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Associations of Early-Life Threat and Deprivation With Executive Functioning in Childhood and Adolescence
A Systematic Review and Meta-analysis

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Supplemental content

Editorial

IMPORTANCE Many studies have demonstrated an association between early-life adversity (ELA) and executive functioning in children and adolescents. However, the aggregate magnitude of this association is unknown in the context of threat and deprivation types of adversity and various executive functioning domains.

OBJECTIVE To test the hypothesis that experiences of deprivation are more strongly associated with reduced executive functioning compared with experiences of threat during childhood and adolescence.

DATA SOURCES Embase, ERIC, MEDLINE, and PsycInfo databases were searched from inception to December 31, 2020. Both forward and reverse snowball citation searches were performed to identify additional articles.

STUDY SELECTION Articles were selected for inclusion if they (1) had a child and/or adolescent sample, (2) included measures of ELA, (3) measured executive functioning, (4) evaluated the association between adversity and executive functioning, (5) were published in a peer-reviewed journal, and (6) were published in the English language. No temporal or geographic limits were set. A 2-reviewer, blinded screening process was conducted.

DATA EXTRACTION AND SYNTHESIS PRISMA guidelines were used to guide data extraction and article diagnostics (for heterogeneity, small study bias, and p-hacking). Article quality was assessed, and data extraction was performed by multiple independent observers. A 3-level meta-analytic model with a restricted maximum likelihood method was used. Moderator analyses were conducted to explore heterogeneity.

MAIN OUTCOMES AND MEASURES Primary outcomes included measures of the 3 domains of executive functioning: cognitive flexibility, inhibitory control, and working memory.

RESULTS A total of 91 articles were included, representing 82 unique cohorts and 31 188 unique individuals. Deprivation, compared with threat, was associated with significantly lower inhibitory control ($F_{1,90}$ = 5.69; P = .02) and working memory ($F_{1,54}$ = 5.78; P = .02). No significant difference was observed for cognitive flexibility ($F_{1,36}$ = 2.38; P = .12). The pooled effect size of the association of inhibitory control with deprivation was stronger (Hedges g = −0.43; 95% CI, −0.57 to −0.29) compared with threat (Hedges g = −0.27; 95% CI, −0.46 to −0.08). The pooled effect size of the association of working memory with deprivation was stronger (Hedges g = −0.54; 95% CI, −0.75 to −0.33) compared with threat (Hedges g = −0.28; 95% CI, −0.51 to −0.05).

CONCLUSIONS AND RELEVANCE Experiences of both threat and deprivation in childhood and adolescence were associated with reduced executive functioning, but the association was stronger for exposure to deprivation. Efforts to address the consequences of ELA for development should consider the associations between specific dimensions of adversity and specific developmental outcomes.

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Early-life adversity (ELA) encompasses a wide range of experiences and exposures, including physical and sexual abuse, violence, neglect, and institutional rearing. It has been estimated that approximately half of all adolescents in the United States have reported at least 1 lifetime ELA.[1] Extensive research has found that ELA is associated with alterations in psychological, cognitive, and neurobiological development. Meta-analyses consistently show an association between ELA and conditions such as anxiety, depression, attention-deficit/hyperactivity disorder, conduct disorder, suicidality, and substance use disorder.[1-14] Evidence suggests that such associations may be mediated by neurocognitive development.[15-20] For example, ELA may encumber the development of key neurocognitive processes, which, in turn, may increase the risk of psychopathology.[15-20] However, a source of ambiguity in the field of childhood adversity is that research often models ELA using the cumulative risk approach (ie, the sum of adversities experienced) but pays minimal attention to the differential risk conferred by different types of ELA. As a result, associations between particular types of ELA and specific neurocognitive processes that mechanistically connect ELA with mental health may go undetected.[21] In this systematic review and meta-analysis, we directly addressed this gap in the literature by examining the association between the type of ELA and executive functioning in children and youth.

Executive functioning consists of top-down, effortful cognitive processes that enable an individual to control cognition, plan actions, solve problems, and engage in goal-directed behavior.[22] Childhood and adolescence are characterized by heightened brain plasticity, the ability of the brain to change in response to environmental experience. Heightened plasticity during childhood may lead to changes in executive functioning for those who were exposed to ELA, which can have cascading implications for psychopathology, health problems, and impairments in social, emotional, and academic functioning.[22] Although multiple taxonomies have been proposed in the classification of executive functioning, a well-supported model posits that executive functioning can be divided into 3 interconnected domains: cognitive flexibility, inhibitory control, and working memory.[23]

The Dimensional Model of Adversity and Psychopathology (DMAP) proposes that ELA has core dimensions that are uniquely associated with the trajectories of neurobiological, cognitive, and socioemotional difficulties.[24] According to the DMAP, specific ELA types can be mapped onto 2 broad dimensions of adversity: threat and deprivation.[24] Threat is the harm, or threat of harm, to the physical integrity of the child and includes experiences of abuse as well as exposures to intimate partner or community violence. In contrast, deprivation consists of the absence of expected environmental input and complexity, including poor cognitive, linguistic, and socioemotional stimulation. Experiences of physical and emotional neglect, institutional rearing, and food insecurity are core examples of deprivation.

The DMAP yields different hypotheses of how and to what extent different dimensions of adversity (threat and deprivation) are associated with executive functioning. The DMAP suggests that the lack of environmental complexity and stimulation that characterizes deprivation will have more substantial consequences for executive functioning than exposure to threat because of the hypothesized association of deprivation with brain networks that support executive functioning.[25,26] Associations between deprivation and executive functioning have been widely observed. For example, neglect has been associated with impairment in cognitive flexibility, inhibitory control, and working memory, and these associations were mediated by atypical neural development.[27] Similarly, institutional rearing has been associated with persistent executive functioning difficulties throughout childhood and adolescence.[20]

Direct comparisons of the association of threat and deprivation with executive functioning reveal somewhat disparate associations. For example, deprivation compared with threat has been associated with worse performance on cognitive control tasks in young children[28] and a better mediator of the association between low socioeconomic status (SES) and executive functioning.[29] Similar associations have been observed in adolescence, with deprivation being associated with poorer cognitive control compared with threat.[30] These findings suggest different neurodevelopmental correlates of threat and deprivation, with possible consequences for psychopathology. For example, cognitive deficits were found to mediate the association of deprivation, but not threat, with externalizing psychopathology in adolescence.[21] Nonetheless, the magnitude of the association of threat and deprivation with various executive functioning domains has not been systematically explored in the extant literature.

Previous systematic reviews and meta-analyses have examined the association between ELA and executive functioning, but these studies either (1) conducted nonquantitative reviews of general ELA and executive functioning[31]; (2) treated adversity as a composite measure[32-34]; or (3) examined ELA types according to some other classification system, such as familial or nonfamilial adversity.[35] Informed by the growing literature that suggests differences in the quality and strength of the association between threat or deprivation and executive functioning, we conducted a systematic review and meta-analysis. We aimed to test the DMAP-derived hypothesis that

Key Points

Question Is the association of executive functioning with early-life experiences of threat different from its association with early-life experiences of deprivation in children and adolescents?

Findings In this systematic review and meta-analysis of 91 studies, early-life deprivation had a stronger association with the domains of inhibitory control and working memory than early-life threat. No differences in the association of threat and deprivation with cognitive flexibility were observed.

Meaning Early-life adversity was associated with reduced executive functioning among children and adolescents, and those who were exposed to deprivation may be at an increased risk for executive functioning difficulties compared with those who were exposed to threat.

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experiences of deprivation are associated with reduced executive functioning to a greater extent compared with experiences of threat during childhood and adolescence. This investigation may offer insights into how experiences of threat and deprivation present different levels of vulnerability to those with executive functioning difficulties. We believe the findings may inform strategies for early identification, prevention, and intervention to mitigate the cascading consequences of atypical neurocognitive development on subsequent psychopathology.

Methods

We followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) reporting guideline and preregistered the study on PROSPERO (eMethods 1 in the Supplement).[36] Potentially relevant articles were identified by searching multiple online databases (Embase, ERIC, MEDLINE, and PsycInfo) from inception through December 31, 2020. Search terms were mapped onto the domains of ELA, executive functioning, and study population of children and adolescents (eTable 1 in the Supplement). The population, exposure, comparator, and outcomes of the study are outlined in eTable 2 in the Supplement.

To be included, an article must be a quantitative analysis, have a sample of children and/or adolescents from birth to 18 years of age, include measures of ELA, have evaluated executive functioning as well as the association between adversity and executive functioning, be published in a peer-reviewed journal, and be written in the English language (eTable 3 in the Supplement lists the full inclusion and exclusion criteria). No temporal or geographic limits were set. We used a 2-independent reviewer process (D.J., J.P., M.L., A.D., and Q.H.) at all 3 levels of blinded screening and data extraction. Abstract and full-text screening were conducted with Covidence software, version 2625, and data extraction was conducted in Microsoft Excel, version 2105 (eTable 4 in the Supplement).[37] Disagreements were addressed through group consensus. One of us (D.J.) conducted both forward and reverse snowball citation searches to identify additional articles for inclusion.[38]

The Newcastle-Ottawa Scale was used to descriptively report risk of bias within individual cohort studies.[39] Although the Newcastle-Ottawa Scale does not provide an overall score, it is useful for providing descriptive information for 3 article quality domains: selection, comparability, and outcome. Selection relates to how the cases of exposure or nonexposure to ELA were identified. Comparability conveys how well the article adjusted for important covariates or effect modifiers. Outcome pertains to how the outcome was assessed, including the time between exposure and outcome as well as the dropout rate.

Consistent with previous research, this study defined threat-related adversities as including exposures that involved harm or threat of harm, such as physical, sexual, or emotional abuse, and any exposure to violence in or outside the home.[40] Deprivation-related adversities included experiences in which the child was deprived of expected environmental stimulation, including physical and emotional neglect, institutionalization or foster care, and food insecurity.[40] A dichotomous variable was generated to specify an outcome as a threat or a deprivation exposure or experience (threat = 0 and deprivation = 1). Based on research conducted by Miyake et al,[23] outcome measures of executive functioning were categorized as cognitive flexibility, inhibitory control, or working memory and then given a quality score (low, medium, or high) based on a similar meta-analysis that considered how specific measures tapped into specific domains of executive functioning (eTable 5 in the Supplement).[23,33]

In many instances, the same article used multiple measures of association (eg, multiple types of ELA or executive functioning were assessed). Multiple articles that used the same cohorts were identified and treated as nonindependent samples. When true redundancies were observed (ie, same variable and same outcome measure), we considered adjustment for covariates, sample size, and how well the data mapped onto the conceptualization of the exposure and outcome in deciding which articles to include (see eTable 6 in the Supplement for decision rules). Specifically, articles were excluded for having an incorrect sample age (n = 91); being nonquantitative or providing insufficient data (n = 69); having no measure of ELA or the entire sample exposed to ELA (n = 81); having no measure of cognitive flexibility, inhibitory control, or working memory (n = 100); not being published in the English language (n = 10); or being a duplicate (n = 4).

Statistical Analysis

To correct for small sample sizes, we standardized measures of association into Hedges *g* effect sizes.[41-43] Three-level meta-analyses with restricted maximum likelihood estimation were conducted to account for the nonindependence of effect sizes, using the metafor package in R, version 4.0.2 (R Foundation for Statistical Computing).[44-46] In these models, each unique article (article_ID) and each unique cohort (cohort_ID) were included as random effects to account for statistical dependency (ie, nonindependence). Thus, the 3-level meta-analyses accounted for dependency of effect sizes (level 1) derived from articles (level 2) that used the same cohort (level 3). To generate a pooled estimate of the association of any adversity with executive functioning, we conducted meta-analyses for each executive functioning domain. To directly assess the differential associations of threat and deprivation with each outcome, we selected a subsample of effect sizes that could be categorized into 1 of these 2 dimensions to serve as the data set for testing the primary hypothesis.

Moderator analyses were conducted for both the full sample and the threat or deprivation subsample (eMethods 2 in the Supplement). The significance threshold was set at $\alpha = .05$. Significant moderators were stratified, and pooled estimates were reported for each category. In addition to the dimension of ELA (ie, threat vs deprivation), moderators included sample age at assessment, sex (percentage of female individuals), race/ethnicity (percentage of individuals from a racial/ethnic minority group), and SES (percentage of individuals with low SES as defined in the articles) as well as ar-

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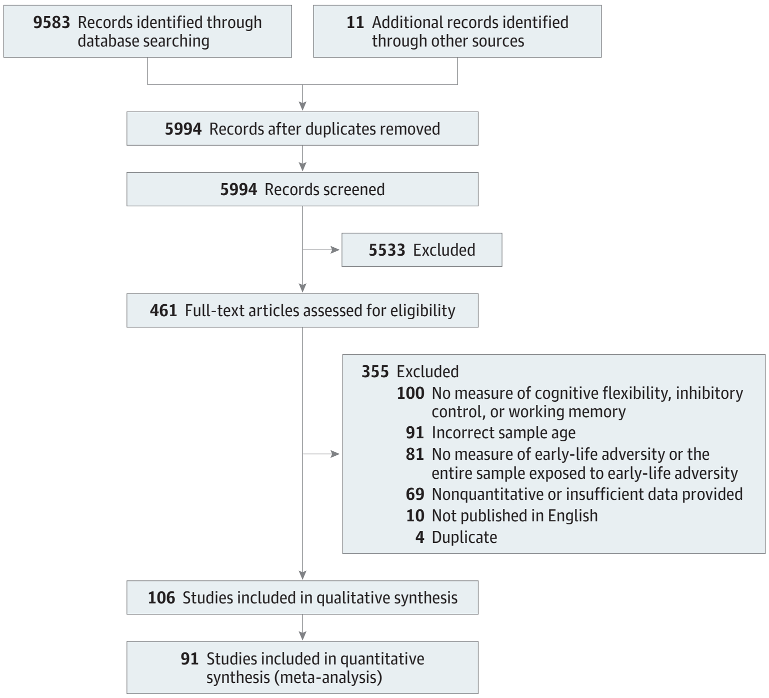
Figure. PRISMA Flow Diagram



ticle impact factor (log-transformed), study design (longitudinal vs cross-sectional), outcome quality, selection quality, and covariate adjustment.

Heterogeneity within effect sizes, heterogeneity between effect sizes from the same article, and heterogeneity between effect sizes from the same cohort were plotted using the dmetar package in R.[47] Significance of heterogeneity was explored by calculating Cochran *Q* and I^2 statistics.

Publication bias was explored using a modified Egger regression model selected to account for the nonindependence of effect sizes.[48] Funnel plots were generated to further explore potential publication bias. Risk of p-hacking was explored through *P*-curve analyses.

Results

The selection of articles is presented in the **Figure**. The literature search yielded 9583 articles, with 3600 duplicates. A total of 5998 abstracts were screened, of which 461 were deemed eligible for full-text screening. A total of 106 relevant articles were included; however, 15 articles were identified as redundant in the presence of more relevant articles that used the same sample. After the removal of redundancies, 91 articles[18,20,28,30,49-135] were included in the meta-analysis. Eleven of these articles[49,59,68,74,76,91,99,105,116,117,122] were identified from the references of included articles.

A total of 307 outcomes were extracted from the 91 articles, representing 82 cohorts (with a median [range] of 108 [22-11 750] individuals per cohort) and 31 188 unique individuals. The full sample comprised 50.6% female and 49.4% male individuals aged 1 to 18 years. The mean (SD) impact factor of the included articles was 2.58 (1.68) and ranged from 0.20 to 14.12. Longitudinal design was used in 20 articles (22.0%).[20,49,54,65,66,70,71,75,76,80-82,89,95,97,109,123,126,131,133] Regarding the quality of outcome measures, 115 of 307 (37.5%) had a low quality score, 90 (29.3%) had a medium quality score, and 102 (33.2%) had a high quality score; 65 of the included measures (21.1%) were adjusted for covariates. The number of associations captured for each outcome measure were 78 for cognitive flexibility, 140 for inhibitory control, and 89 for working memory. Article characteristics and quality assessment are presented in eTables 7 and 8 in the Supplement.

Any Childhood Adversity and Executive Functioning

The pooled estimates of the association of any childhood adversity with cognitive flexibility (Hedges $g = −0.49$; 95% CI, −0.64 to −0.34) showed significant heterogeneity ($Q_{77} = 631.63$; $P < .001$; $I^2 = 97.41$). Evidence of significant publication bias was not observed when carrying out a modified Egger linear regression test, accounting for the nonindependence of effect sizes ($t = −1.89$; $P = .08$). The pooled estimates of the association of any childhood adversity with inhibitory control (Hedges $g = −0.39$; 95% CI, −0.50 to −0.29) showed significant heterogeneity ($Q_{139} = 1432.15$; $P < .001$; $I^2 = 95.24$). Evidence of significant publication bias was observed from a modified Egger linear regression test, accounting for the nonindependence of effect sizes ($t = −3.15$; $P < .01$). The pooled estimates of the association of any childhood adversity with working memory (Hedges $g = −0.47$; 95% CI, −0.60 to −0.34) showed significant heterogeneity ($Q_{88} = 1319.48$; $P < .001$; $I^2 = 98.24$). Evidence of publi-

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cation bias was observed from the modified Egger linear regression test, accounting for the nonindependence of effect sizes (t = −2.67; P < .05). Further details of the any childhood adversity sample results are provided in eMethods 3 to 6 and eFigures 1 to 6 in the Supplement.

Differential Associations of Threat and Deprivation

The subsample of ELA–executive functioning association that was categorized as threat or deprivation (n = 187) was analyzed in 56 of 91 articles (61.5%),[18,20,28,30,49,51,52,55,57,59-62,65,70,71,74,76,79,81-83,85-88,90-97,100,101,103,105,106,108,109,111,114,116,117,120,122-124,126,127,129-131,133,135] which represented 49 cohorts and 25 679 unique individuals. The cognitive flexibility analysis included the association with 15 deprivation and 23 threat effect sizes; the inhibitory control analysis included 52 deprivation and 41 threat effect sizes; and the working memory analysis included 33 deprivation and 23 threat effect sizes. Results presented herein pertain only to this subsample. All P-curve analyses and funnel plots are presented in eFigures 1 to 12 in the Supplement.

Cognitive Flexibility

eFigure 13 in the Supplement shows the pooled effect sizes of the association between ELA and cognitive flexibility.[51,52,59,61,82,83,86,87,91,93,97,108,117,120,127,133,135] Adversity type did not moderate this association ($F_{1,36}$ = 2.38; P = .12). Thus, no differences were observed in the effect sizes for exposure to deprivation compared with threat. Diagnostic test results for heterogeneity, small study bias, and p-hacking are displayed in eMethods 7, eMethods 8, eFigure 7, and eFigure 8 in the Supplement.

Inhibitory Control

eFigure 14 in the Supplement shows the pooled effect sizes of the association between ELA and inhibitory control.[18,28,30,51,52,55,57,60-62,65,70,74,79,81,82,86,91,93-96,101,103,105,106,108,109,111,114,122,123,126,127,129,131,135] Adversity type moderated this association ($F_{1,90}$ = 5.69; P = .02). Significantly lower inhibitory control was observed for exposure to deprivation (Hedges g = −0.43; 95% CI, −0.57 to −0.29) compared with exposure to threat (Hedges g = −0.27; 95% CI, −0.46 to −0.08).

The stratified association of deprivation exposure with inhibitory control was not moderated by sample age or sex or by article impact factor, study design, outcome quality, selection quality, or covariate adjustment. In 12 articles that reported on race/ethnicity[18,28,30,79,95,96,106,109,123,126,129,135] and 6 that reported on SES,[18,55,106,109,129,135] neither demographic trait moderated the association between deprivation and inhibitory control. The stratified association between threat exposure and inhibitory control was not moderated by sample age or sex or by article impact factor, study design, outcome quality, selection quality, or covariate adjustment. In 11 articles that reported on race/ethnicity[18,28,30,52,70,79,82,109,122,127,129] and 5 that reported on SES,[18,51,70,109,129] neither characteristic moderated the association between threat and inhibitory control. Diagnostic test results for heterogeneity, small study bias, and p-hacking are displayed in eMethods 7 and 9 and eFigures 9 and 10 in the Supplement.

In articles that specifically investigated the association between deprivation exposure and inhibitory control,[18,28,30,55,57,60,61,65,74,79,81,86,91,93,95,96,103,105,106,108,109,111,114,123,126,129,135] substantial heterogeneity was observed (Q_{51} = 464.77; P < .001; I^2 = 90.14). Evidence of significant publication bias was not observed from the modified Egger linear regression test, accounting for the nonindependence of effect sizes (t = −2.09; P = .06). In articles that specifically investigated the association between threat exposure and inhibitory control,[18,28,30,51,52,62,70,79,82,91,93,94,101,109,122,127,129,131] substantial heterogeneity was observed (Q_{39} = 446.28; P < .001; I^2 = 97.37). Evidence of publication bias was observed from the modified Egger linear regression test, accounting for the nonindependence of effect sizes (t = −4.08; P < .01).

Working Memory

eFigure 15 in the Supplement shows the pooled effect sizes of the association between ELA and working memory.[18,20,49,52,60,61,71,76,82,83,85-88,90,92,93,96,100,108,111,116,117,123,124,129,130,133,135] Adversity type moderated this association ($F_{1,54}$ = 5.78; P = .02). Significantly lower working memory was observed for exposure to deprivation (Hedges g = −0.54; 95% CI, −0.75 to −0.33) compared with exposure to threat (Hedges g = −0.28; 95% CI, −0.51 to −0.05).

The association of deprivation exposure with working memory was moderated by whether the analysis adjusted for covariates, whereby a smaller effect size was observed when covariates were adjusted (Hedges g = −0.46; 95% CI, −0.71 to −0.21) compared with those that were unadjusted (Hedges g = −0.56; 95% CI, −0.85 to −0.30). The association of adversity with working memory was not moderated by sample age or sex or by article impact factor, study design, outcome quality, or selection quality. In 11 articles that reported on race/ethnicity[18,20,49,71,76,92,96,123,124,129,133] and 5 that reported on SES,[18,71,92,129,135] neither characteristic moderated the association between deprivation and working memory. The association of threat exposure with working memory was moderated by sex and selection quality, whereby a smaller effect size was observed in studies with greater selection quality and a higher proportion of female individuals. The association of threat with working memory was not moderated by sample age or by article impact factor, study design, outcome quality, or covariate adjustment. In 8 articles that reported on race/ethnicity[18,52,82,88,116,124,129,133] and 3 that reported on SES,[18,88,129] neither demographic trait moderated the association between threat and working memory. Diagnostic test results for heterogeneity, small study bias, and p-hacking are displayed in eMethods 7 and 10 and eFigures 11 and 12 in the Supplement.

In articles that specifically investigated the association between deprivation exposure and working memory,[18,20,49,60,61,71,76,83,86,87,90,92,93,96,100,108,111,123,124,129,130,133,135] substantial heterogeneity was observed (Q_{32} = 329.70; P < .001; I^2 = 96.94). Evidence of significant publication bias was observed when carrying out the modified Egger linear regression test, accounting for the nonindependence of effect sizes (t = −2.25; P < .05). In articles that specifically investigated the association between threat exposure and working

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memory,[18,52,82,85,88,93,116,117,124,129,133] substantial heterogeneity was observed (Q_{22} = 481.27; P < .001; I^2 = 98.68). Although visual inspection of the funnel plots (eFigure 12 in the Supplement) suggested some degree of publication bias, no evidence of publication bias was found from the moderated Egger linear regression test, accounting for the nonindependence of effect sizes (t = −1.44; P = .23).

Discussion

This systematic review and meta-analysis found that experiences of both threat and deprivation in childhood and adolescence were associated with reduced executive functioning. However, the association was greater in magnitude for experiences of deprivation in the domains of inhibitory control and working memory. Threat and deprivation did not statistically differ in their association with cognitive flexibility. Overall, ELA was associated with reduced executive functioning in all 3 domains of cognitive flexibility, inhibitory control, and working memory. Consistent with the central hypotheses of the DMAP, these results suggest that ELA is associated with lower executive functioning in childhood and adolescence, and this association may be greater in magnitude for experiences of deprivation than for experiences of threat for some domains of executive functioning.

The lack of environmental input and complexity experienced by children and adolescents who were exposed to deprivation may be associated with alterations in neurodevelopment that undergirds the development of executive functioning. For example, a previous systematic review showed that differences in the frontoparietal network that subserves executive functioning were observed more consistently among children who were exposed to deprivation than those who were exposed to threat.[136] However, this previous systematic review did not differentiate between specific executive functioning domains that may be more sensitive to experiences of deprivation vs threat. The results of the current study suggest that inhibitory control and working memory compared with cognitive flexibility have a greater association with deprivation than with threat. The reason for this apparent discrepancy is unclear. Some evidence suggests that individuals who grow up in unpredictable environments may have reduced inhibitory control but enhanced cognitive flexibility.[137,138] To the degree that deprivation captures greater unpredictability compared with threat, the association between deprivation and cognitive flexibility may be attenuated if, for some individuals, this unpredictability enhances cognitive flexibility. In the current study, we did not code for unpredictability, which has several methodological and conceptual challenges.[139] However, future research that uses other dimensional models of adversity is encouraged to better characterize the various types of ELA that children and youth are exposed to, the association of these types with either reduced or enhanced executive functioning, and the conditions under which these associations may emerge.

Executive functioning difficulties are associated with a range of suboptimal developmental outcomes. Reduced inhibitory control is associated with increased risk of psychopathology, substance use disorder, obesity, poor academic performance, and premature mortality,[140,141] whereas reduced working memory is associated with impaired functioning in social and academic contexts.[142,143] Reduced cognitive flexibility is associated with poor psychological well-being and patterns of ruminative thinking[144,145] as well as lower academic performance.[146] Given the wide-reaching consequences of poor executive functioning, the present research supports the potential use of programs, including interventions that are focused on caregiver behavior, that bolster executive functioning among youth who were exposed to ELA, especially early-life deprivation.[147]

We believe this study adds to a growing body of literature on the differences between experiences of threat and experiences of deprivation for the neurocognitive development of children and adolescents. Given the prominent role that executive functioning plays in fostering other developmental competencies, early prevention and intervention programs that are designed to improve executive functioning may help offset the adverse consequences of ELA and promote recovery among those exposed to early threat and deprivation.

Limitations

This study has several limitations. First, substantial heterogeneity was observed in all pooled estimates. Although this finding was consistent with those of another meta-analysis of threat and deprivation outcomes,[148] variation in study designs must be considered when interpreting the findings. We made attempts to identify the factors associated with heterogeneity by performing moderator analyses, in which we considered multiple article characteristics, such as demographics and study design, and used a 3-level approach to account for within-study and between-study variances. Substantial heterogeneity of associations may also be attributable to the differences in timing, duration, or severity of adversity across studies. Thus, future studies are encouraged to directly assess these potential sources of variation in explaining the differences in the magnitude of associations both within and between adversity experiences.

Second, many articles used a cross-sectional design, which precluded any causal conclusions about ELA and executive functioning. For example, previous evidence has shown that children with higher executive functioning might elicit more stimulation from their caregivers, a pathway that is more genetically mediated than the association between deprivation and executive functioning.[149] Moreover, the presence of small study bias could indicate publication bias or reflect the overrepresentation of individuals with more severe difficulties in smaller studies. Specifically, the publication bias observed in this study may increase the effect sizes for threat exposure and suggest that the observed estimate and difference between threat and deprivation may be conservative and should be considered when interpreting the results.

These limitations highlight the need for longitudinal and genetically informed research in the study of threat and deprivation. Future research should explore the differences between threat and deprivation when emotionally salient executive functioning measures are used. Threat experiences are often associated with alterations in emotional processing, and different findings may be observed when investigating emotionally salient executive functioning outcomes.[30]

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Conclusions

Both types of ELA, threat and deprivation, experienced in childhood and adolescence were found to be associated with reduced executive functioning, although this association was greater in magnitude for deprivation exposure for some domains of executive functioning. Future research is encouraged that assesses other types of ELA and that examines the association of these types with executive functioning and the conditions under which these associations may emerge.

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Concept and design: Johnson, Li, Sheridan, McLaughlin, Wade.
Acquisition, analysis, or interpretation of data: Johnson, Policelli, Li, Dharamsi, Hu, McLaughlin, Wade.
Drafting of the manuscript: Johnson.
Critical revision of the manuscript for important intellectual content: All authors.
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REFERENCES

1. McLaughlin KA, Greif Green J, Gruber MJ, Sampson NA, Zaslavsky AM, Kessler RC. Childhood adversities and first onset of psychiatric disorders in a national sample of US adolescents. *Arch Gen Psychiatry*. 2012;69(11):1151-1160. doi:10.1001/archgenpsychiatry.2011.2277

2. Norman RE, Byambaa M, De R, Butchart A, Scott J, Vos T. The long-term health consequences of child physical abuse, emotional abuse, and neglect: a systematic review and meta-analysis. *PLoS Med*. 2012;9(11):e1001349. doi:10.1371/journal.pmed.1001349

3. Carr CP, Martins CMS, Stingel AM, Lemgruber VB, Juruena MF. The role of early life stress in adult psychiatric disorders: a systematic review according to childhood trauma subtypes. *J Nerv Ment Dis*. 2013;201(12):1007-1020. doi:10.1097/NMD.0000000000000049

4. Lindert J, von Ehrenstein OS, Grashow R, Gal G, Braehler E, Weisskopf MG. Sexual and physical abuse in childhood is associated with depression and anxiety over the life course: systematic review and meta-analysis. *Int J Public Health*. 2014;59(2):359-372. doi:10.1007/s00038-013-0519-5

5. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2(8):e356-e366. doi:10.1016/S2468-2667(17)30118-4

6. Oh DL, Jerman P, Silvério Marques S, et al. Systematic review of pediatric health outcomes associated with childhood adversity. *BMC Pediatr*. 2018;18(1):83. doi:10.1186/s12887-018-1037-7

7. Liu RT, Scopelliti KM, Pittman SK, Zamora AS. Childhood maltreatment and non-suicidal self-injury: a systematic review and meta-analysis. *Lancet Psychiatry*. 2018;5(1):51-64. doi:10.1016/S2215-0366(17)30469-8

8. Angelakis I, Gillespie EL, Panagioti M. Childhood maltreatment and adult suicidality: a comprehensive systematic review with meta-analysis. *Psychol Med*. 2019;49(7):1057-1078. doi:10.1017/S0033291718003823

9. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. *Am J Prev Med*. 1998;14(4):245-258. doi:10.1016/S0749-3797(98)00017-8

10. Boynton-Jarrett R, Ryan LM, Berkman LF, Wright RJ. Cumulative violence exposure and self-rated health: longitudinal study of adolescents in the United States. *Pediatrics*. 2008;122(5):961-970. doi:10.1542/peds.2007-3063

11. Green JG, McLaughlin KA, Berglund PA, et al. Childhood adversities and adult psychiatric disorders in the national comorbidity survey replication I: associations with first onset of DSM-IV disorders. *Arch Gen Psychiatry*. 2010;67(2):113-123. doi:10.1001/archgenpsychiatry.2009.186

12. Kessler RC, McLaughlin KA, Green JG, et al. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *Br J Psychiatry*. 2010;197(5):378-385. doi:10.1192/bjp.bp.110.080499

13. Taillieu TL, Brownridge DA, Sareen J, Afifi TO. Childhood emotional maltreatment and mental disorders: results from a nationally representative adult sample from the United States. *Child Abuse Negl*. 2016;59:1-12. doi:10.1016/j.chiabu.2016.07.005

14. Merrick MT, Ports KA, Ford DC, Afifi TO, Gershoff ET, Grogan-Kaylor A. Unpacking the impact of adverse childhood experiences on adult mental health. *Child Abuse Negl*. 2017;69:10-19. doi:10.1016/j.chiabu.2017.03.016

15. McLaughlin KA, Sheridan MA, Lambert HK. Childhood adversity and neural development: deprivation and threat as distinct dimensions of early experience. *Neurosci Biobehav Rev*. 2014;47:578-591. doi:10.1016/j.neubiorev.2014.10.012

16. Snyder HR, Miyake A, Hankin BL. Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. *Front Psychol*. 2015;6:328. doi:10.3389/fpsyg.2015.00328

17. Dannehl K, Rief W, Euteneuer F. Childhood adversity and cognitive functioning in patients with major depression. *Child Abuse Negl*. 2017;70:247-254. doi:10.1016/j.chiabu.2017.06.013

18. Sheridan MA, Peverill M, Finn AS, McLaughlin KA. Dimensions of childhood adversity have distinct associations with neural systems underlying executive functioning. *Dev Psychopathol*. 2017;29(5):1777-1794. doi:10.1017/S0954579417001390

19. Kilian S, Asmal L, Chiliza B, et al. Childhood adversity and cognitive function in schizophrenia spectrum disorders and healthy controls: evidence for an association between neglect and social cognition. *Psychol Med*. 2018;48(13):2186-2193. doi:10.1017/S0033291717003671

20. Wade M, Fox NA, Zeanah CH, Nelson CA III. Long-term effects of institutional rearing, foster care, and brain activity on memory and executive functioning. *Proc Natl Acad Sci U S A*. 2019;116(5):1808-1813. doi:10.1073/pnas.1809145116

21. Miller AB, Sheridan MA, Hanson JL, et al. Dimensions of deprivation and threat, psychopathology, and potential mediators: a multi-year longitudinal analysis. *J Abnorm Psychol*. 2018;127(2):160-170. doi:10.1037/abn0000331

22. Diamond A. Executive functions. *Annu Rev Psychol*. 2013;64:135-168. doi:10.1146/annurev-psych-113011-143750

23. Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, Wager TD. The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. *Cogn Psychol*. 2000;41(1):49-100. doi:10.1006/cogp.1999.0734

24. Sheridan MA, McLaughlin KA. Dimensions of early experience and neural development: deprivation and threat. *Trends Cogn Sci*. 2014;18(11):580-585. doi:10.1016/j.tics.2014.09.001

25. McLaughlin KA, Sheridan MA, Winter W, Fox NA, Zeanah CH, Nelson CA. Widespread reductions in cortical thickness following severe early-life deprivation: a neurodevelopmental pathway to attention-deficit/hyperactivity disorder. *Biol Psychiatry*. 2014;76(8):629-638. doi:10.1016/j.biopsych.2013.08.016

26. Mackes NK, Golm D, Sarkar S, et al; ERA Young Adult Follow-up Team. Early childhood deprivation is associated with alterations in adult brain structure despite subsequent environmental enrichment. *Proc Natl Acad Sci U S A*. 2020;117(1):641-649. doi:10.1073/pnas.1911264116

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27. Cabrera C, Torres H, Harcourt S. The neurological and neuropsychological effects of child maltreatment. *Aggress Violent Behav.* 2020;54:101408. doi:10.1016/j.avb.2020.101408

28. Machlin L, Miller AB, Snyder J, McLaughlin KA, Sheridan MA. Differential associations of deprivation and threat with cognitive control and fear conditioning in early childhood. *Front Behav Neurosci*. 2019;13:80. doi:10.3389/fnbeh.2019.00080

29. Vogel SC, Perry RE, Brandes-Aitken A, Braren S, Blair C. Deprivation and threat as developmental mediators in the relation between early life socioeconomic status and executive functioning outcomes in early childhood. *Dev Cogn Neurosci*. 2021;47:100907. doi:10.1016/j.dcn.2020.100907

30. Lambert HK, King KM, Monahan KC, McLaughlin KA. Differential associations of threat and deprivation with emotion regulation and cognitive control in adolescence. *Dev Psychopathol*. 2017;29(3):929-940. doi:10.1017/S0954579416000584

31. Lund JI, Toombs E, Radford A, Boles K, Mushquash C. Adverse childhood experiences and executive function difficulties in children: a systematic review. *Child Abuse Negl*. 2020;106:104485. doi:10.1016/j.chiabu.2020.104485

32. Masson M, East-Richard C, Cellard C. A meta-analysis on the impact of psychiatric disorders and maltreatment on cognition. *Neuropsychology*. 2016;30(2):143-156. doi:10.1037/neu0000228

33. Op den Kelder R, Van den Akker AL, Geurts HM, Lindauer RJL, Overbeek G. Executive functions in trauma-exposed youth: a meta-analysis. *Eur J Psychotraumatol*. 2018;9(1):1450595. doi:10.1080/20008198.2018.1450595

34. R-Mercier A, Masson M, Bussières EL, Cellard C. Common transdiagnostic cognitive deficits among people with psychiatric disorders exposed to childhood maltreatment: a meta-analysis. *Cogn Neuropsychiatry*. 2018;23(3):180-197. doi:10.1080/13546805.2018.1461617

35. Malarbi S, Abu-Rayya HM, Muscara F, Stargatt R. Neuropsychological functioning of childhood trauma and post-traumatic stress disorder: a meta-analysis. *Neurosci Biobehav Rev*. 2017;72:68-86. doi:10.1016/j.neubiorev.2016.11.004

36. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *J Clin Epidemiol*. 2009;62(10):1006-1012. doi:10.1016/j.jclinepi.2009.06.005

37. Covidence. Systematic review software. Accessed September 15, 2019. http://www.covidence.org

38. Jonkers J. Information literacy history: search methods. Accessed December 16, 2020. https://libguides.rug.nl/c.php?g=470628&p=3218096

39. Wells GA, Shea B, O'Connell D, et al. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Accessed August 12, 2019. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp

40. McLaughlin K. The long shadow of adverse childhood experiences: adverse environments early in life have lasting consequences for children's health and development. American Psychological Association. April 2017. Accessed January 12, 2020. https://www.apa.org/science/about/psa/2017/04/adverse-childhood

41. Durlak JA. How to select, calculate, and interpret effect sizes. *J Pediatr Psychol*. 2009;34(9):917-928. doi:10.1093/jpepsy/jsp004

42. Hedges LV. Distribution theory for Glass's estimator of effect size and related estimators. *J Educ Stat*. 1981;6(2):107-128. doi:10.3102/10769986006002107

43. Hedges L, Olkin I. *Statistical Methods for Meta-Analysis*. Academic Press; 1985.

44. R Foundation for Statistical Computing. A language and environment for statistical computing. Accessed December 16, 2020. https://www.r-project.org/

45. Viechtbauer W. Conducting meta-analyses in R with the metafor package. *J Stat Softw.* 2010;36(3):1-48. doi:10.18637/jss.v036.i03

46. Assink M, Wibbelink CJM. Fitting three-level meta-analytic models in R: a step-by-step tutorial. *Quant Methods Psychol.* 2016;12(3):154-174. doi:10.20982/tqmp.12.3.p154

47. Harrer M, Cuijpers P, Furukawa TA, Ebert DD. *Doing Meta-Analysis in R: A Hands-on Guide*. Accessed December 16, 2020. https://bookdown.org/MathiasHarrer/Doing_Meta_Analysis_in_R/

48. Rodgers MA, Pustejovsky JE. Evaluating meta-analytic methods to detect selective reporting in the presence of dependent effect sizes. *Psychol Methods*. 2020. doi:10.1037/met0000300

49. Almas AN, Degnan KA, Walker OL, et al. The effects of early institutionalization and foster care intervention on children's social behaviors at the age of eight. *Soc Dev*. 2015;24(2):225-239. doi:10.1111/sode.12089

50. Augusti EM, Melinder A. Maltreatment is associated with specific impairments in executive functions: a pilot study. *J Trauma Stress*. 2013;26(6):780-783. doi:10.1002/jts.21860

51. Barrera M, Calderón L, Bell V. The cognitive impact of sexual abuse and PTSD in children: a neuropsychological study. *J Child Sex Abus*. 2013;22(6):625-638. doi:10.1080/10538712.2013.811141

52. Beers SR, De Bellis MD. Neuropsychological function in children with maltreatment-related posttraumatic stress disorder. *Am J Psychiatry*. 2002;159(3):483-486. doi:10.1176/appi.ajp.159.3.483

53. Bergman AJ, Walker E. The relationship between cognitive functions and behavioral deviance in children at risk for psychopathology. *J Child Psychol Psychiatry*. 1995;36(2):265-278. doi:10.1111/j.1469-7610.1995.tb01824.x

54. Bosquet Enlow M, Petty CR, Svelnys C, et al. Differential effects of stress exposures, caregiving quality, and temperament in early life on working memory versus inhibitory control in preschool-aged children. *Dev Neuropsychol*. 2019;44(4):339-356. doi:10.1080/87565641.2019.1611833

55. Bruce J, Fisher PA, Graham AM, Moore WE, Peake SJ, Mannering AM. Patterns of brain activation in foster children and nonmaltreated children during an inhibitory control task. *Dev Psychopathol*. 2013;25(4 Pt 1):931-941. doi:10.1017/S095457941300028X

56. Bruce J, Kim HK. Behavioral and electrophysiological indices of inhibitory control in maltreated adolescents and nonmaltreated adolescents. *Dev Psychopathol*. 2020;1-10. doi:10.1017/S0954579420001819

57. Bruce J, Tarullo AR, Gunnar MR. Disinhibited social behavior among internationally adopted children. *Dev Psychopathol*. 2009;21(1):157-171. doi:10.1017/S0954579409000108

58. Bücker J, Kapczinski F, Post R, et al. Cognitive impairment in school-aged children with early trauma. *Compr Psychiatry*. 2012;53(6):758-764. doi:10.1016/j.comppsych.2011.12.006

59. Burgers DE, Drabick DAG. Community violence exposure and generalized anxiety symptoms: does executive functioning serve a moderating role among low income, urban youth? *J Abnorm Child Psychol*. 2016;44(8):1543-1557. doi:10.1007/s10802-016-0144-x

60. Cardona JF, Manes F, Escobar J, López J, Ibáñez A. Potential consequences of abandonment in preschool-age: neuropsychological findings in institutionalized children. *Behav Neurol*. 2012;25(4):291-301. doi:10.1155/2012/782624

61. Carrera P, Jiménez-Morago JM, Román M, León E. Caregiver ratings of executive functions among foster children in middle childhood: associations with early adversity and school adjustment. *Child Youth Serv Rev.* 2019;106. doi:10.1016/j.childyouth.2019.104495

62. Carrion VG, Garrett A, Menon V, Weems CF, Reiss AL. Posttraumatic stress symptoms and brain function during a response-inhibition task: an fMRI study in youth. *Depress Anxiety*. 2008;25(6):514-526. doi:10.1002/da.20346

63. Carvalho JN, Renner AM, Donat JC, de Moura TC, Fonseca RP, Kristensen CH. Executive functions and clinical symptoms in children exposed to maltreatment. *Appl Neuropsychol Child*. 2020;9(1):1-12. doi:10.1080/21622965.2018.1497989

64. Coe JL, Micalizzi L, Josefson B, Parade SH, Seifer R, Tyrka AR. Sex differences in associations between early adversity, child temperament, and behavior problems. *Int J Behav Dev*. 2020;44(6):490-504. doi:10.1177/0165025420912012

65. Colvert E, Rutter M, Kreppner J, et al. Do theory of mind and executive function deficits underlie the adverse outcomes associated with profound early deprivation? findings from the English and Romanian adoptees study. *J Abnorm Child Psychol*. 2008;36(7):1057-1068. doi:10.1007/s10802-008-9232-x

66. Conradt E, Abar B, Lester BM, et al. Cortisol reactivity to social stress as a mediator of early adversity on risk and adaptive outcomes. *Child Dev*. 2014;85(6):2279-2298. doi:10.1111/cdev.12316

67. Cowell RA, Cicchetti D, Rogosch FA, Toth SL. Childhood maltreatment and its effect on neurocognitive functioning: timing and chronicity matter. *Dev Psychopathol*. 2015;27(2):521-533. doi:10.1017/S0954579415000139

68. De Bellis MD, Woolley DP, Hooper SR. Neuropsychological findings in pediatric maltreatment: relationship of PTSD, dissociative symptoms, and abuse/neglect indices to neurocognitive outcomes. *Child Maltreat*. 2013;18(3):171-183. doi:10.1177/1077559513497420

69. De Bellis MD, Morey RA, Nooner KB, Woolley DP, Haswell CC, Hooper SR. A pilot study of neurocognitive function and brain structures in adolescents with alcohol use disorders: does maltreatment history matter? *Child Maltreat*. 2019;24(4):374-388. doi:10.1177/1077559518810525

70. Delker BC, Noll LK, Kim HK, Fisher PA. Maternal abuse history and self-regulation difficulties in preadolescence. *Child Abuse Negl*. 2014;38(12):2033-2043. doi:10.1016/j.chiabu.2014.10.014

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71. Demeusy EM, Handley ED, Rogosch FA, Cicchetti D, Toth SL. Early neglect and the development of aggression in toddlerhood: the role of working memory. *Child Maltreat*. 2018;23(4):344-354. doi:10.1177/1077559518778814

72. DePrince AP, Weinzierl KM, Combs MD. Executive function performance and trauma exposure in a community sample of children. *Child Abuse Negl*. 2009;33(6):353-361. doi:10.1016/j.chiabu.2008.08.002

73. Dileo JF, Brewer W, Northam E, Yucel M, Anderson V. Investigating the neurodevelopmental mediators of aggression in children with a history of child maltreatment: an exploratory field study. *Child Neuropsychol*. 2017;23(6):655-677. doi:10.1080/09297049.2016.1186159

74. Eigsti IM, Weitzman C, Schuh J, de Marchena A, Casey BJ. Language and cognitive outcomes in internationally adopted children. *Dev Psychopathol*. 2011;23(2):629-646. doi:10.1017/S0954579411000204

75. Fava NM, Trucco EM, Martz ME, et al. Childhood adversity, externalizing behavior, and substance use in adolescence: mediating effects of anterior cingulate cortex activation during inhibitory errors. *Dev Psychopathol*. 2019;31(4):1439-1450. doi:10.1017/S0954579418001025

76. Fox NA, Almas AN, Degnan KA, Nelson CA, Zeanah CH. The effects of severe psychosocial deprivation and foster care intervention on cognitive development at 8 years of age: findings from the Bucharest Early Intervention Project. *J Child Psychol Psychiatry*. 2011;52(9):919-928. doi:10.1111/j.1469-7610.2010.02355.x

77. Fay-Stammbach T, Hawes DJ. Caregiver ratings and performance-based indices of executive function among preschoolers with and without maltreatment experience. *Child Neuropsychol*. 2019;25(6):721-741. doi:10.1080/09297049.2018.1530344

78. Fay-Stammbach T, Hawes DJ, Meredith P. Child maltreatment and emotion socialization: associations with executive function in the preschool years. *Child Abuse Negl*. 2017;64:1-12. doi:10.1016/j.chiabu.2016.12.004

79. Fishbein D, Warner T, Krebs C, Trevarthen N, Flannery B, Hammond J. Differential relationships between personal and community stressors and children's neurocognitive functioning. *Child Maltreat*. 2009;14(4):299-315. doi:10.1177/1077559508326355

80. Fisher PA, Lester BM, DeGarmo DS, et al. The combined effects of prenatal drug exposure and early adversity on neurobehavioral disinhibition in childhood and adolescence. *Dev Psychopathol*. 2011;23(3):777-788. doi:10.1017/S0954579411000290

81. Frenkel TI, Donzella B, Frenn KA, Rousseau S, Fox NA, Gunnar MR. Moderating the risk for attention deficits in children with pre-adoptive adversity: the protective role of shorter duration of out of home placement and children's enhanced error monitoring. *J Abnorm Child Psychol*. 2020;48(9):1115-1128. doi:10.1007/s10802-020-00671-2

82. Gustafsson HC, Coffman JL, Cox MJ. Intimate partner violence, maternal sensitive parenting behaviors, and children's executive functioning. *Psychol Violence*. 2015;5(3):266-274. doi:10.1037/a0037971

83. Hanson JL, Adluru N, Chung MK, Alexander AL, Davidson RJ, Pollak SD. Early neglect is associated with alterations in white matter integrity and cognitive functioning. *Child Dev*. 2013;84(5):1566-1578. doi:10.1111/cdev.12069

84. Harms MB, Shannon Bowen KE, Hanson JL, Pollak SD. Instrumental learning and cognitive flexibility processes are impaired in children exposed to early life stress. *Dev Sci*. 2018;21(4):e12596. doi:10.1111/desc.12596

85. Hecker T, Hermenau K, Salmen C, Teicher M, Elbert T. Harsh discipline relates to internalizing problems and cognitive functioning: findings from a cross-sectional study with school children in Tanzania. *BMC Psychiatry*. 2016;16(1):118. doi:10.1186/s12888-016-0828-3

86. Helder EJ, Behen ME, Wilson B, Muzik O, Chugani HT. Language difficulties in children adopted internationally: neuropsychological and functional neural correlates. *Child Neuropsychol*. 2014;20(4):470-492. doi:10.1080/09297049.2013.819846

87. Hostinar CE, Stellern SA, Schaefer C, Carlson SM, Gunnar MR. Associations between early life adversity and executive function in children adopted internationally from orphanages. *Proc Natl Acad Sci U S A*. 2012;109(suppl 2):17208-17212. doi:10.1073/pnas.1121246109

88. Jakubovic RJ, Drabick DAG. Community violence exposure and youth aggression: the moderating role of working memory. *J Abnorm Child Psychol*. 2020;48(11):1471-1484. doi:10.1007/s10802-020-00683-y

89. Jankowski KF, Bruce J, Beauchamp KG, Roos LE, Moore WE III, Fisher PA. Preliminary evidence of the impact of early childhood maltreatment and a preventive intervention on neural patterns of response inhibition in early adolescence. *Dev Sci*. 2017;20(4). doi:10.1111/desc.12413

90. Jimeno MV, Latorre JM, Cantero MJ. Autobiographical memory impairment in adolescents in out-of-home care. *J Interpers Violence*. 2020. doi:10.1177/0886260520907351

91. Kavanaugh B, Holler K, Selke G. A neuropsychological profile of childhood maltreatment within an adolescent inpatient sample. *Appl Neuropsychol Child*. 2015;4(1):9-19. doi:10.1080/21622965.2013.789964

92. Kira IA, Somers C, Lewandowski L, Chiodo L. Attachment disruptions, IQ, and PTSD in African American adolescents: a traumatology perspective. *J Aggress Maltreatment Trauma*. 2012;21(6):665-690. doi:10.1080/10926771.2012.698377

93. Kirke-Smith M, Henry LA, Messer D. The effect of maltreatment type on adolescent executive functioning and inner speech. *Infant Child Dev*. 2016;25(6):516-532. doi:10.1002/icd.1951

94. Kochar R, Ittyerah M, Babu N. Understanding aggression and trauma in early life: verbal abuse and cognition in the developing mind. *J Aggress Maltreatment Trauma*. 2015;24(1):1-19. doi:10.1080/10926771.2015.982236

95. Lamm C, Troller-Renfree SV, Zeanah CH, Nelson CA, Fox NA. Impact of early institutionalization on attention mechanisms underlying the inhibition of a planned action. *Neuropsychologia*. 2018;117:339-346. doi:10.1016/j.neuropsychologia.2018.06.008

96. Lewis EE, Dozier M, Ackerman J, Sepulveda-Kozakowski S. The effect of placement instability on adopted children's inhibitory control abilities and oppositional behavior. *Dev Psychol*. 2007;43(6):1415-1427. doi:10.1037/0012-1649.43.6.1415

97. Lewis-Morrarty E, Dozier M, Bernard K, Terracciano SM, Moore SV. Cognitive flexibility and theory of mind outcomes among foster children: preschool follow-up results of a randomized clinical trial. *J Adolesc Health*. 2012;51(2 suppl):S17-S22. doi:10.1016/j.jadohealth.2012.05.005

98. Martin L, Kidd M, Seedat S. The effects of childhood maltreatment and anxiety proneness on neuropsychological test performance in non-clinical older adolescents. *J Affect Disord*. 2019;243:133-144. doi:10.1016/j.jad.2018.09.009

99. Meguid N, Reda M, Sheikh ME, Anwar M, Taman K, Hussein FJ. Salivary cortisol levels in abused children with attention deficit hyperactivity disorder. *J Psychiatry*. 2016;19(1):e348. doi:10.4172/2378-5756.1000348

100. Merz EC, McCall RB, Wright AJ, Luna B. Inhibitory control and working memory in post-institutionalized children. *J Abnorm Child Psychol*. 2013;41(6):879-890. doi:10.1007/s10802-013-9737-9

101. Mezzacappa E, Kindlon D, Earls F. Child abuse and performance task assessments of executive functions in boys. *J Child Psychol Psychiatry*. 2001;42(8):1041-1048. doi:10.1111/1469-7610.00803

102. Mothes L, Kristensen CH, Grassi-Oliveira R, Fonseca RP, de Lima Argimon II, Irigaray TQ. Childhood maltreatment and executive functions in adolescents. *Child Adolesc Ment Health*. 2015;20(1):56-62. doi:10.1111/camh.12068

103. Mueller SC, Maheu FS, Dozier M, et al. Early-life stress is associated with impairment in cognitive control in adolescence: an fMRI study. *Neuropsychologia*. 2010;48(10):3037-3044. doi:10.1016/j.neuropsychologia.2010.06.013

104. Mutluer T, Şar V, Kose-Demiray Ç, et al. Lateralization of neurobiological response in adolescents with post-traumatic stress disorder related to severe childhood sexual abuse: the Tri-Modal Reaction (T-MR) model of protection. *J Trauma Dissociation*. 2018;19(1):108-125. doi:10.1080/15299732.2017.1304489

105. Nadeau ME, Nolin P. Attentional and executive functions in neglected children. *J Child Adolesc Trauma.* 2013;6(1):1-10. doi:10.1080/19361521.2013.733794

106. Nolin P, Ethier L. Using neuropsychological profiles to classify neglected children with or without physical abuse. *Child Abuse Negl*. 2007;31(6):631-643. doi:10.1016/j.chiabu.2006.12.009

107. Nooner KB, Hooper SR, De Bellis MD. An examination of sex differences on neurocognitive functioning and behavior problems in maltreated youth. *Psychol Trauma*. 2018;10(4):435-443. doi:10.1037/tra0000356

108. Nweze T, Nwoke MB, Nwufo JI, Aniekwu RI, Lange F. Working for the future: parentally deprived Nigerian children have enhanced working memory ability. *J Child Psychol Psychiatry*. 2021;62(3):280-288. doi:10.1111/jcpp.13241

109. Pears KC, Bruce J, Fisher PA, Kim HK. Indiscriminate friendliness in maltreated foster children. *Child Maltreat*. 2010;15(1):64-75. doi:10.1177/1077559509337891

110. Pellizzoni S, Apuzzo GM, De Vita C, Agostini T, Ambrosini M, Passolunghi MC. Exploring EFs and math abilities in highly deprived contexts. *Front Psychol*. 2020;11:383. doi:10.3389/fpsyg.2020.00383

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111. Peñarrubia M, Palacios J, Román M. Executive function and early adversity in internationally adopted children. *Child Youth Serv Rev*. 2020;108:104587. doi:10.1016/j.childyouth.2019.104587

112. Perna RB, Kiefner M. Long-term cognitive sequelae: abused children without PTSD. *Appl Neuropsychol Child*. 2013;2(1):1-5. doi:10.1080/09084282.2011.595460

113. Peters AT, Ren X, Bessette KL, et al. Interplay between pro-inflammatory cytokines, childhood trauma, and executive function in depressed adolescents. *J Psychiatr Res*. 2019;114:1-10. doi:10.1016/j.jpsychires.2019.03.030

114. Pollak SD, Nelson CA, Schlaak MF, et al. Neurodevelopmental effects of early deprivation in postinstitutionalized children. *Child Dev*. 2010;81(1):224-236. doi:10.1111/j.1467-8624.2009.01391.x

115. Puetz VB, Viding E, Palmer A, et al. Altered neural response to rejection-related words in children exposed to maltreatment. *J Child Psychol Psychiatry*. 2016;57(10):1165-1173. doi:10.1111/jcpp.12595

116. Saigh PA, Yasik AE, Oberfield RA, Halamandaris PV, Bremner JD. The intellectual performance of traumatized children and adolescents with or without posttraumatic stress disorder. *J Abnorm Psychol*. 2006;115(2):332-340. doi:10.1037/0021-843X.115.2.332

117. Samuelson KW, Krueger CE, Wilson C. Relationships between maternal emotion regulation, parenting, and children's executive functioning in families exposed to intimate partner violence. *J Interpers Violence*. 2012;27(17):3532-3550. doi:10.1177/0886260512445385

118. Seckfort DL, Paul R, Grieve SM, et al Early life stress on brain structure and function across the lifespan: a preliminary study. *Brain Imaging Behav*. 2008;2:49-58. doi:10.1007/s11682-007-9015-y

119. Skowron EA, Cipriano-Essel E, Gatzke-Kopp LM, Teti DM, Ammerman RT. Early adversity, RSA, and inhibitory control: evidence of children's neurobiological sensitivity to social context. *Dev Psychobiol*. 2014;56(5):964-978. doi:10.1002/dev.21175

120. Spann MN, Mayes LC, Kalmar JH, et al. Childhood abuse and neglect and cognitive flexibility in adolescents. *Child Neuropsychol*. 2012;18(2):182-189. doi:10.1080/09297049.2011.595400

121. Speidel R, Valentino K, McDonnell CG, Cummings EM, Fondren K. Maternal sensitive guidance during reminiscing in the context of child maltreatment: implications for child self-regulatory processes. *Dev Psychol*. 2019;55(1):110-122. doi:10.1037/dev0000623

122. Stewart JG, Kim JC, Esposito EC, Gold J, Nock MK, Auerbach RP. Predicting suicide attempts in depressed adolescents: clarifying the role of disinhibition and childhood sexual abuse. *J Affect Disord*. 2015;187:27-34. doi:10.1016/j.jad.2015.08.034

123. Tibu F, Sheridan MA, McLaughlin KA, Nelson CA, Fox NA, Zeanah CH. Disruptions of working memory and inhibition mediate the association between exposure to institutionalization and symptoms of attention deficit hyperactivity disorder. *Psychol Med*. 2016;46(3):529-541. doi:10.1017/S0033291715002020

124. Tran NK, Van Berkel SR, van IJzendoorn MH, Alink LRA. The association between child maltreatment and emotional, cognitive, and physical health functioning in Vietnam. *BMC Public Health*. 2017;17(1):332. doi:10.1186/s12889-017-4258-z

125. Treat AE, Sheffield Morris A, Williamson AC, Hays-Grudo J, Laurin D. Adverse childhood experiences, parenting, and child executive function. *Early Child Dev Care*. 2019;189(6):926-937. doi:10.1080/03004430.2017.1353978

126. Troller-Renfree S, Nelson CA, Zeanah CH, Fox NA. Deficits in error monitoring are associated with externalizing but not internalizing behaviors among children with a history of institutionalization. *J Child Psychol Psychiatry*. 2016;57(10):1145-1153. doi:10.1111/jcpp.12604

127. Valentino K, Bridgett DJ, Hayden LC, Nuttall AK. Abuse, depressive symptoms, executive functioning, and overgeneral memory among a psychiatric sample of children and adolescents. *J Clin Child Adolesc Psychol*. 2012;41(4):491-498. doi:10.1080/15374416.2012.660689

128. Vasilevski V, Tucker A. Wide-ranging cognitive deficits in adolescents following early life maltreatment. *Neuropsychology*. 2016;30(2):239-246. doi:10.1037/neu0000215

129. Vaughn-Coaxum RA, Dhawan N, Sheridan MA, Hart MJ, Weisz JR. Dimensions of adversity in association with adolescents' depression symptoms: distinct moderating roles of cognitive and autonomic function. *Dev Psychopathol*. 2020;32(3):817-830. doi:10.1017/S0954579419001172

130. Viezel KD, Freer BD, Lowell A, Castillo JA. Cognitive abilities of maltreated children. *Psychol Sch*. 2015;52(1):92-106. doi:10.1002/pits.21809

131. Walsh M, Joyce S, Maloney T, Vaithianathan R. Adverse childhood experiences and school readiness outcomes: results from the Growing Up in New Zealand study. *N Z Med J*. 2019;132(1493):15-24.

132. Williams S, McWilliams K, Lyon T. Children's concealment of a minor transgression: the role of age, maltreatment, and executive functioning. *J Exp Child Psychol*. 2020;191:104664. doi:10.1016/j.jecp.2019.104664

133. Wolf S, Suntheimer NM. A dimensional risk approach to assessing early adversity in a national sample. *J Appl Dev Psychol*. 2019;62:270-281. doi:10.1016/j.appdev.2019.03.004

134. Zhai ZW, Yip SW, Lacadie CM, Sinha R, Mayes LC, Potenza MN. Childhood trauma moderates inhibitory control and anterior cingulate cortex activation during stress. *Neuroimage*. 2019;185:111-118. doi:10.1016/j.neuroimage.2018.10.049

135. Zhang H, Li J, Yang B, et al. The divergent impact of catechol-O-methyltransferase (COMT) Val^{158}Met genetic polymorphisms on executive function in adolescents with discrete patterns of childhood adversity. *Compr Psychiatry*. 2018;81:33-41. doi:10.1016/j.comppsych.2017.11.004

136. McLaughlin KA, Weissman D, Bitrán D. Childhood adversity and neural development: a systematic review. *Annu Rev Dev Psychol*. 2019;1(1):277-312. doi:10.1146/annurev-devpsych-121318-084950

137. Mittal C, Griskevicius V, Simpson JA, Sung S, Young ES. Cognitive adaptations to stressful environments: when childhood adversity enhances adult executive function. *J Pers Soc Psychol*. 2015;109(4):604-621. doi:10.1037/pspi0000028

138. Frankenhuis WE, Young ES, Ellis BJ. The hidden talents approach: theoretical and methodological challenges. *Trends Cogn Sci*. 2020;24(7):569-581. doi:10.1016/j.tics.2020.03.007

139. Young ES, Frankenhuis WE, Ellis BJ. Theory and measurement of environmental unpredictability. *Evol Hum Behav*. 2020;41(6):550-556. doi:10.1016/j.evolhumbehav.2020.08.006

140. Moffitt TE, Arseneault L, Belsky D, et al. A gradient of childhood self-control predicts health, wealth, and public safety. *Proc Natl Acad Sci U S A*. 2011;108(7):2693-2698. doi:10.1073/pnas.1010076108

141. Pope CN, Ross LA, Stavrinos D. Association between executive function and problematic adolescent driving. *J Dev Behav Pediatr*. 2016;37(9):702-711. doi:10.1097/DBP.0000000000000353

142. Alloway TP, Gathercole SE, Kirkwood H, Elliott J. The cognitive and behavioral characteristics of children with low working memory. *Child Dev*. 2009;80(2):606-621. doi:10.1111/j.1467-8624.2009.01282.x

143. Gathercole SE, Alloway TP, Willis C, Adams AM. Working memory in children with reading disabilities. *J Exp Child Psychol*. 2006;93(3):265-281. doi:10.1016/j.jecp.2005.08.003

144. Hilt LM, Leitzke BT, Pollak SD. Cognitive control and rumination in youth: the importance of emotion. *J Exp Psychopathol*. 2014;5(3):302-313. doi:10.5127/jep.038113

145. Snyder HR. Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: a meta-analysis and review. *Psychol Bull*. 2013;139(1):81-132. doi:10.1037/a0028727

146. Feng X, Perceval GJ, Feng W, Feng C. High cognitive flexibility learners perform better in probabilistic rule learning. *Front Psychol*. 2020;11:415. doi:10.3389/fpsyg.2020.00415

147. Korom M, Goldstein A, Tabachnick AR, Palmwood EN, Simons RF, Dozier M. Early parenting intervention accelerates inhibitory control development among CPS-involved children in middle childhood: a randomized clinical trial. *Dev Sci*. 2021;24(3):e13054-e13054. doi:10.1111/desc.13054

148. Colich NL, Rosen ML, Williams ES, McLaughlin KA. Biological aging in childhood and adolescence following experiences of threat and deprivation: a systematic review and meta-analysis. *Psychol Bull*. 2020;146(9):721-764. doi:10.1037/bul0000270

149. Tucker-Drob EM, Harden KP. Early childhood cognitive development and parental cognitive stimulation: evidence for reciprocal gene-environment transactions. *Dev Sci*. 2012;15(2):250-259. doi:10.1111/j.1467-7687.2011.01121.x

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