Trauma Symptoms and Executive Functioning in Children: A Pilot Report on Depression and Anxiety as Mediators

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Abstract

Background: Trauma symptoms have been linked to long-term deficits in executive functioning in clinical samples of youth. Symptoms of depression and anxiety, which commonly co-occur with traumatic symptoms, may also play a role in executive functioning deficits. These associations have yet to be explored in healthy children, who may hold important clues for fostering resilience following trauma.

Methods: The present pilot study explores self-reported trauma symptoms and executive functioning in a healthy community sample of children without mental or physical health problems. Depression and anxiety symptoms are explored independently as mediators in the relationship of trauma symptoms and executive functioning.

Results: A meaningful statistically significant dimensional relationship exists between trauma symptoms and executive functioning even in healthy children with sub-clinical trauma symptoms and typical executive functioning. Depression and anxiety symptoms each partially mediate this relationship, speaking to their salience in this association.

Conclusion: These pilot findings in healthy children point to potentially powerful pathways for resilience research aimed at preserving or bolstering executive functioning in children by targeting anxiety and depression symptoms in addition to trauma symptoms. Furthermore, these findings demonstrate that researchers can meaningfully study these relations in a wide range of children, including those who are not in the clinical range. This holds the potential for unraveling new factors related to resilience pertaining to trauma symptoms.

Keywords

Depression; Anxiety; Trauma; Executive functioning; Children; Adolescents

Introduction

Trauma symptoms, such as difficulty sleeping, nightmares, distressing memories, or avoidance, exist on a spectrum and are experienced to some extent by all individuals following trauma [1-3]. Following trauma, most children and adolescents experience mild to moderate trauma symptoms and recover fully and naturally [4]. However, a significant minority of youth experience high levels of trauma symptoms [1] that have a lasting negative impact on a variety of capacities. Recent research has pointed to long-term biological implications of persistent trauma symptoms in childhood including, epigenetic [5] and neurocognitive [6] changes. This research investigates trauma symptoms in healthy non-abused children and not traumatic events by themselves.

Deficits in executive functioning, the brain’s ability to effectively plan and carry out tasks, is a vital neurocognitive capacity that has been linked to trauma symptoms in children and adults [6,7]. To help prevent and treat trauma symptoms and associated deficits in executive functioning, research has understandably focused on children with high trauma symptoms, which includes but is not limited to those diagnosed with post-traumatic stress disorder (PTSD) [2,8]. However, important clues for preventing the negative effects of trauma symptoms on executive functioning may also be found in exploring children at the opposite end of the spectrum. Understanding the relation between trauma symptoms and executive functioning in healthy children with low trauma symptoms may be vital in clarifying key resilience factors that are presently unknown and yet may be of importance in curtailting trauma symptom sequelae.

The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition [9] defines four clusters of trauma symptoms used to diagnose PTSD: intrusion, avoidance, negative alterations in cognitions and mood, and alterations in arousal and reactivity. These trauma symptoms exist on a spectrum and are experienced to some degree by many children following trauma. Trauma symptoms are often mild and do not lead to a diagnosis of PTSD [1]. Previous research has demonstrated that high levels of trauma symptoms are associated with deficits in executive functioning [6,8,10], both of which have also been linked to the diagnosis of PTSD and related co-morbid disorders in children (e.g., anxiety and mood disorders) [11-13]. While these studies have provided important insights to risk factors related to trauma symptoms and corresponding deficits in executive functioning, they do not fully shed light on factors related to resilience, which may be vital for prevention and recovery efforts. Of note, this previous research has not addressed the relationship between trauma symptoms and executive functioning in healthy, typically developing children. A first step in identifying resilience factors pertaining to trauma symptoms and executive functioning would be to determine if a measurable and meaningful relationship exists between these factors among children in the healthy, non-clinical range.

Trauma symptoms are associated with a variety of mental health problems in childhood, chief among these are mood and anxiety disorders [12-14]. A neurocognitive factor that has been linked to trauma symptoms [8,10] as well as mood and anxiety disorders is executive functioning [15-17]. A recent study by Samuelson et al. [8] reported deficits in executive functioning in child witnesses of intimate partner violence as compared to control youth. Of note, these differences in executive functioning were related to the continuous level of trauma symptoms and not diagnosis per se, including PTSD. This suggests that healthy children may also experience a measurable...
range of trauma symptoms and variations in executive functioning that are meaningful and independent of diagnosis. Therefore, it is plausible that exploring these relations in healthy children may provide crucial information for understanding resilience following trauma.

Mental health problems related to trauma symptoms are heterogeneous in children. In fact, it is more likely for a child with high levels of trauma symptoms to have PTSD that is co-morbid with other anxiety and mood disorders than to have PTSD alone [13,18]. Since depression and anxiety disorders are some of the most commonly occurring and co-occurring disorders in children with high levels of trauma symptoms [12], depression and anxiety are also likely to be relevant in understanding resilience in healthy children. After all, just as trauma symptoms exist on a spectrum, so do symptoms of depression and anxiety. Depression and anxiety symptoms have been linked to trauma symptoms [11-13], and executive functioning [15-17] independently, but previous research has not readily explored the role of anxiety and depressive symptoms as possible mediators. Therefore, this relation is also worthy of exploration in studying resilience mechanisms pertaining to trauma symptoms and executive functioning.

The current study aims to further unravel the relationship between trauma symptoms and executive functioning in a healthy, non-clinical sample of community youth. We hope that by understanding this relation in healthy children, we will identify factors pertaining to resilience that can be incorporated into future work aimed at prevention. We are especially interested in how this relation may differ by age, gender, ethnicity, socioeconomic status, IQ, and report of a traumatic incident on the diagnostic interview. We selected the aforementioned constructs to explore in relation to trauma symptoms and executive functioning because they were the central constructs to emerge from the literature [19]. In sum, we are looking at symptoms and not categorical diagnosis related to trauma symptoms and executive functioning; we follow the same dimensional approach pertaining to anxiety and depression rather than diagnosis. Our goal in taking this dimensional approach is to establish relationships in a healthy, non-clinical sample of children as a first step in informing prevention and intervention efforts focused on resilience.

We hypothesize that there will be an observable negative relationship between trauma symptoms and executive functioning among children in the healthy range for both of these constructs. While in the healthy range, we hypothesize that this relationship will be similar to published research with adult participants [19]. Our approach is somewhat novel in that we will be using one comprehensive test of executive functioning to explore the relationship between trauma symptoms and executive functioning. Finally, depressive symptoms and anxious symptoms will be explored independently as possible mediators in the relation of trauma symptoms and executive functioning.

Methods

Participants

Twenty-two school-aged children (8- to 17-years-old) were recruited for an IRB approved pilot study assessing trauma symptoms and executive functioning in children. The data used in the present study had identifiers removed, including participant and caregivers names, participant date of birth, and date of assessment.

Of the original 22 children, the data from 2 children were excluded due to underreporting scores on the trauma scale that exceeded the cutoff for valid responding (T-Score >70). Demographic characteristics of the 20 children (M = 12.9, SD = 2.8) included in these analyses are summarized in Table 1.

Diagnosis

Each participant and legal guardian was administered the Kiddie-Schedule for Affective Disorders and Schizophrenia-Present and Lifetime Version (K-SADS-PL) [20] by a trained member of the research team. The K-SADS-PL is a semi-structured diagnostic interview, which assesses current and past psychopathology in children and adolescents up to 18-years-old. The K-SADS-PL has a PTSD module, which as part of assessment of criteria A of the PTSD diagnosis, queries child participants and legal guardians on various types of trauma experienced by the child participant (e.g., natural disasters, car accidents, sexual abuse, domestic violence). The interview provides DSM-IV-TR diagnoses of a wide range of psychiatric disorders, which are determined after the clinician integrates the legal guardian report and the child’s self-report [21].

Executive functioning

We administered subtests of the Delis-Kaplan Executive Functions System (D-KEFS) [22], the first nationally normed set of tests designed solely for the assessment of executive functioning in individuals aged 8-89 years old. According to the authors [23], the D-KEFS adapt what the authors call a “cognitive-process” approach, in that component functions of the higher level cognitive tasks can be evaluated. All the raw scores are converted into age-corrected scaled scores with a mean of 10 and a standard deviation of 3. Internal consistency of the D-KEFS is moderate to high (r = .52 to .90).

Trauma symptoms

Participants were administered the Trauma Symptom Checklist for Children (TSCC) [24]. It is a self-report measure that evaluates a child’s response to unstipulated traumatic events. The TSCC has six subscales that pertain to a range of reactions following trauma: sexual concerns, dissociation, post-traumatic stress, anger, anxiety, and depression. The TSCC uses a 4-point Likert response scale ranging from 0 (Never) through 3 (Almost all of the time) [24]. Additionally, the scale includes two validity indices to detect “Underresponse” and “Hyperresponse” of symptoms [25]. The TSCC has been found to have moderate to high internal consistency ranging from .58 to

Table 1: Descriptive Characteristics of Our Community Sample of Healthy Children With No Major Medical or Psychiatric Diagnoses.

<table>
<thead>
<tr>
<th>Variable</th>
<th>M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in Years</td>
<td>12.9 (2.8)</td>
</tr>
<tr>
<td>Socioeconomic Status</td>
<td>43.8 (10.7)*</td>
</tr>
<tr>
<td>Trauma Symptoms – TSCC</td>
<td>28.2 (10.7)**</td>
</tr>
<tr>
<td>Executive Functioning – DKEFS</td>
<td>10.0 (1.1)**</td>
</tr>
<tr>
<td>Depression Symptoms- CDI</td>
<td>45.0 (8.0)**</td>
</tr>
<tr>
<td>Anxiety Symptoms – MASC</td>
<td>47.0 (9.0)**</td>
</tr>
<tr>
<td>Descriptive Statistics</td>
<td>N=20 (100%)</td>
</tr>
<tr>
<td>Male</td>
<td>10 (50%)</td>
</tr>
<tr>
<td>Female</td>
<td>10 (50%)</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>4 (20)</td>
</tr>
<tr>
<td>African American</td>
<td>5 (25%)</td>
</tr>
<tr>
<td>Caucasian</td>
<td>11 (55%)</td>
</tr>
<tr>
<td>DSM-IV-TR Criteria A – Yes/No</td>
<td>10/10 (50%/50%)</td>
</tr>
</tbody>
</table>

*Four-Factor Hollingshead; ** Total T-Score; *** Standard Score
.89 (M alpha = .84) [24]. Moderate correlations were found between the TSCC and other related instruments, such as the Child Behavior Checklist, indicating concurrent/convergent validity of the separate TSCC scales [24].

Results

Diagnosis and trauma

Nearly all of children in the present study (19 out of 20) did not meet criteria for a diagnosis based upon the K-SADS-PL interview. One child participant met criteria for an adjustment disorder with anxiety; this child was still included in the analyses. There was no diagnosis of PTSD or other disorders for any of the participants. One legal guardian reported that his/her child had a history of neglect; no other reports of current or past abuse or neglect were made by a child or legal guardian. No children had any current or past year contact with perpetrators or maltreating caregivers. All reporting laws were followed and no reports were made.

As part of the PTSD section of the K-SADS-PL, ten participants and/or legal guardians endorsed that the participant had experienced a traumatic incident as indicted by Criteria A for PTSD in the DSM-IV-TR. The traumatic incidents reported were: unexpected death of a close relative, excluding grandparents, (n=3), serious injury to child requiring hospitalization (n=2), witnessing intimate partner violence (n=2), witnessing non-familial physical violence (n=2), and serious injury requiring hospitalization to close family member (n=1). No child or legal guardian reported abuse in the present study.

Trauma symptoms

As Table 1 reflects, the mean total t-score on the TSCC fell below clinical range (t-score = 28.2, SD = 10.7). Independent samples t-tests indicated that there were no significant differences in the total TSCC score or on any of the subscales based on age, gender, ethnicity, socioeconomic status, or IQ (p>0.05). There was a significant difference in TSCC scores if there was a K-SADS-PL report of traumatic incident meeting criteria A for PTSD (p<.001); those with a traumatic incident (scored “yes”) had significantly higher TSCC scores than those without (scored “no”). Due to the small sample size, we could not evaluate differences by type of trauma; however, there were no abused or maltreated children in this study. Furthermore, the averages for TSCC score in both groups (“yes” and “no” for traumatic incident) were well below the clinical range for TSCC (i.e., “yes” t-score $\overline{X} = 39.5$, $SD = 9.1$; “no” t-score $\overline{X} = 21.0$, $SD = 11.8$). There were no significant differences by gender for those meeting criteria A for PTSD compared to those not meeting criteria (p>0.05).

Executive functioning

The scaled sub-test scores on the D-KEFS were averaged; this mean scaled score was used for the present analyses. As Table 1 reflects, the mean scaled score on the D-KEFS fell within the average range (i.e., mean scaled score $\overline{X} = 10.0$, $SD = 1.1$). No significant differences were found for the D-KEFS by age, gender, ethnicity, socioeconomic status, or IQ (p>0.05). There was a significant difference in the overall mean of the subscale scores for the D-KEFS, if there was a report of traumatic incident meeting criteria A for PTSD on the K-SADS (p<0.001); those with a traumatic incident (scored “yes”) had significantly lower D-KEFS than those without (scored “no”). Due to the small sample size, we could not evaluate differences by type of trauma. However, the average for K-SADS-PL scaled score in both groups (“yes” and “no” for traumatic incident) was in the average range (i.e., “yes” scaled score $\overline{X} = 9.6$, $SD = 0.8$; “no” scaled score $\overline{X} = 10.5$, $SD = 0.7$).

Mediation model

A standard linear regression was conducted between child self-report of trauma symptoms (total TSCC score converted to a z-score) as the independent variable and child executive functioning (average subscale score converted to a z-score) as the dependent variable. Mediation analyses were performed using SAS PROC SOBEL [26] and SAS PROC REG for evaluation of the linear relationship between total trauma symptoms and the average scaled score for executive functioning (both converted to z-scores) as mediated by each of the following: anxiety symptoms and depression symptoms (total scores converted to z-scores). Independent models were produced for each mediator. Results of the evaluation of assumptions for both models indicated that the data were adequate for normality, linearity, and homoscedasticity of residuals. No cases of missing data were found in these pilot data, N = 20. With the use of p < .001 criterion for Malahanobis distance, no outliers were found among these pilot data.

There were no significant differences in the relationship between trauma symptoms and executive functioning based on age, gender, ethnicity, socioeconomic status, or IQ (p>.05).

The Baron and Kenny approach as detailed by Preacher and Hayes [26] for establishing mediation for a model containing the antecedent variable trauma symptoms, the proposed mediator depression symptoms, and the outcome variable executive functioning was evaluated. The following results are depicted in Figure 1a. On step 1, trauma symptoms were significantly associated with depression symptoms ($\beta = .68$, $p = .008$; $R^2 = .46$, $p = .008$). On step 2, trauma symptoms were significantly associated with executive functioning ($\beta = -.49$, $p = .03$; $R^2 = .24$, $p = .03$). On step 3, depression symptoms were significantly associated with executive functioning ($\beta = -.29$, $p = .01$; $R^2 = .08$, $p = .01$). The relationship between trauma symptoms and executive functioning remained statistically significant but was slightly lower than that found on step 2, suggesting that the relationship between trauma symptoms and executive functioning is partially mediated by depression symptoms in this sample of healthy children. The Sobel test [26], however, suggested that the mediated effect was not statistically significant, $z = 1.58$, $p>.05$. Thus, children with higher trauma symptoms tended to have more symptoms of depression, which in turn, was associated with poorer executive functioning. However, children with higher trauma symptoms had poorer executive functioning independent of depression symptoms as well.

The same mediation approach was taken for a model evaluating the antecedent variable trauma symptoms, the proposed mediator anxiety symptoms, and the outcome variable executive functioning. The following results are depicted in Figure 1b. On step 1, trauma symptoms were significantly associated with anxiety symptoms ($\beta = .43$, $p = .006$; $R^2 = .18$, $p = .006$). On step 2, trauma symptoms were significantly associated with executive functioning ($\beta = -.49$, $p = .03$; $R^2 = .24$, $p = .03$). On step 3, anxiety symptoms were significantly associated with executive functioning ($\beta = -.44$, $p = .03$; $R^2 = .19$, $p = .03$). The relationship between trauma symptoms and executive functioning remained statistically significant but was slightly lower than that found on step 2, suggesting that the relationship between trauma symptoms and executive functioning is partially mediated by anxiety symptoms in this sample of healthy children. However, the Sobel test [26] suggested that the mediated effect was not statistically
significant, z = 1.23, p > .05. Thus, children with higher trauma symptoms tended to have more anxiety symptoms, which in turn, was associated with poorer executive functioning. However, children with higher trauma symptoms had poorer executive functioning independent of anxiety symptoms as well.

**Discussion**

In this pilot study, we sought to identify preliminary links between trauma symptoms and executive functioning in a community sample of healthy children without mental health problems as a way of exploring factors related to resilience. We observed a significant measurable relation between healthy children's self-report of trauma symptoms and their performance on a comprehensive test of executive functioning. Specifically, children reporting more trauma symptoms had poorer executive functioning. What is noteworthy about the present finding is that this relationship was found in a healthy sample of children with non-clinical levels of trauma symptoms and average executive functioning. Thus, there does not appear to be a plateau or leveling out of executive functioning as trauma symptoms reach the healthy range; rather, there is an observable spectrum between trauma symptoms and executive functioning that persists throughout the healthy range. This is important because it speaks to the ability of clinicians to meaningfully explore dimensional capacities related to resilience among healthy children, which may hold important answers for trauma prevention as well as effective responses following trauma.

![Diagram of Models Exploring (a) Depression Symptoms and (b) Anxiety Symptoms as Mediators in the Relation of Trauma Symptoms and Executive Functioning](image)

We found that children who had a traumatic incident meeting criteria A for PTSD according to the DSM-IV-TR clinical interview had correspondingly higher trauma symptoms and lower executive functioning than children who did not have a traumatic incident. Controlling for covariates including gender, age, ethnicity, socioeconomic status, and IQ did not change or contribute significantly to our model. Although there was this difference pertaining to a traumatic incident, the overall pattern of results for those with and without a traumatic incident was the same. Furthermore, all of the results for trauma symptoms and executive functioning were in the healthy range and well below clinical cutoffs for those with and without a traumatic incident. This further speaks to the presence of an observable, continuous spectrum for the healthy children in our pilot study that holds even among those who did not have a traumatic incident.

This pilot study took another step forward in exploring specific factors pertaining to resilience that commonly co-occur with trauma symptoms, namely depression symptoms and anxiety symptoms. In keeping with the literature, which point to depression symptoms and anxiety symptoms as trauma sequelae as well as conduits to diminished executive function [15-17], we found similar relations in our pilot study of healthy children. Specifically, in separate analyses, depression symptoms and anxiety symptoms each partially mediated the relationship of trauma symptoms and executive functioning. These findings in healthy children point to potentially powerful pathways for research aimed at decreasing anxiety and depression symptoms in children, who have trauma symptoms, as a way of strengthening executive functioning. Furthermore, these findings demonstrate that researchers can test interventions in a wide range of children, including those who are not in the clinical range. This opens new possibilities for applications in school-based settings, comprised of largely healthy children, as well as in areas where finding a sufficient clinical sample for research would be challenging.

A primary aim of the current pilot study was to take a step forward in exploring resilience, particularly as it relates to higher order cognitive capacity, by examining trauma symptoms and executive functioning in a healthy sample of children. However, this pilot study had some limitations. The measures in this study were collected during a single visit; therefore, these preliminary pilot findings should be interpreted with caution. The associations, found between trauma symptoms and executive functioning, do not imply causation. Furthermore, due to the relatively small number of participants in this pilot study, results must be viewed with caution. It is also important to emphasize that we were exploring executive functioning and trauma symptoms, not traumatic incidents; a larger sample size is required to evaluate how the type of traumatic incident may impact executive functioning. However, the meaningful results of this pilot study, speak to the value of extending the present work to a larger sample that includes the full spectrum of trauma symptoms in children as well as other factors characterizing traumatic reactions, such as the type, severity, and chronicity of trauma.

**Future directions and clinical implications**

Childhood interventions with the strongest evidence-base for treatment of clinical levels of trauma symptoms, including those diagnosed with PTSD (e.g., Trauma-Focused Cognitive Behavioral Therapy [27]), require children to have robust cognitive capacities, chief among which is executive functioning. Even relative deficits in executive functioning, as demonstrated here in healthy children, may contribute to diminished effectiveness of cognitively focused treatments for children; these deficits may be magnified in children who are referred for treatment. Furthermore, understanding the role of co-occurring symptoms such as depression and anxiety are central in effectively curtailing trauma symptoms, particularly related to executive functioning, as well as maximizing chances of resilience.
and recovery.

The present study, which focused on healthy children without mental health problems, also offers novel insights into the full spectrum of trauma symptoms and its relations, which opens new doors for prevention and intervention strategies. This pilot research regarding the association of trauma symptoms and executive functioning in healthy children connects with recent findings in epigenetics, which have reported lasting biological changes following trauma symptoms [5,6]. The finding of depression and anxiety as partial mediators in the present study extends previous findings by pointing to new factors that may contribute to biological changes [6]. Connecting biological and phenotypic research in this manner is essential for effectively preventing and treating trauma sequelae as brain and behavior are interdependent [5].

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References


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