AMERICAN PSYCHOLOGICAL ASSOCIATION

Developmental Psychology

ISSN: 0012-1649

2025, Vol. 61, No. 11, 2082–2096
https://doi.org/10.1037/dev0001993

Perceived Uncontrollability as a Potential Mechanism of Parental Child Abuse Predicting Executive Dysfunction in Adulthood 18 Years Later: Replication Across Two Studies

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Although it is well-established that child abuse precedes and predicts poorer executive functioning (EF), the potential mechanisms are not well understood. We thus used counterfactual mediation analysis to test how perceived control (lower personal mastery or higher perceived uncontrollability) mediated maternal or paternal child abuse, predicting lower future EF scores. Community adults from two separate samples (N = 3,291 and 2,550 in Samples 1 and 2) completed a retrospective parental child abuse self-report at Time 1 (T1), a trait-level perceived control self-report at T2, and performance EF tests at T3. Time intervals spanned approximately 6 months and 9 years in Samples 1 and 2. Stronger T1 maternal and paternal child abuse consistently predicted higher T2 uncontrollability (Cohen's d = 0.232–1.175), which then predicted lower T3 EF scores (d = −0.411 to −0.244). Higher uncontrollability consistently mediated the effect of higher maternal and paternal child abuse predicting poorer EF scores (d = −0.229 to −0.164). Although mastery mediated the effect of maternal, but not paternal, abuse on future EF in Sample 1, this mediation effect did not survive in Sample 2. Sensitivity analyses testing for nonlinearities and adjusting for age and the predictor–mediator interaction implied similar findings in both samples. Uncontrollability, instead of mastery, might be a key mechanism accounting for the pathway from early-life parental abuse to EF outcomes. Assessing and targeting perceived uncontrollability and EF and harnessing precision medicine approaches in prevention programs and treatments might optimize psychotherapies for individuals exposed to child abuse.

Public Significance Statement

The present study highlights the far-reaching public health importance of detecting and decreasing the risk of adverse effects of child abuse on adulthood executive functioning (EF), considering the instrumental role of EF in aging and psychosocial well-being. By emphasizing the salience of perceived uncontrollability as a crucial mediator or potential mechanism, the findings underscore how optimizing psychotherapy entails decreasing uncontrollability to preserve EF abilities among adults exposed to child abuse. Targeted preventive efforts equipping previously abused midlife-to-older adults with optimal coping skills might mitigate the adverse long-term effects of child abuse on EF abilities.

Keywords: child abuse, executive function, longitudinal, mechanism, perceived control

Supplemental materials: https://doi.org/10.1037/dev0001993.supp

This article was published Online First June 9, 2025.

Peter Bos served as action editor.

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The data used in this study are publicly available from the Midlife Development in the United States project via the Interuniversity Consortium for Political and Social Research (https://www.icpsr.umich.edu/web/ICPSR/series/203). All authors report no conflicts of interest. Since 1995, the Midlife Development in the United States study has been funded by the John D. and Catherine T. MacArthur Foundation Research Network and the National Institute on Aging (Grants P01-AG020166 and U19-AG051426). Nur Hani Zainal received funding from the National University of Singapore Presidential Young Professorship Start-Up Grant—date of funding: July 1, 2024, to June 30, 2029. Natalia Van Doren was funded by the U.S. National Institute on Drug Abuse (Grant T32DA007250). All funding agencies are not responsible for the analyses or interpretations presented here.

Nur Hani Zainal played a lead role in conceptualization, formal analysis, investigation, supervision, validation, writing–original draft, and writing–review and editing. Benjamin Garthwaite played a supporting role in conceptualization, data curation, formal analysis, investigation, and writing–review and editing. Sarah Josephine Rajendra played a supporting role in conceptualization, investigation, validation, and writing–review and editing. Natalia Van Doren played a supporting role in conceptualization, data curation, formal analysis, investigation, supervision, validation, and writing–review and editing.

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Executive functioning (EF) is referred to as a holistic collection of advanced cognitive functioning processes intertwined with the prefrontal cortex (PFC), which form the foundation for purposeful behaviors (Friedman & Miyake, 2017). EF could encompass adaptability, emotion regulation, impulse control, organization, self-observation, strategic planning, and working memory (WM; ability to register and alter information in real time; Miyake & Friedman, 2012). Moreover, better EF is linked to optimal lifestyles (Gray-Burrows et al., 2019), mental health (Snyder et al., 2015), mathematical skills (Chen & Bailey, 2021), reading (Peng, 2023), scholastic performance (Spiegel et al., 2021), and social functioning (Demetriou et al., 2018), thereby impacting important life outcomes for individuals who experience more retrospective child parental abuse. Thus, identifying plausibly modifiable risk factors of EF deficits is essential.

Child abuse is a theory-grounded risk factor for future EF deficits. Child abuse could lead to disruptions in the functioning of the hypothalamic–pituitary–adrenal (HPA) axis and associated systems by elevating stress hormones (e.g., cortisol) across extended periods (Ortiz et al., 2023). Continuous activation of the HPA axis in response to child abuse experiences might further sensitize and increase hyperalertness to threats over time (Hosseini-Kamkar et al., 2021). Further, the PFC, which has been shown to be dense with glucocorticoid receptors (McKlveen et al., 2019), is pivotal in modulating neuroendocrine responses mediated by the HPA axis and among the final brain regions to fully form in human development (McLaughlin et al., 2014). The neurochemical changes arising from abuse could ultimately impede the functions of the PFC involved in higher cognitive functioning, especially when the person feels no control over their situation (Arnsten, 2009). Consequently, PFC dysregulations induced by child abuse could adversely affect the capacity to evaluate threats and implement optimal responses to regulate the HPA, immune, and related systems, potentially impairing EF in enduring ways.

Ample evidence exists in support of the proposition that increased child abuse is a correlate of EF deficits (Letkiewicz, Funkhouser, & Shankman, 2021; Letkiewicz, Weldon, et al., 2021; Spann et al., 2012). A recent systematic review of mostly single-time point studies revealed a robust cross-sectional positive association between higher frequency of child abuse and more deficits in EF among children (Lund et al., 2020). Further, adults with (vs. without) child abuse experiences exerted more mental effort when performing WM tasks at a single time point (Mark et al., 2019). Although these studies highlight the associative nature of EF deficits and childhood maltreatment, such cross-sectional studies on this topic preclude establishing cause–effect associations (Pearl, 2009).

Fortunately, longitudinal studies have provided insight into the causal relationship between early child abuse and future EF impairments. Although a study failed to observe child abuse–EF relations in adolescents at risk of antisocial and substance use issues (Kent et al., 2022), this study was an exception rather than the norm. A review of 11 longitudinal studies instead reported that child abuse reliably preceded various impaired EF, intelligence, and related subdomains (Yingying et al., 2019). For instance, increased maternal child abuse, child–mother conflicts (Zhang et al., 2022), and neglect (Hawkins et al., 2021) predicted poorer future *inhibitory control* (or inhibition; ability to act opposite to impulses), *set-shifting* (adeptness to flexibly switch between unique cognitive modes), and WM in adolescents. Moreover, higher child abuse frequency compromised future episodic memory in adolescents (Dunn et al., 2016) and inhibition and set-shifting in preschoolers (Kang & Rodriguez, 2023). Early child abuse was also found to predict impairments in cognitive flexibility and processing speed well into adulthood (Nikulina & Widom, 2013). However, less is known about *potential change mechanisms* (mediators) via which child abuse might impair EF capacities over time. It is crucial to determine mediators connecting child abuse with adulthood EF issues, as this might pave the way for interventions aimed at addressing both the risk factor and mediator.

Perceived control, denoting the belief in having sufficient internal and external resources to handle potential stressors and effect change over circumstances (Fishman, 2014), might be a viable mediator to target for preventing a downward cascade of future EF decline. Perceived control is comprised of two opposite yet interconnected concepts (Lachman & Weaver, 1998). The first concept, *mastery*, represents confidence in one's competence and effort, that is, the belief in one's capability to carry out necessary actions effectively (Skinner, 1996). The second concept, *uncontrollability* (also called *perceived constraints*), refers to situations that result in the perception of a limited connection between actions and outcomes, embodying deep-seated beliefs that external uncontrollable factors hinder desired results (Infurna & Mayer, 2015). A greater sense of control has been linked to better health outcomes, both mentally and physically (Botha & Dahmann, 2024; Gale et al., 2008; Hong et al., 2021), which underscores its viability as a protective factor for cognitive impairments (Soederberg Miller & Lachman, 2000) such as EF deficits. Cumulative child abuse experiences could trigger prolonged low mastery and higher uncontrollability across time, which might thereby impair future EF.

The *triple vulnerability theory* (Barlow et al., 2014) proposed that child abuse might shape the belief that humans lack the agency to act and impact environments in ways that increase the odds for desired events to occur (Rimular & Berzenski, 2022). Such beliefs might emerge in response to abuse as a protective factor and serve an adaptive function during childhood development in abusive environments (Wadsworth, 2015). However, in adulthood and in contexts where abuse is no longer taking place, these beliefs are associated with poor outcomes. For example, compromised perceived control has been theorized to impair EF performance by undermining the use of take-charge strategies and healthy lifestyles that protect against aging-related cognitive functioning deficits or declines (Lachman, 2006). Deficits in perceived control might decrease effort and motivation to engage in activities that enhance and preserve cognitive health by encouraging the usage of problem-solving and sustained attention skills (Ly et al., 2019). High perceived control might enhance or maintain frequent physical activity and meaningful social engagements (Infurna & Gerstorf, 2014; Robinson & Lachman, 2017), thereby protecting against cognitive decline in the aging developmental stages (Cohrdes & Bretschneider, 2018; Kelly et al., 2017). Together, higher uncontrollability and lower mastery might be a mechanism via which child abuse weakens future EF over time.

No prospective studies have directly determined perceived control as a potential mechanism or mediator between child abuse and adulthood EF deficits. However, prospective studies that offer separate evidence for the proposed predictor–mediator and mediator–outcome associations exist. Regarding predictor–mediator relations, youths and adults who experienced lower childhood parental affection, stronger abuse, or neglect exhibited reduced future perceived control than their nonabused counterparts across days (Nguyen-Feng et al., 2017), years

(Bolger & Patterson, 2001; Liu et al., 2023), and decades (Elliot et al., 2018). With respect to mediator–outcome associations, such reduced perceived control, in turn, predicted decreased EF and episodic memory two decades later (Ng et al., 2023; Robinson & Lachman, 2018). Collectively, the above evidence points to the possibility that perceived control could be a mediator that should be targeted to prevent the long-term detrimental effect of child abuse on adulthood EF.

The present study, therefore, examined how trait-level perceived control mediated parental child abuse predicting adulthood EF and built on prior literature in several ways. First, rather than lumping perceived control as a unitary construct, we independently examined dimensions of mastery and uncontrollability. This point is essential since each construct has been associated with differential outcomes (Wen & Sin, 2022). Examining mastery and uncontrollability as distinct factors has implications for interventions to enhance or preserve EF and mental health following child abuse. Second, we determined the potentially unique effect of maternal and paternal child abuse. Each caregiver might exhibit distinct parenting approaches and duties within the family in ways that could have varying effects on a child (Cox & Paley, 1997; Cui et al., 2018). However, most studies combined the effect of maternal and paternal abuse rather than testing their potentially unique effects (e.g., refer to reviews by Lund et al., 2020; Yingying et al., 2019). Third, our study utilized three assessment waves over 20 years to test the potential causal chain (Maxwell & Cole, 2007) of baseline child abuse predicting adulthood EF through perceived control at the midpoint. Fourth, the hypothesized mediation pathway of perceived control intervening between child abuse and future EF is especially germane to older adulthood, as EF grows in importance to adapt and handle experiences linked to aging. Ample research showed that older adults frequently face waning cognitive abilities (Seblova et al., 2020), physical health (Siervo et al., 2014), and social networks (Shor et al., 2013), emphasizing the need to sustain perceived control and EF to optimally manage these realities. Decreased perceived control (i.e., low personal mastery, high perceived uncontrollability) undermines efforts, such as promoting brain-stimulating activities, physical exercise, and social connections, that could protect against aging-related cognitive declines (Curtis et al., 2018; Neupert & Bellingtier, 2020).

Based on theory and research, three hypotheses were tested in the present study in two unique community-dwelling adult samples: Higher frequencies of both maternal and paternal child abuse would predict future reduced mastery and increased uncontrollability (Hypothesis 1). Reduced mastery and increased uncontrollability would, thereby, predict subsequent EF deficits (Hypothesis 2). Last, reduced mastery and increased uncontrollability would mediate the 18-year effect of maternal and paternal child abuse on adulthood EF (Hypothesis 3).

Method

Transparency and Openness

The data used in this study are publicly available from the Midlife Development in the United States (MIDUS) project via the Inter-university Consortium for Political and Social Research (https://www.icpsr.umich.edu/web/ICPSR/series/203). All codes for data cleaning and analyses, including scripts for multiple imputation and causal counterfactual mediation models, are available upon reasonable request from the corresponding author to promote reproducibility. We adhered to recognized standards for reporting mediation models, effect sizes, and sensitivity analyses. The study hypotheses and analytic plans were not preregistered prior to conducting the analyses.

Participants

MIDUS Original

The data are derived from the publicly available National Survey of MIDUS database (C. D. Ryff & Lachman, 2017). Participants ($N = 3,291$) completed a series of assessments at Time 1 (T1; 1994–1995), Time 2 (T2; 2004–2006), and Time 3 (T3; 2013–2014; Brim et al., 2020; C. Ryff et al., 2019; C. D. Ryff & Lachman, 2017). At T1, participants were 46.52 years old on average ($SD = 9.68$), 54.9% were women, and 45.1% were men. Regarding education, 39.4% completed college education and above, 29.7% had some college education, 24.8% had high school education, and the remaining 6.1% had no high school diploma or missing data. Most identified their race as White (89.7%), whereas 10.3% self-reported as multiracial, Native American, African American, Asian, or other.

MIDUS Refresher

An independent sample from the MIDUS Refresher study (C. Ryff et al., 2017) allowed us to assess generalizability, that is, if any notable findings in the MIDUS Original sample were observed in another community adult sample. Participants ($N = 2,550$) completed the same assessment set at T1 (2011–2014), T2 (about 5 months after T1), and T3 (about 6 months from T1; C. D. Ryff & Lachman, 2021; Weinstein et al., 2019). At T1, participants had an average age of 52.60 ($SD = 14.17$), and 52.2% were women, whereas the remaining 47.8% were men. The education profiles showed that 55.1% completed college, 18.0% had some college, 17.3% had a high school education, and 9.6% had no high school diploma, did not know, or did not respond. Regarding racial identity, 83.8% were White, and the remaining 16.2% were Asian, African American, Native Hawaiian/Pacific Islander, Native American, or others. Table 1 displays sociodemographic, clinical, and neurocognitive characteristics descriptives with a correlation matrix in both samples.

Procedure

Retrospective parental child abuse data were self-reported at T1. Trait-level mastery and uncontrollability were self-reported at T2. Telephone-administered EF assessments were conducted at T3. The present study focused on a subset of participants (3,291 in MIDUS and 2,550 in MIDUS Refresher) who completed the T3 EF assessment protocol. Figures 1 and 2 display the bivariate plots among the study variables of interest.

Measures

T1 Child Abuse

T1 child maternal and paternal abuse was assessed through the Revised Conflict Tactics Scale Version 2 (CTS2; Straus, 1979; Straus et al., 1996). Participants assessed their responses using a 7-point scale (1 = *strongly agree* to 7 = *strongly disagree*). The CTS2 assessed three types of child abuse: emotional, physical, and severe physical abuse, with each type evaluated through a single item, and

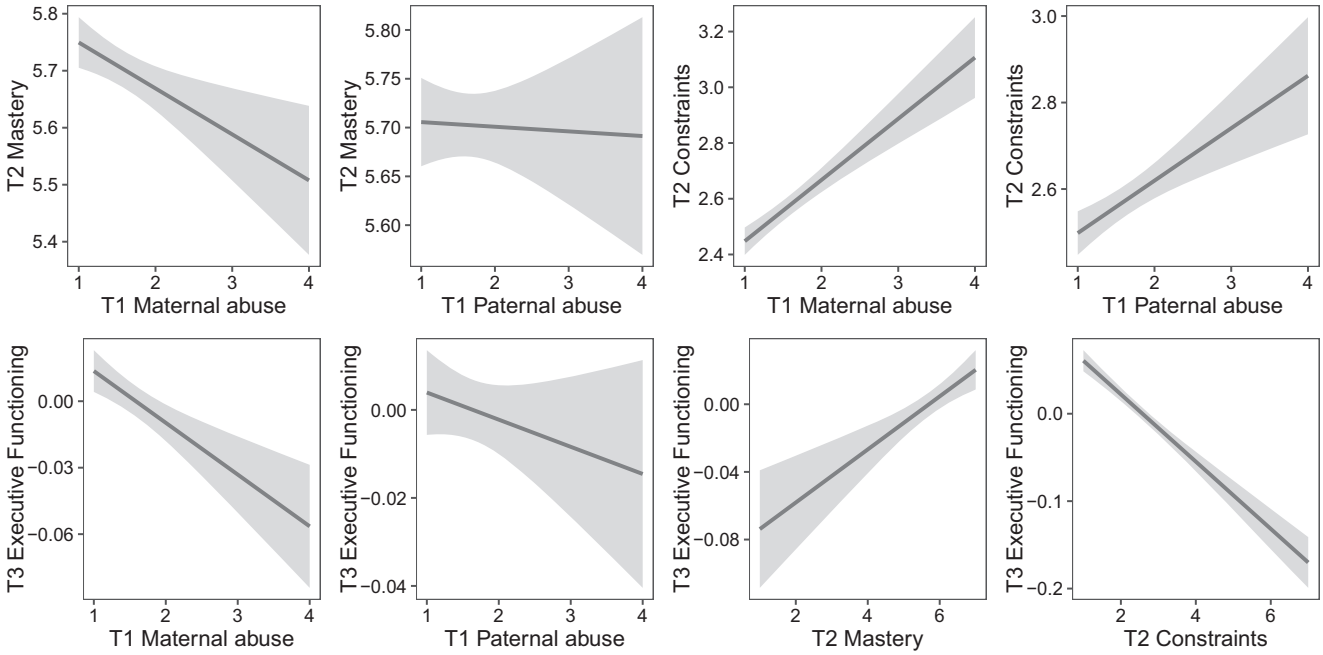
Table 1
Descriptive Statistics and Correlation Matrix of Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	—	−.01	.11***	−.10***	−.10***	.05**	−.09***	−.07***	−.24***	−.14***	−.21***	−.03
2. Female	.09***	—	−.09***	.04*	−.06**	.01	−.02	.00	−.02	.03	−.15***	−.06**
3. White	.05**	.06***	—	−.09***	−.05**	.02	−.04	−.01	.15***	.06**	.16***	.09***
4. W1 maternal abuse	−.07***	.09***	−.08***	—	.75***	−.49***	.48***	.04*	−.03	−.06**	−.07***	−.07***
5. W1 paternal abuse	−.10***	−.06***	−.04*	.49***	—	−.49***	.51***	.03	−.04*	−.06**	−.07***	−.08***
6. W2 trait mastery	−.01	−.12***	.01	−.04*	.00	—	−.69***	−.04*	.05*	.07***	.02	.03
7. W2 trait uncontrollability	−.04*	.21***	−.03*	.12***	.08***	−.52***	—	.04	−.09***	−.13***	−.12***	−.09***
8. W3 backward counting	−.32***	−.25***	.09***	−.04*	−.01	.07***	−.18***	—	.04*	.00	−.02	−.36***
9. W3 verbal fluency	−.26***	−.14***	.06***	−.03	−.02	.03	−.12***	.46***	—	.24***	.37***	.15***
10. W3 backward DS	−.18***	−.07***	.05**	.00	.00	.02	−.11***	.36***	.25***	—	.38***	.11***
11. W3 number sequencing	−.27***	−.29***	.08***	−.09***	−.05**	.05**	−.15***	.56***	.42***	.36***	—	.22***
12. W3 SGST mixed task	−.15***	−.12***	.05**	−.03	.00	.02	−.13***	.30***	.28***	.22***	.26***	—
MIDUS sample												
M or *n*	46.52	1.810	2.956	1.57	1.64	5.72	2.56	0.00	0.00	0.00	0.00	0.00
(*SD* or %)	(9.68)	(54.9)	(89.7)	(0.61)	(0.65)	(0.94)	(1.05)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
Minimum	21.00			1.00	1.00	1.00	1.00	−2.91	−3.01	−3.21	−1.36	−4.72
Maximum	86.00			4.00	4.00	7.00	7.00	4.66	3.86	2.00	1.85	.45
Skewness	0.43	0.37	−2.82	1.44	1.36	−1.01	0.64	0.23	0.29	0.15	0.36	−3.61
Kurtosis	0.77	−0.71	5.96	2.44	2.01	1.68	0.22	0.49	0.17	−0.02	−1.04	13.20
MIDUS Refresher sample												
M or *n*	52.60	1.330	2.136	1.74	1.86	5.27	2.97	0.00	0.00	0.00	0.00	0.00
(*SD* or %)	(14.17)	(52.16)	(83.76)	(0.92)	(1.03)	(1.32)	(1.37)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)
Minimum	23.00			1.00	1.00	1.00	1.00	−0.57	−2.89	−3.39	−1.63	−4.54
Maximum	76.00			4.00	4.00	7.00	7.00	8.20	3.85	1.91	1.60	0.41
Skewness	−0.18	−0.09	−1.83	1.14	1.02	−0.74	0.51	7.99	0.28	0.19	−0.01	−3.80
Kurtosis	−1.16	−1.99	1.35	0.05	−0.40	−0.24	−0.74	62.51	0.06	−0.39	−1.11	14.00

Note. Values for W3 executive functioning tasks were standardized with a mean of 0 and *SD* of 1. The correlation estimates in the bottom triangle were from the original Midlife Development in the United States (MIDUS) Original sample ($N = 3,291$). In contrast, those in the above triangle were from the MIDUS Refresher sample ($N = 2,550$). W1 = Wave 1; W2 = Wave 2; W3 = Wave 3; DS = digit span; SGST = stop-and-go switch task.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 1

Correlation Plots of Predictor–Mediator, Mediator–Outcome, and Predictor–Outcome Associations (Midlife Development in the United States Original Sample)



Note. The terms "constraints" and "uncontrollability" are used interchangeably in the present figure and throughout the article. T1 = time 1; T2 = time 2; T3 = time 3.

three items comprised the CTS2 scale for retrospective child maternal and paternal abuse. Participants were requested to indicate how often their parents or caregivers engaged in behaviors such as physical pushing or shoving (*physical abuse*); kicking, biting, or hitting with a fist (*severe physical abuse*); and swearing or verbal insults (*emotional abuse*). In this study, the abuse inflicted by participants' mothers or female primary caregivers and fathers or male primary caregivers was analyzed separately. The dimensions assessed by the CTS2 showed acceptable internal reliability (MIDUS Original: Cronbach's αs = .79 and .81 for maternal and paternal child abuse, respectively; MIDUS Refresher: αs = .87 and .91). The CTS2 also exhibited consistently high retest reliability (Vega & O'Leary, 2007) and robust construct validity across varied groups (Chapman & Gillespie, 2019).

T2 Perceived Control

T2 mastery scores were computed by summing the values of the four items from the Midlife Development Inventory (Lachman & Weaver, 1998; e.g., "Whether or not I am able to get what I want is in my own hands"; Pearlin & Schooler, 1978). T2 uncontrollability was calculated by totaling the eight Midlife Development Inventory item scores (e.g., "Other people determine most of what I can and cannot do"). Participants rated their level of agreement or disagreement with 12 statements using a 6-point Likert scale (1 = *strongly disagree* to 7 = *strongly agree*). The internal consistencies (Cronbach's αs) of these domain-specific scales were high for mastery (MIDUS Original: .96; MIDUS Refresher: .87) and uncontrollability (MIDUS Original: .98; MIDUS Refresher: .91). These scales have also been shown to have good convergent validity (Fok et al., 2012) and discriminant validity (Skinner, 1996).

T3 EF

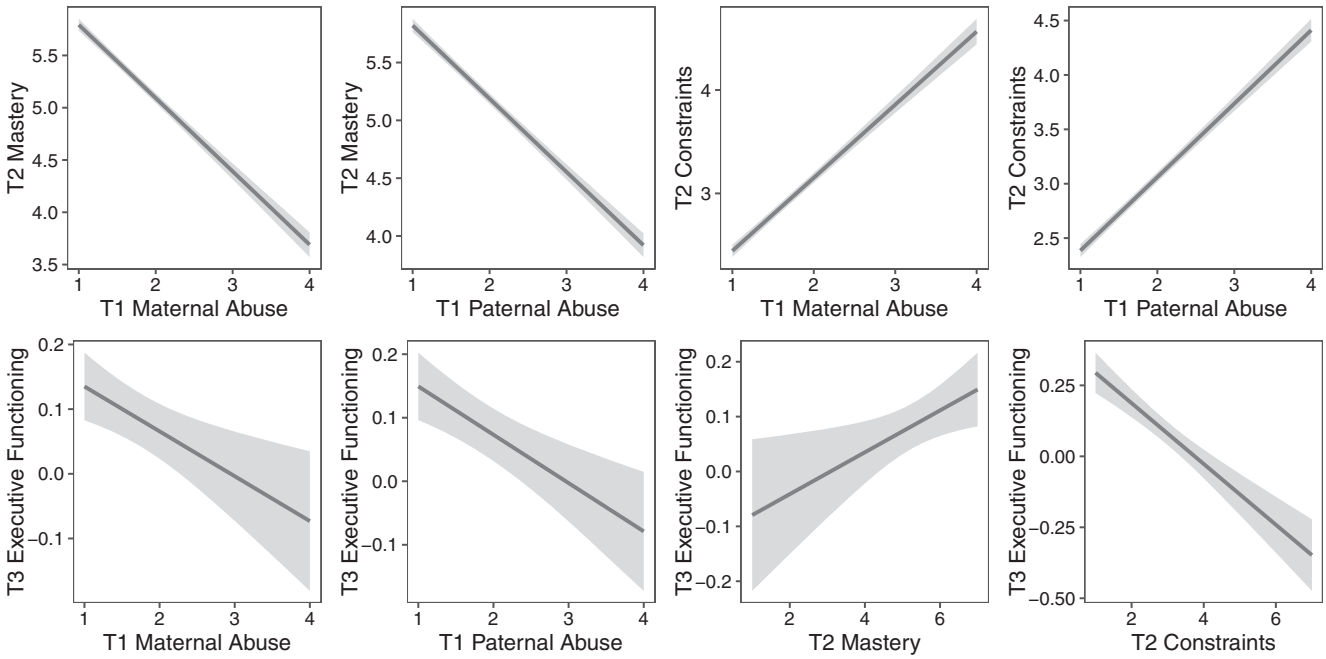
The Brief Test of Adult Cognition by Telephone assessed global EF (Lachman et al., 2014). It included five subtests: (a) *Backward Digit Span* (recalling number sequences with increasing length in reverse order accurately); (b) *Backward Counting* (counting backward from 100 within 30 s correctly); (c) *Verbal Fluency* (listing as many unique types of animals or food as possible within a minute); (d) *Number Series* (correctly completing digit strings by identifying patterns and giving the final number); and (e) *Stop-and-Go Switch Task* (which alternates between normal and reverse sets to assess inhibition and set-shifting, respectively). Strong 4-week retest reliability, good convergent validity (r = .41–.52 with distinct EF measures), and excellent discriminant validity (r = .16–.17 with memory assessments) of the Brief Test of Adult Cognition by Telephone have been shown (Lachman et al., 2014). EF composite values were computed by standardizing the item scores on the same scale (M of 0 and SD of 1) and summing them such that higher values denoted stronger EF. The internal consistency (Cronbach's αs) for the composite EF score herein is .73 in the MIDUS Original sample and .68 in the MIDUS Refresher sample.

Data Analyses

Missing data (a total of 10.1% of the data set) were handled using multiple imputation via random forest imputation with the

Figure 2

Correlation Plots of Predictor–Mediator, Mediator–Outcome, and Predictor–Outcome Associations (Midlife Development in the United States Refresher Sample)



Note. The terms "constraints" and "uncontrollability" are used interchangeably in the present figure and throughout the article. T1 = time 1; T2 = time 2; T3 = time 3.

missRanger R package (Mayer, 2023). Next, we employed a causal counterfactual mediation approach (Ten Have & Joffe, 2012; VanderWeele, 2016a). This approach calculated the variation in results between the abuse-exposed group and a hypothetical non-abuse-exposed group that functioned as a point of reference for understanding what might have happened to the abused individuals if they had not experienced abuse (Imai, Jo, & Stuart, 2011). In other words, instead of having an actual control group, this method creates a hypothetical comparison group representing what may have occurred if the abused individuals had not experienced abuse. This approach allows researchers to estimate causal effects without requiring randomization or the assumption of no unmeasured confounding variables. The hypothetical nonabuse group serves as a counterfactual reference point to understand potential outcomes in the absence of abuse exposure (Qin, 2024; Valeri & Vanderweele, 2013). Causal mediation analysis differs from conventional structural equation mediation modeling (SEMM; e.g., Hayes & Preacher, 2014), removing the assumption that unmeasured variables do not affect predictor–mediator, mediator–outcome, and predictor–outcome associations (or "sequential ignorability"; Cuartas & McCoy, 2021). It eliminates the necessity of sequential ignorability by establishing associations between the mediator and causal parameter estimates (Imai, Keele, et al., 2011).

In several ways, causal counterfactual mediation analysis generates more generalizable and robust effects than the typical SEMM methods. First, it enables the disaggregation of total effects into direct and indirect effects, even in the context of moderation effects and nonlinear relations among variables, thereby overcoming limitations in traditional SEMM approaches (Imai et al., 2010). Second, causal mediation offers ways to assess causal pathways via sensitivity analyses, improving the rigor and interpretation of results (MacKinnon et al., 2020). Third, causal mediation clearly defines direct and indirect effects informed by plausible outcomes, enabling more accurate construal of findings across diverse data set structures and variable types (Pearl, 2014). By accounting for hypothetical counterfactual situations, causal mediation strengthens the understanding of plausible causal effects that optimize clinical and policy decision making (VanderWeele, 2016b). Together, the capacity of causal mediation methods to remedy the shortcomings of SEMM methods provides a more thorough comprehension of intricate child abuse phenomena, resulting in more actionable and generalizable results.

Relatedly, the sensitivity analyses included predictor–mediator interactions in studying how perceived control might mediate between child abuse and adulthood EF based on several theoretical assumptions. Child abuse could lead to diverse outcomes, and the extent to which perceived control mediates its effects on EF might vary by child abuse severity (Aafjes-van Doorn et al., 2020). Further, perceived control is a complex multidimensional concept (Skinner, 1996), and its unique aspects (mastery or uncontrollability) may differentially interact with child abuse to impact EF (Infurna et al., 2015). In addition, any substantial predictor–mediator interactions could shed light on risk and protective factors to inform nuanced, targeted treatments (Blangis et al., 2024). Building on simpler mediation models, these sensitivity analyses could thus detect threshold effects and nonlinear pathways that more accurately capture

intricate developmental trajectories from childhood abuse to adulthood EF.

The mediation analyses comprised three paths. "Path a" denoted the effect of T1 child abuse on T2 perceived control. "Path b" indicated the effect of T2 perceived control on T3 EF. "Path c" signified the direct effect of T1 child abuse on T3 EF. Considering the theoretical importance of each potential mediator and their correlated nature, we opted not to control for either mediator within each equation (Vansteelandt & Daniel, 2017). We presented the unstandardized regression coefficients (*b*) with 95% confidence intervals and performed bootstrapping with 1,000 resampling iterations (Cheung & Lau, 2008). Under the causal mediation analysis framework, sensitivity analyses were conducted to test the extent to which the pattern of results remained by including predictor–mediator interactions, which could predict EF (Lin et al., 2020).

Additionally, sensitivity analyses that allowed for nonlinearities in predictor–mediator, mediator–outcome, and predictor–outcome relations were explored (Imai et al., 2010). The *intmed* (Chan, 2020), *mgcv* (Wood, 2014), and *mediation* (Tingley et al., 2014) *R* packages were used to conduct the analyses (https://tinyurl.com/codesintmed; https://tinyurl.com/codesmediation). More sensitivity analyses were done to test if findings remained similar after adjusting for age (Cerino et al., 2024), gender (Grissom & Reyes, 2019), predictor–mediator interaction (Imai et al., 2010), and presence of any of the following physical health conditions (Allan et al., 2016; Bourassa et al., 2017; Holanda & de Almondes, 2016). These conditions included AIDS/HIV infection, alcohol/drug problems, asthma, bronchitis/emphysema, autoimmune disorders, bone/joint diseases, chronic sleeping problems, chronic trouble with teeth/piles/hemorrhoids, diabetes/high blood sugar, emotional disorders, gallbladder issues, gum/mouth issues, hay fever, high blood pressure, hernia/rupture, migraine headaches, neurological disorders, other lung problems, persistent foot trouble, long-term skin trouble, recurring stomach trouble/sciatica/lumbago, and repeating backache, stroke, tuberculosis, and urinary/bladder problems, as well as varicose veins requiring treatment (Zainal & Newman, 2021).

Effect sizes were computed to ease the interpretation of each parameter estimate. Cohen's *d* values were calculated using the $d = 2 \times t/(df)$, where *t* indicated the *t* statistic of the parameter estimate, and *df* referred to the model's degree of freedom (Dunst & Hamby, 2012). These effect sizes were computed across 10 independent and randomly selected subsamples from each study, with an average subsample size of 300 from Study 1 and 250 from Study 2.

Results

Effect of T1 Child Abuse on T2 Perceived Control (Path "a")

MIDUS Original

Higher (vs. lower) exposure to maternal ($d = -0.101$, $p = .018$), but not paternal ($d = -0.008$, $p = .851$), child abuse significantly predicted reduced mastery (Supplemental Table S1). Similarly, higher (vs. lower) maternal ($d = 0.232$, $p < .001$) and paternal ($d = 0.778$, $p < .001$) child abuse significantly predicted increased uncontrollability (Supplemental Table S2).

MIDUS Refresher

More (vs. less) exposure to both maternal ($d = -1.089$, $p < .001$) and paternal ($d = -1.089$, $p < .001$) abuse significantly decreased mastery (Supplemental Table S5). Likewise, more (vs. less) maternal ($d = 1.104$, $p < .001$) and paternal abuse ($d = 1.175$, $p < .001$) significantly predicted higher uncontrollability (Supplemental Table S6). Hypothesis 1 was partially supported.

Effect of T2 Perceived Control on T3 Adulthood EF (Path "b")

MIDUS Original

For the model examining recalled maternal child abuse as the predictor, lower (vs. higher) mastery ($d = 0.117$, $p = .001$) and higher (vs. lower) uncontrollability ($d = -0.400$, $p < .001$) significantly predicted lower adulthood EF scores. Likewise, for the model testing retrospective paternal child abuse as the predictor, lower (vs. higher) mastery ($d = 0.109$, $p = .001$) and higher (vs. lower) uncontrollability ($d = -0.411$, $p < .001$) significantly predicted poorer EF in adulthood (Supplemental Tables S1 and S2).

MIDUS Refresher

For the model testing retrospective maternal child abuse as the predictor, higher (vs. lower) uncontrollability ($d = -0.285$, $p < .001$), but not mastery ($d = 0.044$, $p = .291$), significantly predicted poorer adulthood EF. Similarly, for the model assessing recalled paternal child abuse as the predictor, higher (vs. lower) uncontrollability ($d = -0.244$, $p < .001$) but not mastery ($d = 0.022$, $p = .521$) significantly predicted lower adulthood EF scores (Supplemental Tables S5 and S6). Hypothesis 2 was, therefore, partially supported.

T2 Mastery as a Mediator of the Effect of T1 Child Abuse on T3 Adulthood EF

MIDUS Original

Reduced mastery significantly mediated the effect of higher (vs. lower) frequency of child maternal abuse on adulthood EF ($d = -0.137$, $p = .016$; proportion mediated = 5.6%; Table 2 Part A). This mediation effect remained significant after adjusting for predictor–mediator interactions (Part B) and T1 age (Part C) but not gender (Part D). However, mastery did not significantly mediate the effect of child paternal abuse on adulthood EF in the primary model ($d = 0.000$, $p = .840$; Part E; proportion mediated = 0.0%) and after adjusting for covariates, including the predictor–moderator interaction (Part F), age (Part G), and gender (Part H). These nonsignificant mediation effects remained in sensitivity analyses that examined nonlinear associations (Supplemental Table S3) and after adjusting for physical health status (Supplemental Tables S9 and S10). The 10 random subsamples showed similar effect sizes for path "a" (maternal: $d = -0.325$ to 0.043; paternal: $d = -0.352$ to 0.118), path "b" (maternal: $d = 0.073$–0.290; paternal: $d = 0.074$–0.290), indirect effects (maternal: $d = -0.270$ to 0.034; paternal: $d = -0.290$ to 0.080), direct effects (maternal: $d = -0.204$ to 0.090; paternal: $d = -0.279$ to 0.127), and total effects (maternal: $d = -0.222$

Table 2

Time 1 Childhood Abuse Predicting Time 3 Executive Functioning Through Time 2 Mastery With the Midlife Development in the United States Original Data Set

Effect	*b*	[95% CI]	*p*	*d*
A. Maternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.001*	[−0.002, −0.001]	.016	−0.137
Direct effect	−0.017**	[−0.028, −0.005]	.006	−0.101
Total effect	−0.018**	[−0.029, −0.006]	.006	−0.107
Proportion mediated	5.6%			
B. Maternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.001*	[−0.002, −0.001]	.030	−0.137
Direct effect	−0.017**	[−0.029, −0.005]	.004	−0.097
Total effect	−0.018**	[−0.029, −0.006]	.004	−0.107
Proportion mediated	5.6%			
C. Maternal abuse as predictor (model with age as a covariate)				
Indirect effect	−0.001*	[−0.002, −0.001]	.010	−0.137
Direct effect	−0.025***	[−0.035, −0.015]	.000	−0.171
Total effect	−0.026***	[−0.036, −0.015]	.000	−0.169
Proportion mediated	3.8%			
D. Maternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.001	[−0.001, 0.000]	.054	−0.137
Direct effect	−0.015**	[−0.026, −0.004]	.008	−0.187
Total effect	−0.015**	[−0.027, −0.004]	.008	−0.187
Proportion mediated	6.7%			
E. Paternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	0.000	[−0.001, 0.001]	.840	0.000
Direct effect	−0.006	[−0.016, 0.005]	.290	−0.039
Total effect	−0.005	[−0.017, 0.005]	.294	−0.031
Proportion mediated	0.0%			
F. Paternal abuse as predictor (model with age as a covariate)				
Indirect effect	0.000	[−0.001, 0.001]	.788	0.000
Direct effect	−0.005	[−0.015, 0.005]	.334	−0.034
Total effect	−0.005	[−0.016, 0.005]	.336	−0.033
Proportion mediated	0.0%			
G. Paternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	0.000	[−0.001, 0.001]	.810	0.000
Direct effect	−0.016***	[−0.025, −0.006]	.000	−0.115
Total effect	−0.016***	[−0.025, −0.006]	.000	−0.115
Proportion mediated	0.0%			
H. Paternal abuse as predictor (model with age as a covariate)				
Indirect effect	0.000	[−0.001, 0.000]	.440	0.000
Direct effect	−0.011*	[−0.021, −0.001]	.026	−0.075
Total effect	−0.011*	[−0.022, −0.001]	.026	−0.072
Proportion mediated	0.0%			

Note. Refer to Figure 1 as well as Supplemental Tables S1 and S3 for more details on the predictor-to-mediator and mediator-to-outcome pathways. *b* = unstandardized regression weight; CI = confidence interval. * $p < .05$. ** $p < .01$. *** $p < .001$.

to 0.082; paternal: $d = -0.259$ to 0.122) for this set of analyses (Supplemental Tables S13 and S14).

MIDUS Refresher

Mastery did not significantly mediate the effect of child maternal abuse frequency on adulthood EF ($d = -0.039$, $p = .300$; proportion mediated = 18.8%; Table 3 Part A). This mediation pathway stayed statistically nonsignificant after controlling for the predictor–mediator interaction (Part B), T1 age (Part C), and gender (Part D). Likewise, mastery was not a significant mediator of the pathway from child paternal abuse to adulthood EF ($d = -0.023$, $p = .552$; proportion mediated = 9.2%; Table 3 Part E), including after adjusting for predictor–moderator interaction (Part F), age (Part G), and gender (Part H). Similar patterns emerged when examining nonlinear relations (Supplemental Table S7) and after controlling for physical health status (Supplemental Tables S11 and S12). The 10 random subsamples displayed identical effect sizes for path "a" (maternal: $d = -0.419$ to -0.383; paternal: $d = -0.311$ to -0.008), path "b" (maternal: $d = -0.071$ to 0.144; paternal: $d = -0.125$ to 0.264), indirect effects (maternal: $d = -0.144$ to 0.066; paternal: $d = -0.150$ to 0.309), direct effects (maternal: $d = -0.208$ to 0.191; paternal: $d = -0.192$ to 0.092), and total effects (maternal: $d = -0.273$ to 0.100; paternal: $d = -0.108$ to 0.138) for this set of analyses (Supplemental Tables S17 and S18).

Table 3

Time 1 Childhood Abuse Predicting Time 3 Executive Functioning Through Time 2 Mastery With the Midlife Development in the United States Refresher Data Set

Effect	*b*	[95% CI]	*p*	*d*
A. Maternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.013	[−0.040, 0.012]	.300	−0.039
Direct effect	−0.056	[−0.111, 0.002]	.066	−0.077
Total effect	−0.069**	[−0.117, −0.023]	.008	−0.114
Proportion mediated	18.8%			
B. Maternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.039	[−0.082, 0.009]	.100	−0.067
Direct effect	−0.091*	[−0.164, −0.016]	.012	−0.096
Total effect	−0.130*	[−0.224, −0.027]	.014	−0.103
Proportion mediated	30.0%			
C. Maternal abuse as predictor (model with age as a covariate)				
Indirect effect	−0.015	[−0.040, 0.010]	.232	−0.047
Direct effect	−0.095***	[−0.148, −0.038]	.000	−0.134
Total effect	−0.109***	[−0.154, −0.063]	.000	−0.186
Proportion mediated	13.8%			
D. Maternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.015	[−0.041, 0.011]	.250	−0.045
Direct effect	−0.051	[−0.107, 0.006]	.090	−0.070
Total effect	−0.066*	[−0.113, −0.019]	.010	−0.109
Proportion mediated	22.7%			
E. Paternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.007	[−0.032, 0.015]	.552	−0.023
Direct effect	−0.069**	[−0.116, −0.022]	.002	−0.114
Total effect	−0.076***	[−0.117, −0.037]	.000	−0.148
Proportion mediated	9.2%			
F. Paternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.027	[−0.068, 0.019]	.258	−0.048
Direct effect	−0.094**	[−0.152, −0.031]	.002	−0.121
Total effect	−0.121**	[−0.200, −0.032]	.004	−0.112
Proportion mediated	22.3%			
G. Paternal abuse as predictor (model with age as a covariate)				
Indirect effect	−0.008	[−0.030, 0.014]	.464	−0.028
Direct effect	−0.105***	[−0.151, −0.062]	.000	−0.184
Total effect	−0.113***	[−0.148, −0.074]	.000	−0.238
Proportion mediated	7.1%			
H. Paternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.006	[−0.030, 0.016]	.614	−0.020
Direct effect	−0.074***	[−0.122, −0.027]	.000	−0.121
Total effect	−0.081***	[−0.122, −0.042]	.000	−0.158
Proportion mediated	7.4%			

Note. Refer to Figure 2 as well as Supplemental Tables S5 and S7 for more details on the predictor-to-mediator and mediator-to-outcome pathways. *b* = unstandardized regression weight; CI = confidence interval. * $p < .05$. ** $p < .01$. *** $p < .001$.

T2 Uncontrollability as a Mediator of the Effect of T1 Child Abuse on T3 Adulthood EF

MIDUS Original

Higher (vs. lower) uncontrollability significantly mediated the effect of more frequent child maternal abuse on adulthood EF ($d = -0.219$, $p < .001$; proportion mediated = 44.4%; Table 4 Part A). This mediation effect stayed significant even after controlling for the predictor–mediator interaction (Part B), T1 age (Part C), and gender (Part D). Similarly, stronger uncontrollability significantly mediated the effect of more frequent child paternal abuse on adulthood EF ($d = -0.164$, $p < .001$; proportion mediated = 83.3%; Table 4 Part E).

Table 4

Time 1 Childhood Abuse Predicting Time 3 Executive Functioning Through Time 2 Uncontrollability With the Midlife Development in the United States Original Data Set

Effect	*b*	[95% CI]	*p*	*d*
A. Maternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.008***	[−0.010, −0.005]	.000	−0.219
Direct effect	−0.010	[−0.021, 0.001]	.088	−0.062
Total effect	−0.018***	[−0.029, −0.006]	.002	−0.107
Proportion mediated	44.4%			
B. Maternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.007***	[−0.010, −0.004]	.000	−0.160
Direct effect	−0.008	[−0.020, 0.003]	.176	−0.048
Total effect	−0.015*	[−0.027, −0.003]	.008	−0.086
Proportion mediated	46.7%			
C. Maternal abuse as predictor (model with age as a covariate)				
Indirect effect	−0.008***	[−0.011, −0.005]	.000	−0.182
Direct effect	−0.018**	[−0.028, −0.008]	.000	−0.123
Total effect	−0.026***	[−0.036, −0.016]	.000	−0.178
Proportion mediated	30.8%			
D. Maternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.006***	[−0.009, −0.004]	.000	−0.164
Direct effect	−0.009	[−0.021, 0.003]	.106	−0.051
Total effect	−0.016**	[−0.027, −0.004]	.008	−0.095
Proportion mediated	37.5%			
E. Paternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.005***	[−0.007, −0.003]	.000	−0.171
Direct effect	−0.001	[−0.012, 0.010]	.862	−0.006
Total effect	−0.006	[−0.017, 0.005]	.308	−0.037
Proportion mediated	83.3%			
F. Paternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.005***	[−0.008, −0.003]	.000	−0.137
Direct effect	−0.002	[−0.012, 0.009]	.778	−0.013
Total effect	−0.007	[−0.018, 0.004]	.228	−0.044
Proportion mediated	71.5%			
G. Paternal abuse as predictor (model with age as a covariate)				
Indirect effect	0.010***	[0.007, 0.014]	.000	0.196
Direct effect	−0.016**	[−0.026, −0.006]	.004	−0.109
Total effect	−0.005	[−0.015, 0.005]	.336	−0.034
Proportion mediated	100.0%			
H. Paternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.005***	[−0.008, −0.003]	.000	−0.137
Direct effect	−0.005	[−0.015, 0.005]	.286	−0.034
Total effect	−0.011**	[−0.021, −0.001]	.040	−0.075
Proportion mediated	45.5%			

Note. Refer to Figure 1 as well as Supplemental Tables S2 and S4 for more details on the predictor-to-mediator and mediator-to-outcome pathways. *b* = unstandardized regression weight; CI = confidence interval. * $p < .05$. ** $p < .01$. *** $p < .001$.

This mediation effect stayed significant after accounting for the predictor–mediator interaction (Part F), T1 age (Part G), and gender (Part H). These mediation effects remained significant when testing nonlinear relations (Supplemental Tables S3 and S4) and after adjusting for physical health status (Supplemental Tables S9 and S10). The 10 random subsamples indicated similar effect sizes for path "a" (maternal: $d = 0.164$–0.614; paternal: $d = 0.088$–0.479), path "b" (maternal: $d = -0.503$ to -0.348; paternal: $d = -0.559$ to -0.362), indirect effects (maternal: $d = -0.371$ to -0.135; paternal: $d = -0.384$ to -0.061), direct effects (maternal: $d = -0.135$ to 0.137; paternal: $d = -0.278$ to 0.214), and total effects (maternal: $d = -0.211$ to 0.085; paternal: $d = -0.256$ to 0.144) for these analyses (Supplemental Tables S15 and S16).

MIDUS Refresher

More (vs. less) uncontrollability significantly mediated the pathway from higher child maternal abuse to weaker adulthood EF ($d = -0.229$, $p < .001$; proportion mediated = 100.0%; Table 5 Part A). This mediation pathway remained significant after adjusting for the predictor–mediator interaction (Part B), T1 age (Part C), and gender (Part D). Likewise, higher uncontrollability significantly mediated the pathway from more child paternal abuse frequency to lower adulthood EF scores ($d = -0.212$, $p < .001$; proportion mediated = 100.0%; Table 5 Part E). This statistical significance was retained after controlling for the predictor–mediator interaction (Part F), T1 age (Part G), and gender (Part H). Similar mediation patterns were observed with nonlinear associations (Supplemental Table S8) and after controlling for physical health status (Supplemental Tables S11 and S12). Hypothesis 3 was, therefore, partially supported. The 10 random subsamples demonstrated identical effect sizes for path "a" (maternal: $d = 0.824$–1.471; paternal: $d = 1.049$–1.555), path "b" (maternal: $d = -0.433$ to -0.169; paternal: $d = -0.413$ to -0.112), indirect effects (maternal: $d = -0.403$ to -0.177; paternal: $d = -0.380$ to -0.109), direct effects (maternal: $d = -0.157$ to 0.272; paternal: $d = -0.269$ to 0.218), and total effects (maternal: $d = -0.288$ to 0.041; paternal: $d = -0.390$ to 0.049) for these analyses (Supplemental Tables S19 and S20).

Discussion

The present study used counterfactual mediation analysis to test how mastery and uncontrollability mediated the effect of maternal and paternal child abuse on adulthood EF across two community-dwelling adult samples. A series of sensitivity analyses adjusting for age, predictor–mediator interactions, physical health status, and probing nonlinear pathways generated identical findings. Perceived uncontrollability, instead of personal mastery, was a consistent mediator of the pathway from child abuse to adulthood EF in both samples. Findings have several implications for future research, theory, clinical practice, and public health.

Concordant with our hypotheses, why did higher maternal and paternal child abuse consistently predict greater future uncontrollability, which subsequently preceded lower EF in both the MIDUS Original and Refresher samples? Behaviorally, if left untreated, child abuse could increase avoidant, self-sabotaging coping styles that thwart the formation of healthy control beliefs, promoting chronic distress (Nguyen-Feng et al., 2017) and increasing uncontrollability over time. Biologically, neural pathways responsible for EF may

Table 5

Time 1 Childhood Abuse Predicting Time 3 Executive Functioning Through Time 2 Uncontrollability With the Midlife Development in the United States Refresher Data Set

Effect	*b*	[95% CI]	*p*	*d*
A. Maternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.078***	[−0.104, −0.051]	.000	−0.229
Direct effect	0.008	[−0.049, 0.067]	.746	0.011
Total effect	−0.069**	[−0.117, −0.023]	.008	−0.114
Proportion mediated	100.0%			
B. Maternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.114***	[−0.154, −0.072]	.000	−0.216
Direct effect	−0.053	[−0.125, 0.025]	.202	−0.055
Total effect	−0.167***	[−0.260, −0.069]	.000	−0.136
Proportion mediated	68.3%			
C. Maternal abuse as predictor (model with age as a covariate)				
Indirect effect	−0.088***	[−0.114, −0.063]	.000	−0.268
Direct effect	−0.022	[−0.076, 0.033]	.452	−0.031
Total effect	−0.109***	[−0.154, −0.063]	.000	−0.186
Proportion mediated	80.7%			
D. Maternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.080***	[−0.107, −0.053]	.000	−0.230
Direct effect	0.014	[−0.043, 0.072]	.612	0.019
Total effect	−0.066**	[−0.113, −0.019]	.010	−0.109
Proportion mediated	100.0%			
E. Paternal abuse as predictor (model without predictor–mediator interaction)				
Indirect effect	−0.071***	[−0.096, −0.044]	.000	−0.212
Direct effect	−0.005	[−0.053, 0.045]	.852	−0.008
Total effect	−0.076***	[−0.117, −0.037]	.000	−0.148
Proportion mediated	93.4%			
F. Paternal abuse as predictor (model with predictor–mediator interaction)				
Indirect effect	−0.093***	[−0.134, −0.049]	.000	−0.170
Direct effect	−0.042	[−0.105, 0.019]	.198	−0.053
Total effect	−0.135**	[−0.221, −0.053]	.004	−0.125
Proportion mediated	68.9%			
G. Paternal abuse as predictor (model with age as a covariate)				
Indirect effect	−0.080***	[−0.104, −0.055]	.000	−0.254
Direct effect	−0.033	[−0.076, 0.014]	.170	−0.057
Total effect	−0.113***	[−0.148, −0.074]	.000	−0.238
Proportion mediated	70.8%			
H. Paternal abuse as predictor (model with gender as a covariate)				
Indirect effect	−0.071***	[−0.095, −0.043]	.000	−0.212
Direct effect	−0.010	[−0.058, 0.041]	.692	−0.016
Total effect	−0.081***	[−0.122, −0.042]	.000	−0.158
Proportion mediated	87.7%			

Note. Refer to Figure 2 as well as Supplemental Tables S6 and S8 for more details on the predictor-to-mediator and mediator-to-outcome pathways. *b* = unstandardized regression weight; CI = confidence interval.
** $p < .01$. *** $p < .001$.

undergo developmental disturbances from these chronic abuse and high uncontrollability experiences, leading to behavioral disruptions and a lack of optimal neuroplastic adaptability to stressors over long durations (Luciana & Collins, 2022). Such neurobehavioral disruptions are likely to be intimately linked to sustained stress appraisals, which are believed to result in alterations in the functioning of stress regulation systems (McLaughlin et al., 2014; Zainal et al., 2024) in ways that compromise perceived control and EF across long periods. Child abuse and increased uncontrollability could induce long-term alterations in both the structure and function of the ventromedial PFC, plausibly due to the fear response within this region and the prolonged activation of the HPA axis linked to ongoing threats (Doom et al., 2014; Kaess et al., 2018). These experiences have been correlated with heightened inflammation and weakened antiviral and adaptive immune responses (Bower & Kuhlman, 2023). Such biological alterations that heighten uncontrollability might persistently alter brain-immune signaling pathways in ways that compromise EF. Together, our findings suggested that commencing in childhood and persisting throughout life, both maternal and paternal child abuse might heighten sensitivity to external threats and erode perceptions of control (Shaw & Krause, 2002; Shaw et al., 2004), thereby affecting sensitive EF brain areas.

In addition, in the MIDUS Original sample, the mediation effect of mastery in the child maternal abuse-adulthood EF pathway was nullified with gender as a covariate. This finding highlights the intricate interrelations among child abuse, gender, and lifetime cognitive functioning changes. Sex differences have been found in the rates and effects of child abuse as well as the development of EF (Grissom & Reyes, 2019), mastery (Wang et al., 2023), and coping skills (Seppälä et al., 2024). Together, these complex sex difference factors might explain most of the variance in the pathway between child abuse and adulthood EF, possibly overshadowing the mediating effect of mastery with gender in the equation.

More importantly, findings across two unique community adult samples lend credence to uncontrollability, rather than mastery, as a stable mediator of child abuse predicting future EF. Although mastery mediated the pathway from child maternal abuse to adulthood EF in the MIDUS Original study, a small effect size in this well-powered large sample was observed (5.6% of the mediation effect relative to the total effect), limiting its practical significance. Further, the MIDUS Refresher data set with a relatively smaller sample size revealed no statistically significant mediation effects of mastery. The greater mediating potency of uncontrollability over mastery across studies could be due to the persistent stressors and helplessness faced by child abuse victims, which might have long-term repercussions on cognitive processing (Rodriguez & Tucker, 2015; Vizard et al., 2022). Chronic uncontrollability could disrupt stress regulation systems, possibly adversely affecting the growth of EF domains, such as inhibition, set-shifting, and WM, over long durations (Victor et al., 2024). Moreover, persistent uncontrollability stemming from child abuse might hinder the learning of optimal emotion regulation and problem-solving skills (Mansueto et al., 2019; Rimular & Berzenski, 2022), which might unfavorably impact future EF. Future longitudinal studies should test these conjectures.

Notably, most mediation effect sizes for statistically significant mediation pathways ranged from 44.4% to 100.0% across samples and child abuse forms, reflecting the practical significance of the findings on uncontrollability as a potential mechanism. Relatedly, Cohen's *d* effect sizes for path "a" (predictor-to-mediator), path "b" (mediator-to-outcome), and the indirect mediation effects consistently ranged from small to large in the whole sample for both studies and the 10 smaller randomly selected subsamples in the sensitivity analyses. These parameter estimates were the most essential to our research question. Even small Cohen's *d* effect size values that range between 0.1 and 0.2 could be practically meaningful in longitudinal studies across long durations in the order of months and years that recruit large community samples to identify the neurocognitive consequences of child abuse (Lakens, 2013; McGough & Faraone, 2009). The population-level nature of these Cohen's *d* effect sizes derived from such epidemiological designs

thus could have important clinical implications (Lamberink et al., 2018; Panjeh et al., 2023). On that note, these mediation effect sizes concurred with prospective evidence on the small but practically meaningful direct effects of child abuse on diverse EF domains (Op den Kelder et al., 2022), such as attentional control (Carvalho et al., 2020). Together, the reliable mediation effects for uncontrollability reflected that this mediator might indicate a crucial mechanism bridging between child abuse and adulthood EF.

The present study should be interpreted considering its limitations. Our assessment of child abuse relied on retrospective reports, which were susceptible to recall bias and underendorsements and might encompass varying categories of child abuse victims compared to prospective reports (Baldwin et al., 2024). The arbitrary time schedule and lack of T2 EF assessment were also study limitations. Relatedly, we have recorded only a narrow range of possible abuse events. For example, other conceivable scenarios include how child neglect might impair performance-based (Wade et al., 2019) and self-reported (Merz et al., 2013) EF domains via perceived uncontrollability in the long term. Notably, the indirect effect for mastery as the mediator was no longer significant after including gender as a covariate in the MIDUS Original sample, but this finding was not replicated in the MIDUS Refresher sample. In addition, although our longitudinal study accounted for temporality, potential third variables, such as genetics and temperament (Kagan, 2022), might have also contributed to our findings. Also, given the primarily highly educated White samples across both MIDUS samples, future replication efforts should test these mediational hypotheses in culturally diverse samples. Finally, although the counterfactual causal mediation method we used was more stringent than the typical SEMM approach, it still could not entirely account for the intricacies of lived human experiences as complex as child abuse.

Despite these limitations, the study's strengths included the rigorous causal mediation analysis that facilitated generalizability and attempts to replicate the models across two samples. Third, the large sample size rendered the present study well-powered to test the stated mediational hypotheses. Fourth, most findings remained similar even under sensitivity analyses that tested other assumptions (e.g., nonlinearities, predictor–mediator interactions). Last, the results with uncontrollability as the mediator were consistently replicated across two community-dwelling samples, suggesting these models applied to midlife-to-older adults.

If future population studies replicate the present findings, our study might have several clinical and public health implications. Preventing child abuse is an urgent public health priority, as research indicated that individuals with a history of such abuse tended to have poorer responses to psychological and pharmacological treatments (Harkness et al., 2012; Williams et al., 2016). It may be helpful to implement extensive screening and personalized treatment approaches targeting child abuse, uncontrollability, and suboptimal EF to enhance prevention and intervention strategies aimed at promoting healthy cognitive aging and optimal brain function. Fostering a stable, nurturing environment that values children and supports parents, perhaps via promising parenting programs (van Leuven et al., 2022), would ultimately promote brain health and EF throughout adulthood. Moreover, the emphasis on positive parenting is crucial, as research indicated that positive parental behaviors could be associated with higher global EF, inhibition, and WM in children. In addition, children who experienced a safe, positive, and emotional environment have enhanced cognitive development, and the lack of negative parental emotions allowed children to develop their thought processes (Valcan et al., 2018). As child abuse (Baldwin et al., 2024) and EF deficits (Lynch et al., 2021; Zainal & Newman, 2022) are established transdiagnostic risk factors, decreasing uncontrollability could be effective in reducing the odds of mental disorders in middle-to-older adulthood for those who suffered early child parental abuse. Strategies to reduce uncontrollability and boost EF could include encouraging high-intensity physical exercises (Moreau & Chou, 2019), enhancing meaningful social activities (Kelly et al., 2017), or altering limiting beliefs and avoidant patterns linked to trauma memories for abused midlife and older adults (Lee & Brown, 2022). To this end, the allocation of scarce public health resources would be optimized by identifying what prevention or intervention strategies work best for persons who have experienced child parental abuse.

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Received September 17, 2024
Revision received March 27, 2025
Accepted April 9, 2025 ■