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Executive function performance and trauma exposure in a community sample of children☆

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ABSTRACT

Objective: Though children exposed to familial violence are reported to have difficulties with a range of emotional and behavioral problems (e.g., lower school achievement) that implicate executive function (EF) deficits, relatively little research has specifically examined EF as a function of trauma exposure in children.
Methods: Based on parent report of children's exposure to potentially traumatic events, children ($N = 110$; $\text{Age}_{Mean} = 10.39$) from an ethnically diverse community sample were compared across three trauma-exposure groups: familial trauma, non-familial trauma, and no trauma. Children completed a battery of tests to assess working memory, behavioral inhibition, processing speed, auditory attention, and interference control.
Results: Familial trauma (relative to non-familial and no trauma exposure) was associated with poorer performance on an EF composite (composed of working memory, inhibition, auditory attention, and processing speed tasks); the effect size was medium. Both trauma-exposure status and dissociation symptoms explained unique variance in EF performance after controlling for anxiety symptoms, socio-economic status, and potential traumatic brain injury. While IQ and EF performance were related, SES predicted unique variance in IQ (and not EF) scores, while familial-trauma exposure did not.
Conclusions: The contribution of trauma exposure to *basic* executive functioning held after taking into account symptoms (anxiety and dissociation), socio-economic status, and possible traumatic brain injury exposure. EF problems may provide one route via which maltreated children become at risk for peer, academic, and behavior problems relative to their peers.
Practice implications: EF problems may provide one route via which maltreated children become at risk for peer, academic, psychological, and behavior problems relative to their peers. Recently, intervention strategies have emerged in the anxiety and mood disorder treatment literatures that appear to effectively target EFs. As future research continues to specify the relationship between child trauma exposure and EF performance, these innovative treatments may have important practice implications for addressing EF deficits.

Executive functions (EFs) are comprised of such diverse abilities as directing attention (including shifting, inhibiting, and focusing attention), manipulating information in working memory, and self-monitoring. These functions are critical to goal-directed behavior, allowing us to maintain, update, and integrate information to "navigate our ever-changing environmental context" (Willcutt et al., 2005, p. 185). Disruptions in EF have been consistently replicated in samples of adults exposed to

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trauma (El-Hage, Gaillard, Isingrini, & Belzung, 2006; Navalta, Polcari, Webster, Boghossian, & Teicher, 2006; Stein, Kennedy, & Twamley, 2002), including those with PTSD (e.g., Foa, Feske, Murdock, & Kozak, 1991; Kremen et al., 2007; McKenna & Sharma, 1995; Parslow & Jorm, 2007; Uddo, Vasterling, Brailey, & Sutker, 1993) and dissociative (e.g., DePrince & Freyd, 1999; Simeon et al., 2006) symptoms. However, relatively less research has examined EFs among children exposed to familial trauma (e.g., sexual abuse, physical abuse, witnessing domestic violence). Because EFs are central to many of the developmental tasks children face—from navigating peer relationships to performance in academic settings and behavioral control—the extension of systematic study of EFs and trauma exposure to children is particularly important.

To date, most approaches to studying EF correlates among children exposed to familial trauma have emphasized attention to emotional (particularly threat-related) stimuli. For example, children diagnosed with PTSD or high levels of dissociative symptoms appear to process threat-related information differently than control groups (e.g., Becker-Blease, Freyd, & Pears, 2004; Dalgleish, Moradi, Taghavi, Neshat-Doost, & Yule, 2001; Moradi, Taghavi, Neshat-Doost, Yule, & Dalgleish, 1999). Similarly, children exposed to severe physical abuse show attention biases towards negatively valenced emotion stimuli (e.g., Pollak, Cicchetti, Hornung, & Reed, 2000). While biases to emotionally salient information have important implications for the development and maintenance of psychopathology, this body of work does not address potentially important links between trauma exposure and other EFs that are critical to goal-directed behaviors, such as working memory, inhibition, and processing speed (see Willcutt et al., 2005). Further, EFs in response to neutral (i.e., not emotionally salient or threat-related) stimuli have been understudied and may have important implications for developmental tasks generally.

Indeed, deficits in *basic* EFs are likely to disrupt a range of developmental tasks, including those with which children exposed to familial trauma have demonstrated difficulties (e.g., school achievement; Eckenrode, Laird, & Doris, 1993; Kendall-Tackett & Eckenrode, 1996; Shonk & Cicchetti, 2001). For example, working memory, processing speed, and inhibitory skills are all required to maintain, update, and integrate information (Willcutt et al., 2005). To date, very few studies have examined basic EF performance in trauma-exposed children. Cromer, Stevens, DePrince, and Pears (2006) reported that higher levels of dissociation in preschool aged children in foster care ($N = 24$) were associated with deficits in tasks requiring inhibition, but not with tasks requiring primarily planning, strategy, or multiple rule sets; however, data on children's trauma exposure were unavailable. In another study, children diagnosed with maltreatment-related PTSD performed more poorly than their non-maltreated peers on several EF measures, such as freedom from distractibility and sustained visual attention tasks ($N = 29$; Beers & De Bellis, 2002). While this study points to EF problems associated with maltreatment-related PTSD, the lack of a maltreated no-PTSD group conflates PTSD and maltreatment status, making it difficult to determine whether the observed deficits are related to maltreatment status, PTSD symptoms, or both.

The paucity of research on basic EFs, as well as the inferential problems caused by conflating PTSD and violence exposure, may mask important relationships between familial-trauma exposure (including sexual or physical victimization or witnessing domestic violence) and EF performance in children. For example, chronic stress in the violent family environment could have an impact on brain regions responsible for EFs, such as the medial prefrontal cortex (mPFC), thus affecting EF performance. Child maltreatment is associated with dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis (Tarullo & Gunnar, 2006). Regions that are particularly vulnerable to HPA axis dysregulation, such as the hippocampus, make inputs to the mPFC (e.g., Ishikawa & Nakamura, 2003) and could, therefore, influence EF performance. Insults to brain regions involved in EF caused by mild traumatic brain injuries (TBIs) could also impact EF performance. In adults, at least, family violence is associated with TBIs. For example, 92% of women in domestic violence shelters report being struck in the head; the majority complained of EF problems, including distractibility, difficulty dividing attention, difficulty concentrating, forgetting appointments, and confusion (Jackson, Philp, Nuttall, & Diller, 2002).

In addition to insults to brain regions responsible for EF, various cognitive strategies to avoid threat-related cues may contribute to global changes in information processing (DePrince, 2005), including EF performance. Because children exposed to familial traumas are generally powerless to control the violence or leave the relationship (for a review of related issues, see Freyd, DePrince, & Gleaves, 2007), ongoing awareness of threat may result in deleterious consequences, such as increased stress, decreased attachment to caregivers, or increased conflict with caregivers. Thus, the ability to decrease attention to threat cues may help children navigate environments characterized by inescapable harm (Freyd et al., 2007). For example, children may engage in distraction to avoid threat cues (DePrince & Freyd, 1999) that may have a negative impact on the development of EFs more generally.

Other environmental stressors could also underlie risk for EF problems among children exposed to familial violence, such as socio-economic status (SES). For example, previous research has demonstrated that shared environment explains significant variability in IQ scores among children living in poverty (e.g. Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003). IQ and EF represent related, though separable, constructs (Friedman et al., 2006). Thus, to the extent that low SES influences IQ scores, studies of other related constructs—in this case, EF performance—should take SES into account.

Current study. The current study tests the prediction that children exposed to familial trauma (including physical abuse, sexual abuse, and/or witnessing domestic violence) will show poorer EF performance relative to children exposed to non-familial traumas (e.g., natural disaster, motor vehicle accident) and children exposed to no trauma. Notably, we include a non-familial-trauma group because of the cross-sectional nature of the study. If, as predicted, familial trauma has unique links with EF performance, the familial-trauma group will perform differently from the non-familial and no-trauma groups, which should perform similar to one another. We present and test our hypotheses in terms of weights assigned to corresponding hypothesized means (see Loftus, 1996). To test the prediction that the familial-trauma group would show deficits in EF performance relative to children exposed to non-familial traumas or no trauma, planned contrast weights were assigned as follows: familial trauma = −2, non-familial trauma = 1, no trauma = 1. After testing our initial hypothesis, we examined the relative contributions of several factors to EF performance, including: familial-trauma-exposure status, anxiety and dissociation symptoms; presence of mild traumatic brain injuries; SES.

Methods

Participants

One hundred and fourteen school-aged children were recruited for a two-session study on stress and attention through flyers in social service and mental health agencies, community centers, and local businesses in a large western city in the United States. Parents who called about the study (after having seen a flyer that advertised the "Children's Attention Research" study) were told that they would be asked to complete questionnaires about their child and family, including the child's experience of potentially stressful events. They were also told that their child would be asked to complete a variety of school-like tasks and a few brief questionnaires.

Of the initial sample, 111 were retained for both sessions. At session 2, one guardian did not answer questions on children's exposure to potentially traumatic events. Thus, data analyses are based on the 110 for whom we had guardian-reported trauma exposure. Of these 110 children (Age *Mean*: 10.39; *SD*: 1.19) whose guardians reported their child's gender ($N = 104$), 58% were female. Of the 109 whose guardians reported on child ethnicity and race, 3.7% of children were described as Asian, 30.3% as Black or African-American, 33.7% as Hispanic, 8.3% as Native American, 49.5% as White or Caucasian, and 3.7% as members of another racial or ethnic group (percentages total over 100% because 23% of guardians reported that their child was a member of at least two racial or ethnic groups). While the convenience sampling methods used impede our ability to evaluate the representativeness of our sample, a comparison to the overall ethnic and racial diversity in the study city suggests we attained reasonable representation on this dimension (Denver residents identify as belonging to the following groups: 65.3% White, 1.3% Native American, 2.8% Asian, .1% Hawaiian, 19.3% Other or multi-racial, 31.7% Hispanic or Latino; U.S. Census Bureau, 2008). Table 1 provides demographic variables by trauma-exposure group. Groups did not differ on demographic variables, with the exception of age [$F(2,107) = 3.20$, $p = .045$]. A post hoc Tukey's HSD test revealed that the familial-trauma group was older than the non-familial-trauma group ($p = .04$).

Materials: Cognitive variables

Drawing on other studies of EF in children (e.g., Willcutt et al., 2001, 2005), we administered a battery of tasks to assess working memory, inhibition, processing speed, interference control, and auditory attention. The specific tasks used are described below. Because previous studies have reported that interference control measures such as the Stroop task used in the current study do not consistently load with other EF tasks (e.g., Willcutt et al., 2001), we used a factor analytic strategy to examine the underlying factor structure before creating an EF composite.

Several scales of the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV; Wechsler, 2003), scaled for child age, were used. To assess working memory, the arithmetic, letter-number sequencing, and digit span subscales were administered. Processing speed was assessed with the Symbol Search scale. Finally, full scale IQ scores were estimated using the Block Design and Vocabulary scales.

Behavioral inhibition was assessed with the Gordon Diagnostic System (GDS; Gordon & Barkley, 1998), which requires children to press a key each time they see a "1" followed by a "9" under two conditions. In the first (vigilance) condition, children see a single stream of numbers. In the second (distractibility) condition, children see three strings of numbers and must make the key press only after seeing the correct number sequence in the center column of numbers. The task was scored by calculating the number of commission and omission errors in each condition.

Auditory attention was assessed using the Brief Test of Attention (BTA; Schretlen, Bobholz, & Brandt, 1996), which requires participants to listen to a recording of several series of letters and numbers being read aloud; following each series, the child is asked to indicate how many numbers were in the series. Children are not permitted to count on their fingers.

Interference control was assessed using a Stroop task. Children were asked to make a key press with their left index finger if words appeared in green and with their right index finger if words appeared in red. They were instructed to ignore the word meaning and focus only on the color of the words. All children completed a practice block of 10 trials with names as the stimuli (e.g., ron, sally, kate, bob, and danny). They then completed the test block. Words appeared for 1700 ms with a

Table 1
Demographic variables by trauma-exposure group.

	No trauma[a]	Non-familial trauma[b]	Familial trauma[c]	Tukey's HSD test
% Female	67%	57%	53%	
% Belonging to racial/ethnic minority group	61%	50%	70%	
Age	10.36 (1.34)	10.05 (1.09)	10.70 (1.11)	b,c

2000 ms inter-trial interval. Test trials included several word types (e.g., neutral, negative, positive, incongruent). For the purposes of the current paper, we were concerned only with neutral and incongruent trials. Ten incongruent trials included the word "red" appearing in green or the word "green" appearing in red. Five neutral trials included the following words: coffee, hat, curtain, farmer, and button.

Materials: Guardian report

Guardians reported on children's exposure to potentially traumatic events and current posttraumatic symptoms using the UCLA PTSD Index (Pynoos, Rodriguez, Steinberg, Stuber, & Frederick, 1998), which reflects the symptom criteria for PTSD from the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV*; American Psychiatric Association, 1994). The measure has been shown to have good reliability (Roussos et al., 2005) and validity (Rodriguez, Steinberg, Saltzman, & Pynoos, 2001). Guardians were asked to indicate potentially traumatic events to which their children were exposed; the severity of PTSD symptoms experienced in response to the most distressing traumatic event. Guardians rated symptoms on a 5-point scale (0 = none of the time; 4 = most of the time). A total PTSD symptom score was calculated by summing the severity score for each symptom. Internal consistency for PTSD symptoms scores was excellent in this sample (Cronbach's alpha = .88).

Dissociation was assessed using the Child Dissociative Checklist (CDC; Putnam, 1997), a 20-item guardian-report measure that assesses multiple types of observable, dissociative behaviors. The CDC has been demonstrated to have high reliability and validity (Putnam, 1997). Guardians also reported on children's anxiety problems using the DSM-Anxiety Problems Scale of the Child Behavior Checklist (CBCL; Achenbach, 1991). The CBCL has been shown to have excellent test-retest reliability as well as very good construct validity (Putnam, 1997). Internal consistency was excellent in this sample (Cronbach's alpha = .87).

A demographic form asked guardians to report on their occupation, marital status, years of education, and estimated family income. Occupational prestige was coded based on Hollingshead (1975). If guardians were married, the partner's whose education and occupation scores were highest were used in the composite. After transforming occupation, education and income ratings to *z*-scores, an SES composite was created by averaging the *z*-scores. To screen for TBIs, parents were asked ". . .has your child ever experienced a head injury (for example after having fallen and hit his/her head)?" Because we did not have access to medical records to confirm the presence of TBIs, "yes" responses to this question are referred to as potential TBIs.

Procedure

Prior to data collection, all procedures were approved by the University of Denver Institutional Review Board. All participants completed an extensive informed consent process; testing took place only after the parent consented and the child assented. Understanding of consent/assent materials was assessed with a "quiz." Both child and adult participants had to answer all quiz questions correctly in order to take part in the study. After the consent/assent procedures, guardians answered questionnaires in a quiet room. A research assistant was present to answer questions the guardians had while completing measures, but the assistant did not observe guardians' responses.

All of the measures of child EF were completed at session 1. Children, tested in a separate room by a graduate research assistant, were encouraged to take breaks as needed. Children first completed the WISC-IV scales. Next, they completed GDS blocks in the following order: Practice, Vigilance, and Distractibility. The Stroop task was then administered via computer. Finally, children and guardians completed an extensive debriefing process that involved reporting on their responses to research participation.

Results

Guardian-report measures

According to guardian report, 44 children were exposed to physical maltreatment at home, sexual maltreatment by an adult, and/or witnessing domestic violence (familial-trauma group); 38 children were exposed to non-familial traumas only, such as natural disasters, motor vehicle accidents, and/or community/peer violence (non-familial-trauma group); 28 children were not exposed to trauma (no-trauma group). Of the 44 children categorized in the familial-trauma group, 6 were reported to have experienced only sexual maltreatment by an adult, but the victim-perpetrator relationship was not specified. These children were assigned to the familial-trauma group because sexual maltreatment by an adult was assumed to be more similar to the experiences of children in the familial-trauma than non-familial-trauma groups.

To help describe the trauma exposure in the sample, Table 2 details the average number of familial and non-familial traumas reported. Table 2 also provides guardian-report of symptoms on the CDC, UCLA PTSD Index, and DSM-Anxiety Problems subscale of the CBCL as well as SES and child history of potential TBI. The relationship between the predicted and observed patterns of means for symptoms is reported as $r_{\text{effect size}}$ (Furr, 2004; Loftus, 1996) in Table 2. Children in the familial-trauma group were more likely to have experienced a potential TBI relative to their peers [$\chi^2(1) = 4.12$, $p = .04$].

Table 2
Descriptive statistics (reported as *Mean* (*SD*) unless otherwise noted) for factors relevant to the development of EF problems by group.

	No trauma	Non-familial trauma	Familial trauma	$r_{\text{effect size}}$
Dissociation (CDC)	.25 (.34)	.24 (.19)	.38 (.31)	−.24
PTSD (UCLA)	–	12.58 (9.54)	16.60 (9.55)	−.21
Anxiety (CBCL raw scores)	2.32 (2.16)	2.61 (2.39)	2.73 (2.34)	−.05
SES *z*-score	−.03 (.86)	.24 (.86)	−.16 (.86)	.17
IQ estimate	95.75 (17.24)	96.63 (12.46)	89.02 (13.33)	.25
% reporting "yes" to TBI screen	7%	19%	30%	
Sum familial trauma (0–3)	0	0	1.36 (.61)	
Sum non-familial trauma (0–10)	0	1.61 (.79)	1.61 (1.53)	

Note: For continuous measures, effect sizes ($r_{\text{effect size}}$) were calculated based on the following contrast weights assigned to each group: no trauma = 1, non-familial trauma = 1, family trauma = −2).

Cognitive measures

GDS (total commission and omission errors), BTA (total correct), and WISC-IV scales were scored per standard instructions provided by task developers (see Gordon & Barkley, 1998; Schretlen et al., 1996; Wechsler, 2003). Stroop data were cleaned to delete all error trials and trials where reaction time was greater than 2000 or less than 200 ms. Reaction times were brought back to 2.5 *SD* above each individual's mean in each condition (DePrince & Freyd, 1999). Mean reaction time for neutral and incongruent conditions were then calculated. To calculate Stroop interference, the mean reaction time to neutral words was subtracted from the mean reaction time to incongruent (i.e., red appears in green) words for each individual.

To reduce data to test the EF hypothesis, all measures were transformed to *z*-scores and scaled such that lower scores indicated poorer performance. Working memory (arithmetic, letter-number sequencing, and digit span) and inhibition (GDS distractibility and vigilance errors) composite scores were created by averaging *z*-scores. Descriptive statistics for these measures and $r_{\text{effect size}}$ (which captures the correspondence between predicted and observed patterns of means; Furr, 2004; Loftus, 1996) are reported in Table 3. A principal-components analysis (PCA) with the direct oblimin rotation method was conducted on the five EF measures (working memory composite, inhibition composite, BTA, Stroop interference, and processing speed). The working memory, inhibition, BTA, and processing speed scores resulted in loadings above .60 on a single component; however the Stroop interference measure did not load above .30. This pattern is consistent with other research that has found Stroop performance does not load with other EF measures (Willcutt et al., 2001). When the PCA was re-run without the Stroop, a single EF component emerged. The same solution was obtained using the orthogonal method of rotation. Based on the factor analysis, an EF composite was created by averaging the working memory composite, inhibition composite, interference control, and processing speed scores. The planned contrast comparing the familial-trauma group to non-familial-trauma and no trauma groups on EF composite scores was significant [$t(107) = 3.20$, $p < .01$] and revealed a medium effect size ($r_{\text{effect size}} = .30$).

Testing multiple contributions to EF performance

Table 4 details bivariate correlations among variables used in the multiple regression analysis. Table 5 provides *betas* and *t*-values for individual contributors for each of the multiple regression analyses reported here. Having established a link between familial-trauma-exposure status (using the planned contrast weights) and EF performance, we next tested the relative contributions of familial-trauma-exposure status contrast weights, SES, potential TBI, dissociation, and anxiety to EF performance. The full model was significant [$F(5, 101) = 4.15$; $p = .002$, $R^2 = .17$]. Familial-trauma status and dissociation made unique contributions to the prediction of the EF composite scores. Notably, analyses were also conducted without the six children exposed to only sexual maltreatment by an adult for whom we did not know the victim-

Table 3
Executive function (*Mean* (*SD*)) performance by trauma-exposure group.

	No trauma	Non-familial trauma	Familial trauma	$r_{\text{effect size}}$
Working memory composite	.11 (.81)	.24 (.72)	−.26 (.86)	.27
Inhibition composite	.18 (.54)	.10 (.62)	−.25 (1.16)	.22
Interference control: Stroop[a]	.14 (.87)	.06 (1.12)	−.09 (1.00)	.09
Auditory attention: Brief Test of Attention	.03 (1.13)	.20 (.94)	−.24 (.96)	.18
Processing speed: Symbol Search	.16 (1.09)	.21 (.83)	−.27 (1.07)	.22
EF composite	.12 (.58)	.19 (.53)	−.25 (.76)	.30

Note: Measures of EF were transformed to *z*-scores. The Stroop and inhibition composite were multiplied by −1 so that lower scores on all measures indicate poorer performance. *Mean* (*SD*) of transformed scores are reported. In addition, $r_{\text{effect size}}$ to indicate the size of the relationship between the planned contrast weights (familial trauma = −2; non-familial trauma group = 1; no trauma group = 1) and cognitive factors. Note, positive $r_{\text{effect size}}$ values indicate greater impairment for the familial-trauma group relative to the non-familial- and no-trauma groups.

[a] Measure is *not* included in EF composite based on factor analysis.

Table 4
Bivariate correlations among variables used in multiple regression analysis.

	Familial-trauma-exposure status	Dissociation	Anxiety	SES	Potential TBI	PTSD
EF composite	.30**	−.36***	−.18†	.20*	−.05	−.29**
Familial-trauma-exposure status		−.24*	−.05	.17†	−.20*	−.21†
Dissociation			.58***	−.21*	.15	.59***
Anxiety				−.05	.08	.47***
SES					.04	−.03
Potential TBI						.06

Note: Correlations with PTSD include participants from the familial- and non-familial-trauma groups only.
* $p < .05$.
** $p < .01$.
*** $p < .001$.
† $p = .10$.

perpetrator relationship. Results were comparable when these children were excluded; therefore, they were retained in the sample.

A separate model that included PTSD scores was run with trauma-exposed children only. Because we used a subsample of children and thus decreased power, SES and potential TBI were dropped from this regression because they failed to explain unique variance in the previous analysis. The full model was significant [$F(3, 77) = 6.10$; $p = .001$], $R^2 = .19$. PTSD symptom severity did not explain unique variance in EF scores.

To examine whether EF and IQ were predicted by different variables, which would suggest they tap different constructs, we repeated the first regression to examine the relative contribution of our five theoretically relevant variables to estimated IQ scores. While the full model was significant [$F(5, 100) = 4.83$; $p = .001$], $R^2 = .19$, a different picture emerged among individual predictors relative to the model predicting EF composite scores. Specifically, SES and dissociation (but not familial-trauma status) made unique contributions to the prediction of estimated IQ.

Exploratory analyses

We did not have information on the age of onset, chronicity, recency, or severity of the potentially traumatic events to which children were exposed. We reasoned, however, that exposure to different types of potentially traumatic events reflects at least one aspect of trauma-exposure severity. Therefore, we examined the relative contributions of the number of familial trauma (0–3) and non-familial traumas (0–10) to EF performance in exposed children. The full model was significant [$F(2, 79) = 7.53$, $p = .001$, $R^2 = .16$]; however, only the number of familial-trauma event types explained unique variance in EF performance (see Table 5).

Table 5
Regression coefficients for models predicting EF and IQ performance.

Variable	*B*	SE(*B*)	*Beta*	*t*
Model predicting *EF composite* (all participants)				
Trauma status	.10	.04	.21	2.22*
Dissociation	−.64	.27	−.28	−2.34*
Anxiety	−.003	.03	−.01	−.10
SES	.08	.07	.10	1.04
Potential TBI	.05	.15	.03	.30
Model predicting *EF composite* (trauma-exposed participants only)				
Trauma status	.11	.05	.25	2.29*
Dissociation	−.59	.34	−.23	−1.76†
PTSD	−.01	.01	−.10	−.82
Model predicting *estimated IQ scores* (all participants)				
Trauma status	1.33	.91	.14	1.46
Dissociation	−11.70	5.83	−.23	−2.01*
Anxiety	−.24	.70	−.04	−.35
SES	4.15	1.53	.25	2.71**
Potential TBI	−.33	3.29	−.01	−.10
Model predicting *EF composite scores* (trauma-exposed participants only)				
Number of familial events	−.30	.09	−.36	−3.44**
Number of non-familial events	−.09	.06	−.15	−1.48

* $p < .05$.
** $p < .01$.
† $p = .10$.

Discussion

The current study revealed a medium effect size for the relationship between familial-trauma-exposure status and EF performance, as assessed by a composite of working memory, inhibition, auditory attention, and processing speed measures. The direct effect of exposure to familial trauma was maintained even when the contributions of dissociation, anxiety symptoms (including PTSD for trauma-exposed youth only), socio-economic status, and potential TBI exposure were considered. Among these factors, only familial-trauma-exposure status and dissociation contributed unique variance to the prediction of EF performance. Previous research on children has tended to focus on alterations in information processing associated with emotion stimuli and internalizing symptoms. Strikingly, the current study demonstrates that the relationship between familial-trauma exposure and *basic* executive functioning (that is, the absence of emotional content) holds even after taking into account internalizing symptoms, environmental stressors (via SES), and potential TBIs. Thus, children exposed to family violence show poorer EF performance relative to their peers, even in the absence of trauma-relevant cues.

IQ was significantly related to both familial-trauma-exposure status and EF performance; however we did not control for IQ in analyses of EF for several reasons. To the extent that IQ and the EF composite share variance because of common measurement method in this study, controlling for IQ would remove that shared variance, which is actually variance of interest. Further, some researchers have argued against the use of covariates generally in quasi- and non-experimental designs where groups differ at the outset (e.g., Miller & Chapman, 2001). In lieu of controlling for IQ, we conducted an additional multiple regression analysis to test whether the pattern of factors that predicted IQ differed from those that predicted EF. Differences in predictors, we posited, would contribute to our understanding of how (and if) EF and IQ are separable in this current study. While dissociation yielded comparable effect sizes across the two analyses, two notable differences were observed. First, SES predicted unique variance in IQ, but not EF. Second, trauma status predicted unique variance in EF, but not IQ. Thus, these findings point to a unique relationship between trauma status and EF that is not observed in, and therefore separable from, general IQ performance.

In the face of relatively little research on dissociation and information processing in children (Cromer et al., 2006), the observation of medium effect sizes for the relationship with both EF and IQ is particularly noteworthy. While guardians, teachers, and clinicians may be more likely to notice or look for anxiety-related problems in children exposed to violence, the current study suggests that dissociation may be especially important to consider in academic settings. This study is among the first in the literature examining basic information processing and dissociation in children.

Because the present study relied on a parent report of child dissociation, it is possible that parents' recognition of their children's difficulties in EF influenced their report of dissociation. Some researchers (e.g., Bruce, Ray, Bruce, Arnett, & Carlson, 2007) have already begun to disentangle the measurement of dissociation and EF, observing that adult high dissociators report more EF difficulties but do not appear to show impaired performance on EF tasks relative to low dissociators. However, further research will be necessary in order to clarify the role of dissociation and to understand the measurement of dissociation and EF among children.

Regardless of whether we examined anxiety symptoms in the full sample (with maximal power) or PTSD symptoms among the trauma-exposed children, anxiety symptoms did not explain unique variance in EF performance. The first regression that used the full sample included 107 participants and five predictors; 91 participants would be required to detect a medium effect size with power = .80. The trauma-exposed only analysis included 81 participants with three predictors; 76 participants would be required for power = .80. Thus, we had adequate power to detect an effect of anxiety and PTSD in the respective analyses. At least two possibilities should be considered in interpreting these findings. First, anxiety and PTSD symptoms would be more strongly related to EF in a clinical sample. While that may be the case, it is notable that dissociation explained unique variance in both EF and IQ performance in this non-referred sample. Thus, it does not appear to be the case that this sample simply did not report the degree of internalizing symptoms necessary to see relationships with information processing. Second, the shared variance between PTSD and dissociation symptoms may mask either the contributions of PTSD or the contributions of those PTSD symptoms that are related to dissociation. Future studies should evaluate the relative contributions of individual PTSD clusters and dissociation to EF performance.

Several limitations should be taken into consideration. The current study relied on guardian-report of child trauma history and thus may include false negatives given guardians' potential concerns about mandated reporting. Every effort was made to minimize inaccurate reports by developing procedures to allow guardians to report on trauma history anonymously; however, the relationship between familial-trauma exposure and dissociation scores may have been decreased because of error variance caused by false negatives. Further, given the structure of the UCLA PTSD Index, we did not have data on age of onset, severity, recency, frequency and/or chronicity of exposure. In exploratory analyses, we did find that the number of familial (but not non-familial) events explained unique variance in EF composite scores. Though a very rudimentary measure of one aspect of severity (that is, simply the number of different types of events reported), this finding is consistent with research on cumulative risk gradients (e.g., Masten & Wright, 1998) and points to the need for future research to carefully assess and evaluate the contributions of event characteristics to cognitive performance.

The lack of relationship between EF and the potential TBIs may reflect that our screen only included a single item. With more extensive screening, TBI exposure may have related to EF performance. Given that work with women exposed to domestic violence has demonstrated relationships between mild TBIs and self-reported attention problems (Jackson et al., 2002), future research with children should include more thorough screening of TBI history. Future research should also include other factors relevant to healthy EF development. For example, prenatal alcohol/drug exposure could be a factor in both increasing risk of EF problems and violence exposure.

This cross-sectional study cannot determine the causal direction of the relationship between EF and familial-trauma-exposure status. It might be the case that poorer EF performance increases risk of trauma exposure, rather than trauma exposure leading to poorer EF performance. That the non-familial-trauma group performed differently than the family violence group suggests that poor EF performance did not increase the chances of trauma exposure generally. We cannot rule out, though, that impaired EF abilities increase risk of violence in the home.

Future directions and implications

Additional research should focus on several areas. First, efforts should be made to better understand possible modifiers of the relationship between trauma exposure and EF, including trauma characteristics (e.g., severity, recency), anxiety, and dissociation. Second, future research should continue to focus on disentangling the measurement of dissociation and EF. Third, these findings must be leveraged for intervention. In recent years, two major intervention strategies that effectively target EF performance have emerged in the anxiety and mood disorder treatment literatures: attention control training and mindfulness-based interventions (e.g., Ma & Teasdale, 2004; Mohlman, 2004; Papageorgiou & Wells, 2000; Segal, Williams, & Teasdale, 2002). Both approaches teach clients better self-regulation of attention, thus demonstrating that EF performance is malleable. To the extent that risk for externalizing behavior and peer problems are associated with EF deficits, it is critical to explore treatments that may address executive weakness.

Further, the absence of anxiety and PTSD symptoms as unique contributors to the prediction of EF points to the need for future research to continue to disentangle violence exposure from PTSD status. When violence-exposure and PTSD are conflated in studies comparing PTSD groups to healthy controls, we cannot be sure whether deleterious consequences are associated with the experience of violence or internalizing symptoms. In the current non-referred sample, trauma-exposure status alone was related to poorer EF performance and suggests a different approach to interventions. While resources are more likely to be dedicated to youth diagnosed with a problem, the current study provides an explanation for the more general finding that children exposed to family violence have greater school difficulties, in terms of both academic achievement and behavioral problems. That is, poorer EF performance may underlie problems regulating behavior and performing in school settings. Thus, these findings point to the need for academic interventions that may be targeted broadly, and not just to children who meet criteria for PTSD.

Conclusions

The current study demonstrated links between EF performance and trauma-exposure status in a community sample of children. Children exposed to familial-trauma performed more poorly than children exposed to non-familial or no traumas. Dissociation explained unique variance in EF scores while controlling for other relevant variables. Thus, greater attention to dissociation and information processing is warranted. Further, the current study highlights the importance of assessing trauma-exposed children for basic (not threat-related) cognitive problems that may contribute to more general behavioral and achievement problems in school.

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