

Associations of Early-Life Threat and Deprivation With Executive Functioning in Childhood and Adolescence

A Systematic Review and Meta-analysis

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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.

JAMA Pediatr. doi:10.1001/jamapediatrics.2021.2511
Published online July 26, 2021.

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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 stimula-

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.

tion 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 children²⁸ 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 functioning³¹; (2) treated adversity as a composite measure³²⁻³⁴; 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 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 ($n = 4$).

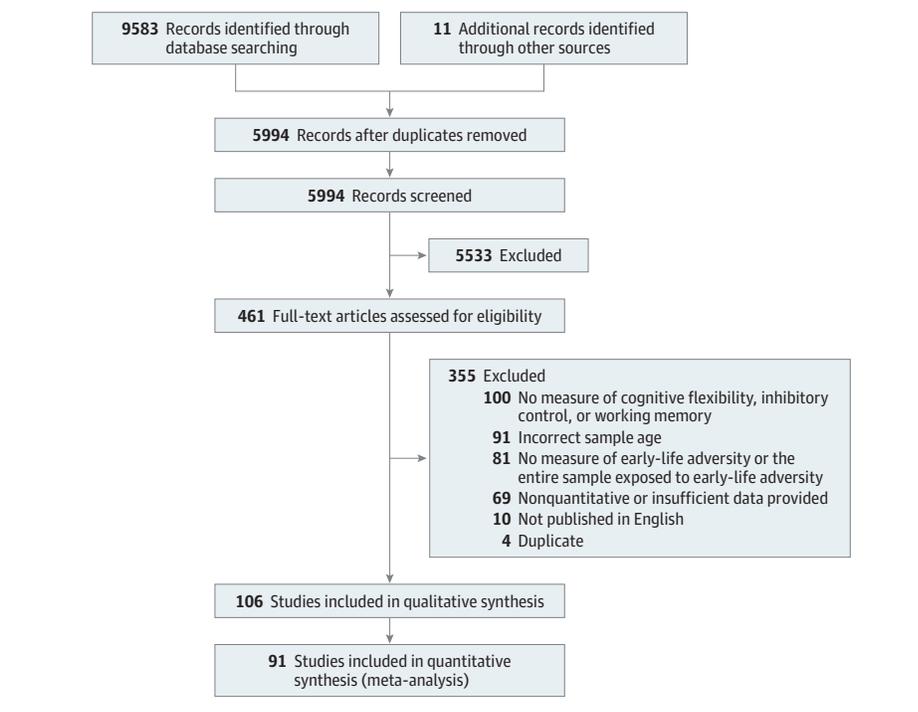
Statistical Analysis

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 article 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

Figure. PRISMA Flow Diagram



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 publication 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 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

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.

ARTICLE INFORMATION

Accepted for Publication: April 23, 2021.

Published Online: July 26, 2021.
doi:10.1001/jamapediatrics.2021.2511

Author Contributions: Mr Johnson had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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Drafting of the manuscript: Johnson.

Critical revision of the manuscript for important intellectual content: All authors.

Statistical analysis: Johnson.

Obtained funding: Wade.

Administrative, technical, or material support: Johnson, Policelli, Li, Dharamsi, Hu, Wade.

Supervision: Johnson, McLaughlin, Wade.

Conflict of Interest Disclosures: None reported.

Funding/Support: This study was supported by a Connaught New Researcher Award from the University of Toronto (Dr Wade).

Role of the Funder/Sponsor: The funder had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

Additional Contributions: Natalie L. Colich, PhD, University of Washington, assisted with conceptualizing data analysis; Duj'on Daniel, MEd, University of Toronto, assisted with abstract/full-text screening and data extraction; Shalyn Isaacs, BA, University of Toronto, assisted with abstract/full-text screening; and Robert D. Meade, PhD, University of Ottawa, assisted with data analysis and statistical coding. Written permission was obtained to acknowledge the contributions of these individuals. These individuals received no additional compensation, outside of their usual salary, for their contributions.

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