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EXPOSURE TO VIOLENCE AND ABUSE

Interpersonal Violence, Depression, and Executive Function

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This study considers links between the number of types of violence to which women have been exposed, depression, and executive functions (EFs). Substantial research has established EF deficits among depressed individuals as well as individuals exposed to trauma. Studies have also indicated a relationship between trauma exposure and depressive symptoms across a range of traumatic events, such as combat exposure, motor vehicle accidents, natural disasters, and assaults. This study examines this relationship in an ethnically diverse community sample of 93 women exposed to interpersonal violence who completed a battery of EF tasks that assessed processing speed, working memory, response inhibition, and set shifting. Women reported an average of 5.8 types of interpersonal violence events. The number of types of interpersonal violence events was significantly related to depressive symptoms, although not EF performance. Specific EFs, such as working memory and response inhibition, were positively related to depressive symptoms.

KEYWORDS adult survivor, exposure to violence, females, trauma

Over the past several decades, an expanding body of epidemiological and clinical research has established that individuals exposed to potentially traumatic events have substantially higher lifetime rates of depression than do individuals who have not been exposed to potentially traumatic events (Blanchard, Buckley, Hickling, & Taylor, 1998; Brown, Cohen, Johnson, &

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Smailes, 1999; Fergusson, Horwood, & Lynskey, 1996; Harper & Arias, 2004; Kaplow & Widom, 2007; Kendler, Gardner, & Prescott, 2002; Putnam, 2003; Shalev et al., 1998; Sternberg, Lamb, Greenbaum, & Cicchetti, 1993). Recent research also suggests an association between violence exposure and executive function (EF) deficits (e.g., Stein, Kennedy, & Twamley, 2002). Stein and colleagues (2002) found that female victims of intimate partner violence and childhood sexual abuse performed worse on tests of EF in comparison to counterparts without a similar trauma history. However, the relationship among violence exposure, depression, and EF together has not yet been examined. This study examined the potential role of EF as a mediator of the relationship between interpersonal violence and depression. Specific aspects of EF are also poorly understood; thus, we also sought to contribute to the literature by obtaining multiple indexes of EF and including where possible EF tasks that contain neutral, negative (trauma- and threat-related), and positive items.

INTERPERSONAL VIOLENCE AND DEPRESSION

Trauma exposure influences the occurrence of depression in several ways. Trauma survivors have a greater likelihood of developing depressive symptoms following exposure. Further, their depressive symptoms are more severe and persistent in comparison to psychiatric control groups without trauma histories (Brown & Moran, 1994). Symptoms following trauma exposure are also more chronic and severe in individuals who have been victimized multiple times than in those who have experienced either an isolated incident of victimization or no victimization at all (Follette, Polusny, Bechtle, & Naugle, 1996; Marx, Heidt, & Gold, 2005). Furthermore, links have been established between depression and specific forms of trauma, including interpersonal violence (e.g., Hedtke et al., 2008). Hedtke and colleagues (2008) also found the likelihood of depression increased as the number of different types of interpersonal violence increased. In sum, the link between interpersonal violence and depression has been well established in the literature.

INTERPERSONAL VIOLENCE AND EXECUTIVE FUNCTION

Trauma exposure and EF deficits have also been linked in recent research (e.g., DePrince, Weinzierl, & Combs, 2009). In this study, we sought to extend this association by examining specific characteristics of the violent event(s) that might produce variance in the severity of EF impairment. For example, much of the existing literature has focused on the relationship between general trauma exposure and resulting deficits in EF. However, the association between interpersonal violence exposure, specifically, and EF

has not yet been fully explored. One exception is a study by DePrince and colleagues (2009) where they found that EFs in children exposed to interpersonal violence were significantly impaired in comparison to children exposed to noninterpersonal violence or no violence. This finding suggests that interpersonal violence might contribute uniquely to EF deficits as compared to other types of trauma events.

Additionally, Koso and Hansen (2006) found that EF deficits in a sample of Bosnian combat veterans were more severe and persistent compared to results obtained using samples of veterans from other wars. The authors theorized that prolonged exposure to multiple stressors (given the duration of this particular conflict) might have contributed to the increased severity; as well as the fact that when the conflict ended, veterans continued to reside in the same location where the events had occurred, triggering constant reminders of the trauma. Both dimensions—the length of the stressor and the need to return to the context where the event occurred—are relevant to interpersonal violence. Thus, in this study we examined the association between multiple incidents and EF deficits in women exposed to interpersonal violence.

EF AS MEDIATOR OF INTERPERSONAL VIOLENCE AND DEPRESSION

In addition to the relationship between interpersonal violence and EF deficits, as well as depression symptoms, research has also established associations between EF and depression. Research has suggested that individuals with full-scale depression are more prone to EF deficits than their nondepressed counterparts; other research has suggested an association between increase in severity of symptoms of depression and EF deficits such as greater impairments in EF in severe depression than in mild depression (Paelecke-Habermann, Pohl, & Leplow, 2005). EF deficits might persist even after remission from depressive symptoms (Nakano et al., 2008; Reppermund, Ising, Lucae, & Zihl, 2009) and could also be predictive of depression symptoms over time (Withall, Harris, & Cumming, 2009). However, we are aware of no studies that have examined interpersonal violence, EF, and depression together. Thus, we extend previous findings to consider EF as a mediator in the relationship between interpersonal violence and depression symptom severity.

MULTIPLE DIMENSIONS OF DEPRESSION AND EF

Depression

In addition to testing EF as a mediator of interpersonal violence and depression, we also examined in greater detail different aspects of depression

and EF. The phenomenon of depression has many components; evidence suggests that individual items within the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), a widely used measure of depression, can be grouped together to form meaningful symptom clusters. Buckley, Parker, and Heggie (2001) recommended a three-factor model consisting of cognitive, affective, and somatic dimensions. This study followed the three-factor model to examine EF deficits in relation to each of the depressive symptom clusters.

Executive Function

The role of the executive system in navigating situations that are novel; threatening; or that require planning, troubleshooting, or inhibiting habitual responses has been the focus of increasing attention over the past few decades. Recent studies suggest that EF is best understood as a multifactorial construct, and can be grouped into several factors, including inhibition (limiting or inhibiting automatic responses), set shifting (shifting between tasks or mental sets), working memory (the addition of new information and the deletion of unnecessary information), processing speed (cognitive efficiency), and interference control (resistance to competing or distracting information; see Sergeant, Geurts, Huijbregts, Scheres, & Oosterlaan, 2003; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005).

Research has identified deficits in different elements of EF in depressed participants. Studies have demonstrated a relationship between depression and deficits in working memory (e.g., Harvey et al., 2004; Paelecke-Habermann et al., 2005). Specifically within the area of working memory, depressed individuals have been shown to exhibit poorer recall of word categories when these items are presented in random versus organized order, suggesting strategy deficits in recall. Furthermore, they are less able to correctly identify the words that they do recall; research suggests that this could be the result of encoding deficits in addition to strategy deficits (Channon, Baker, & Robertson, 1993; Channon & Green, 1999). Interference control deficits have also been observed in depressed individuals (Constant et al., 2005; Markela-Lerenc, Kaiser, & Fiedler, 2006), as has impaired response inhibition when completing tasks including word–nonword pairs (Channon & Green, 1999; Stordal et al., 2004). Decreased performance on set shifting tasks has been suggested by some research, although findings are still discrepant at this point (Kyte, Goodyer, & Sahakian, 2005; Stordal et al., 2004). We administered a wide range of tasks to examine potential deficits in different domains of EF (e.g., interference control, set shifting, working memory, response inhibition, and processing speed).

Emotions serve important roles in interpersonal interactions and maintaining social relationships (Barrett & Campos, 1987; Campos, Campos, &

Barrett, 1989). Numerous studies of emotional valence and information processing have demonstrated an attentional bias toward threat-related words in veteran and civilian populations with PTSD (Buckley, Blanchard, & Neill, 2000). Research has also shown that processing of, and responses to, affective information can be altered in survivors of interpersonal violence. For example, women who have experienced abuse by a close other (e.g., caregiver) in childhood show alterations in automatic emotional processes such as mimicry of facial expressions (Reichmann-Decker, DePrince, & McIntosh, 2009). Goeleven, De Raedt, Baert, and Koster (2006) found impairments in depressed patients' abilities to inhibit responses to negatively valenced information in comparison to never-depressed controls. Lau, Christensen, Hawley, Gemar, and Segal (2007) also found that depressed patients showed global performance impairments on a measure of cognitive inhibition, which included positive and neutral stimuli; and that these impairments were especially pronounced for negatively valenced adjectives. Thus, whenever possible, we presented EF tasks in different emotionally valenced conditions: neutral, negative (further divided into trauma-related and threat-related when possible), and positive. We examined whether EF might be differentially related to depression and interpersonal violence as a function of emotional valence.

THIS STUDY

This study tested the relationships among the number of interpersonal victimizations reported, depressive symptom severity, and EF deficits. This study makes several unique contributions. First, this is one of few investigations (of which we are aware) that examined interpersonal violence, EF, and depression together. Specifically, we examined EF as a mediator of interpersonal violence and depression. Given interrelationships between PTSD symptoms, depression symptoms, interpersonal violence, and information processing, we included and controlled for PTSD symptoms in the multiple regression models tested. Second, this study viewed depression as both an overall construct (in terms of symptom severity) in addition to a three-factor model of symptom clusters. Third, we examined EF performance on a range of tasks representing different areas of EF, including working memory, interference control, response inhibition, and processing speed. We also evaluated the extent to which responses to emotional and neutral stimuli differ from each other following exposure to interpersonal violence. Specifically, we examined neutral, positive, and negative stimuli. Where possible, we separated the negative task condition by threat-related and trauma-related stimuli.

METHOD

Participants

Data for this study were obtained from 93 women recruited through flyers and electronic postings at various community organizations in a metropolitan area for a larger study. English-speaking women who had recently experienced an interpersonal crime such as sexual assault or domestic violence, or who had experienced some type of abuse before the age of 14, were invited to participate. Women who reported either a suicide attempt or a psychiatric hospitalization during the previous 6 months were excluded from the study. This ethnically diverse sample ranged in age from 19 to 40 ($M = 30.6$, $SD = 6.2$). Participants were 66% White ($n = 57$), 17% Black or African American ($n = 15$), 3% Asian ($n = 3$), 1% Native American ($n = 1$), and 12% other or multiracial ($n = 10$). Of those, 23% reported being of Hispanic origin, and 67% reported not being of Hispanic origin. The sample also included a range of education levels: 7% of participants reported attending school through Grade 8 or lower, 12% reported completing part of high school, 17% completed high school, 41% completed some college or specialized training, 13% completed college, and 10% reported receiving graduate or professional training.

Measures

Self-report questionnaires and interview

Background demographic information was collected, including ethnicity, age, education, and occupation.

Depression was measured using the BDI, a 21-item self-report instrument intended to assess the existence and severity of symptoms of depression. Internal consistency in this sample for the full-scale BDI was excellent (Cronbach's alpha = .90). Investigation into the psychometric properties of the BDI (Buckley et al., 2001) suggests that the full measure can also be divided into three factors, which have been shown to be closely related: the cognitive subscale, which includes symptoms such as sadness, pessimism, past failure, guilt, punishment, self-dislike and criticalness, and worthlessness (Cronbach's alpha = .87); the affective subscale, which taps loss of pleasure, crying, loss of interest, and indecisiveness (Cronbach's alpha = .65); and the somatic subscale, which taps physical symptoms such as agitation, loss of energy, sleep disturbance, irritability, loss of appetite, concentration difficulty, fatigue, and loss of sexual interest (Cronbach's alpha = .72).

The Posttraumatic Diagnostic Scale (PDS; Foa, Cashman, Jaycox, & Perry, 1997) was administered to assess the severity of PTSD symptoms. Although the 17 items that tap *Diagnostic and Statistical Manual of Mental Disorders* (4th ed. [DSM-IV]; American Psychiatric Association, 1994) criteria for PTSD can be grouped according to symptom clusters, for the purposes of

this study, a total posttraumatic stress symptom severity score ranging from 0 to 51 was created by summing all 17 items (Cronbach's alpha = .85).

Trauma history was assessed using a two-stage interview strategy used in the National Crime Victims Survey, as recommended by Fisher and Cullen (2000). In the first stage, each woman was asked a series of specific screening questions that described victimization, ranging from attempted theft to completed rape. Participants who answered "yes" to any of the first series of screening questions were then asked a series of detailed questions about the offenders and incidents in the second stage. A victimization variable was created by summing the total of all types of interpersonal events reported in this measure (range = 1–15). Prevalent types of victimization reported by participants included physical abuse (84.9%), sexual abuse (81.7%), verbal abuse (20.4%), sexual harassment (7.5%), and witnessing abuse (6.4%).

Executive function

Neutral EF tasks included in this study involve items and stimuli that are not intended to produce an emotional response. The emotional tasks included in this study involve the use of items or stimuli that have the potential to produce a negative emotional response. Two types of emotional stimuli were used: general threat-related words such as *lost* and *dark,* which are related to nonspecific threat; and trauma-related words such as *injured* and *punch,* which are specifically related to a range of interpersonal violence.

The Stroop task was used to assess interference control. For this task, participants were asked to view words that appeared one at a time in the center of a computer screen. Each word presented was in color (red, green, blue, or yellow) against a black background. Participants were instructed to name the color of each word without saying the word itself. Congruent items included words that were neutral, threat-related, or trauma-related. Incongruent items included words that indicated a color (e.g., red) incongruent with the presentation color (e.g., green). To measure response time for this task, participants made their responses into a microphone that recorded the time (in milliseconds) that elapsed between stimulus onset and participant response. For the purposes of this study, three separate Stroop scores were created: (a) subtracting response time to neutral items from response time to incongruent items; (b) subtracting response time to neutral items from response time to general threat-related items; and (c) subtracting response time to neutral items from response time to trauma-related items.

The set shifting task was administered to assess set shifting. Similar to the Stroop task, this task required participants to view words that appeared one by one on a computer screen, but also required participants to alternate between naming the color of words that were presented and reading the words themselves. They were directed to name the color of words that appeared against a black screen without reading the words themselves, and

to read words that appeared within a white box against a black screen without naming the color of the words. An item was considered to be a "shift" item if it required the participant to shift from one type of response (naming the ink color) to another (reading the word), and a "nonshift" item if it required the same response type as the preceding item. For the purposes of this study, scores for neutral, trauma-related, and general threat-related set shifting scores were calculated by subtracting response time for nonshift items from response time for shift items within each stimulus type.

Two measures were used to assess working memory. For the sentence span task, participants were read a series of sentences from which the final word was missing. For each sentence, participants were asked to supply a word that would complete the sentence. There was often more than one word that would appropriately complete each sentence, but each was intended to elicit a word that was neutral (e.g., The sun shines during the day, the moon at: *night*), negative (e.g., Love is the opposite of: *hate*), or positive (e.g., The radio station plays good: *music*). Similar sentences were grouped together (positive, negative, neutral) and were read in blocks to participants. At the end of each block, participants were asked to recall the words that they had supplied, in the order in which they had been given. The number of sentences within each block increased as the task continued (ranging from 2–6); thus, the number of words participants provided and were asked to recall increased over the course of the task to increase memory load. Participants discontinued the task if they were unable to correctly recall the words that they had supplied in the order in which they had been given. Separate scores were created by summing the number of correctly completed blocks within each category (neutral, negative, and positive), ranging from 0 to 6.

The letter–number sequencing task was also administered to assess working memory. This task required participants to listen to groups of numbers and letters read by the examiner. Participants were then asked to reorder each group by reciting the numbers in numeric order, followed by the letters in alphabetical order. The length of the number–letter groupings remained constant over three trials, which formed one item. The length of the number–letter groups increased as the items continued, thus, increasing the working memory load over the course of the task. The task was discontinued if the participant incorrectly completed all three trials within an item, or if the participant completed the seventh and final trial. A scaled scored was obtained by summing the number of correctly completed trials and converting to a range from 0 to 19 ($M = 10$, $SD = 3$) according to age-based normative data.

The stop task (Logan, Cowan, & Davis, 1984; Verbruggen & Logan, 2008) was administered to assess response inhibition. This task was divided into two sections, requiring participants to press a key in response to a set of emotional stimuli including happy and angry faces. Response inhibition was measured by assessing the frequency with which participants were able to

stop their response to the trial when directed to do so by the stop signal (a loud beep); for the emotional section of the task, response time was also measured according to the speed at which participants were able to stop their responses to angry faces in relation to happy faces. For both the standard and emotional conditions, participants were asked to practice pressing the appropriate key for 32 practice trials without interference from the stop signal, followed by 32 practice trials in which the stop signal was present. They were then asked to complete 128 trials, in which the stop signal was present for 25% of trials. The signal was randomly presented at one of four delays ranging from 250 to 450 msec following stimulus presentation, and occurred randomly throughout the task.

The symbol search task was administered to assess processing speed. For this task, participants were directed to visually scan rows consisting of two groups of geometric symbols: a group of two target symbols and a group of five search symbols. Within each row, participants were asked to indicate the presence or absence of a match between either target symbol and any search symbol by marking a "Yes" or "No" box at the end of each row. They were then given 120 sec to complete as many items as possible from a set of 60 items, with the instruction to work as quickly as possible without skipping any items or altering any of their responses. Scores on this task were converted to scaled scores ranging from 0 to 19 ($M = 10$, $SD = 3$) according to age-based normative data.

Procedure

Potential participants called the lab in response to advertisements for a women's coping study. Callers who denied suicide attempts and hospitalizations for psychiatric reasons in the previous 6 months were invited to schedule an appointment for a testing session. Participants reviewed written consent information while the interviewer reviewed the information verbally. The interviewer then administered a consent quiz to ensure understanding of consent information. If participants demonstrated understanding of the consent information, participants completed questionnaires, lab tasks, and the trauma history interview over two sessions (additional tasks and questionnaires were also administered as part of a larger study). Participants were paid after each testing session and debriefed at the end of the study. All participants received an educational newsletter that provided information about community resources following violence.

RESULTS

Data from depression, PTSD, interpersonal violence history, and EF measures were examined to assess for outliers, normality, skewness, and kurtosis. See

TABLE 1 Descriptive Statistics

	M	Range	*SD*
Working memory			
Neutral sentence span	2.8	0–5	1.1
Negative sentence span	2.4	0–4	0.9
Letter–number sequencing	10.5	2–19	3.7
Interference control			
Neutral Stroop	230.9	−33.6–607.9	127.6
Negative Stroop	−6.7	−222.9–157.1	72.6
Response inhibition			
Neutral stop task	214.9	134.9–391.9	54.2
Negative stop task	220.1	140.9–365.7	52.6
Set shifting			
Neutral condition	8.96	−3.01–4.06	1.2
Negative condition	49.1	−304.0–404.1	122.1
Processing speed			
Symbol search	10.3	4–17	3.0

Note. These are descriptive statistics prior to transformation and rescaling.

Table 1 for descriptive statistics for all measures. Stroop and set shift data were cleaned, and all error trials and trials where reaction time was above 2,000 or below 200 msec were deleted. Stroop, set shift, and stop reaction times were then Winsorized to 2.5 *SD* above individual means within each condition. Mean reaction times for each condition (e.g., neutral, incongruent, negative, threat-related, trauma-related) were then calculated. Scores on all measures were transformed to *z* scores and scaled so that higher scores indicated stronger performance on these tasks. Zero-order correlations between EF measures are reported in Table 2.

Bivariate correlations among EF tasks, depression (including BDI subscales), interpersonal violence, and PTSD symptom severity are reported in Table 3. Of the tasks included in these analyses, stronger performances on the neutral and negative sentence span scores of working memory were significantly correlated with increases on the cognitive subscale of the BDI. Although positive stimuli were not included in the study hypotheses, because depression was associated with stronger performance on negative and neutral sentence span items, an additional bivariate correlation was performed to assess the relationship between depression and the positive condition for this task. Performance on this test of positive working memory was negatively associated with greater scores on the somatic subscale of the BDI. Finally, trauma-related set shifting was significantly correlated with both the full-scale BDI and the cognitive subscale of the BDI. None of the EF tasks was significantly correlated with the affective subscale of the BDI. PTSD was positively correlated with the full-scale BDI, the three subscales of the BDI, and interpersonal violence. PTSD was not significantly correlated with any EF tasks.

TABLE 2 Zero-Order Correlations among Executive Function Tasks

	Negative EF tasks				
	Set shifting (trauma-related)	Set shifting (threat-related)	Stroop (trauma-related)	Stroop (threat-related)	Stop task
Set shifting (trauma-related)	—	—	—	—	—
Set shifting (threat-related)	−.13	—	—	—	—
Stroop (trauma-related)	−.15	−.06	—	—	—
Stroop (threat-related)	−.01	−.01	.29*	—	—
Stop task	−.24	−.03	−.17	.07	—
Sentence span	.14	−.09	.22	.09	.33**
	Neutral EF tasks				
	Set shifting	Stroop	Stop task	Sentence span	Letter–number sequencing
Stroop	−.14	—	—	—	—
Stop task	.13	−.05	—	—	—
Sentence span	.02	.05	.27*	—	—
Letter–number sequencing	.04	−.02	.34*	.50**	—
Symbol search	−.11	−.05	.32*	.39*	.54**

Note. EF = executive function.
*$p < .05$. **$p < .01$.

TABLE 3 Bivariate Correlations Between Depression Variables and PTSD, Interpersonal Violence, and EF Tasks

	Total BDI	Cognitive	Affective	Somatic
Interpersonal violence	.38**	.51**	.26*	.16
PTSD symptom severity	.53**	.44**	.51**	.49**
Letter–number sequencing	−.01	.05	.03	−.11
Symbol search	−.01	.03	.01	−.08
Sentence span				
Neutral	.18	.25*	.16	.04
Positive	−.04	.11	−.07	−.24*
Negative	.23	.33**	.20	.03
Stop task				
Neutral	−.07	−.10	−.01	−.03
Negative	−.01	−.06	.11	−.03
Stroop				
Neutral	.11	.05	.12	.15
Threat-related	−.08	−.04	−.01	−.14
Trauma-related	−.03	.04	−.06	−.09
Set shifting				
Neutral	−.07	−.03	.03	−.11
Threat-related	−.20	−.14	−.23	−.19
Trauma-related	.32**	.35**	.20	.24

Note. PTSD = posttraumatic stress disorder; EF = executive function; BDI = Beck Depression Inventory.
*$p < .05$. **$p < .01$.

TABLE 4 Regression Coefficients for Models Predicting Depression

	Variable	*SE*(B)	Beta	*t*
Models predicting BDI cognitive symptoms	Neutral working memory	.45	.19	2.11*
	Interpersonal violence	.13	.44	4.72***
	PTSD	.04	.37	3.97***
	Negative working memory	.50	.24	2.66**
	Interpersonal violence	.14	.39	4.23***
	PTSD	.03	.39	4.21***
	Trauma-related set shifting	.49	.13	1.37
	Interpersonal violence	.14	.38	3.86***
	PTSD	.04	.38	3.75***
	Negative sentence span	.89	.34	1.71
	Interpersonal violence	.23	.47	2.33*
	PTSD	.07	.05	.31
Model predicting BDI somatic symptoms	Positive sentence span	.43	−.15	−.14
	Interpersonal violence	.11	.00	.00
	PTSD	.03	.46	4.17***
Model predicting BDI full-scale scores	Trauma-related set shifting	1.01	.13	1.27
	Interpersonal violence	.28	.19	1.88
	PTSD	.08	.50	4.79***

Note. BDI = Beck Depression Inventory; PTSD = posttraumatic stress disorder.
*$p < .05$. **$p < .01$. ***$p < .001$.

Mediational tests following Barron and Kenny (1986) were performed among significant bivariate depression–EF task correlations to assess whether EF deficits mediate the relationship between multiple types of interpersonal violence and depression (see Table 4 for regression coefficients for tests that follow). In the first test of mediation, number of types of interpersonal violence was the independent variable, depression severity was the dependent variable, and EF composite score was the mediational variable. First, depression severity was regressed onto number of interpersonal violence types. Next, EF composite score was regressed onto number of interpersonal violence types. The last step simultaneously regressed number of interpersonal violence types and the EF composite score onto depression severity to evaluate whether EF mediates the relationship between interpersonal violence and depression. In addition, we controlled for PTSD symptoms given the interrelationships among PTSD, depression, and interpersonal violence. Separate regression models testing for mediation were run for neutral working memory (neutral sentence span) and negative working memory (negative sentence span) as regressed onto the cognitive subscale of the BDI; positive working memory (positive sentence span) as regressed onto the somatic subscale of the BDI; and trauma-related set shifting as regressed onto the full-scale and cognitive subscale of the BDI.

For the model testing neutral working memory, results indicated the total number of reported types of interpersonal violence accounted for a significant amount of the variance in the BDI cognitive subscale. The number of types of interpersonal violence events did not account for a significant

amount of the variance in neutral working memory scores. The partial regression coefficient relating number of interpersonal violence types to neutral working memory scores was not significant. Finally, neutral working memory, PTSD, and interpersonal violence were regressed onto BDI cognitive subscale scores. The overall regression model was significant, $F(2, 65) = 16.82$, $p < .001$, $R^2 = .34$. Increased interpersonal violence was found to be significantly related to increases on the BDI cognitive scale, as were increased neutral working memory and increased PTSD.

For the model testing negative working memory, increased interpersonal violence accounted for a significant amount of the variance in BDI cognitive subscale scores. Interpersonal violence did not account for a significant amount of the variance in negative working memory. The partial regression coefficient relating interpersonal violence to negative working memory was not significant. Negative working memory and interpersonal violence were then regressed onto BDI cognitive subscale scores. The overall model was significant, $F(2, 65) = 14.86$, $p < .001$. Increases in interpersonal violence, negative working memory, and PTSD were each found to account for increases in depression.

For the model testing trauma-related set shifting, increased interpersonal violence accounted for a significant amount of the variance in BDI cognitive scale scores. The partial regression coefficient relating interpersonal violence to increased depression was statistically significant. Interpersonal violence did not account for a significant amount of the variance in trauma-related set shifting, although it did approach significance. The partial regression coefficient relating interpersonal violence to threat-related set shifting was not significant. Trauma-related set shifting and interpersonal violence were then regressed onto BDI cognitive subscale scores. The overall model was significant, $F(2, 62) = 14.84$, $p < .001$. Interpersonal violence and PTSD were significantly related to increases in depression, whereas trauma-related set shifting was not significantly related.

Another model was tested using the trauma-related set shifting variable and the full-scale BDI. Increased interpersonal violence accounted for a significant amount of the variance in full BDI scale scores. The partial regression coefficient relating interpersonal violence to depression was positive and statistically significant. Interpersonal violence did not account for a significant amount of the variance in trauma-related set shifting, although it did approach significance. The partial regression coefficient relating interpersonal violence to trauma-related set shifting was not significant, although it approached significance. Trauma-related set shifting and interpersonal violence were then regressed onto full BDI scores. The overall model was significant, $F(2, 62) = 7.22$, $p < .01$. Interpersonal violence and trauma-related set shifting were not significantly associated with full-scale BDI scores. PTSD was found to have a significant positive association with depression.

For the model testing positive working memory and the somatic subscale of the BDI, increased interpersonal violence did not account for a significant amount of the variance in somatic subscale scores. The partial regression coefficient relating interpersonal violence to depression was not significant. Interpersonal violence did not account for a significant amount of the variance in positive working memory. Positive working memory and interpersonal violence were then regressed onto somatic subscale BDI scores. The overall model was not significant, $F(2, 62) = 7.22$, $p < .01$. Interpersonal violence and positive working memory were not significantly associated with full-scale BDI scores. PTSD was found to have a significant positive association with depression.

DISCUSSION

This study examined the relationship among exposure to interpersonal violence, depression, and EF. Findings indicated a significant, positive relationship between the number of interpersonal violence types to which women are exposed and depressive symptoms, consistent with previous research (Follette et al., 1996; Hedtke et al., 2008). Building on past research, we examined separately cognitive, affective, and somatic depression symptoms in relation to violence exposure. The number of types of interpersonal violence to which women were exposed was positively linked to severity of cognitive and affective depressive symptoms, but not somatic symptoms. These findings suggest that interpersonal violence experiences might impact different aspects of depression based on symptom clusters. A more nuanced understanding of the association between violence exposure and different types of depression symptoms might help researchers and clinicians to design and implement more specific intervention strategies for depression.

Regression analyses indicated that interpersonal violence was associated with elevations in depression symptoms from the full-scale and the cognitive subscale of the BDI, but did not account for significant variance in performance on EF tasks. EF is understood to be a multifactorial construct that can be measured using many different measures. This study included several different measures that tapped multiple EF indicators, and consistently failed to find evidence of mediation across the multiple EF components that were included. Therefore, the current data do not provide evidence for the role of EF as a mediator in the relationship between the number of interpersonal violence exposures and depressive symptoms.

A strength of this study was the thorough assessment of different domains of EF using multiple measures (e.g., working memory, set shifting, response inhibition, processing speed). This approach revealed some surprising information about links between depression symptoms and EF. For example, we documented a positive relationship between depression

symptom severity and working memory performance for negative and neutral stimuli using the sentence span task, such that as depression symptom severity increased, so did working memory performance. In light of past research pointing to negative relationships between depression and working memory performance (e.g., Harvey et al., 2004; Paelecke-Habermann et al., 2005), a possible explanation for this unexpected finding could be that people with depression are more likely to focus on negative information. Therefore, participants with higher levels of depression symptoms were more able to retain the negative words used for this task and were more attentive to the entire task as a result. Further, we found a negative relationship between depression and recall of positive words on the same task. If heightened attention to negative information did contribute to better recall of negative words on this task, a corresponding decrease in attention to, and recall of, positive words would not be surprising. This explanation is also in line with the well-established connection between depression and negativity bias, where individuals with depression appear to pay better attention and have better memory for negative emotional stimuli (e.g., Fales et al., 2008).

Although improved recall of neutral and negative words was associated with cognitive symptoms of depression, poorer recall of positive words was associated with somatic symptoms of depression. Further research might be required to determine whether physical symptoms associated with depression are uniquely related to working memory deficits or might impact global cognitive functioning more generally.

Although participants' attention to negative words might have influenced links between depression and working memory in the sentence span task, no correlation was observed between depression and another measure of working memory that involved only neutral stimuli: the letter–number sequencing task. The changing picture regarding links between depression and working memory performance points to the importance of using multiple measures of EF constructs in neuropsychological studies as well as understanding how task demands (e.g., emotional stimuli) affect task performance.

Trauma-related set shifting was positively correlated with both the full-scale BDI and the cognitive subscale of the BDI, which is also surprising in light of research that would suggest the opposite effect. If increased attention to negative information does contribute to better performance on working memory tasks that incorporate negative words, it is possible that this increased attention also influenced performance on a shifting task that also included negative words. Performance on the general threat-related set shifting task, which also incorporated negative words, did not improve in relation to increased depression. However, stronger performance on a task involving trauma-related words in comparison to a task involving more generally threatening words might be uniquely associated with depression in samples of violence or trauma-exposed individuals.

Limitations

Although this study found associations among violence exposure, depressive symptoms, and EF deficits, the cross-sectional design of the study does not allow us to draw conclusions about how the relationships among depression, PTSD, and EF developed. Future research should examine these relationships using longitudinal designs. Although this study included a range of tasks intended to tap different aspects of EFs, other EF tasks might be more or less associated with interpersonal violence and depression than the tasks included in this study. Examining these relationships in a broader range of tasks (e.g., Wisconsin Card Sorting Test, Trails tests, etc.) might provide additional information about their relationship to interpersonal violence and depression. This study also focused on a narrow section of participants who had been exposed to interpersonal violence, which represents a specific type of trauma exposure. EF performance in depressed individuals who have experienced other types of trauma (e.g., exposure to natural disasters, motor vehicle accidents, life-threatening medical conditions, etc.) might show different patterns of association with trauma; further research is needed to examine whether there is something unique about the cognitive correlates of violence-related depression. In addition, to observe the impact of gender differences on the relationship among trauma exposure, EF deficits, and depressive symptoms, it would be useful to replicate these analyses using a mixed-gender sample.

Future Directions

There are several research directions that warrant further consideration. Although at least one incident of exposure to interpersonal violence was required as an inclusion criterion for this study, many participants reported being exposed to more than one incident; on average, participants reported 5.8 lifetime incidents of violence exposure. Although this study examined violence exposure as a lifetime frequency, the events reported included many different types of violence exposure. Future studies should assess the possibility that exposure to different types of violence might produce different patterns of association with EF tasks. Given the potential impact of violence exposure on the developing brain, it is possible that the age at which the first interpersonal violence event occurred might also be related to depression and EF in this sample. Future research should examine the impact of age at first exposure on the relationship between EF and depression, as well as assessing for potential differences among participants who experienced interpersonal violence only in childhood, only in adulthood, and in both childhood and adulthood. Finally, it is possible that the time that has passed since the most recent incident of interpersonal violence could

impact both depression and EF. Examining each of these characteristics of interpersonal violence exposure might prove useful to understanding the associations among interpersonal violence, EF, and depression.

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