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Emotion regulation mediates the relationship between verbal learning and internalizing, trauma-related and externalizing symptoms among early-onset, persistently delinquent adolescents

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Abstract

Research supports cascading relationships among internalizing and externalizing symptoms, and academic problems. This constellation of problems characterizes Early-Onset/Persistent Delinquent [EOPD] youth and appropriately targeted interventions accounting for this comorbidity may improve outcomes. To investigate these relationships in EOPD youth, we characterized their cross-diagnostic psychopathology and verbal (word-list) learning/memory and evaluated: 1) verbal learning/memory profiles of Withdrawn/Depressed relative to Non-Withdrawn/Depressed youth; 2) cognitive and psychiatric predictors of verbal learning; and 3) emotion regulation as a mediator of psychiatric and cognitive relationships. Results indicated Withdrawn/Depressed youth recalled significantly fewer words during immediate, and some delayed, recall conditions. Less word-learning was predicted by: Withdrawn/Depressed classification, higher trauma-specific re-experiencing symptoms, greater emotion dysregulation, weaker executive skills, fewer trauma-avoidance and aggressive symptoms, and earlier alcohol-use onset. Emotion regulation strongly mediated the relationship between verbal learning and psychopathology, but not cognitive skills, among youth at high-risk for school dropout. Mental health and education implications are discussed.

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1. Introduction

While current education policy calls for standardization of school curricula, teaching format, and measures of success ('high stakes testing'), these practices do not inherently account for individual learning differences or potential obstacles to learning that disproportionately affect marginalized students (low income youth, youth with mental health needs), thereby amplifying disparities. Existing research indicates that complex trauma (severe, direct interpersonal harm and/or betrayal by caregivers that is repetitive and/or pervasive during development, Ford and Courtois, 2013), cumulative adversity (accumulated stressor burden, Lloyd and Turner, 2003) and psychiatric disorders (e.g., depression, trauma-related disorders) are associated with cognitive deficits that may impact learning (Austin et al., 2001; Crozier & Barth, 2005; Jaffee & Maikovich-Fong, 2011; Kira et al., 2012), and adversely affect marginalized students. This body of research, particularly in the context of ongoing brain development, supports supplemental individualized learning opportunities that engage a broader range of students, and informed, responsive school-systems that understand the learning/academic implications of psychopathology and adversity-exposure among vulnerable youth.

Notably, both internalizing (withdrawn, depressed, anxious) and externalizing (disruptive behavior, aggressive, attention) symptoms impact efficient learning for academic success. Although these problems are commonly concurrent (Achenbach and Rescorla, 2001; Frey and Ekins, 2002), externalizing symptoms often overshadow internalizing psychopathology due to the intense and observably acute impact of disruptive behavior on the external environment (Campbell et al., 2000; Cicchetti and Toth, 1991; Eisenberg et al., 2001). Emerging evidence further suggests a reciprocal relationship between these symptom clusters (Beyers and Loeber, 2003; Ritakallio et al., 2008; Van Lier et al., 2012), with support for comorbid depression and antisocial symptomatology that is stable and co-occurring over time (Ritakallio et al., 2008). Thus, internalizing and externalizing symptoms are optimally addressed in tandem.

Academic failure is a critical contributor to the relationship between internalizing and externalizing symptomatology (Masten et al., 2005; Moilanen et al., 2010; Van Lier et al., 2012). Longitudinal epidemiological studies indicate interrelationships among internalizing, externalizing, and academic problems across time points, with cascading effects. While internalizing and externalizing symptoms and academic problems are present at each assessed time point and demonstrate multiple longitudinal relationships (i.e., academic problems lead to greater internalizing and externalizing symptoms, externalizing symptoms lead to greater academic problems and internalizing symptoms, etc.), path analyses indicate strongest support for a path beginning with externalizing problems during early childhood that predict later academic failure, followed by internalizing problems (Masten et al., 2005; Moilanen et al., 2010; Van Lier et al., 2012). Further longitudinal data suggest that perceived peer victimization (bullying) mediates this process (Van Lier et al., 2012). Academic failure could exacerbate internalizing problems as youth are rejected by peers, teachers, and parents because of failure, causing social withdrawal from normative peers and depressive symptoms (Van Lier et al., 2012). Furthermore, movement away from normative peers in favor of associating with deviant peers then may then exacerbate externalizing behaviors

(Deater-Deckard, 2001). These data highlight the importance of considering internalizing problems, even in populations that gain attention for their disruptive externalizing behaviors.

Unfortunately, externalizing behaviors also pose a substantive barrier to the detection of the very cognitive deficits that adversely impact learning and contribute to internalizing symptomatology. This problem is amplified among youth identified as ‘delinquent’ whose behavior may disrupt important milestones such as school completion. Without intervention, school dropout is the trajectory for many who become system-involved, with 43% of delinquents not returning to school after their correctional facility release (LeBlanc et al., 1991). School disengagement is especially troubling because detained adolescents typically function four grade levels behind on reading alone (See summary: Vacca, 2008), and dropouts from one graduating class in the US cost >\$329 billion in lost productivity- which does not even include potential mental health treatment, education intervention or incarceration costs (DeBaun and Roc, 2013; Alliance for Excellent Education, 2007).

Overall, delinquents experience numerous obstacles to academic success, including high rates of special education disabilities (See review Mallet, 2014), set against a backdrop of broader cognitive deficits (verbal, memory, attention, executive; Lansing et al., 2014; Moffitt and Caspi, 2001; Ogilvie et al., 2011). Research supporting the developmental theory of Life-Course Persistent Delinquents (Moffitt et al., 2002; Donnellan et al., 2000; Raine et al., 2005) indicates that cognitive deficits, criminality and poor academic, social, and health outcomes (e.g., Piquero et al., 2007; Ge et al., 2001) are most prominent with early-onset persistent delinquency [EOPD]. These data highlight the importance of prioritizing academics among EOPD youth, including the detection of obstacles and contributors to successful learning.

Verbal learning, or the ability to encode and retain verbal information over time (learning facts presented by a teacher) is critical for school success and an important research consideration. Verbal learning is influenced by an interplay of presentation (e.g., visual vs. auditory, word frequency), word attribute (e.g., length, familiarity, meaningfulness), and individual (mood, age, sex) characteristics (Burgess and Hitch, 2006; Carpenter et al., 2012; Cowan, 1988; Geffen et al., 1990; Postman, 1975; Repovš and Baddeley, 2006). The verbal learning process includes encoding (information acquisition, including memory storage) and retrieval (accessing the information). Successful encoding results in knowledge acquisition (learning) and depends on executive function skills (e.g., attention; working memory; Alloway, 2009; Baddeley, 1992; Gathercole and Baddeley, 2014). Many everyday tasks in academic (learning names, dates) and social (maintaining conversational threads) settings utilize verbal learning skills, which in turn predict functional abilities for activities of daily living (e.g., Liss et al., 2001). Unfortunately, several psychopathologies prevalent among high-risk youth, including delinquents, are implicated in verbal learning difficulties (depression, Post-Traumatic Stress Disorder [PTSD], disruptive behavior disorders).

1.1 Internalizing and externalizing disorders among delinquent youth

Delinquent youth exhibit high rates of internalizing and externalizing psychiatric disorders (66% of boys and 73.8% of girls met criteria for at least one disorder), cross-diagnostic symptomatology and comorbidity (Teplin et al., 2002; Abram et al., 2003; 2015). PTSD

includes both types of symptoms (e.g., avoidance/numbing vs. arousal/reactivity), is prominent among delinquents (e.g., Abram et al., 2013) and is commonly comorbid with affective (17% of boys, 24% of girls) and behavioral (43% of males, 46% of females) disorders (Abram et al., 2007; 2013). Across populations, PTSD and depression comorbidity is associated with lower levels of functioning, greater symptom severity, and more emotional, behavioral and memory dysregulation (Green et al., 2006; Johnsen et al., 2008; Zlotnick, 1997).

1.2 Cognitive and learning/memory deficits among delinquents

Antisocial youth (officially detected and self-reported delinquents, Conduct Disorder diagnosed youth), demonstrate cognitive and learning/memory difficulties, regardless of sex, race/ethnicity, SES, academic attainment or arrest (e.g., Moffitt et al., 1981; Lynam et al., 1993; Piquero, 2001). First, cognitive/intellectual deficits and learning disabilities, particularly with respect to language, are evident in antisocial youth (Moffitt and Lynam, 1994; Lansing, et al., 2014; Harris et al., 2009; Shelley-Tremblay et al., 2007; Snow and Powell, 2008). Studies consistently find lower intellectual functioning [IQ], with lower verbal [VIQ] than performance [PIQ] IQ among delinquents (Isen, 2010; Moffitt and Lynam, 1994; Moffitt and Caspi, 2001), although not necessarily more discrepant than in normative samples (Lansing et al., 2014). Our large-scale epidemiological U.S. sample of detained youth found receptive word knowledge was the greatest relative and absolute cognitive deficit (Lansing et al., 2014), which aligns with data indicating auditory language processing deficits (e.g., Moncrieff et al., 2014). Notably, verbal deficits are the best predictors of self-reported delinquency, linked to aggression, and problematic given the central role language competence plays in overall (intellectual, academic, social, emotional) development (Beitchman et al., 1996a; b; 2001; Brownlie et al., 2004; Vermeiren et al., 2002; Rutter and Mawhood, 1991).

Second, executive function deficits are observed in antisocial youth, but vary depending on the specific skill-types assessed and measurement methods (Ogilvie et al., 2011). The most consistent executive deficits occur with comorbid ADHD (for review Ogilvie et al., 2011), and substance use indicators may be another source of variability (Giancola et al., 1996). EOPD youth fall squarely within this cross-diagnostic intersection, with evidence implicating executive deficits specifically in early-onset conduct problems, impulsive aggression, and difficult temperament (Fairchild et al., 2009; Villemarette-Pittman et al., 2003). Further, based on elevated PTSD rates among delinquents and cognitive data implicating executive/attention deficits in maltreated samples (Beers and De Bellis, 2002), differences in trauma-related exposure and psychopathology among delinquent samples may further contribute to variability in executive dysfunction across studies, but this has not been systematically evaluated. This is an important oversight as executive skills are critical for successful use of fundamental cognitive skills (verbal abilities), goal-directed behavior, working memory, and learning.

Third, studies explicitly assessing EOPD youths' cognitive status typically find more pronounced intellectual, verbal, spatial and executive deficits relative to adolescent-onset delinquents and controls (Donnellan et al., 2000; Moffitt and Caspi, 2001; Piquero, 2001;

Piquero and White, 2003; Raine et al., 2005). Importantly, among EOPD youth, verbal and executive deficits appear progressive and subsequent to adverse experiences (familial and economic distress, loss etc.; Aguilar et al., 2000). To date, few studies explicitly assess EOPD youths' verbal learning/memory. Although some conflicting evidence has been reported (Raine et al, 2005), Moffitt et al., (1994) found verbal deficits and verbal learning/memory problems predicted the development of EOPD in a large New Zealand birth cohort and EOPD youth were more impaired on unstructured word-list learning than adolescent-limited delinquents and controls (Moffitt and Caspi, 2001).

1.3 Learning, memory and executive deficits characterize depressed and PTSD populations

To date, little consideration has been given to the impact of internalizing symptoms on verbal learning performances among EOPD youth. However, important insight may be gained from populations with overlapping, cross-diagnostic, psychopathologies. Notably, both depression and PTSD, two of the most common non-externalizing psychopathologies among delinquents, are also associated with specific cognitive deficits. First, verbal memory deficits are noted in populations with depression, and in those with PTSD (e.g., Lauer et al., 1994; Beers and DeBellis, 2002; Johnsen and Asbjørnsen, 2008). Data further indicate that comorbid depression and PTSD may be associated with greater deficits (Johnsen et al., 2008). The scope of these findings are underscored by the high comorbidity of these disorders (e.g., ~50% of PTSD patients meet criteria for Major Depressive Disorder; Kessler et al., 1995; Shalev et al., 1998).

Second, substantial evidence suggests that PTSD and depression are also associated with executive function deficits (e.g., mental flexibility, problem-solving, attention; Austin et al., 2001; Polak et al., 2012). These are the very skills needed for successful learning. Thus, this pattern of psychopathology and cognitive deficits align with difficulties reported among EOPD youth, and suggest potential disruptions in efficient learning that would interfere with academic and social success.

1.4. Background summary

On the whole, verbal, general intellectual and academic-related deficits appear to be the most common findings among delinquent youth who, by definition, exhibit externalizing behavior problems, with the most pronounced deficits occurring in EOPD youth. Findings of executive, learning and memory deficits are more variable in delinquent populations, but are characteristic of their two most common non-externalizing disorders: depression and PTSD. It is likely that the occurrence of internalizing and stress/trauma-related disorders among a substantial portion of delinquents accounts for executive, learning and memory function variability. It is therefore important that the relationships among psychiatric symptoms and cognitive deficits not be limited to externalizing disorders in “high-risk” populations (learning disabled, high-school dropouts, delinquents), but expanded to include internalizing symptoms, trauma-related psychopathology and emotional dysregulation.

1.5 Neural underpinnings linking depression, stress and learning: postnatal hippocampal neurogenesis

Recent research highlights the complex interplay between psychiatric symptoms, cognitive functions, and underlying neural correlates, particularly the hippocampus. First, smaller hippocampal volume has been consistently noted among individuals with depression (Videbech and Raynkilde, 2015), and in adults with chronic PTSD (see review, Kitayama et al., 2005). Among EOPD adolescents, smaller hippocampal volume, independent of psychiatric disorder, has been reported relative to well-matched (e.g., demographics, SES, parent head-of-household status, neighborhood residence) non-system involved controls (Lansing, Virk, et al., 2016). Interestingly, PTSD-related hippocampal volume reductions are not seen among children (Kitayama et al., 2005), suggesting a potential therapeutic window before trauma-related brain changes occur. Second, stress has specifically been shown to cause decreased postnatal hippocampal neurogenesis (e.g., Anacker et al., 2013), which has been implicated in learning and memory formation as well as in the etiology of depression (Thuret et al., 2009; Zainuddin and Thuret, 2012). These results suggest that addressing both internalizing syndromes, such as depression, and stress/trauma-related symptomatology is important for optimizing postnatal hippocampal neurogenesis and learning.

1.6 Theoretical Context: Complex trauma, cumulative adversity and emotion dysregulation

Delinquents experience elevated trauma exposure, including a host of Adverse Childhood Experiences (ACEs, addressing 10 exposure-types such as childhood abuse or neglect and parental distress; Felitti et al., 1998). Large-scale epidemiological survey research indicates that 45% of detained girls and 27% of boys report 5/10 ACEs (Baglivio et al., 2014). Additional data support links between specific ACE indicators and adolescent- and early-onset delinquency, criminality, violence victimization and perpetration (Aguilar et al., 2000; Duke, et al., 2010; Reavis et al. 2013; Whitfield et al., 2003). These data underscore the role of adversity in these vulnerable youths' lives and the need for least-restrictive community-based prevention and intervention efforts (US General Accounting Office, 2005).

This trauma burden is best captured by the concept of complex trauma (ongoing/repeated, often inescapable interpersonal traumas such as childhood maltreatment; Herman, 1992; Ford and Courtois, 2013) and cumulative adversity, with multiple severe stressors exerting the most impact on mental health (Schilling et al., 2008). Increasing evidence suggests that complex trauma is best understood from a developmental perspective (Pynoos et al., 1995; Cloitre et al., 2009) that acknowledges the role of early and pervasive trauma in producing disturbances in emotion regulation (the ability to manage emotional reactions), symptom complexity, disrupted attachment and interpersonal difficulties (Cloitre et al., 2009; Shipman et al., 2000; 2005).

Trauma alone may result in extreme emotion modulation variability, which impacts arousal, cognition (initiated and automated avoidance strategies to intrusive re-experiencing of memories) and behavior, including fluctuations in goal-directed behaviors necessary for learning (Weiss et al., 2012; Brewin and Holmes, 2003; Frewen et al, 2008). Further, lower intelligence, cognitive difficulties, attributional style and distortions in processing emotional or stressful information are also linked to PTSD vulnerability and maintenance across

populations (Bomyea et al, 2012; Elwood et al., 2009; Mathews and MacLeod, 2005). Taken together, there is evidence for the impact of combined cognitive deficits and psychiatric symptomatology disrupting successful learning, with emotion dysregulation as an important link.

Successful regulation of emotions is initiated by parents (Bernier et al., 2010), and disruption in caregiver attachment such as occurs with ACE-exposures, can result in impaired self-regulatory processes that impact emotional and cognitive control required for efficient learning and school success (Bernier et al., 2010). Emotion regulation requires a coordinated integration of cognitive, behavioral, physiological and neural mechanisms, with self-regulatory abilities essential for adaptive functioning (Hofmann et al., 2012). Emotions are distinct from mood and represent a response to internal states and/or external events of significance to the individual (Berkling et al., 2014; Lazarus, 1993), including stressful situations, be they traumatic events or cognitive challenges such as those encountered in school and while learning.

Learning/memory impairments may be linked to antisocial behavior through hippocampal dysfunction which disrupts affect/emotion regulation and inhibition, and this may vary with comorbidities (depression, PTSD, psychopathy; Koenigs et al., 2011; Kosson et al., 2006; Weiss et al., 2012; Berkling et al., 2014). Some studies have noted very early spatial deficits in children who become EOPD, and hypothesized an underlying right hemisphere dysfunction disrupting affect regulation development, bonding and attachment (Raine et al., 2002; 2005); early trauma exposure is a potential culprit in this trajectory. However, given the importance of verbal learning to successful school, work and interpersonal functioning, alongside links between verbal learning/memory and psychopathology (depression, PTSD), developmental disorders (Nichols et al., 2004) and neurological conditions (e.g., Lansing et al., 2004), verbal learning is an important area of investigation for the developmental presentation of EOPD youth who evidence cognitive deficits, internalizing and externalizing symptoms against the backdrop of complex trauma exposure.

1.7 Present study

In the present study, we address limitations in the literature to further our understanding of verbal learning in the midst of broad cognitive deficits and cross-diagnostic symptomatology. Specifically, we examine the potential impact of withdrawn-depression on verbal learning/memory among EOPD boys and girls; address a range of psychiatric and emotion regulation predictors of verbal learning; assess the impact of relevant cognitive skills (receptive language, executive skills) on verbal learning; and examine emotion regulation as a potential mediator for learning. These additions to our understanding of verbal learning are important for an integrated educational and mental health perspective that will facilitate better tailored interventions relevant to ACE-exposed youth, such as delinquents, who are at high-risk for poor academic outcomes.

We therefore descriptively characterize EOPD youths' cross-diagnostic psychopathology and verbal (word-list) learning/memory and aim to address three primary hypotheses. First, based on similar links to learning, memory and executive functioning among psychiatric populations, Withdrawn/Depressed EOPD youth will exhibit significantly more difficulty

with verbal learning and memory (total wordlist learning; short and long delay, free and cued recall) than Non-Withdrawn/Depressed EOPD youth. Second, we hypothesized that fundamental (receptive vocabulary) and higher-order (executive functions) cognitive abilities; internalizing (Withdrawn/Depressed), trauma-related (PTSD re-experiencing, avoidance/numbing, arousal) and externalizing (attention, aggressive) symptoms; and emotion regulation would significantly predict CVLT-2 word-list learning (Trials 1-5). Third, among all EOPD youth, emotion regulation will mediate the relationships of all psychiatric symptoms to word-list learning. Finally, we explored potential differences between the groups in learning strategies (e.g., semantic clustering), retention rates, error patterns, susceptibility to interference and recognition memory.

2. Method

2.1 Participant screening and consenting procedures

Subjects included 93 incarcerated adolescents, ages 16 to 18 years old ($n = 48$ boys, $n = 45$ girls), who participated in a study on EOPD, cognitive abilities, life events and psychiatric symptoms. Demographic data are provided in Table 1. An older adolescent population was chosen to permit evaluation of persistent delinquency and to narrow the age band for assessing executive functioning. Participants were recruited from San Diego County Probation Department's [SDCPD] Camp Barrett and Girls' Rehabilitation Facility. Youth at SDCPD facilities have similar age, offense and racial/ethnic minority distributions as institutional commitment rates nationwide (Keaton et al., 2008; Sickmund and Puzzanchera, 2014). Individuals were randomly selected from the three primary ethnic/racial groups represented in this setting (Hispanic, African American, Caucasian).

Eligibility included right-handedness; English fluency (bilingual youth were eligible); evidence of disruptive behavior symptoms by the age of 10; multiple arrests, adjudications and/or incarcerations alongside self-reported delinquency; and a Full Scale IQ [FSIQ], VIQ and/or PIQ ≥ 70 so that youth with specific learning disabilities that might disproportionately impact FSIQ were still included. Exclusions included color blindness, serious neurological disorders (e.g., active/uncontrolled seizure disorder, moderate/severe Traumatic Brain Injury: TBI), and psychotic symptoms interfering with informed consent/decisional capacity. Female staff, with psychology- or psychiatry-related degrees, experience interviewing high-risk youth and extensive training/supervision, interviewed participants. Clinical interviews were reviewed and supervised, or administered, by a clinician. All youth completed testing over several sessions to reduce subject burden, allow research staff to know the youth better, promote optimal data collection, and allow flexibility in working around the youth's schedule.

Research involving incarcerated youth requires special procedures because they are Wards of the Court and may not have a legal guardian who can provide consent. Our Juvenile Court Order permitted access to official records and incarcerated youth. Consistent with federal regulations, the University of California, San Diego Institutional Review Board [UCSD-IRB] and Department of Health and Human Services [DHHS], parental consent was waived and instead, youths' assent was overseen by a participant-advocate who represented the youths' interests and ensured understanding of study procedures. Study methods and

consent/assent forms were approved by UCSD-IRB, the US Office of Protection from Research Risks and DHHS which provides guidance on the involvement of prisoners in research (HHS regulations at 45 CFR part 46, subpart C).

Youth consented for screening in writing and all participants signed a study assent (<18 years old) or consent form (≥ 18 years old). Youth were asked questions about the various study elements to ensure comprehension (e.g., purpose; risks and benefits; voluntary and knowing participation with Human Subjects Bill of Rights; no impact on their sentence length etc.).

2.2 Measures

Screening Measures

2.2.1 Wechsler Abbreviated Scale of Intelligence [WASI] (Wechsler, 1999): The WASI is a reliable and valid abbreviated measure of general intellectual abilities (Vocabulary, Block Design, Similarities, Matrix Reasoning) that correlates well with other full IQ measures and was co-normed with the Delis-Kaplan Executive Function System [D-KEFS; Delis et al., 2001]

2.2.2 Early disruptive behavior scale: (Diagnostics and Statistics Manual-4th Edition-Text Revision [DSM-IV-TR], 2000): Youth were asked about the presence or absence of all Oppositional Defiant and Conduct Disorder symptoms by age 10, or earlier.

2.2.3 Traumatic Brain Injury [TBI]: TBI is common among delinquent youth (Vaughn et al., 2014). Our severity scale is designed to characterize mild TBI using a 7-point scale derived from extensively queried details capturing associated features (e.g., presence and length of any loss of consciousness, confusion or amnesia; headache; nausea). Scoring methods stem from our extensive work rating TBI injuries and evaluating the neurobehavioral sequelae of pediatric TBI and stroke (e.g., Lansing et al., 2004; Max et al., 2001).

2.2.4 Family Resource Scale (Dunst et al., 1987): This original 30-item self-report, plus additional free/reduced school lunch eligibility item, was used to determine the adequacy of family resources as a proxy for socioeconomic status useful for lower income individuals (Brannan et al., 2006), using a 5-point scale (1=not at all adequate to 5=almost always adequate). Resources include food, shelter, financial, transportation, healthcare, time to be with family, childcare, and 'time for self,' captured by six subscales calculated as means (Brannan et al., 2006). Childcare requirements (two items) were relevant to only a few participants and not included in our total score, which is the sum of five subscales.

2.2.5 Substance use screen: Youth were asked the age at which they first used alcohol and different illegal substances, along with onset of weekly and/or daily use. After screening, the Customary Drinking and Drug Use Record Form was administered to obtain data on number and type of alcohol and substances used (currently, regularly and lifetime), as well as substance/alcohol dependence, withdrawal, and negative consequences (Brown et al., 1998). Overall, 15 types of substances were specifically queried (e.g., alcohol, cigarettes,

marijuana, methamphetamines). However, subjects could endorse other substances we did not specifically query (e.g., synthetic cannabinoids “spice”).

Verbal Learning and Memory

2.2.6 California Verbal Learning Test, Second Edition [CVLT-2] (Delis et al., 1987): The CVLT-2 is a measure of verbal learning and memory, appropriate for individuals 16 years old and older. The CVLT-2 has adequate psychometric properties (Paolo et al., 1997) and was administered in its complete and standard form (Delis et al., 1987). The CVLT-2 is a multi-trial word-list learning test consisting of 16 items (List A) presented five times, yielding 5 immediate recall trials. List A Trials 1-5 word recall is the global index of verbal learning used in regression analysis. List A learning trials are followed by a distractor word-list (List B) and immediate recall, a free-retrieval recall of List A (Short Delay Free) and a semantically cued recall of List A (Short Delay Cued). After 20 minutes, List A recall is solicited freely, followed by semantic cued recall (Long Delay Free and Cued, respectively). Recognition memory uses a Yes/No response-format to presented words from Lists A and B, and non-presented words. Guided by prior work in both adult and pediatric populations (e.g., Delis et al., 1988, 1991; Shear et al., 1992), we included CVLT-2 indices that tapped immediate learning, delayed recall, and recognition memory, as well as process-oriented measures (e.g., contrast measures tapping rate of forgetting and retroactive and proactive interference). For descriptions of more novel CVLT indices, please see Results section 3.2.

Psychopathology, Emotion Regulation and Cognitive Correlates of Learning

2.2.8 Achenbach Youth Self Report [YSR] (Achenbach and Rescorla, 2001): The YSR self-report for adolescents, aged 11-18, addresses behavioral/emotional problems within the last six months, which are rated on a 0 to 2 scale (0=Not True, 1=Somewhat or Sometimes True, and 2=Very True or Often True) and cover eight, non-overlapping, factor analysis-derived scales (e.g., Anxious/Depressed, Withdrawn/Depressed, Attention Problems) grouped into three broadband subscales: Internalizing (anxious/depressed; withdrawn/depressed; somatic), Externalizing (rule-breaking; aggressive), and Total Problems (i.e., a total of all problem subscales). Meeting threshold for a summary score is not equivalent to meeting a problem score threshold (e.g., Withdrawn/Depressed is only one problem area contributing to Internalizing Score). The YSR provides a reliable and valid assessment of current mental health problems (Doyle et al., 2007). YSR gender- and age-based T-scores range from 50-100 (normal range: 50-59). Our classifications for comparisons related to the presence/absence of clinically meaningful Withdrawn/Depressed, aggressive, attention, and internalizing and externalizing problems were based on a T-score cut-off of 60 (borderline to extreme clinical range; see Achenbach and Rescorla, 2001). Regression modeling included the Withdrawn/Depressed classification and aggressive and attention continuous T-scores. Partial correlations used continuous T-scores. The Withdrawn/Depressed scale was our main grouping variable and primarily taps withdrawal (e.g., prefer to be alone) depressive (lacks energy, sad) and anhedonia-type symptomatology.

2.2.9 Clinician Administered PTSD Scale – for Children [CAPS-CA] (DSM-IV-TR, 2000; Nader et al., 1996): Based on the National Institute for Clinical Excellence (2005),

the CAPS-CA is considered to be the gold-standard for assessing PTSD symptoms among children and adolescents. This 33-item structured interview provides current and lifetime (reflecting their most symptomatic past [MSP] timeframe) categorical PTSD diagnoses in response to the youth's self-identified 'worst' traumatic event (17 core PTSD symptoms), which is determined by the Life-Events Checklist (LEC, Gray et al., 2004). Time points may overlap (i.e., for some youth their current symptom level is also their most symptomatic period). Each symptom's severity is determined by a sum of frequency (not at all – every day) and intensity (not at all – a whole lot) on a 0-4 scale. The total severity score is the sum of frequency and intensity scores for all 17 symptoms and yields the following classifications: asymptomatic/few symptoms (<20), mild (20-39), moderate (40-59), severe (60-79), and extreme (80–136) PTSD (Weathers et al., 1999).

We report the total MSP and current severity scores along with symptom counts obtained by adopting the most frequently used scoring rule for determining symptom presence: requiring a Frequency of at least '1' and an Intensity level of at least '2' ('F1I2' criteria; Weathers et al., 1999). This metric for total symptom counts was used in regression analyses predicting verbal learning and focused on the youth's Lifetime/MSP based on previous reports that symptoms from the most symptomatic period, but not current PTSD symptoms, were related to verbal learning and memory (Tischler et al., 2006). PTSD diagnosis was determined using F1I2 criteria. Cronbach's alpha of .75 was found for the numbing and avoidance, arousal and re-experiencing subscales in a study of incarcerated adolescents (Newman et al., 1997). Inter-rater reliability diagnostic rates range from 100% among hospitalized children (Daviss et al., 2000) to .84 for current PTSD and .54 for lifetime PTSD among traumatized adolescents (Ohan et al., 2002).

2.2.10 ACE Coding: 10 traditional ACEs were derived from multiple self-report and youth interview measures; if any measure indicated evidence for a specific ACE (e.g., emotional abuse or parental incarceration), that ACE was coded as present. We used the *Childhood Trauma Questionnaire* to code child abuse and neglect ACE indicators, supplemented with the *Neglect Scale*. All other events were queried during our demographic interview. Divorce was the only ACE that was not coded traditionally. Instead, we coded a '*family disruption through loss*' ACE, which, in addition to divorce, included the youth not living with both parents because many of youths' parents were never married.

2.2.11 Delis Rating of Executive Functions [D-REF] - Self Rating (Delis, 2012): This 36-item self-report assesses executive function problems in youth using a 0-4 time-frequency scale for the previous six months (*seldom/never to daily*). The D-REF has acceptable reliability and validity (Delis, 2012). Only the youth informant version was used in the present study. The D-REF contains 36 questions about emotion, cognition and behavior; written at a fourth-grade level. T-scores ≤ 55 fall within the normal limits; 55-59 scores are borderline elevated; 60-70 indicates mild executive dysfunction, and ≥ 70 severe executive dysfunction concerns. Our focus was on the Emotional Functioning domain (eight items), which assesses the ability to regulate emotions in response to environmental demands and includes aspects of reactivity, anger response and emotional control. The Emotional Functioning domain of the youth self-rating form shows high internal consistency.

2.2.12 D-KEFS: The D-KEFS is a comprehensive, performance-based measurement of executive functioning abilities consisting of tests assessing a broad range of higher-level cognitive skills, with acceptable reliability and validity (Delis et al., 2004). We focused on five measures (Trail making, design fluency, verbal fluency, color-word interference, card sorting) found to be particularly sensitive to frontal-lobe damage, set-shifting ability and/or mental flexibility (e.g., Baldo, et al., 2001; McDonald, et al., 2005) in order to calculate the composite Executive Functioning Quotient [EFQ], described in our earlier work (Delis et al., 2007).

2.2.13 Peabody Picture Vocabulary Test, 4th Edition (PPVT-4: Form L): The PPVT-4 (Dunn and Dunn, 2007) is a test of receptive vocabulary assessing single-word comprehension, and standardized on a large national sample. All reliability and validity coefficients fall in the .90s range. The PPVT-4 evaluates language comprehension independent of expressive language production abilities. Words are read out loud by the examiner and the participant points to which one of four pictures visually depicts the word.

2.3 Participants

No youth refused screening, one 17-year old assented girl's mother did not provide consent for her daughter's participation, and one consented 18-year-old boy dropped out of the study due to disinterest. Due to early facility release or transfers to other facilities, data were missing for CVLT-2 data (n=2) and YSR data (n=6). Data are presented for 93 of 101 participants.

2.4 Statistical analysis

Descriptive statistics and exploratory graphing were used to assess the normality of the data in terms of the presence of skew and/or outliers of primary variables. All data were within normal range and none were transformed. Potential covariates were summarized with descriptive statistics and graphs to determine if representation (continuous, categorical, or an interval) was appropriate. All missing data were examined to assess randomness. The comparability of the groups was tested with analyses of variance [ANOVAs] or independent sample t-tests for continuous variables and Chi-square analyses for categorical variables. To provide a consistent comparison of functional classification of different types of standardized scores (e.g., "average," "below average/low extreme" as seen in Figure 1) across cognitive measures, we used Lezak et al.'s (2004) systematic classification method for standardized scores for key subtests (e.g., T-score on CVLT-2 Trails 1-5 Total score relative to z-scores for CVLT-2 Short and Long Delay Free and Cued Recall using standard cutoffs: average T-score ranges from 40 to 60; average z-score ranges from -1.0 to 1.0).

Hypotheses were tested using multivariate analyses of variance [MANOVA]. Pearson correlation, partial correlation and regression models were used to examine relationship among variables and test mediator models. The mediator model was conducted with procedures recommend by Baron and Kenny (1986). All statistical tests were two-tailed and conducted using SPSS version 23. Differences were considered statistically significant provided a p-value of 0.05 or less is obtained. The same criteria were used to evaluate regression and mediator models.

3. Results

3.1 EOPD youth sample

For EOPD youth as a group, 44.1% ($n = 41$) were classified as Withdrawn/Depressed. Regardless of current Withdrawn/Depressed classification, 20.4% of EOPD youth (15 girls and 6 boys) endorsed attempting suicide, with significant gender differences ($X^2(1,93) = 5.766$; $p = 0.016$). All EOPD youth experienced at least one traditional ACE exposure, and 75.3% of EOPD youth had 4 different ACE-type exposures. MSP PTSD rates were high: 48.9% met full diagnostic criteria (60.2% 40 moderate; 41.9% 60 severe; 25.8% 80 extreme CAPS-CA clinical score ranges), and 27.2% met current PTSD criteria (35.5% 40; 14.0% 60; 9.7% 80 CAPS-CA clinical score ranges), with 7.5% of the sample experiencing their worst episode of PTSD at their interview age. Current Withdrawn/Depressed status combined with full-criteria PTSD occurred among 17.2% of EOPD youth. Concurrent Withdrawn/Depressed and aggressive problems were also high (35.5%; $n = 33$) and correlated ($r = 0.517$; $p < 0.001$). Additionally, 54.3% endorsed significant attention problems, 52% endorsed elevated emotion regulation problems, with 13.2% of all EOPD youth endorsing extremely elevated problems, and no significant gender differences on meeting threshold for these classifications, using chi-square analyses.

Figure 1 demonstrates the percent of youth falling within the Below Average/Lower Extreme, Average, and Above Average/Upper Extreme on classifications for cognitive tests and illustrates the profile for all EOPD youth. In terms of clinical classifications, 52.5% of youth scored below average to lower extreme classification on VIQ, with 47.3% scoring in this range on receptive word knowledge (PPVT). Over 30% of these 16-18 year old EOPD youth demonstrated receptive word knowledge of children only between the ages of 8 and 12 years old. Only 23.9% were below average/low extreme on EFQ and 21.5-24% fell at this level on CVCLT delayed free recall indices.

A 2 (Gender) by 3 (Race/ethnicity) MANOVA showed no significant main effect for race/ethnicity (Wilks Lambda = 0.906, $F(10,166) = 0.839$, $p = .59$) or gender (Wilks Lambda = 0.914, $F(5,83) = 1.559$, $p = .18$) on CVLT-2 variables (T- and z-scores). The Gender by Race/ethnicity interaction also was not significant (Wilks Lambda = 0.843, $F(10,166) = 1.482$, $p = .15$). There were no significant gender ($X^2(93,1) = 1.746$; $p = 0.186$) or race/ethnicity ($X^2(93,2) = 1.247$; $p = 0.536$) differences between Withdrawn/Depressed classification groups. Therefore, we present data collapsed across girls and boys and racial/ethnic groups.

3.2 Withdrawn/Depressed group differences

Withdrawn/Depressed and Non-Withdrawn/Depressed EOPD youth were comparable on key variables (e.g., age, family resources, TBI, IQ, and receptive vocabulary, Table 1). Groups were also similar on number of substance-types used (last year, regularly or lifetime) and number of times drunk or high. Comparable ACE exposure rates were endorsed in Withdrawn/Depressed ($m = 5.29$; $SD = 2.23$) and Non-Withdrawn/Depressed ($m = 4.88$; $SD = 2.10$) youth. However, significantly more Withdrawn/Depressed youth (53.7%) exceeded the CAPS-CA frequency/intensity severe PTSD symptom cutoff (> 60) than non-Withdrawn/

Depressed youth at MSP (32.7%; $X^2(1, 93)=4.14$; $p < 0.05$) and current (22.0% and 7.7%, respectively; $X^2(1, 93)=3.88$; $p < 0.05$) timeframes. Withdrawn/Depressed ($n = 11$) and Non-Withdrawn/Depressed ($n = 8$) youth did not significantly differ in suicide attempt history. Significant differences ($p < 0.05$) did emerge on alcohol use age of onset, EFQ (D-KEFS), and PTSD arousal and avoidance MSP symptoms. Withdrawn/Depressed EOPD youth demonstrated significantly higher symptomatology on all YSR problem scores and summary scores (internalizing and externalizing problems, Figure 2).

In terms of their CVLT-2 profile, Withdrawn/Depressed youth showed lower encoding rate and flat learning slope between Trials 4-5, but groups performed similarly on List B learning, minimal response to cueing and Recognition memory (Figure 3; Table 2). Withdrawn/Depressed youth performed significantly worse on the CVLT-2 immediate word-list learning (Trial 1 and Trial 5 individual learning trials; Trials 1-5 Total), Short Delay Free Recall and Long Delay Cued Recall than their Non-Withdrawn/Depressed counterparts (Table 2).

No significant group differences emerged on: 1) Proactive Interference (change in recall of List B relative to Trial 1 List A); 2) Semantic (ratio of List A words from the same category recalled together relative to chance expectations given word recall output) or Serial (ratio of List A words recalled in the same forward-order presented, relative to chance expectations given word recall output) clustering learning strategies; 3) Long Delay Forgetting (change in List A recall between long delay free recall and Trial 5); 4) recall error types (Intrusions: summed number of non-List A words reported across learning and delayed recall trials; Word Repetitions: summed number of words perseverated across learning and delayed recall trials); 5) Retroactive Interference (change in List A recall between short delay free recall and Trial 5) susceptibility; or 6) Recognition Hits (yes/no accuracy of List A words relative to distractor words). Withdrawn/Depressed ($m = 99.9\%$) and Non-Withdrawn/Depressed youth ($m = 99.7\%$) also did not differ on the percentage of words correctly identified on forced choice recognition ($t(91) = -0.631$; $p = 0.529$).

3.3. Regression model predicting verbal learning

In initial correlation and regression analyses, TBI, race/ethnicity, gender and bilingualism were not significantly associated with verbal learning. Variables were selected based on the theoretical model (e.g., trauma, emotion regulation), known verbal learning relationships (e.g., attention, language abilities, executive functioning), initial group differences (e.g., Age 1st Used Alcohol, D-KEFS), primary psychopathologies among delinquents (depression, PTSD, aggression) and/or results from partial correlations (e.g., receptive vocabulary) to examine their ability to predict verbal learning using multiple regression technique. Due to the high intercorrelation between VIQ and PPVT ($r = 0.535$), only one language ability indicator could be retained in the model. While VIQ was significant ($p < 0.05$), it only accounted for 6.3% of the variance in overall verbal learning, compared to receptive vocabulary ($p < 0.01$), which accounted for 9.1% of variance. Therefore, VIQ was not retained in our regression model. Aggression was included in the model as a way to control for a component of delinquency that is more variable within the population than rule-breaking or general externalizing behaviors.

Our regression model predicting CVLT-2 word-list learning (Trials 1-5) therefore included the D-REF Emotion Regulation T-Score; Withdrawn/Depressed Categorization; PTSD Re-experiencing, Avoidance and Arousal symptoms from the youths' most severe episode; EFQ (D-KEFS); Receptive Vocabulary (PPVT-4 T-score); Aggressive and Attention problems (YSR T-scores); and Age 1st Used Alcohol as independent variables. The final regression model was significant ($F_{7,74}=6.776$; $p < 0.001$, Table 3) and accounted for more than 39% of variance when all variables were entered in the model using backward method. Attention, Receptive Vocabulary and PTSD Arousal symptoms were removed via backward selection from the final model. All remaining independent variables except age of alcohol use onset were significant, with emotion regulation (D-REF Emotional Functioning T-Score) as the most significant independent variable (Standard Beta: $-.52$). See Table 3 for all Betas.

3.4 Emotional regulation mediation results

Emotional regulation (D-REF Emotional Functioning) was significantly correlated with CVLT-2 Total Learning Trials 1-5 ($r = -.342$, $p = .001$). Similarly, Withdrawn/Depressed internalizing symptoms, Attention problems, receptive vocabulary and executive cognitive functioning (D-KEFS EFQ) were significantly correlated with CVLT-2 indices (Table 4). Only executive cognitive functioning and receptive vocabulary continue to be significantly correlated with CVLT-2 indices after controlling for mediator effect of emotion regulation. However, correlation between internalizing Withdrawn/Depressed symptoms (T-score, not clinical classification) and Attention problems with CVLT-2 indices was not significant after controlling for the mediator effect of emotion regulation. PTSD symptom clusters (re-experiencing, arousal, avoidance), Aggressive problems and alcohol use onset were not significantly correlated with word-list learning individually or after controlling for emotion regulation, even though all but PTSD arousal made significant contributions to the optimal model for predicting word-list learning.

4. Discussion

4.1 Verbal learning and memory in withdrawn/depressed EOPD youth

The present study extends our understanding of verbal learning and memory among EOPD youth who are at high-risk for school dropout, and confirms our hypothesis of more impaired learning of unstructured verbal material for Withdrawn/Depressed EOPD youth. Compared to Non-Withdrawn/Depressed EOPD youth, those who are experiencing notable withdrawn/depressed symptomatology demonstrate an impaired initial attention-related learning span (Trial 1), less benefit from repeated rehearsal (flattened learning curve from trials 4 to 5) and fewer overall words acquired (Trials 1-5 Total), suggesting less efficient learning despite similar learning strategies (semantic and serial clustering). This difficulty with effortful processing and encoding of information is consistent with historical documentation of cognitive difficulties in depressed populations (e.g., Hartlage et al., 1993). However, our findings stand in contrast with a study finding no group differences among inpatient adolescents with Major Depression, Conduct Disorder or combined Major Depression/Conduct Disorder in wordlist learning/memory using the CVLT Children's Version (Horan et al., 1997). Compared to Horan's adolescent inpatients, EOPD youth performed more poorly on the CVLT-2, with worse performance when clinically significant

withdrawn-depression was present. The present study's cohort may have more severe conduct problems (early-onset disruptive behavior, repeated arrests versus inpatient Conduct Disorder), were racially/ethnically diverse (no race/ethnicity information was provided in the Horan study), had lower IQ eligibility criteria (FSIQ, VIQ or PIQ 70 versus FSIQ 80) and were older adolescents who received the CVLT-2, as appropriate for individuals aged 16 and older. Notably, EOPD youth also endorsed depressive symptoms primarily indicative of sadness, withdrawal, lethargy, apathy and anhedonia – all of which may serve to reduce their energy and focus on demanding cognitive tasks.

Withdrawn/Depressed youth were significantly more impaired on short delay recall, even though there were no significant group differences in retroactive interference (a comparison between Trial 5 and Short Delay Free Recall). This suggests that susceptibility to interference was not more prominent among Withdrawn/Depressed youth, but rather there was no further benefit of memory consolidation between the last learning trial and the first delayed recall trial. Similarly, the Withdrawn/Depressed EOPD youth benefited less from cues after a long delay. The overall pattern of encoding difficulties, when combined with no significant differences in terms of retention rate, susceptibility to proactive or retroactive interference, and similar recognition memory abilities, is most consistent with political violence-exposed adults who have PTSD but whose depressive symptoms were most predictive of their verbal learning and memory (Johnsen et al., 2008).

4.2 Predictors, and mediation, of verbal learning and memory among EOPD youths

Consistent with research on the impact of psychopathology on verbal learning and our hypothesis, support was obtained for independent predictive contributions of internalizing (withdrawn/depressed), externalizing (aggressive) and trauma-related (re-experiencing, avoidance) symptomatology, with both emotion regulation and executive function skills additionally making unique contributions to EOPD youths' verbal leaning abilities. Further, while links between depression and less efficient learning are supported in the literature, it is striking that PTSD symptomatology from youths' most symptomatic timeframe was relevant, leaving a lasting imprint. In particular, higher levels of PTSD-related avoidance were associated with better word-list learning, with other factors held constant. Given that higher levels of re-experiencing symptoms reduced word-learning, it seems likely that strategies that allow some EOPD youth to avoid intrusive thoughts and emotions related to their traumatic experiences may also be an effective strategy for focusing on cognitive tasks, and perhaps other scholastic endeavors. In contrast, PTSD-specific arousal was not relevant to verbal learning when re-experiencing and avoidance symptomatology were controlled for in the model, rather their broadly-defined emotion regulation was critical among all EOPD youth. While single-event PTSD specific arousal was not a useful predictor, the present results provide support for emotion dysregulation, independent of a specific trauma, disrupting efficient learning.

Emotion dysregulation may be a cumulative product of significant complex trauma and other stressor exposures present among all EOPD youth and represent the impact of a variety of adversity-burden indicators (number, type, frequency, age of onset, symptom-response) which deserve consideration in understanding learning among vulnerable individuals. Of

note, EOPD boys (a subset of the present sample) not only demonstrated fronto-temporal effects related to their lifetime cumulative trauma, adversity and grief symptoms, but also smaller hippocampal volumes relative to matched control boys, with all of these regions implicated in verbal, executive and memory abilities (Lansing, Virk, et al., 2016)

The combined predictive importance of emotion dysregulation, alongside higher re-experiencing and lower avoidance symptoms, indicated less efficient verbal learning which is consistent with conceptualizations of PTSD as a disorder of cognitive control (impaired executive function) over thought and negative emotion regulation (for review, see Bomyea and Lang, 2015). Consistent with this, cognitive resource deficits result in difficulties down-regulating (inhibiting) intrusive information and increasingly solidify neural networks that are overly sensitive to distressing stimuli and may even generalize response sensitivity to a larger range of stimuli perceived as stressful. In fact, as hypothesized, current self-perceived emotion regulation mediates the word-list learning relationship with affective disturbance (both internalizing withdrawn/depressed symptoms and externalizing aggression) and trauma-related symptoms.

While improved word-list learning with higher levels of aggression may seem paradoxical, it is only a meaningful predictor when modeled with other covariates. Potentially, the energizing effects of aggression may serve to off-set cognitive sluggishness associated with withdrawn/depressed symptoms (improving attention-driven word acquisition, at least with neutral stimuli). Because EOPD youth have numerous early developmental ACE/trauma exposures, stress relevant dysregulation may not be tied exclusively to PTSD that is linked specifically to their self-identified worst traumatic event, as historically conceptualized in the DSM (symptomatology assessed based on a single worst event). As observed in this complex trauma and cumulative adversity exposed sample, emotion regulation and executive cognitive skills primarily drive verbal learning across this EOPD sample of girls and boys of different race/ethnicities.

What was not significant in predicting verbal learning among EOPD youth was also illuminating. First, even in a very high-risk population, TBI, and substance/alcohol use indicators did not meaningfully predict verbal learning. Second, while receptive language skills and attention were both independently correlated and predictive of learning, they failed to be retained in the optimal model. Receptive word knowledge deficits are frequent among delinquents, but were not critical to predicting EOPD youths' verbal learning when psychopathology, emotion regulation and executive function were simultaneously considered. Executive skills may predominate in learning unstructured material (e.g., wordlists not grouped by category) while word knowledge may be more directly tied to accurate contextual (stories) memory. Examination of other components of receptive language functioning (e.g., auditory processing abilities) and different task complexities would further refine the characterization of verbal learning among high-risk youth in future studies. Third, attention as captured by self-perception on the Achenbach was not relevant, but cognitive performance on directed and sustained attention tasks may be more useful in explaining learning differences and warrants additional consideration.

4.3 Cognitive and psychiatric findings among EOPD youth

EOPD girls and boys did not differ on their verbal learning and memory profiles, nor did significant differences emerge based on race/ethnicity. Overall, EOPD youth demonstrate mild encoding and recall difficulties relative to the CVLT-2 standardization sample, little memory benefit from semantic cues, and no pronounced perseverative or intrusive error patterns. The lack of benefit from semantic cues may be related to the relatively poorer verbal abilities among delinquents or their learning cap. Most importantly, however, EOPD youths' effort was good, as indicated by their forced choice performance at essentially 100% accuracy.

In terms of general cognitive functioning, and consistent with prior data in detained and EOPD populations (Lansing et al., 2014; Moffitt and Lynam, 1994; Piquero, 2001), a disproportionate number of EOPD youth fell below average on indices of general intellectual abilities, particularly VIQ, and receptive language. However, executive function skills were a relative strength for EOPD youth. While our eligibility did require intellectual abilities of 70 or higher, allowing eligibility to be met by FSIQ, VIQ or PIQ reduced the exclusion of youth with Learning Disabilities, and suggests that some EOPD youth have untapped executive function relative strengths that could be recruited to bolster learning strategies in school settings that disproportionately rely on verbal abilities for success. These findings are consistent with community youth data indicating that intellectual and executive skills are divergent cognitive abilities, with 13-23% of youth having significant discrepancies between these two domains (Delis et al., 2007).

The psychiatric profiles of EOPD youth also align with existing data indicating a wide-range of psychopathology against a backdrop of high ACE/trauma exposure. EOPD youth demonstrated high levels of symptoms across assessed syndrome and problem scales, with Withdrawn/Depressed youth exhibiting significantly higher on all assessed YSR psychopathologies, suggesting a strong interplay between the Withdrawn/Depressed and other problem domains. PTSD diagnoses among EOPD youth in the present study were also elevated compared to community (3.7% of boys and 6.3% of girls; Kilpatrick et al., 2003) and detained delinquent (13.6%; Abram et al., 2007) youth samples, with approximately half meeting full diagnostic criteria, and more than a quarter of all EOPD youth endorsing extreme PTSD levels, at their most symptomatic. This profile was coupled with profound emotion regulation deficits: more than half of EOPD youth endorsed problems that were greater than 84% of the normative sample of community youth (Delis, 2012). Further, nearly one-quarter of EOPD youth had attempted suicide, with one-third of EOPD girls having a suicide attempt history. This stands in stark contrast to community adolescents' lifetime suicide attempt rate of 7.1% (Andrews and Lewinsohn, 1992). Taken together, the present study adds to a growing body of literature suggesting that high-risk youth with early exposure to trauma/stress have complex symptom presentations (cross-diagnostic), impaired affect regulation and cognitive difficulties such as verbal learning that merit integrated assessments and interventions.

5. Implications

5.1 Identify youth in need of educational support services for improved learning

Cognitive deficits associated with internalizing symptoms are likely to remain unidentified among youth with disruptive behavior. Routine, appropriate cognitive evaluations designed to identify weaknesses and strengths for all youth, especially those at risk for comorbid psychopathology, is warranted based on the growing body of literature supporting verbal and executive deficits impact learning and school engagement. In addition, screening of cognitive abilities should evaluate relative strengths that may be recruited to bolster other, more impaired, abilities.

5.2 Screening for depression

Consistent with federal guidelines to assess for depressive disorders in adolescents, the present data support the need to identify and refer youth for depression evaluations that include a nuanced appreciation for withdrawn symptomatology which may, by its very nature, go unnoticed (Williams et al., 2009). While the guidelines indicate screening should be implemented when adequate systems are in place (e.g., for accurate diagnosis, effective treatment, follow-up), too few community-based resources are available. More widely available services are essential, especially given that “high-risk” youth are unlikely to be seen in traditional health settings (Liebenberg and Ungar, 2014). Accessible mental health services, integrated through schools, have the potential to not only improve psychiatric outcomes for students but also aid in potential academic engagement gains and reduce drop-out.

5.3 Concurrent treatment for depressed mood and improved neurogenesis

These data provide additional support for therapeutic interventions that concurrently address psychiatric and cognitive functioning. Emotion regulation may act as a gateway between internalizing/externalizing problems and cognition, highlighting that some, interventions (e.g., antidepressant medications which are known to stimulate hippocampal neurogenesis necessary for memory (Anacker et al., 2011); cognitive behavioral therapies or psychoeducation which do not explicitly target emotion regulation) are likely to be most beneficial when combined with coping skills targeting emotion regulation and cognitive rehabilitation strategies. Neurogenesis is also a promising target for intervention, particularly considering modifiable lifestyle factors, such as diet and exercise, have been shown to promote neurogenesis alongside memory and mood improvements (see summary: Canales, 2016) and these programs may be efficient to implement, and have fewer inherent barriers to receipt of services, in communities lacking adequate mental health care options, and less adverse to health disparity populations.

5.4 Implement early interventions to improve outcomes

Given what is known about the long-term medical and psychiatric morbidity and mortality outcomes of ACEs, ACE-exposed youth are at serious risk for depression, psychotic spectrum disorders and suicide (Anda et al., 2006; Dube et al., 2001). Data indicating verbal and executive deficits among children and adults with PTSD and depression further support

links between cognitive deficits and trauma history. Emotion regulation is also an important intervention target for improved academic success, and supports the role of social-emotional learning in schools. It is essential that we intervene early and that youths' systems of care, including schools, be aware of the links among trauma/adversity exposure, psychopathology and cognitive skills to promote academic success, optimal health and well-being.

6. Limitations and future directions

Our 16-18 year old EOPD sample may not generalize to: 1) different age groups at different developmental stages; 2) community youth with self-reported delinquency in the absence of arrest, incarceration or early disruptive behavior symptoms; or 3) youth from other ethnic groups (Asian, Pacific Islander). To allow for informed consent we excluded anyone with an FSIQ, VIQ and PIQ<70. While this includes a broad range of IQs, our data do not represent youth at the lowest general intellectual levels who may have a different pattern of verbal learning and memory. Further, our sample size was modest given the potential number of CVLT-2 indices available to evaluate EOPD youths' verbal learning and memory profile. We also did not include adolescent-limited delinquent, or community control, groups and future studies would benefit from these comparisons in a larger sample.

Further, reliance on adolescent self-report data is a potential limitation. However, studies suggest that youth are better reporters of trauma exposure and symptoms than parents (Shames et al., 2005), and that concordance on Conduct Disorder symptom reporting is high (Cantwell et al., 1997). The YSR was used to identify problem domains as this is the “gold-standard” psychiatric self-report for adolescents and allowed for a single measure to assess non-trauma specific psychopathology. However, it should be noted that the YSR truncates lower scores at a T-score of 50, creating a floor effect for populations with low levels of psychopathology, in contrast to our sample. Raw scores may be more useful in some studies, requiring caution when comparing data across samples.

Additional cognitive (visual learning) and emotional/behavioral (depression diagnosed with a structured clinical interview, rather than self-report data) indicators should be explored in longitudinal studies. Future studies would benefit from examining broad spectrum trauma symptoms in response to all experienced stressors (symptoms related to cumulative trauma and adversity burden, e.g., Myers et al., 2015, not just single worst event PTSD, as cumulative adversity is associated with greater symptomatology and more functional impairment among delinquent youth, Lansing, Plante, et al., 2016) and different indicators of emotion regulation in high-risk, developmentally trauma-exposed populations. Further, emerging data suggest that intra-individual fluctuations in mood do not predict variability in cognitive functioning in individual analyses with multiple testing (von Stumm, 2016). While this appears contradictory to data indicating that mood interferes with optimal cognitive performances, neither emotion regulation or extreme populations (e.g., EOPD youth) were explicitly examined. More data are needed to test interrelationships among mood, emotion regulation and cognitive status over time using longitudinal intra-individual analyses in a range of populations. Finally, the present study was limited to verbal learning for an unstructured and demanding word-list, with semantic cues only introduced during delayed

recall. Future studies with EOPD youth should examine contextual (structured) verbal learning and memory, as well as visual learning and memory.

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Highlights

- Early-onset persistent delinquent youth exhibit verbal learning difficulties.
- Withdrawn/Depression was associated with more verbal learning and memory deficits.
- Psychopathology, executive skills, and emotion regulation predict verbal learning.
- Emotion regulation mediates the relationship between psychopathology and cognition.

Figure 1. Cognitive Classifications among EOPD youth

Figure 2. YSR Problem and Summary Scores Based on Withdrawn/Depressed Classification
 p<.001, *p<.0001

Figure 3. CVLT-2 Profile of EOPD youth

The mean number of words recalled on learning (Trials 1-5), delayed recall and recognition trials for Withdrawn/Depressed and Non-Withdrawn/Depressed youth

Table 1

Demographic and Clinical Indicators among EOPD Youth

	Non-Withdrawn/Depressed EOPD youth (n = 52)			Withdrawn/Depressed EOPD youth (n = 41)			F	Partial Eta Squared
	Mean	SD	Range	Mean	SD	Range		
Age	16.96	0.74	16-18	16.68	0.65	16-18	3.615	.038
Family Resources Scale ^{ns}	21.84	3.31	13.60-25	20.69	3.80	9.72-25	2.306	.026
Early Disruptive Behavior ^{ns}	9.83	4.31	1-18	10.71	5.41	2-22	0.763	.008
WASI-2 FSIQ ^{ns}	92.55	9.68	66-109	91.76	9.86	74-113	0.150	.002
Verbal IQ	90.96	10.89	68-109	91.56	11.88	64-112	0.063	.001
Performance IQ	95.58	9.47	70-112	93.63	8.87	77-120	1.006	.011
PPVT-4 ^{ns}	91.22	12.43	59-111	90.15	15.80	61-133	0.129	.001
D-KEFS EFQ *	97.60	7.51	82-114	93.95	9.18	75-120	4.218	.047
D-REF Emotion Regulation **	58.31	9.02	38-79	63.82	7.43	46-78	9.653	.098
Age Drug Use Onset ^{ns}	12.82	1.65	9-16	12.15	2.23	6-15	2.755	.030
Age Alcohol Use Onset *	13.10	2.26	6-17	12.13	2.24	6-16	4.122	.044
Age First Loss Exposure ^{ns}	5.22	5.64	0-17	4.81	5.35	0-15	0.121	.001
Age First Trauma Exposure ^{ns}	9.57	3.63	2-17	8.34	4.59	0-17	2.012	.022
PTSD Re-experiencing symptoms (MSP) ^{ns}	2.46	1.80	0-5	2.85	1.64	0-5	1.179	.013
PTSD Avoidance Symptoms (MSP) *	2.35	2.11	0-7	3.24	2.17	0-7	4.048	.043
PTSD Arousal Symptoms (MSP) *	2.31	1.74	0-5	3.02	1.65	0-5	4.058	.043
PTSD Frequency+Intensity Total MSP ^{ns}	46.25	32.72	0-107	59.46	31.37	6-109	3.876	.041
PTSD Frequency +Intensity Total Current *	25.33	23.66	0-98	38.44	30.92	2-107	5.370	.056
Number of Detentions ^{ns}	5.87	2.70	2-15	5.93	2.68	1-13	0.012	.000
Brain Injury severity score ^{ns}	1.31	1.37	0-4	1.71	1.68	0-6	1.605	.017
Race	N		%	n		%		
African American	15		28.8	9		22.0		
Caucasian	21		40.4	15		36.6		
Latino	16		30.8	17		41.5		

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$p < 0.01$
Df 1,89 to 1,91.
**
*
;500 > d

Verbal Learning and Memory among Non-Withdrawn/Depressed and Withdrawn/Depressed EOPD Youth CYLT-2 Scores

Table 2

<u>LEARNING</u>	Non-Withdrawn/Depressed EOPD youth (n = 52)			Withdrawn/Depressed EOPD youth (n = 41)			F	Partial Eta Squared
	Mean	SD	Range	Mean	SD	Range		
Trial 1 List A Learning *	-0.40	1.12	-2-3	-0.90	1.01	-2.5-2.5	4.933	0.051
Trial 5 List A Learning *	-0.33	1.38	-4-1.5	-1.00	1.29	-4-1.5	5.800	0.060
Total Trial 1-5 (T-Score) *	48.17	11.64	24-73	43.24	10.17	24-72	4.588	0.048
Proactive Interference ^a	-0.09	1.16	-4-3	0.30	0.94	-3-3	3.064	0.033
Retroactive Interference ^b	0.24	0.63	-1-2	0.21	0.83	-2-2	0.048	0.001
<u>LEARNING STRATEGIES</u> ^c								
Semantic Clustering	-0.24	0.87	-1.5-2.5	-0.24	0.71	-1.0-3.0	0.000	0.000
Serial Clustering (Forward)	0.20	1.14	-1.5-4.0	-0.16	0.75	-1.5-1.5	3.051	0.032
<u>MEMORY</u>								
Short Delay Free Recall **	-0.09	1.14	-3.5-2	-0.79	1.06	-3.5-1.5	9.300	0.093
Short Delay Cued Recall	-0.51	1.25	-3-1.5	-0.94	1.06	-3.5-1.5	3.094	0.033
Long Delay Free Recall	-0.23	1.14	-3.5-1.5	-0.62	1.02	-3.5-1.5	2.953	0.031
Long Delay Cued Recall *	-0.39	1.19	-4-1.5	-0.90	1.06	-4-1.5	4.634	0.048
Long Delay Forgetting/Retention ^d	0.10	0.76	-2-2	0.38	0.95	-2-3	2.534	0.027
Delayed Recognition Hits	-0.45	1.07	-5-.5	-0.70	1.25	-5-.5	1.015	0.011
<u>TOTAL ERROR TYPES</u>								
Repetitions	0.41	1.07	-1-4.5	0.46	1.01	-1-3	0.052	0.001
Intrusions	0.28	0.97	-1-3.5	0.59	0.95	-1-3.5	2.329	0.025

All scores are z-scores unless otherwise indicated and all df=1,91.

* p < 0.05;

** p < 0.01;

^a List B vs. List A Trial 1;

^b List A: Short Delay vs. Trial 5;

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^cBased on Learning List A Trials 1-5;
^dBased on Long Delay Free Recall vs Trial 5

Table 3**EOPD youth: Regression Predicting Total Recall Trial 1-5**

	B	SE	Beta	t	Sig
Emotional Functioning T-Score (D-REF)	-0.64	0.18	-0.52	-3.52	0.001
PTSD Re-experiencing symptoms (CAPS-CA)	-2.64	0.84	-0.40	-3.14	0.002
Executive Function Quotient (D-KEFS)	0.29	0.13	0.22	2.29	0.025
PTSD Avoidance symptoms (CAPS-CA)	1.67	0.73	0.31	2.27	0.026
Withdrawn/Depressed Categorization (YSR)	-4.84	2.25	-0.21	-2.15	0.035
Aggressive Behavior T-score (YSR)	0.30	0.14	0.29	2.10	0.040
Age of Alcohol Use Onset (CDDR)	-0.88	0.48	-0.17	-1.83	0.071

$F(7,74)=6.776$; $p < 0.001$; $R^2=.391$

Table 4
EOPD youth: Partial Correlations Controlling for Emotion Regulation

		Correlations		Partial Correlation
	N	CVLT-2 Trials 1-5 Total (T-score)	Emotion Regulation (D-REF T-score)	CVLT-2 Trials 1-5 Total (T- score)
Withdrawn/Depressed (YSR T-Score)	93	-0.218 *	0.424 **	-0.090
Executive Function Quotient (DKEFS)	88	0.377 **	-0.229 *	0.303 **
Receptive Vocabulary (PPVT-4 Standard Score)	90	0.303 **	-0.033	0.252 *
Attention (YSR T-Score)	93	-0.209 *	0.487 **	-0.036
Aggressive (YSR T-Score)	93	-0.129	0.731 **	0.170
PTSD Re-experiencing Symptoms	93	-0.184	0.274 **	-0.151
PTSD Avoidance Symptoms	93	-0.004	0.358 **	0.079
PTSD Arousal Symptoms	93	-0.165	0.384 **	-0.090
Alcohol Use Onset Age	91	-0.085	-0.176	-0.164

*
 $p < 0.05$ (2-tailed);

**
 $p < 0.01$ (2-tailed)