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# NEUROCOGNITIVE PERFORMANCE AND IPV IN U.S. ARMY SOLDIERS AND VETERANS

Neurocognitive Performance Predicts Future Partner Violence Among U.S. Iraq- and  
Afghanistan-deployed Army Soldiers and Veterans

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## Abstract

**Objective:** Intimate partner violence (IPV) constitutes a major U.S. national health concern and disproportionately affects military families. Prior research, which has been conducted primarily in civilian populations, suggests that relative neurocognitive weaknesses may increase risk for IPV. This prospective study examined the associations between post-deployment neurocognitive performance and subsequent IPV (5 - 13 years later) among warzone veterans in the context of psychological health and TBI.

**Method:** Participants were 217 warzone veterans from a nationally-dispersed sample of service members and veterans who had previously deployed to the Iraq war zone and their intimate partners. Warzone veterans had previously completed performance-based neurocognitive assessments at a post-deployment assessment. An average of eight years later, participants completed structured psychiatric interviews and psychometric surveys assessing TBI history, posttraumatic stress disorder (PTSD), depression, alcohol use, and IPV perpetration.

**Results:** Regression analyses revealed that relatively greater psychopathology and history of TBI were significantly associated with more frequent warzone veteran IPV psychological perpetration. Further, relatively poorer post-deployment neurocognitive performance predicted

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higher subsequent psychological and physical IPV perpetration, adjusting for demographics, psychological health, and TBI.

**Conclusions:** Our findings highlight the importance of identifying both psychological/behavioral and neurocognitive correlates of IPV among warzone veterans. An integrative understanding of IPV risk can help inform both IPV prevention and treatment efforts for warzone veterans.

**Keywords:** Intimate partner violence, warzone veterans, neurocognitive performance

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Intimate partner violence (IPV) constitutes a major public health concern in the U.S., contributing to extensive health costs resulting from physical harm and health conditions, psychological burden, and reproductive consequences (Black, 2011; Dillon et al., 2013). The estimated economic cost of IPV to society over victims' lifetimes is approximately \$3.6 trillion in the U.S. (Peterson et al., 2018). Significant health and societal consequences of IPV call for continued identification of risk factors that could inform preventative and treatment efforts, especially in vulnerable populations. The present study aims to explore psychological/behavioral and neurocognitive risk factors of IPV perpetration among warzone veterans.

The prevalence of IPV perpetration occurs at greater rates among veterans compared to their civilian counterparts (Gierisch et al., 2013), and may be elevated specifically for warzone veterans (Marshall et al., 2005). Such factors include posttraumatic stress disorder (PTSD) and depression, which affect warzone veterans at elevated rates and are both associated with higher IPV perpetration (Spelman et al., 2012; Taft et al., 2011; Tinney & Gerlock, 2014). Alcohol use and misuse is also greater among veterans, compared to the general civilian population, and is linked to veteran IPV perpetration and partner discord (Martin et al., 2010; Seal et al., 2011). Lastly, traumatic brain injury (TBI) is common among warzone veterans, with more than 400,000 reports of veteran TBIs worldwide from 2000 to 2020 (TBICoE, 2021) and high combat exposure as a risk factor for sustained TBI (Lindquist et al., 2017). Studies have also documented an association between TBI and IPV perpetration (Horne et al., 2020). Such findings highlight a constellation of veteran health concerns that may contribute to elevated levels of IPV perpetration, particularly among warzone veterans.

In addition, relatively less proficient neurocognitive performance has been associated with IPV perpetration in civilian studies (for reviews, see Humenik et al., 2020; Pinto et al.,

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2010). In particular, relative weaknesses in certain aspects of executive functioning (Horne et al., 2020; Humenik et al., 2020; Pinto et al., 2010), learning and memory (e.g., Cohen et al., 1999; Vitoria-Estruch et al., 2018), and verbal ability (Cohen et al., 2003; Donovan & Ferraro, 1999) are thought to confer risk of IPV. For example, poorer working memory (an aspect of executive functioning) was associated with observed aggression during experimental conflict discussions among couples (Godfrey et al., 2020). Similarly, difficulties with other executive functions, such as inhibition, may further reduce capacity to manage aggressive behavioral urges and to effectively control response tendencies during conflict (Corvo, 2014). Regarding learning and memory, difficulty learning conflict resolution strategies and modifying behavioral patterns may increase risk of IPV (Cohen et al., 1999). Further, relatively weak verbal skills may lead to ineffective communication during interpersonal conflicts (Cohen et al., 2003).

Despite evidence of associations between neurocognitive performance and IPV, several gaps remain in the literature. First, strong evidence suggesting associations of PTSD, depression, substance abuse, and TBI with IPV, yet little is known about the extent to which neurocognitive performance challenges contribute to IPV risk above and beyond these clinical and health concerns (Humenik et al., 2020; Pinto et al., 2010). Secondly, many previous studies have relied on a narrow operationalization of IPV that focuses solely on physical IPV perpetration, omitting experiences of psychological IPV, which is equally important given its prevalence and health implications (Dokkedahl et al., 2019). Thirdly, extant research has employed cross-sectional designs, preventing inferences on longitudinal relations between neurocognition and IPV. Lastly, despite elevated prevalence of both IPV (Gierisch et al., 2013) and cognitive deficits (Vasterling et al., 2006b) in military populations, we are not aware of prior studies examining associations between neurocognitive performance and IPV specifically within military/veteran populations.

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### **Present Study**

To address these gaps, we used a nationally-dispersed sample of previously deployed US warzone veterans and their partners to examine whether neurocognitive performance following return from Iraq War deployment (“post-deployment”) predicted physical and psychological warzone veterans’ IPV perpetration 5 to 13 years later (“long-term follow-up”) as part of the Family Foundations Study (Vasterling et al., 2015). More specifically, we hypothesized that: (1) health indicators found to commonly affect warzone veterans (i.e., PTSD, depression, problematic alcohol use, TBI) measured at long-term follow-up would be associated with veteran physical and psychological IPV perpetration; and (2) poorer performance at post-deployment on tasks assessing working memory, verbal-auditory learning and memory, and verbal ability would predict higher subsequent reports of physical and psychological IPV perpetration at long-term follow-up independently of warzone veteran mental health variables and TBI.

### **Method**

#### **Participants**

The analytic sample included 217 couples (warzone veterans and cohabitating partners). Warzone veterans were drawn from the Neurocognition Deployment Health Study (Vasterling et al., 2006a) cohort and included regular Active Duty Army soldiers, members of the Army National Guard/Reserve, and Army veterans. Human subjects approvals were obtained from the Department of Veterans Affairs (VA) Boston Healthcare System and Boston University Medical Center review boards. All participants provided verbal informed consent by telephone. Warzone veterans consented to access of their archived data, as described below.

#### **Procedures**

Warzone veterans from the original NDHS were followed longitudinally starting prior to

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deployment to Iraq (for most, their first deployment) and were assessed again following return from deployment. Most additionally participated in a long-term (6-8 year) follow-up assessment (VA Cooperative Study Program [CSP#566]; Aslan et al., 2014). Eligible warzone veterans were invited to participate in the Family Foundations Study following their CSP#566 participation. Family Foundations was later expanded to include warzone veterans who had participated in the NDHS but did not participate in CSP #566. Eligibility criteria for Family Foundations also included a) having an English- or Spanish-speaking spouse or partner who lived within the warzone veterans' household for at least one year and b) consent to allow access to archived NDHS and/or CSP#566 assessment data. After obtaining warzone veterans' consent, partners were contacted for their consent to participate. For more details about participant inclusion, see Figure 1.

The current study incorporated both secondary data (archived neurocognitive data from the NDHS post-deployment assessment and archived mental health and TBI information from CSP#566) and primary Family Foundations data (i.e., IPV assessment data) central to Family Foundations aims. Neurocognitive measures were administered on-site at military installations by civilian study personnel according to standardized procedures. The post-deployment assessment was chosen as an index of warzone veteran post-deployment neurocognitive functioning, administered at a time in which neurocognitive functioning could have changed due to deployment-related factors (Vasterling et al., 2006b).

All procedures for Family Foundations were carried out remotely, as participants were nationally dispersed. Archived mental health and TBI interview data were used for warzone veterans who had completed CSP#566 procedures (also remotely) within three months of participation in the current study. Otherwise, clinician-administered TBI and mental health



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interviews were conducted by phone by a doctoral level psychologist. For other measures (i.e., demographic information and IPV measures), warzone veterans and their partners were offered the choice of completing the written surveys by mail or a secure web-based platform (PsychData, <http://psychdata.com>). A total of 106 warzone veterans completed the questionnaires via web, and 111 via mail. Among partners, 109 completed the questionnaire via the web and 108 by mail. Following completion of study procedures, a thank you letter and compensation were mailed to each participant.

### Measures

***Neurocognitive Performance.*** Archived neurocognitive measures were drawn from a larger battery of performance-based neurocognitive tasks administered to warzone veterans post-deployment to assess various indices of cognitive performance/dysfunction (see Vasterling et al., 2006a) and were selected to include domains indicated in the literature to be most strongly associated with IPV. Specifically, candidate variables included those measuring visual and verbal learning and memory, verbal ability (i.e., verbal reasoning; vocabulary), and executive functioning (i.e., working memory; inhibition). The neurocognitive battery for the present study included the Automated Neuropsychological Assessment Metrics (ANAM; Reeves et al., 2002), Neurobehavioral Evaluation System, Third Edition Continuous Performance Test and Vocabulary (NES3; Letz, 2000; Letz et al., 1996), which were both administered in a computer-assisted format. Non-computer-administered, standardized, neurocognitive performance-based tasks included the Trail-making Test (Rietan, 1958), Wechsler Memory Scale, Third Edition (WMS3; Wechsler, 1997) Verbal Paired Associates, and the Wechsler Memory Scale Visual Reproductions (WMS; Wechsler, 1945). Previous studies have demonstrated adequate validity for each of these tests of cognitive performance/dysfunction (e.g., Bleiberg et al., 2000; Kabat et

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al., 2001; Krenzel et al., 1996; Lezak et al., 2004; Rietan, 1958; Sánchez-Cubillo et al., 2009), and research indicates deployment-related performance differences in the neurocognitive variables included in the present study (Vasterling et al., 2006b). ANAM variables were all “throughput” scores, which are normalized scores reflecting both time and accuracy. For memory measures, in addition to learning scores (immediate recall), retention ratios were calculated to account for quality of initial learning. For the Trail-making Test, time to completion for Part A (requiring sequencing of a numerical sequence) was subtracted from time to completion for Part B (requiring alternation of alphabetic and numerical sequences) to isolate higher order processes while accounting for basic attention and psychomotor speed. See Table 1 for further information about the scoring and constructs measured.

***Intimate Partner Violence.*** IPV over the past six months was assessed using the 78-item Conflict Tactics Scale-2 (CTS2; Straus et al., 1996), which was administered to warzone veterans and their partners. In the present study, we accounted for both warzone veteran and partner reports of warzone veteran perpetration. As is standard within the IPV literature (e.g., Taft et al., 2015), warzone veteran- and partner-reported items were compared, and the greater of the two scores was used. The CTS2 demonstrates excellent test-retest reliability (Moffitt et al., 1997); internal consistency estimates range from .79 to .95 (Straus et al., 1996). Physical IPV count scores were calculated by dichotomously scoring each physical assault item as either “occurring” or “not occurring” and then summing the total number of behaviors that had occurred over the past six months (potential range: 0-12). Psychological IPV was calculated as a frequency score; midpoints were used for responses containing a range of scores (e.g., 3-5 times received a score of 4; Straus et al., 1996); reports of >20 times were recoded as 25. Items were then summed to a total frequency score (potential range: 0-200).

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### *Health Indicators*

*Lifetime warzone veteran TBI* was assessed at long-term follow-up (CSP #566) by a clinical psychologist using a structured phone interview and updated during the Family Foundations interview. As described elsewhere (Alosco et al., 2016), the interview documents lifetime history of TBI events associated with either a) alteration of consciousness (explained as “dazed” or loss of memory for “what was happening during, immediately before, or immediately after the injury”), or b) loss of consciousness. A dichotomous variable assessing any reported history of lifetime TBI of any severity level was created and used in the present analyses. Interrater reliability for lifetime TBI at long-term follow-up was high ( $\kappa = 0.97$ ; Alosco et al., 2016).

*Psychological symptoms* were assessed at long-term follow-up (CSP #566) or during the Family Foundations assessment. Warzone veterans completed the Alcohol Use Disorders Identification Test (AUDIT; Saunders et al., 1993), a self-report survey consisting of 10 items assessing participants’ alcohol use behaviors. Total scores were classified as non-problematic (0–7) or harmful/problematic (8 or higher), using established cut-points (Saunders et al., 1993). The reliability and validity of the AUDIT has been consistently demonstrated; internal consistency estimates range from .75 to .97 (Reinert & Allen, 2007). Warzone veteran PTSD was assessed using the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1995), a structured clinical interview based on the Diagnostic and Statistical Manual, Fourth Edition, Text Revision (DSM-IV; APA, 2000). In addition to meeting DSM-IV criteria, a CAPS diagnosis of PTSD required: a) an overall severity score 45 or higher (Orr, 1997) of a possible score of 0–136; b) duration of symptoms for 1 month or longer; and c) clinical significance (i.e., score of 2 or higher on the distress item or functional impairment item). Inter-rater reliability for the CAPS PTSD diagnosis

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was calculated from a randomly selected subset (14%) of warzone veterans' interviews and was high ( $\kappa = .99$ ). The Mini-International Neuropsychiatric Interview version 5.0 (MINI; Sheehan et al., 1997) is a brief fully structured diagnostic screening. Used in the current study to screen for warzone veteran depression, operationalized as current major depressive episode or dysthymia, the MINI demonstrates strong inter-rater reliability and test-retest reliability (Sheehan et al., 1997; Lecrubier et al., 1997). Inter-rater reliability in the current sample, calculated on a randomly selected subset (14%) of warzone veterans' interviews, was high for depression diagnoses ( $\kappa = 1.0$ ).

### ***Demographics.***

Demographic variables were collected via self-report and included age, education (highest grade completed), and race/ethnicity. Education was reported at post-deployment; other demographics were reported at long-term follow-up.

### **Data Analysis Plan**

Variables of central interest were assessed for skewness and kurtosis. The CTS2 physical perpetration scale and the calculated Trail-making Test variable were log-transformed due to non-normal distributions. For our main analyses, we used ordinary least squares regression with stepwise entry of predictors to examine outcomes of psychological and physical IPV perpetration. In the context of multiple variables per cognitive domain, we conducted preliminary bivariate correlations to determine variable inclusion for our main analyses to prevent overfitting of regression models and reduce chance findings. One neurocognitive variable per cognitive domain of interest (learning/memory, verbal ability, and executive functioning) was selected based on their strength of association with our outcome variables (see Table 2). For each regression, step 1 examined the association of health indicators and

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demographics with IPV (hypothesis 1), adjusting for age and education due to their documented associations with IPV (Capaldi et al., 2012). In step 2, we added neurocognitive performance variables (log-transformed Trail-making Test B-A time to completion, VPA I summary score, NES3 vocabulary summary score) to examine the incremental role of cognitive performance (hypothesis 2) in predicting IPV. Using G\*Power (Faul et al., 2009), a statistical power analysis revealed that our sample size exceeded the minimum ( $N = 115$ ) needed to achieve 90% power and detect an association of moderate effect size ( $f^2 = .15$ ) at  $\alpha = 0.05$  with nine predictors in multiple regression analyses, after adjusting for multiple comparisons.

### Results

#### Sample Characteristics

Sample characteristics are detailed in Table 3 ( $N = 217$ ). Among warzone veteran participants with a history of TBI, the average number of TBIs reported was 2.56 ( $SD = 1.88$ ) with an average of 118.97 months ( $SD = 93.38$ ) since the most recent TBI. Less than 10% ( $n = 21$ ) reported TBI severity that was moderate or severe. Among participants reporting TBIs, none occurred within 3 months of Family Foundations study participation. Psychological IPV was commonly endorsed by both warzone veterans and their partners ( $> 90\%$  of dyads;  $n = 197$ ), with frequency estimates exceeding an average of 20 incidents over the past six months. Physical IPV was less common, with 73% of couples reporting no incidents of perpetration over the past six months.

#### Associations of Health and Neurocognitive Variables with IPV

##### *Psychological IPV*

At step 1, warzone veteran PTSD, depression, problematic alcohol use, TBI, education, and age significantly contributed to warzone veteran psychological IPV perpetration,  $F(6, 216) =$

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4.65,  $p < .001$ , accounting for 12% of the variance (hypothesis 1). In particular, diagnoses of problematic alcohol use ( $\beta = .14, p = .034$ ), depression ( $\beta = .17, p = .048$ ), and TBI ( $\beta = .15, p = .022$ ) were each independently associated with more frequent psychological warzone veteran IPV perpetration. After adding in neurocognitive variables at step 2, diagnoses of problematic alcohol use ( $\beta = .15, p = .027$ ), and history of TBI ( $\beta = .15, p = .020$ ) remained significant predictors of more frequent psychological warzone veteran IPV perpetration. Neurocognitive performance variables (Trail-making Test B-A, VPA learning, NES3 vocabulary) significantly explained additional variance in step 2,  $F(9, 216) = 4.26, p < .001, \Delta R^2 = .04, p = .025$  (hypothesis 2), with Trail-making Test performance significantly predicting unique variance in the model,  $\beta = .15, p = .022$  (see Table 4 for results of final model). Specifically, poorer cognitive performance was associated with more frequent psychological IPV perpetration.

### ***Physical IPV***

At step 1, warzone veteran PTSD, depression, problematic alcohol use, TBI, education, and age did not significantly contribute to variance in warzone veterans' physical IPV perpetration,  $F(6, 216) = 1.87, p = .088$ , accounting for 2.4% of the variance (hypothesis 1). However, as an individual variable, diagnosis of problematic alcohol use was associated with higher perpetration at both step 1,  $\beta = .14, p = .038$ , and step 2,  $\beta = .15, p = .027$ . The addition of neurocognitive performance variables (Trail-making Test B-A, VPA learning, NES3 vocabulary) significantly accounted for additional variance in step 2,  $F(9, 216) = 3.97, p < .01, \Delta R^2 = .05, p = .012$  (hypothesis 2), with poorer performance associated with greater physical IPV perpetration (see Table 4 for results of final model).

## **Discussion**

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Our findings extend prior research examining associations between neurocognitive performance and IPV by examining both physical and psychological IPV in an understudied sample (i.e., warzone veterans). Moreover, although existing literature examining relations between neurocognitive performance and IPV has accounted for problematic alcohol use and TBI (i.e., Cohen et al., 2003; Easton et al., 2008), depression and trauma-related indicators have not been examined in this context. Further, we are aware of no studies to date that have examined these variables simultaneously, which is important in understanding whether neurocognitive performance contributes to IPV risk above and beyond other clinical and health-related difficulties. Our study is also novel in its examination of longitudinal associations linking post-deployment neurocognitive performance to subsequent IPV perpetration across 5 – 13 years. Overall, our findings suggest that, in addition to health factors, warzone veteran neurocognitive functioning plays a role in IPV perpetration by the warzone veterans among military couples.

Our findings partially supported our first hypothesis: warzone veteran health factors significantly predicted psychological but not physical IPV perpetration, though warzone veteran problematic alcohol use significantly contributed to both dependent variables. Consistent with prior research, the health variables that demonstrated the strongest associations with IPV perpetration were warzone veteran problematic alcohol use and history of TBI. Both problematic alcohol use and TBI have been commonly examined within the context of neurocognition and IPV among civilian populations (Humenik et al., 2020). Our findings extend these patterns of associations to warzone veterans. There is robust evidence linking alcohol use/misuse and IPV, through several postulated mechanisms, including indirect effects via executive dysfunction (Giancola, 2000) and direct effects on aggression (Leonard & Quigley, 2017). Moreover, history

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of TBI has been found to be associated with higher frequency of IPV perpetration, possibly through post-injury cognitive compromise, including executive dysfunction (Horne et al., 2020). Our findings suggest that problematic alcohol use and TBI are important IPV risk factors to address among warzone veterans.

Congruent with our second hypothesis, our findings demonstrated an association between warzone veteran neurocognitive performance and warzone veteran psychological and physical IPV. Congruent with prior research on civilian samples, results of the present study suggest that poorer warzone veteran neurocognitive performance after return from deployment predicts subsequent higher physical IPV perpetration (Cohen et al., 1999; Teichner et al., 2001). Although prior work has primarily focused on physical IPV perpetration, our findings revealed associations between neurocognitive performance and psychological IPV, as well. Psychological IPV, the most common form of IPV, has serious health consequences and is a significant risk factor for physical IPV (Lagdon et al., 2014). Our findings point to neurocognitive functioning as a meaningful contributor to IPV beyond PTSD, depression, problematic alcohol use, and TBI and reflect the need for a biopsychosocial approach to understanding IPV.

Among the neurocognitive predictors examined, Trail-making Test performance predicted unique variance in psychological IPV perpetration. Indeed, relative to other cognitive domains, facets of executive functioning, including working memory, are more commonly reported as correlates of IPV (Horne et al., 2020; Pinto et al., 2010). Our findings suggest that difficulties with working memory may adversely influence interpersonal functioning, especially in the context of conflict and discord. In contrast, although neurocognitive performances collectively predicted physical IPV perpetration, no specific test was associated with physical perpetration.



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It is important to note several methodological differences between our study and prior studies, in addition to the simultaneous entry of neurocognitive variables, that may limit direct comparability. For example, most prior research examined differences in neurocognitive performance between samples with high rates of physical IPV perpetration (i.e., court-ordered, incarcerated, substance-abusing samples) versus matched controls. Our sample, in contrast, reported less physical IPV and had a skewed distribution of physical IPV. Lastly, unique associations may be hard to replicate as they are influenced by multiple factors, which in the present study included a variety of health factors, age, and education.

Although the present study cannot directly address mechanisms underlying the link between working memory and subsequent IPV, it is possible that social information processing factors may be involved. For example, the relationship of working memory with IPV may reflect errors and biases throughout the different steps of social information processing, such as encoding of cues, interpretation of emotions, and enaction of behavioral responses (Van Rest et al., 2019). In this way, the relationship between working memory and IPV observed in our sample may be amplified and potentially mediated by biases in social information processing, which prior work indicates can influence anger expression among veterans experiencing PTSD symptoms (Taft et al., 2015). Consequently, working memory deficits may increase cognitive biases towards threat or hostility, which may be elevated among warzone veterans experiencing IPV, and may in turn lead to aggressive behavior. Additionally, other factors of executive functioning, including impulsivity, have also been linked to potential problems in social information processing, such as elevated cognitive distortions and irrational beliefs (Persampiere et al., 2014).

### **Limitations**

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Several limitations of this study deserve consideration. First, we used only one measure relevant to executive functioning in our main analyses. Though the Trail-making Test may capture some aspects of executive attention in addition to working memory (Salthouse, 2011), Trail-making Test performance does not assess inhibition/impulsivity and decision making, which are established executive functioning-related correlates of IPV among civilians (Humenik et al., 2020). Of note, however, in our preliminary analyses, we included a measure of inhibition (i.e., continuous performance test false positives), but it was not correlated with either IPV measure in unadjusted analyses. Second, our process for selecting the main neurocognitive variables for inclusion in our main analyses, based on their strength of associations with our IPV outcome variables, could have potentially increased the likelihood of positive findings. Third, although our sample was larger than the minimum size specified by a power analysis, our participants reported lower levels of physical IPV compared to other studies. This may have affected the probability of detecting significant associations in analyses. Fourth, our sample was limited in terms of racial/ethnic diversity. IPV research suggests that the prevalence of IPV may vary by race/ethnicity (Langhinrichsen-Rohling et al., 2012). Lastly, although we used a longitudinal design, inferences of causality are limited in any observational study.

### **Future Research Directions**

These limitations suggest avenues for future research. Understanding that executive functioning incorporates multiple cognitive processes, future research could benefit from more comprehensively assessing other executive processes not captured in our study. Future research that include veteran subpopulations at higher risk for IPV levels (e.g., veterans referred to anger management treatment) may provide more variability across IPV variables. Further, more targeted recruitment across different racial/ethnic groups would allow for representation and

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examination of racial inequities. Future studies might also incorporate examination of mechanisms (e.g., social processing deficits) to better understand the processes through which neurocognitive integrity influences IPV perpetration. Lastly, due to potential discordance of IPV reports between partners, research could benefit from multimodal assessments of IPV, such as psychophysiological measurement of dyadic interactions (Gates & Liu, 2016).

### **Clinical Implications**

Our findings reinforce the importance of addressing a variety of health and neurocognitive factors in assessing for and managing IPV. Among health targets for assessment and intervention include problematic alcohol use, as well as sustained TBI. Our findings also highlight the potential utility of addressing neurocognitive factors in treating IPV. Treatments that incorporate neurocognitive rehabilitative components, such as skills building and learning compensatory strategies, have been found to not only improve neurocognitive performance, but also to improve trauma and mood symptoms among veterans (Twamley et al., 2014). Hence, directly targeting neurocognition may prevent or decrease IPV behaviors and help mitigate other problems commonly experienced among warzone veterans. Further, enhancing neurocognition could potentially improve treatment response for psychotherapy (Crocker et al., 2018).

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**Table 1.**

*Neuropsychological Measures*

Measure	Variable	Construct
WMS-III Verbal Paired Associates (VPA)		
VPA I	Total correct	Verbal-auditory learning
VPA II	Percent retention	Verbal-auditory memory
WMS Visual Reproductions (VR)		
VR immediate recall	Total correct	Visual-spatial learning
VR delayed recall	Percent retention	Visual-spatial memory
Trail-making Test		
	Trails B - Trails A completion time <sup>a</sup>	Working Memory/sequencing/switching
ANAM		
Running Memory	Throughput score <sup>b</sup>	Working Memory
Mathematical Processing	Throughput score <sup>b</sup>	Working Memory
Logical Reasoning	Throughput score <sup>b</sup>	Verbal Reasoning
Code Substitution, delay	Throughput score <sup>b</sup>	Incidental Memory
NES3		
Continuous Performance Task (CPT)	No. of false positives <sup>a</sup>	Inhibition
Vocabulary	Total Correct	Verbal ability/IQ estimate

*Note.* ANAM = Automated Neuropsychological Assessment Metric. CPT = Continuous Performance Task. NES3 = Neurobehavioral Evaluation System, 3rd Edition. WMS = Wechsler Memory Scale. WMS-III = Wechsler Memory Scale, 3rd edition. (WMS3).

<sup>a</sup>Log-transformed

<sup>b</sup>Throughput scores reflect efficiency (i.e., speed in the context of accuracy)

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**Table 2.***Correlations Between IPV Perpetration and Neurocognitive Performance*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Psychological IPV perpetration	1	.54**	-.12	-.04	-.11	-.05	.19**	-.04	-.09	-.10	-.12	-.13	-.03
2. Physical IPV perpetration	.54**	1	-.19**	-.10	-.11	-.03	.09	-.09	-.02	-.11	-.18**	-.15*	-.07
3. VPA, summary score	-.12	-.19**	1	.44**	.30**	.15*	-.10	.16*	.11	.18**	.27**	.34**	-.07
4. VPA, percent retention	-.04	-.10	.44**	1	.12	.11	-.13	.04	.06	.11	.29**	.19**	-.03
5. VR, summary score	-.11	-.11	.30**	.12	1	.02	-.08	.29**	.13	.24**	.24**	.21**	-.06
6. VR, percent retention	-.05	-.03	.15*	.11	.02	1	.05	.12	.11	.17*	.23**	.09	.01
7. TMT, Trails B-A completion time	.19**	.09	-.10	-.13	-.08	.05	1	-.06	-.21**	-.22**	-.09	-.20**	.05
8. ANAM, running memory throughput	-.04	-.09	.16*	.04	.29**	.12	-.06	1	.29**	.49**	.46**	.14*	-.08
9. ANAM, math processing throughput	-.09	-.02	.11	.06	.13	.11	-.21**	.29**	1	.45**	.22**	.26**	-.08
10. ANAM, logical reasoning throughput	-.10	-.11	.18**	.11	.24**	.17*	-.22**	.49**	.45**	1	.51**	.31**	.02
11. ANAM, code substitution throughput	-.12	-.18**	.27**	.29**	.24**	.23**	-.09	.46**	.22**	.51**	1	.23**	-.02
12. NES3 Vocabulary, total correct	-.13	-.15*	.34**	.19**	.21**	.09	-.20**	.14*	.26**	.31**	.23**	1	-.09
13. NES3 CPT, false positives	-.03	-.07	-.07	-.03	-.06	.01	.05	-.08	-.08	.02	-.02	-.09	1

*Note.* IPV = Intimate partner violence; VPA = Verbal paired associates; VR: Visual reproduction; TMT = Trail-making test; ANAM = Automated neuropsychological assessment metrics; NES3 = Neurobehavioral evaluation system; CPT = Continuous performance test.  
 \*  $p < .05$ , \*\*  $p < .01$

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**Table 3.***Sample Characteristics (N = 217)*

Characteristics	Warzone Veterans (Long-Term Follow-up)		Partner (Long-Term Follow-up)	
	N	M (SD) or %	N	M (SD) or %
Age	217	35.92 (5.94)	185	34.23 (6.49)
Sex (Male)	206	94.9%	9	4.1%
Race				
White	169	77.9%	145	66.8%
Black	23	10.6%	15	6.9%
Asian	2	0.9%	7	3.2%
Native American	1	0.5%	1	0.5%
Hawaiian	1	0.5%	1	0.5%
Other	11	5.1%	13	6.0%
Ethnicity (Hispanic)	29	13.4%	18	8.3%
Education (highest grade completed) <sup>a</sup>	217	12.66 (1.49)	-	-
Less than High School	-	-	1	0.5%
High School Graduate/GED	36	16.6%	37	17.1%
Some College/Associates	106	48.8%	82	37.8%
College Graduate	32	14.7%	45	20.7%
Professional/Advanced Degree	14	6.5%	20	9.2%
Military Status				
Ever Served	217	100%	26	12.0%
Active Duty	74	34.1%	-	-
National Guard/Reserve	27	12.4%	-	-
Veteran	116	53.5%	-	-
# of Deployments				
1	86	39.6%	-	-
2	65	30.0%	-	-
3	47	21.7%	-	-
4	16	7.4%	-	-
5 +	3	1.4%	-	-
Health Indicators				
Problematic alcohol use	217	14.7%		
PTSD	217	22.6%		
Depression	217	24.9%		
TBI	217	63.6%		
Neurocognitive Performance				
TMT, Trails B – A completion time	217	31.05 (15.16)		
VPA, summary score	217	21.69 (6.52)		
NES3 Vocabulary, total correct	217	18.09 ( 4.27)		
Intimate Partner Violence				
Psychological Perpetration	217	23.48 (25.29) <sup>b</sup>		

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Physical Perpetration	217	0.60 (1.43) <sup>b</sup>
	Family (Long-Term Follow-up)	
	N	M (SD) or %
Married [Warzone veterans and Partner]	169	77.9%
Relationship Duration [yrs; Warzone veterans and Partner]	215	10.77 (6.76)

*Note.* TMT = Trail-making test; VPAI = Verbal paired associates part I; NES3 = Neurobehavioral evaluation system, 3<sup>rd</sup> edition.

<sup>a</sup> Warzone veterans' education was measured at post-deployment.

<sup>b</sup> Frequency scores were used for psychological perpetration whereas count scores were used for physical perpetration. Psychological perpetration scores ranged from 0 – 133 and physical perpetration scores ranged from 0 – 9.



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**Table 4.***Summary of Regression Analyses Examining Health and Neurocognitive Associations with Intimate Partner Violence (N = 217)*

Variable	Psychological Perpetration			Physical Perpetration		
	<i>B</i>	<i>SE B</i>	$\beta$	<i>B</i>	<i>SE B</i>	$\beta$
<b>Step 1 variables</b>						
Problematic alcohol use	10.39	4.67	0.15*	0.23	0.10	0.15*
PTSD	5.04	4.91	0.08	0.07	0.11	0.05
Depression	7.63	4.88	0.13	0.03	0.11	0.02
Lifetime TBI	7.97	3.41	0.15*	0.08	0.07	0.07
Education	1.91	1.21	0.11	0.05	0.03	0.12
Age	-0.07	0.30	-0.02	0.00	0.01	0.01
<b>Step 2 variables</b>						
TMT	13.41	5.83	0.15*	0.10	0.13	0.05
VPA learning	-0.28	0.28	-0.07	-0.01	0.01	-0.14
NES3 vocabulary	-0.40	0.45	-0.07	-0.02	0.01	-0.13
$R^2$	0.16			0.10		
F for $\Delta R^2$	3.19*			3.75*		

*Note.* Table results are from the final model of regression analyses. Neurocognitive variables and education were reported at post-deployment and all other variables were reported at long-term follow-up. PTSD = Posttraumatic stress disorder; TBI = Traumatic brain injury; TMT = Trail-making test, log transformed Trails B – A time to completion; VPA = Verbal paired associates; NES3 = Neurobehavioral evaluation system, 3<sup>rd</sup> edition; *B* = unstandardized coefficient;  $\beta$  = standardized coefficient. Problematic alcohol use, PTSD, depression, and TBI (any lifetime TBI) are diagnostic/categorical.

\*  $p < .05$ , \*\*  $p < .01$

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**Figure 1.**  
*Study Derivation*

