Adverse childhood experiences and psychotic-like experiences are associated above and beyond shared correlates: Findings from the adolescent brain cognitive development study

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A B S T R A C T

Adverse childhood experiences (ACEs) are associated with increased risk for psychotic-like experiences (PLEs). However, ACEs and PLEs are also both associated with several shared factors (e.g., internalizing symptoms, suicidality). Few studies have explicitly examined whether the association between ACEs and PLEs remains over and above shared correlates. To address this question, using 10,800 9–11-year-olds, we examined whether ACEs and school-aged PLEs were associated when accounting for shared correlates, and whether there was evidence of mediation in associations between PLEs, ACEs, and these shared factors. Greater number of ACEs were associated with greater PLEs, including several specific ACEs (e.g., bullying). Importantly, ACEs and PLEs were related even when accounting for shared correlates. Further, PLEs partially mediated the relationships between ACEs and both internalizing symptoms and suicidality, including suicidal behavior. The current study helps clarify the nature of the associations between PLEs and ACE and has important clinical implications for addressing PLEs.

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1. Introduction

Adverse childhood experiences (ACEs) are a common experience worldwide, with the results of the original ACEs study finding that almost two-thirds of participants reported at least one ACEs before adulthood (CDC and Permanente, 2016). Definitions of ACEs vary, and can encompass a range of experiences, including sexual abuse, physical abuse, emotional/psychological abuse, and peer victimization (e.g., bullying) (Affifi et al., 2020). Research indicates that ACEs may result in neural alterations affecting the hypothalamus-pituitary-adrenal (HPA) axis, thereby leading to a host of functional impairments (Isvoranu et al., 2017). For example, ACEs are associated with greater risk for a range of health problems, including increased risk of anxiety disorders, depression, and psychotic disorders (Croft et al., 2019; Loewy et al., 2019). However, research is limited regarding the extent of these associations in school-age children, particularly in relation to psychotic spectrum symptoms. Therefore, the current study examined the associations between ACEs and psychotic-like experiences (PLEs) in a large sample in middle childhood.

PLEs, or nonclinical schizophrenia spectrum symptoms (e.g., unusual beliefs, perceptual abnormalities) in childhood are associated with greater odds of developing psychiatric disorders, including psychotic disorders, during adulthood (Poulton et al., 2000). Importantly, research generally indicates that exposure to childhood ACEs is associated with increased risk of psychotic disorders (Croft et al., 2019; Loewy et al., 2019). A recent meta-analysis found that approximately 87% of individuals at ultra-high risk for psychosis endorse an ACE (Kraan et al., 2015). Some research indicates that specific types of traumatic experiences with intention to harm (Moriyama et al., 2018), such as the experience of bullying (Strauss et al., 2018) or sexual abuse (McGrath et al., 2017), may be most strongly associated with PLEs. However, more work is needed to determine if one or more of these types of ACEs are specifically associated with PLEs, or if there is a more general relationship between ACEs and PLEs.

Critically, ACEs and PLEs are both associated with a number of shared correlates (Fig. 1a) (Isvoranu et al., 2017), including everyday stress (Cristobal-Narvaez et al., 2016), impairments in cognition (e.g., fluid cognition) (Mansueto et al., 2019), depression and generalized anxiety (Barzilay et al., 2019), and suicidality (Grivel et al., 2018), including both suicidal ideation and suicidal behavior (e.g., attempts) (Gaweda et al., 2020; Merrick et al., 2017; Yates et al., 2019). In addition, family history of mental illness (e.g., family history of psychosis) is a risk factor for both PLEs and ACEs (Felitti et al., 1998; Polanczyk et al., 2010). However, few studies have examined evidence that the association...
between ACEs and PLEs remains over and above these shared correlates (Arseneault et al., 2011; Barzilay et al., 2019). For example, ACEs and PLEs might appear to be related because they are both associated with stress, internalizing symptoms, and impaired cognitive function, but may no longer demonstrate an independent relationship to each other once accounting for these shared correlates.

There is a need for more research on the interrelationships of PLEs, ACEs and their shared correlates, specifically to begin to understand the nature of these associations, including whether PLEs are the mechanism underlying the association between ACEs and other negative psychopathological correlates (i.e., greater anxiety/depression and suicidality). Research has focused on internalizing symptoms and cognitive impairments as potential mediators of the association ACEs and PLEs (Fig. 1b) (Gaweda et al., 2019; Mansueto et al., 2019; Williams et al., 2018). There is evidence that depression and anxiety partially mediate the association between trauma and PLEs (Fisher et al., 2013). However, conceptually, previous research also supports the possibility that PLEs lead to increased anxiety and depressive symptoms and suicidal outcomes following a trauma (Conus et al., 2010; Gaweda et al., 2020), suggesting the possibility that PLEs might mediate at least some aspects of the relationships between ACEs and other mental health outcomes (Fig. 1c). Along these lines, there is support for PLEs mediating the association between ACEs and suicidality (Gaweda et al., 2020). Thus, while evidence indicates that PLEs mediate the association between ACEs and suicidality, the direction of mediation is less clear for other correlates, such as internalizing symptoms (i.e., whether PLEs mediate the association between ACEs and internalizing symptoms, or whether internalizing symptoms mediate the association between ACEs and PLEs). Clarifying these interrelationships has important clinical implications, including understanding the mechanisms contributing to the development of PLEs and other negative psychopathological correlates.

The current study examined the associations between ACEs and PLEs using data from 9 to 11-year-olds in the Adolescent Brain Cognitive Development (ABCD) study. First, we examined whether, as expected, greater endorsement of ACEs is associated with greater report of PLEs. We also examined whether PLEs were associated with specific types of ACEs, such as sexual abuse, physical abuse, and bullying. Also, given evidence for shared correlates between ACEs and PLEs, we examined whether the association between ACEs and PLEs remained when accounting for stress, cognitive deficits, internalizing symptoms, family history of psychosis, and suicidality. Lastly, we examined whether there was evidence of PLEs mediating the association between ACEs and stress, fluid cognition, internalizing symptoms, suicidality or vice versa.

Fig. 1. Illustration of the potential relationships among ACES, PLEs and shared correlates. A: Representation of evidence that ACEs, PLEs, and a number of factors are all intercorrelated based on prior research; B: A model whereby the shared correlates of ACES and PLEs mediate the relationship between ACEs and PLEs; C: A model whereby PLEs mediate the relationship between ACES and these shared correlates.
2. Materials and methods

2.1. Participants

A sample of 11,874 individuals was obtained from the ABCD study, a large-scale study tracking 9–11-years-olds recruited from 21 research sites across the United States. Study exclusion criteria are listed in Supplement. All procedures comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. All parents provided written informed consent and all children provided assent.

ABCD data were accessed from the National Institutes of Mental Health Data Archive (Acknowledgments). Participants were removed from analyses due to missing data (n = 1074; Supplemental Table 1). The final sample size was 10,800 individuals (47.9% female; 52.8% White, 20.0% Hispanic, 14.5% African American, 2.2% Asian, and 10.6% Other).

2.2. Measures

2.2.1. Symptom measures

Child participants completed the Prodomal Questionnaire-Brief Child Version (PQ-BC), a 21-item self-report questionnaire that has been previously validated for use with school-age children using the ABCD sample (Karcher et al., 2018). Consistent with previous research (Karcher et al., 2018; Loewy et al., 2011), distress scores were calculated, which are the sum of total endorsed questions weighted by level of distress (i.e., 0 = no, 1 = yes (but no distress), 2–6 = yes (1 + score on distress scale)). PQ-BC distress scores were also divided into two separate scores, one for questions pertaining to unusual beliefs and another for perceptual abnormalities in follow-up analyses (Supplemental Table 2) (Karcher et al., 2019).

The parent and child versions of the validated and computerized Kiddie-Structured Assessment for Affective Disorders and Schizophrenia (K-SADS) for DSM-5 (Kobak et al., 2013, April) were used as measures of other psychopathology (Barch et al., 2018). The computerized self-administered parent and child versions of the K-SADS show good to excellent concordance with the clinician-administered computerized K-SADS (Townsend et al., 2020). The ACES variable was defined as summations of parent-rated child experience of traumatic experiences from the K-SADS, a parent-rated question from the K-SADS about whether the child was bullied at school or in the neighborhood, and seven parent-rated questions of financial adversity from a demographic questionnaire (e.g., “Were evicted from your home for not paying the rent or mortgage?”; see Supplement for all financial adversity questions, results using an alternative definition of ACES; Supplemental Table 3 for frequencies of endorsement of each ACE). Therefore, our definition of ACES included a number of traumatic life experiences and chronic financial stress. Information regarding the timing of ACE and onset of PLEs is not available in the ABCD sample, precluding the ability to examine causal associations.

In addition, internalizing symptoms were examined using summations of current child-rated depression and generalized anxiety disorder (GAD) symptoms from the K-SADS (see Supplement for analyses with externalizing symptoms). Suicidality was examined using summations of endorsements of current child-rated suicidal ideation (i.e., thinking of a method for a suicide attempt, suicidal thinking with intent to act, thinking of a specific suicidal plan) and suicidal behavior (i.e., self-injury with intent to die, self-injury and thinking you could die from behavior, made preparation for a suicide attempt, aborted or interrupted suicide attempts, the method of an actual suicide attempt, or a suicide attempt in which they thought they could die) from the K-SADS. Stress was measured using the stress subscale from the parent-rated Child Behavior Checklist (Achenbach, 2009).

2.2.2. Other measures

Participants completed all National Institutes of Health Toolbox Cognitive Battery (NIHTB-CB) tests (Weintraub et al., 2014). The current study utilized uncorrected NIHTB-CB fluid composite scores, but all analyses include age and sex as covariates (see Supplement and Weintraub et al., 2013 for descriptions of individual NIHTB-CB tests and for analyses for total composite scores). The family history of psychotic disorder in first-degree relatives was assessed using the parent-rated Family History Assessment Module Screener (Rice et al., 1995), with each score as either present or absent.

2.3. Statistical analyses

The analyses used hierarchical linear models (HLMs), with all multiple comparisons False Discovery Rate corrected (FDR-corrected). Analyses were conducted in R lme4 package (Bates et al., 2015) (multicomp package for multiple comparison analyses (Hothorn et al., 2008)), with family unit and research site modeled as random intercepts, and age, sex (see Supplement for additional analyses of sex differences), and race/ethnicity included as covariates. Results are expressed as standardized estimates (βs) with 95% bootstrapped (5000 iterations) confidence intervals (Cs). Due to significant skew and zero inflation of PQ-BC scores, we also examined log-transformed scores, with consistent results. Differences between significant correlations with each type of ACE were examined using Meng’s z-test procedures (Meng et al., 1992). HLMs examined the association between PLEs and a) number of ACES, and b) individual ACES (and ACE composites of accidents, disaster, physical abuse, emotional abuse, and sexual abuse; Table 1). Associations between ACES and individual PLE items were analyzed using ordered logistic regressions (R package ordinal (Christensen, 2015)). We also examined whether associations between PLEs and number of ACES remained when accounting for shared correlates, including family history of psychosis, stress, fluid cognition, internalizing symptoms, and suicidality. We performed model-based mediation analyses using the lavaan package in R (Rosseel, 2012) to better understand whether PLEs mediated the association between ACES and stress, fluid cognition, internalizing symptoms, and/or suicidality.

3. Results

3.1. Associations between PLEs and ACES

Greater number of ACES were associated with greater PLEs (β = 0.102, p < .001, full model R² = 0.320, partial R² = 0.033; Table 1). In terms of covariates, being African American (β = 0.306, FDR-corrected p < .001), Hispanic (β = 0.225, FDR-corrected p < .001), male (β = −0.053, FDR-corrected p = .004), and younger (β = −0.052, FDR-corrected p < .001) were all significantly associated with greater PLEs.

3.1.1. Associations between PLEs and individual ACES

In a model including all of the individual ACES simultaneously, greater PLEs were associated with several specific ACES, including witnessing domestic violence (β = 0.100, FDR-corrected p = .04; partial R² = 0.025), traumatic grief (β = 0.066, FDR-corrected p = .025; partial R² = 0.025), bullying (β = 0.304, FDR-corrected p < .001; partial R² = 0.037), and financial adversity (β = 0.046, FDR-corrected p < .001; partial R² = 0.028). Note, these results did not change when removing low frequency ACE items (i.e., <1% reported frequency), or when using ACE composite scores (Table 1). Bullying was significantly more strongly related to PLEs than witnessing domestic violence (Z = 16.354, p < .001), traumatic grief (Z = 18.593, p < .001), or financial adversity (Z = 20.664, p < .001). Furthermore, witnessing domestic violence was significantly more strongly related to PLEs than either traumatic grief (Z = 2.866, p = .002) or financial adversity (Z = 5.086, p < .001).
with the shared correlates remained significant when the ACE composite score were in the model (Table 2).

3.3. Evidence of PLEs mediating associations between ACEs and shared correlates

Given the evidence for associations between these shared correlates and both ACEs and PLEs, we next examined whether there was evidence of PLEs mediating the associations between ACEs and these shared correlates. There was evidence that PLEs partially mediated the relationship between ACEs and internalizing symptoms (Supplemental Fig. 1; indirect effect [path ab] bias-corrected 95%CI:0.028–0.048; proportion mediated = 41.30%). In contrast, we found that evidence that internalizing symptoms mediated only 1.55% of the association between ACEs and PLEs.

There was also evidence that PLEs partially mediated the relationship between ACEs and suicidality (Fig. 2; indirect effect [path ab] bias-corrected 95%CI:0.017–0.032; proportion mediated = 46.30%). In contrast, we found evidence that suicidality only mediated 2.02% of the association between ACEs and PLEs. We found evidence that PLEs mediated 37.50% of the association between ACEs and suicidal ideation and 58.49% of the association between ACEs and suicidal behavior. In terms of other shared correlates (i.e., fluid cognition, and stress, there was evidence that PLEs mediated ~7.55% of these associations. However, there was evidence that family history of psychosis mediated 28.57% of the association between ACE and PLE, fluid cognition mediated 8.33% of the association between ACE and PLE, and stress mediated 20.0% of the association between PLEs and ACEs.

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4. Discussion

Using data from the ABCD study, a prospective longitudinal study assessing children aged 9–11 years old, we found that exposure to adverse experiences during childhood was associated with psychotic-like experiences. Critically, this association was not explained by a range of other predictors of psychotic-like experiences, including genetic risk for psychotic disorders, general stress, cognitive impairment, internalizing symptoms, and suicidality, indicating a relationship between ACEs and PLEs that exists above and beyond these shared correlates. Exposure to adverse experiences in general was associated with psychotic experiences, but several types of adverse experiences were individually associated with PLEs, including bullying, financial adversity, domestic violence exposure, and traumatic grief. The current study also found evidence consistent with PLEs mediating the association between adverse experiences and both internalizing symptoms and suicidality (especially suicidal behavior).

Our findings of an association between adverse experiences and PLEs replicates several lines of previous research connecting trauma and psychotic experiences (Bailey et al., 2018; Cristobal-Narvaez et al., 2016; Croft et al., 2019; Fisher et al., 2013; Loewy et al., 2019; Strauss et al., 2018; Varese et al., 2012). However, some research has failed to find associations between trauma and psychosis (for reviews of studies, including studies that failed to find a significant effect, see (Bailey et al., 2018)), lending credence towards the possibility that childhood and adolescence is a particularly sensitive time for this association. Exposure to adverse experiences in general was associated with psychotic experiences, but several types of adverse experiences were individually associated with PLEs, including bullying, financial adversity, domestic violence exposure, and traumatic grief. The current study also found evidence consistent with PLEs mediating the association between adverse experiences and both internalizing symptoms and suicidality (especially suicidal behavior).

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The current study makes an important contribution finding an association between ACEs and PLEs, demonstrating that this relationship exists above and beyond associations with shared correlates, consistent with previous work (Barzilay et al., 2019). Furthermore, this work points to some specificity in this relationship both on the part of ACEs and PLEs, with certain ACEs more strongly associated with PLEs, including bullying, financial adversity, witnessing domestic violence, and traumatic grief. Furthermore, in terms of PLEs, suspiciousness, grandiosity, and perceptual abnormalities may be more strongly associated with ACEs. Lastly, this work found evidence consistent with PLEs mediating associations between trauma and both internalizing symptoms and suicidality. This work has important implications regarding mechanisms underlying the development of negative psychological outcomes and implications for treatment pathways following trauma. The results of the current study suggest that subsequent to a client’s disclosure of trauma, clinicians should assess PLEs. Additionally, following client endorsement of PLEs, clinicians should consider using evidence-based assessments to determine the presence of trauma and, if found, trauma-focused interventions that address PLEs (Folk et al., 2019) as a tool for potentially reducing associated internalizing symptoms and suicidality following trauma.

**Author contributions**

N.R.K. and D.M.B. developed the study concept/design. Data analysis and interpretation was performed by N.R.K. under the supervision of T.A.N. and D.M.B. N.R.K. drafted the paper, and T.A.N. and D.M.B. provided critical revisions. All authors approved the final version of the paper for submission.

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**Declaration of competing interest**

T. Niendam is a co-founder and shareholder in Safari Health, Inc.

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