2010). Those with persistent stress reactions, however, experience functional impairment in multiple domains. The way children think about (La Greca et al. 1998), or process trauma (Sales et al. 2005) is also associated with adjustment. Thus, obtaining recollections from children who have been exposed to disaster may be an ideal way to evaluate their processing of

trauma and the links between disaster exposure, cognitive and emotional processing, and children's experience of post-disaster mental health symptoms.

Joplin Tornado

The multi-vortex tornado that struck Joplin, Missouri on May 22, 2011, was rated an EF5, the highest severity category. It was the seventh deadliest tornado in United States history (Time 2011), carving a six-by-two-mile path through the town. Joplin is a mid-sized Midwestern town, and most residents were directly exposed to tornado-related events either during the storm or on an ongoing basis in the weeks and months following the storm. The intensity of the storm was unexpected, visibility was impaired, and a lack of basements due to mine shafts beneath the city left most residents without adequate shelter. The death toll was over 160, including 13 children. Close to 7,500 homes were destroyed, 17,000 people from the town's approximate population of 50,000 were displaced, 1,200 individuals were injured, and almost 500 families remained in Federal Emergency Management Agency trailers 1 year later. Throughout data collection, the psychological and physical effects of the storm were evident (V. Mieseler, personal communication, March 16, 2012). A child psychological services center was opened to meet the increased mental health need. Public memorial events were held regularly, and the city's mantras became "Rebuild Joplin" and "Don't let one disaster lead to another."

Current Study

This study sought to examine and describe the association between children's processing in trauma recollections and post-trauma mental health symptoms. A composite of mental health symptoms was used rather than a measure of a specific clinical disorder due to the small sample size. Moreover, because children may experience more generalized adjustment difficulties compared to adults (Bonanno et al. 2010), we wanted to see if children's processing was broadly associated with mental health problems. Researchers coded several aspects of cognitive and emotional processing in transcripts of two child recollections of trauma: (1) the "bad" things that happened to them because of the tornado, and (2) the "good" things that happened to them because of the tornado. It was hypothesized that more associations between processing and mental health symptoms would be found when children were discussing the "bad" things, since this task may demand more efforts to process the trauma (e.g., Fivush and Baker-Ward 2005). However, specific hypotheses regarding the direction of the associations

between child processing and mental health symptoms were not made due to the mixed nature of existing literature.

Method

Participants

Data come from a project on child trauma recollections, *Project-Share Joplin*. Fifty 8- to 12-year-olds ($M=9.42$, $SD=1.39$; 24 female) and their mothers who lived in Joplin, Missouri and experienced an EF5 tornado participated. The sample was restricted to 8- to 12-year olds so that children were old enough to provide reliable independent recollections of the tornado (without caregiver assistance; e.g., Riley 2004) yet young enough to still be classifiable as children and not adolescents. Three children were excluded (and not included in the previous statistics) due to verbal deficits or to non-residence in Joplin during the tornado. Participants were 78% white/non-Hispanic, 7.8% Hispanic, 3.9% Black, and 7.8% other/biracial. Yearly household income ranged from 0 to \$20,000 to greater than \$100,000; median \$30,000 - \$40,000. Data collection was completed 14 to 18 months post-tornado.

Recruitment

Three human subjects institutional review boards approved this project: The University of Kansas, the Missouri Department of Mental Health, and Will's Place, a mental health agency in Joplin. Several local service organizations allowed researchers to recruit on-location, including YMCAs© and religious organizations. Recruitment was also conducted via a website, Facebook® page, Twitter® account, TV news stories, and announcements disseminated by schools. Potential participants were informed that participation would entail children talking about their tornado-related experiences prior to being enrolled in the study.

Measures

Tornado-Related Traumatic Experiences (TORTE; Vernberg and Jacobs 2005) 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 TORTE, which was adapted from a measure previously used to assess hurricane-related traumatic experiences among children and adolescents (Vernberg et al. 1996). Proximal trauma exposure was measured with 7 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 additional elements of traumatic events that might occur during severe tornadoes

(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 subjective level of 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). Table 1 shows all question stems. In the current analysis, only the 23 items assessing actual exposure to life-threatening events were used (e.g., Marsee 2008). Because the TORTE is a frequency count of distinct, potentially unrelated aspects of a person’s tornado experiences, internal consistency was not computed. The 23-item TORTE scale yielded the following descriptive statistics in this study: $M=6.10$, $SD=4.44$, range = 0–15.

UCLA Reaction Index for Children-Self Report Version, Diagnostic and Statistical Manual – IV Revision (RI, DSM-IV (2000) Revision; Pynoos and Steinberg 2002)

The RI PTSD

Table 1 Tornado-related traumatic experiences: child report

Experience type	% Endorsing item
Part A: during the tornado	
1) ... windows or doors break in place you stayed	36
2) ... get hurt	10
3) ... see anyone get hurt badly	38
4) ... a pet you liked get hurt or die	22
5) ... get hit by anything flying or falling	6
6) ... apart from parent during tornado	8
Part B: after the tornado	
7) ... home damaged badly or destroyed	48
8) ... go do a new school	36
9) ... move to a new place	42
10) ... parent lost job	16
11) ... hard to see friends because of moves	48
12) ... family have trouble getting food or water	28
13) ... clothes or toys ruined by the tornado	36
14) ... pet run away/given away	16
15) ... anyone stolen anything from your home	22
16) ... have to live away from parents for a week or more	12
Part C: since the tornado	
17) ... all damage to home now fixed	26
18) ... living in house lived in before tornado	52
19) ... living in house with leaky roof	0
20) ... have to travel a lot longer to get to new school	20
21) ... parent now out of a job	8

Response options were 0 (no) or 1 (yes)

symptom scale is a child self-report measure that contains 22 items with five response options ranging from 0 (none) to 4 (most of the time) for children ages 7 to 18. Children were asked respond based on how they had felt due to the tornado in the past month. The RI can be used to determine whether a child meets symptom criteria for PTSD. Convergent validity has been cited at 0.70 and internal consistency at 0.90 (as cited in Steinberg et al. 2004). In this study, Chronbach's $\alpha = .85$, $M = 23.56$, $SD = 12.08$, range = 5–52.

Behavioral Assessment System for Children - Second Edition (BASC-2; Reynolds and Kamphaus 2004) In its entirety, the child version of the BASC-2 is used as a measure of a child's adaptive, internalizing and externalizing behavioral functioning. Only child report of the depression and anxiety scales were used in this study. The BASC-2 has well-established reliability and validity: test–retest reliability ranges from $r = .77$ to $r = .81$, and internal consistency ranges from $\alpha = 0.80$ to 0.87 (Reynolds and Kamphaus 2004). For this study, because different response forms were used for 8 to 11-year-old and 12-year-old children, t -scores were used in analyses. Thus, internal consistency was not assessed.

Riddles (subscale of Kaufman Brief Intelligence Scale, Second Edition; Kaufman and Kaufman 1997) The Riddles subtest was administered to measure verbal reasoning abilities and to exclude participants with verbal reasoning abilities falling within the potentially intellectually disabled range (< 70). The Riddles subtest contains 48 items that measure “verbal comprehension, reasoning, and vocabulary knowledge” (p. 4, Kaufman and Kaufman 1997). This subtest can be administered to participants ages 4 through 90. Internal consistencies for children range from 0.84 to 0.89. The raw score of the Riddles subtest was used as a measure of verbal ability in this study; $M = 23.38$, $SD = 6.66$, range = 12–36.

Rehearsal of Events Scale (Bahrck et al. 1998) The Rehearsal of Events Scale, which was created for a study of psychological distress following Hurricane Andrew, was adapted to determine the frequency of family discussion of tornado-related events. This questionnaire assessed mother–child frequency of discussion of tornado-related events at three different time points: 1 week post tornado, 1 week prior to participation in this study, and the time in between. Mothers rated the amount their family discussed the tornado in the presence of their child on a scale from 1 (none) to 5 (several times per day) during each of the three time points. These three questions were summed to create a total Event Rehearsal score: $M = 9.84$, $SD = 2.45$, range = 5–15.

Procedures

Children met with researchers at the family's residence or local service sites, depending on participant preference. Following receipt of parental consent and child assent, the child completed a task of verbal comprehension and measures of psychosocial adjustment with an interviewer (PTSD Reaction Index, BASC anxiety and depression subscales). Although it is traditional for children to answer questions about their full history of exposure to traumatic events when completing the PTSD Reaction Index, this screener was omitted in this study to reduce the potential stressfulness and length of the study for children. While children completed their own questionnaires, the mother completed a demographic questionnaire (including a question regarding whether their child had received psychotherapy due to the tornado) and the Rehearsal of Events Scale. Next, researchers obtained individual child recollections of their tornado experiences using a protocol of four open-ended prompts, which were designed for this study to elicit reflection on tornado events. Prompts were: (1) “Tell me some things that happened to you or your family because of the tornado”; (2) “What were some challenging or bad things that happened to you or your family because of the tornado”; (3) “What were some positive or good things that happened to you or your family because of the tornado”; and (4) “How have things been different for your or your family since the tornado.” Following participants' responses to each prompt, they were asked, “Is there anything else you want to tell me about [prompt stem]?” to elicit as much of a story as they were willing or able to provide. The prompts of interest to this study were only the prompts regarding the challenging or “bad” and positive or “good” aspects of their tornado experiences, as the first prompt was designed to help the child warm up to the task, and the fourth prompt was designed to allow them the opportunity to share as much about the tornado as desired.

After completing the recollection task, children completed the TORTE to measure severity of tornado exposure. Children completed the TORTE before providing their open-ended recollections to prevent the questions about tornado severity from interfering with children's spontaneous recall of tornado-related events (e.g., Bauer et al. 2007). To end, families were screened for participation-related distress and given gift certificates (\$20 mother, \$10 child). No children evidenced significant participation distress (we published an article on the participation risks of this study, reference blinded for review). All data used in this cross-sectional study were collected during a single data collection event.

Recollection Coding

Recollections were transcribed verbatim and checked for accuracy. Transcripts were then divided into prompts, and only the prompts asking participants to discuss the “bad” things that happened to them because of the tornado and the “good” things that happened to them because of the tornado were coded for analysis. These two prompts were coded separately for Coherence, Positive and Negative Emotion, and Resolutions (Table 2). A master coder coded each transcript; 20% of transcripts were coded by a reliability coder. Coders were blind to children’s scores on other measures. Once acceptable inter-rater reliability was achieved, defined as interclass correlations above 0.80 (Bakeman and Gottman 1986), only the master coder’s codes were used.

Coherence Coherence was coded using a scheme developed by Reese et al. (2011). Three dimensions of coherence were coded on a scale of 0 (no coherence) to 3 (fully coherent) per prompt: Context (degree to which the participant situates the event in time and place), Chronology (degree to which the recollection is temporally organized), and Theme (degree of explanations used to create a logical story with links to autobiographical memory). Interclass correlations were 0.94 for Context, 0.95 for Chronology, and 0.93 for Theme. Context, Chronology and Theme were summed per prompt to create two total Coherence scores: one for the “bad” things that happened ($M = 2.16$, $SD = 1.71$, range = 0–5), another for the “good” things ($M = 2.1$, $SD = 1.4$, range = 0–5). Coding examples:

- Context, (1-point response): “*We had to stay with some friends sometimes.*”
- Theme, (3-point response):

Well, um, first, my sister lived on...closer, inward toward the tornado...and she was coming home from work by the mall and she walked out of the building and heard the sirens, came back in...got in her vehicle, drove over and uh, came up in the house and said “I’m taking you over back to my apartment” and my parents said, uh, “no you’re not taking him [me] over, the sirens are going off. And so she stayed here and

I’m kinda glad that she listened to my parents and, ‘cause her...she was the middle apartment...and now the whole entire other side of the apartment complex was gone.

Emotion The Linguistic Inquiry and Word Count (LIWC) program was used to analyze the transcripts for the presence of emotion terms (positive/neutral and negative; Tausczik and Pennebaker 2010). The emotion term library used was adapted to child populations (e.g., Legerski et al. 2015). Due to the observation that many children would say “I was not sad,” and that LIWC was counting this emotion as a negative emotion, LIWC was used to identify emotion terms within the recollections, and then these identified terms were hand-coded for classification as a positive or negative emotion term. Interclass correlations between the master and reliability coders’ codes were 0.92 for positive emotion and 0.95 for negative emotion. Four variables to represent the frequency of Positive and Negative Emotion terms in recollections and conversations were used in analyses: frequency of Positive/Neutral ($M = 0.76$, $SD = 2.25$, range = 0–15) and Negative Emotion ($M = 1.45$, $SD = 2.04$, range = 0–10) in child recollections about the “bad” things and then about the “good” things ($M = 1.27$, $SD = 1.5$, range = 0–6; $M = 0.49$, $SD = 1.34$, range = 0–8, respectively). The resulting emotion variables were divided by word count to obtain the proportion of emotion terms in each transcript. Coding examples:

- Negative Emotion: “*Some of us are still a little worried. And that’s all I have to say....*”
- Positive/Neutral Emotion: “*It wasn’t scary.*”

Resolution A coding scheme developed by Greenhoot et al. (2013), which was adapted from McLean and Pratt (2006), was used to code Resolutions, or the degree to which the main character’s problems were resolved in the recollection. A resolution was scored if the child made reference to having resolved how they felt about tornado-related events, or if there was some mention of things being bad due to the tornado but then getting better. If participants provided more than one Resolution, the score for the highest Resolution was used. Interclass correlations between coders were 0.96. Two resolution scores were computed: one from the recollections about the “bad” things ($M = 0.27$, $SD = 0.60$, range = 0–2)

Table 2 Variables coded per prompt of child recollections

Coding dimension	Unit of analysis	Codes	Resulting variables
Coherence	Each Prompt	Context (0–3) Chronology (0–3) Theme (0–3)	Coherence (0–6)
Emotion	Each Prompt	Frequency, Positive/Neutral & Negative Emotion Terms	Positive Emotion (#) Negative Emotion (#)
Resolution	Each Prompt	Resolution (0–2)	Resolution (0–2)

and one from the recollections about the “good” things ($M=0.35$, $SD=0.67$, range = 0–2). Coding example:

- Resolution (2-point response):

...my dad was losing business when, before the tornado hit, and we were about to shut down, and close. When the tornado came through, everyone was buying appliances because everyone’s house had broken [down]. So, thanks to the tornado, we, it saved our business.

Data Analysis A composite score of child-reported mental health symptoms (PTSD, depression, and anxiety) was created: total severity score on the PTSD RI (Pynoos and Steinberg 2002), a child’s t -score on the depression subscale of the BASC-2, and a child’s t -score on the anxiety subscale of the BASC-2. These three scores were standardized and summed to create the mental health composite. Then, two hierarchical linear regression models were conducted to determine the association between child processing of tornado-related events and mental health symptoms. The first regression analyzed associations between child processing (coherence, negative and positive emotion, and resolutions) and mental health symptoms when children were discussing the challenging or difficult things that happened to them because of the tornado (“Bad” things). The second regression analyzed associations between child processing variables and mental health symptoms when children were discussing the positive or good things that happened to them because of the tornado (“Good” things). Control variables were age, gender, verbal ability, whether or not the child had received tornado-related mental health treatment, frequency of event rehearsal, family income, and tornado exposure (as measured by the TORTE; Vernberg and Jacobs 2005).

Results

Frequency of child-reported tornado-related traumatic events are presented in Table 1. Many children reported direct exposure to the tornado: 48% of children endorsed having a home that was damaged badly or destroyed, while 38% endorsed seeing someone get hurt badly. Descriptive statistics of variables used in regression analyses are reported in Table 3. Point-biserial and Spearman correlations (see Table 4) indicated a correlation between mental health symptoms and tornado exposure ($r=.28$) and coherence when children were talking about the “bad” things ($r=.29$). Because correlations between mental health symptoms, tornado exposure, and child processing variables were found, two hierarchical linear regressions were conducted.

Table 3 Descriptive statistics

Variables	<i>N</i>	Range	<i>M</i>	<i>SD</i>
Age (in months)	50	97–156	119.18	17.62
Gender	50	0–1	0.48	0.51
Family income	50	1–7	3.36	2.00
Verbal ability	50	12–36	23.38	6.66
MH treatment	50	0–1	0.24	0.43
Event rehearsal	50	5–15	9.84	2.45
Tornado exposure	50	0–15	6.06	4.44
Coherence - Bad	50	0–5	2.16	1.71
Coherence - Good	50	0–5	2.10	1.40
Neg Emo - Bad	49	0–17	0.03	0.04
Pos Emo - Bad	49	0–20	0.01	0.03
Neg Emo - Good	49	0–15	0.01	0.02
Pos Emo - Good	49	0–29	0.03	0.05
Resolutions - Bad	49	0–2	0.27	0.57
Resolutions - Good	48	0–2	0.35	0.67
MH symptoms	50	–1.38–2.53	0.00	0.90

Gender: Male = 0. Family Income: 1 = \$0–\$20,000; 2 = \$20,000–\$30,000; 3 = \$30,000–\$40,000; 4 = \$40,000–\$50,000; 5 = \$50,000–\$70,000; 6 = \$70,000–\$100,000; 7 = > \$100,000. *MH* mental health. *MH Treatment* coded as 0 (no treatment) or 1 (treatment). *Bad Prompt* “Tell me about some challenging or difficult things that happened to you or your family because of the tornado. *Good Prompt* “Tell me about some positive or good things that happened to you or your family because of the tornado.” *Neg* Negative, *Emo* Emotion, *Pos* Positive. *MH symptoms* score is standardized

The first hierarchical regression was conducted to determine the association between children’s processing and mental health symptoms when children were discussing the “Bad” things. When controlling for age, gender, verbal ability, whether or not the child received tornado-related mental health treatment, frequency of event rehearsal, family income, and tornado exposure, child processing variables were significantly associated with mental health symptoms (see Tables 5 and 6). Specifically, Coherence ($B=0.275$, $t=3.607$, $p=.001$), Positive Emotion ($B=12.425$, $t=-3.137$, $p=.003$), and Resolutions ($B=-.598$, $t=-2.507$, $p=.017$) were associated with mental health symptoms. Whether or not a child had received tornado-related mental health treatment was the only other significant variable in the regression ($B=-6.94$, $t=-2.44$, $p=.019$). Children whose recollections about the “bad” things that happened were highly coherent and contained positive emotion terms were more likely to have mental health symptoms than children whose recollections were less coherent and contained fewer positive emotion terms. Children whose recollections about the “bad” things contained resolutions were less likely to have mental health symptoms than children whose recollections did not.

The second hierarchical regression was conducted to determine the association between children’s processing

Table 4 Correlations amongst predictor variables and mental health symptoms

	Age	Gender	Family income	Verbal ability	MH treatment	Event rehearsal	Tornado exposure	Coherence – Bad	Coherence – Good	Neg Emo – Bad	Pos Emo – Bad	Neg Emo – Good	Pos Emo – Good	Resolution – Bad	Resolution – Good
Gender	-0.04														
Family income	-0.02	-0.03													
Verbal ability	0.22	0.06	0.32*												
MH treatment	-0.2	-0.17	0.37**	-0.10											
Event rehearsal	0.26	0.02	0.13	-0.01	0.09										
Tornado exposure	-0.18	0.04	-0.49**	-0.29*	-0.07	-0.08									
Coherence – Bad	0.17	0.36*	-0.03	0.24	0.04	0.03	0.27								
Coherence – Good	-0.08	-0.28	0.14	0.21	0.02	0.15	-0.04	0.07							
Neg Emo – Bad	-0.03	0.08	0.06	0.05	0.15	0.14	0.11	0.30	0.20						
Pos Emo – Bad	0.49	0.18	0.08	0.01	-0.18	0.002	-0.11	0.40**	0.02	-0.09					
Neg Emo – Good	-0.09	-0.36*	-0.23	-0.09	-0.04	-0.06	0.03	0.02	0.19	0.23	-0.12				
Pos Emo – Good	-0.14	-0.24	0.22	0.18	0.07	-0.11	0.11	0.09	0.38**	0.08	0.08	0.15			
Resolutions – Bad	0.51	0.10	0.06	0.20	-0.18	-0.03	-0.08	0.45**	0.05	0.04	0.66**	-0.05	0.19		
Resolutions – Good	0.04	-0.10	0.28	0.33*	0.15	0.23	-0.08	0.29*	0.48**	0.26	-0.04	0.22	0.44**	0.11	
MH symptoms	-0.16	0.09	-0.11	-0.31*	-0.13	0.05	0.28*	0.29*	0.03	-0.02	0.21	0.19	0.07	-0.04	0.09

Gender: Male=0. Family Income: 1 = \$0–\$20,000; 2 = \$20,000–\$30,000; 3 = \$30,000–\$40,000; 4 = \$40,000–\$50,000; 5 = \$50,000–\$70,000; 6 = \$70,000–\$100,000; 7 => \$100,000. MH mental health. MH Treatment coded as 0 (no treatment) or 1 (treatment). *Bad* Prompt “Tell me about some challenging or difficult things that happened to you or your family because of the tornado. Good Prompt “Tell me about some positive or good things that happened to you or your family because of the tornado.” *Neg* Negative, *Emo* Emotion, *Pos* Positive. * = p < .05. ** = p < .01

Table 5 Regression model performance: child processing & mental health symptoms

Model	R	R ²	SEE	R ² change	F change	df	P
1. Tell me about the challenging or difficult things...							
1	.498	0.248	0.836	0.248	1.931	7, 41	0.089
2	.733	0.537	0.691	0.289	5.780	4, 37	0.001
2. Tell me about the positive or good things...							
1	.497	0.247	0.846	0.247	1.876	7, 40	0.099
2	.553	0.305	0.857	0.058	0.754	4, 36	0.562

1. Predictors: Exposure, Gender, Event Rehearsal, Mental Health Treatment, Verbal Ability, Age, Family Income; Outcome: Mental Health Symptoms 2. Predictors: (Constant), Exposure, Gender, Event Rehearsal, MH Treatment, Verbal Ability, Age, Family Income, Negative Emotion, Positive Emotion, Coherence, Resolution; Outcome: Mental Health Symptoms

Table 6 Regressions: child processing and mental health symptoms

	Unstandardized coefficients		Standardized coefficients			Collinearity statistics	
	B	Std. Error	Beta	t	p	Tolerance	VIF
Tell me about the challenging or difficult things...							
(Constant)	0.448	0.957		0.469	0.642		
Age	-0.299	0.224	-0.170	-1.338	0.189	0.779	1.283
Gender	-0.014	0.007	-0.273	-1.869	0.070	0.586	1.708
Verbal ability	-0.022	0.019	-0.167	-1.185	0.244	0.629	1.590
MH treatment	-0.694	0.284	-0.338	-2.444	0.019*	0.653	1.531
Event rehearsal	0.088	0.044	0.246	2.026	0.050	0.852	1.174
Family income	0.093	0.064	0.209	1.444	0.157	0.596	1.677
Exposure	0.054	0.028	0.262	1.952	0.059	0.695	1.439
Coherence	0.275	0.076	0.529	3.607	0.001**	0.582	1.717
Neg Emo	-0.669	2.892	-0.027	-0.231	0.818	0.894	1.118
Pos Emo	12.425	3.961	0.425	3.137	0.003**	0.681	1.469
Resolution	-0.598	0.239	-0.382	-2.507	0.017*	0.539	1.856
Tell me about the positive or good things...							
(Constant)	0.542	1.213		0.447	0.657		
Age	0.052	0.295	0.029	0.176	0.861	0.702	1.424
Gender	-0.008	0.008	-0.150	-0.940	0.353	0.762	1.312
Verbal ability	-0.034	0.023	-0.256	-1.499	0.143	0.663	1.508
MH treatment	-0.559	0.361	-0.264	-1.548	0.130	0.665	1.503
Event rehearsal	0.068	0.055	0.188	1.230	0.227	0.827	1.209
Family income	0.052	0.090	0.115	0.570	0.572	0.478	2.093
Exposure	0.075	0.034	0.363	2.176	0.036*	0.695	1.439
Coherence	-0.050	0.112	-0.079	-0.446	0.658	0.616	1.623
Neg Emo	10.985	10.933	0.154	1.005	0.322	0.819	1.222
Pos Emo	-1.089	2.987	-0.059	-0.365	0.718	0.728	1.374
Resolution	0.300	0.241	0.223	1.243	0.222	0.602	1.661

Gender: Male=0. Family Income: 1=\$0–\$20,000; 2=\$20,000–\$30,000; 3=\$30,000–\$40,000; 4=\$40,000–\$50,000; 5=\$50,000–\$70,000; 6=\$70,000–\$100,000; 7=>\$100,000. *MH* mental health. *MH Treatment* coded as 0 (no treatment) or 1 (treatment). *Bad Prompt* “Tell me about some challenging or difficult things that happened to you or your family because of the tornado. *Good Prompt* “Tell me about some positive or good things that happened to you or your family because of the tornado.” *Neg* Negative, *Emo* Emotion. *=p<.05. **=p<.01

and mental health symptoms when children were discussing the “Good” things. When controlling for age, gender, verbal ability, whether or not the child received tornado-related mental health treatment, frequency of event rehearsal, family income, and tornado exposure, child processing variables were not significantly associated with mental health symptoms (see Tables 5 and 6).

Discussion

The goal of this study was to examine and describe links between indicators of children’s cognitive and emotional processing in their recollections of a devastating tornado and concurrent mental health symptoms (anxiety, depression, and post-traumatic stress). Understanding how children’s processing relates to adjustment may ultimately inform the creation and selection of intervention strategies (Simon et al. 2010). This study included a sample of 50 children directly exposed to the Joplin tornado. When discussing the “bad” things that happened because of the tornado, children whose narratives were more coherent and contained a greater frequency of positive emotion terms were more likely to experience mental health symptoms, whereas children who provided more resolutions were less likely to experience mental health symptoms. No relation was found between indicators of processing and symptoms when children discussed the “good” things that happened because of the tornado.

Indicators of cognitive and emotional processing of trauma provided during trauma recollections may be a “mirror” into how children are “thinking about and reflecting on their experiences” (Fivush and Baker-Ward 2005, p. 456). However, how these indicators are related to the potentially psychologically adaptive process of meaning-making remains unclear. This study was a step toward better understanding if these variables may reflect children’s post-trauma meaning making by determining if they are associated with children’s post-trauma adjustment. We found that indeed there are associations between cognitive and emotional processing and children’s psychological adjustment when children discussed their “bad” tornado experiences. The direction of the associations was not consistent amongst the various measured indicators of cognitive and emotional processing.

Coherence

Coherence measured the degree to which the child placed the event in context of time and place, and whether the recollection contained explanations to create a logical story about the event. When discussing the “bad” things, children with more coherent recollections were more likely to endorse mental health symptoms. This finding is consistent with

recent research from the adult literature, which suggests that memory incoherence may not maintain post-trauma maladjustment in all situations (Rubin 2011). Instead, children’s provision of highly coherent recollections may indicate that their memory for the trauma has “high centrality,” or is a memory that is important to their identity (e.g., Bernsten and Rubin 2007). As such, especially when high levels of coherence are evident over a year post-tornado, it may reflect a child’s “over focus” on the event. Another potential interpretation is that children whose recollections about the bad things that happened to them are highly coherent are still actively processing the trauma. Research in adult populations suggests that making meaning of trauma is associated with concurrent distress, and that it is only when meaning has been made that psychological benefits are conferred (Park 2010).

Emotion Expression

Surprisingly, frequency of children’s positive and neutral emotion terms when discussing the “bad” things that happened because of the tornado was related to increased psychological symptoms. This finding contrasts with research showing that positive emotion relates to fewer psychological symptoms 6 years post-disaster (Sales et al. 2005). However, the current study occurred 14–19 months post tornado, and there may be an interaction between time since the trauma and emotional processing. Another significant methodological distinction between the current study and the Sales et al. (2005) study were the demand characteristics of the prompts. In the current study, children were specifically asked to discuss the “bad” things that happened to them (as opposed to free recall). A high level of positive emotions in response to this prompt could be an indicator of avoidance or minimization of discussion of negative emotions or events, which then may have interfered with a creating an accurate, complete understanding of the event and engaging in effective coping (i.e., seeking social support, genuine emotional disclosure, ability to engage in meaning-making processes; Vernberg et al. 2016). It is important for future studies to separately examine mental health symptoms (anxiety, depression, and post-traumatic stress symptoms) to better understand the complex association between positive emotion expression and psychological symptoms.

Resolutions

A resolution was scored if the child referenced having resolved how they felt about tornado-related events, or if there was mention of things being bad and then getting better. When children talked about the “bad” things that happened to them because of the tornado, those who provided more resolutions had fewer psychological symptoms. This

finding is consistent with literature that conceptualizes resolutions as indicating a “present-focus” (Greenhoot et al. 2013). Therefore, results suggest that resolutions may be an indicator of meaning made (Park 2010) and an ability to find the positive in difficult situations, a skill which is linked to better psychological adjustment (Aldwin and Sutton 1998).

Limitations and Future Directions

Children self-reported their mental health symptoms, and as such, children who were avoidant or reluctant in discussing the tornado and its effects may have also underreported on measures of psychosocial adjustment. Additionally, sampling bias likely occurred. Due to the sensitive nature of the study, families were informed of the study’s methods prior to enrolling. Five families declined, stating that their child was “over the trauma.” The way that cognitive and emotional processing was conceptualized and measured in this study also may have influenced outcomes. For example, emotion expression was a count of positive/neutral versus negative emotion terms. Evaluating the timing of children’s use of emotion terms in the broader context of the content of their recollection may yield different results.

Also, lack of pre-tornado measures of children’s functioning makes it difficult to attribute this study’s findings to tornado exposure rather than trait-based attributes. This limitation was particularly compounded by lack of information regarding children’s cumulative level of trauma exposure. It is likely that many children in the sample had previously been exposed to potentially traumatic events. It is difficult to know if the findings are a result of exposure to the Joplin tornado alone or due to exposure to a different trauma, or even chronic trauma exposure. Research suggests that trauma exposure, particularly when it is chronic and occurs early in life, can disrupt cognitive development (Zilberstein 2014), including executive functioning and IQ (Enlow et al. 2012) and emotional development, including self-soothing (Courtois 2004). In turn, these deficits could affect a child’s ability to create a coherent account of their traumatic experiences or to identify or express emotions or ways the trauma has been resolved. Yet, there is also literature to suggest that cognitive therapies and therapies addressing emotion-regulation capacities are effective even for individuals with histories of repeated trauma exposure (Briere and Lanktree 2012; Resick et al. 2003). Thus, examining how exposure to multiple traumas influences the cognitive and emotional processing variables examined in this study is a key future direction.

Other important future directions include longitudinal studies to determine how children’s processing influences post-trauma adjustment over time. Wider age ranges should be studied to allow for an understanding of when, how, and what children say about trauma is related to distress versus

positive adjustment. Replication with larger samples would allow for analysis of potentially curvilinear relations between recollection qualities and adjustment due to exposure or age. Larger samples would also allow for a better understanding of how the recollection qualities work together to promote adjustment. For example, perhaps coherence is adaptive when it occurs in the context of resolutions. An understanding of how these findings generalize to children who have experienced other types of trauma (e.g., non-public traumas such as sexual traumas) and who are exhibiting specific mental health problems is also needed.

Despite limitations and the need for ongoing research, this study contained several strengths, including utilizing a relatively homogenous sample with high levels of tornado exposure and multiple data collection and analysis methods. In addition, the study evaluated several potential indicators of cognitive and emotional processing. We found that the association between children’s processing of trauma and psychological adjustment is complex yet likely important. When asked to discuss “bad” things that happened because of a tornado, children who described resolutions to the problems the tornado caused showed better psychological adjustment. However, children with highly coherent recollections about the “bad” things or who used high levels of positive emotion terms showed poorer psychological adjustment, potentially due to over-focusing on or minimizing, respectively, the tornado’s impact. Although clinical implications are speculative at this point, it does seem prudent that clinicians do not make assumptions about a child’s mental health functioning based solely on the characteristics of the child’s trauma recollection. For example, this study highlights the fact that assuming that a child who can give a detailed, descriptive account of a traumatic event with mention of positive emotions is not suffering from mental health problems may be incorrect. Indeed, learning more about the implications of children’s post-trauma processing could promote improvements in the understanding of how to help children process trauma in adaptive ways.

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Compliance with Ethical Standards

Disclosure of Interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical Standards and Informed Consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation [institutional and national] at the University of Kansas, and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

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