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Growth in self-regulation over the course of adolescence mediates the effects of foster care on psychopathology in post-institutionalized children: a randomized clinical trial

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Abstract

Children reared in institutions experience severe psychosocial deprivation, with lasting consequences for social and emotional development. This study evaluated growth trajectories of self-regulation from ages 8 to 16 among institutionally-reared children randomized to foster care (foster care group; FCG) or to remain in institutional care (care as usual group; CAUG), compared to a never-institutionalized group (NIG). We then tested a developmental pathway by which growth in self-regulation reduces general psychopathology at 16 for FCG versus CAUG. FCG experienced modest growth in self-regulation over adolescence and "caught up" to NIG by age 16. The beneficial effect of foster care on psychopathology operated through growth in self-regulation; part of this effect was further mediated by reduced peer difficulties for FCG. Findings reveal that the effects of foster care on self-regulation emerge over adolescence and that growth in self-regulation is a mechanism by which foster care mitigates the impact of institutionalization on psychopathology.

Keywords

neglect; early adversity; developmental psychopathology; longitudinal methods

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AUTHOR CONTRIBUTIONS

CEM, MW, NAF, CHZ, and CAN contributed to conceptualization of the study; NAF, CHZ, and CAN designed and performed research. CEM and MW performed statistical analysis. CEM wrote the manuscript with comments from MW, NAF, CHZ, and CAN. All authors read and approved the final manuscript.

1. INTRODUCTION

Consistent, responsive caregiving early in life lays the foundation for healthy social and emotional development (Ainsworth, Bell, & Stayton, 1974; Davies & Cicchetti, 2004; Feldman & Eidelman, 2009). Children reared in institutions face profound disruption of this expected caregiving environment, subject to low caregiver-to-child ratios, high staff turnover, and rigid routines (Berens & Nelson, 2015; Smyke et al., 2007). Post-institutionalized children and adolescents show poor social skills (Almas et al., 2012; Etel & Yagmurlu, 2015; Julian & McCall, 2016), problematic social behaviors (Caprin, Benedan, Ballarin, & Gallace, 2017; Gunnar & Van Dulmen, 2007; Humphreys, Gabard-Durnam, et al., 2018), peer difficulties (Hodges & Tizard, 1989; Humphreys, Gabard-Durnam, et al., 2018; Pitula et al., 2014), and vulnerability to psychiatric problems (Colvert et al., 2008; Gunnar & Van Dulmen, 2007; Sonuga-Barke et al., 2017; Wiik et al., 2011). However, the processes by which early institutionalization shape later psychosocial well-being remain unclear.

Self-regulation, broadly defined as the capacity to regulate one's thoughts, emotions, and behavior, is a pivotal ability shaped by early experience. Caregiving interactions facilitate development of basic self-regulation skills (Feldman, Greenbaum, & Yirmiya, 1999; Fox & Calkins, 2003) and self-control (Vazsonyi & Huang, 2010). Early institutional care is associated with poor self-regulation, including reduced executive control (Pollak et al., 2010; Wade, Fox, Zeanah, & Nelson, 2019), emotional dysregulation (Tottenham et al., 2010), and disinhibited social behavior (Chisholm, 1998; Gleason et al., 2014; Guyon-Harris, Humphreys, Fox, Nelson, & Zeanah, 2018; Sonuga-Barke et al., 2017) from childhood into young adulthood.

Individual differences in self-regulation may, in turn, be associated with long-term psychosocial outcomes (Fergusson, Boden, & Horwood, 2013; Moffitt et al., 2011). Better control over emotions and behavior in early childhood predict social status (Maszk, Eisenberg, & Guthrie, 1999), peer rejection (Trentacosta & Shaw, 2009), and peer relationship quality later in development (Blair et al., 2014). Furthermore, recent studies indicate that basic self-regulatory processes predict risk for general psychopathology, i.e., "p" factor (Bloemen et al., 2018; Caspi et al., 2014; Martel et al., 2017; Wade, Zeanah, Fox, & Nelson, 2019). These findings implicate self-regulation as a potential mechanism by which early psychosocial experiences shape later peer and psychiatric outcomes.

Moreover, emerging longitudinal evidence suggests that self-regulation may impact risk for psychopathology *through* its effects on social relationships. For example, a recent study suggests that associations between self-regulation in preadolescence and both internalizing and externalizing psychopathology in young adulthood are partly mediated through negative social interactions with peers, parents, and romantic partners (Laceulle, Veenstra, Vollebergh, & Ormel, 2017). Prior work indicates that the association between maltreatment and psychiatric symptoms at one-year follow-up is serially mediated through emotion regulation and its effects on peer relations (Kim & Cicchetti, 2010). Given the persistent effects of early institutionalization on psychopathology (Humphreys et al., 2015;

Sonuga-Barke et al., 2017), it is critical to evaluate developmental pathways through which these effects can be mitigated or reversed.

Research from the Bucharest Early Intervention Project (BEIP), a randomized controlled trial to assess the efficacy of a foster care intervention for institutionalized children, suggests that the effects of early psychosocial deprivation can be partially remediated following placement into family-based care. In this trial, infants reared in Romanian institutions were randomly assigned to receive high-quality foster care intervention (foster care group; FCG) or to continue to receive care as usual, i.e., institutional care (care as usual group; CAUG). Developmental outcomes in this cohort were assessed longitudinally, facilitating evaluation of intervention effects (FCG versus CAUG) across development and additional comparison to a cohort of never-institutionalized children (NIG) reared with their biological families in Romania. At age 8, FCG children placed into foster care before 20 months of age demonstrated better overall social skills than CAUG (Almas et al., 2012). FCG children were also less reticent to speak and elicited more peer engagement while interacting with NIG children at this age (Almas et al., 2015). To better understand how the capacity to enact these social behaviors develops over time, it is critical to evaluate growth in self-regulatory processes from childhood into adolescence, a period of significant social and biological change. Recent work suggests that the effects of foster care intervention on social-emotional development may not fully manifest until later in adolescence. For instance, although CAUG and FCG demonstrate similar levels of general psychopathology (p factor) at age 8, FCG show a modest decline from ages 8 to 16, leading to lower general psychopathology by age 16 (Wade, Fox, Zeanah, & Nelson, 2018). Still, the developmental mechanisms by which foster care mitigates risk for general psychopathology remain unclear.

Using longitudinal data from BEIP, the current study maps developmental trajectories of self-regulation in social contexts among previously-institutionalized children from middle childhood to adolescence (ages 8 to 16 years). First, we estimated growth parameters (intercept and slope) for self-regulation with latent growth modeling within a Bayesian framework. The randomized controlled design of the trial allowed us to identify effects of the foster care intervention by comparing growth in self-regulation in FCG versus CAUG. In addition, we were able to characterize developmental trajectories of self-regulation among institutionally-reared youth (FCG and CAUG) in relation to the NIG, which served as a community comparison group. Moreover, we tested whether the foster care intervention mitigated risk for general psychopathology via its effects on self-regulation in social contexts and peer relationships. We predicted that placement into high-quality foster care would facilitate more growth in self-regulation over the course of adolescence in FCG compared to CAUG, ultimately contributing to reduced peer difficulties and, in turn, reduced vulnerability to general psychopathology at 16 years.

2. METHODS

2. 1. Clinical Trial Design

The Bucharest Early Project is the only randomized controlled trial (RCT) of a foster care intervention for institutionalized children to date. Study enrollment and randomization began in 2001. Inclusion criteria for institutionalized children included being 31 months or

younger and having spent at least half of their lives in institutional care. Exclusion criteria included frank genetic, neurological, or fetal alcohol syndromes, and microcephaly. After baseline screening, 136 children (between 6 and 31 months of age) living in six institutions throughout Bucharest, Romania, were randomly assigned to be moved out of the institutions and placed into foster families selected and trained by study investigators (foster care intervention group, FCG; n=68) or to receive care as usual, i.e., continued institutional care (care as usual group, CAUG; n=68). At baseline, FCG and CAUG children did not differ on demographic characteristics, age of entry into institutions, or duration of institutional care (McLaughlin, Fox, Zeanah, & Nelson, 2011). As part of the RCT, foster parents were trained to provide high-quality, responsive caregiving to the children placed in their care and received support from social workers in Bucharest with ongoing consultation from clinicians in the U.S. (Smyke, Zeanah, Fox, & Nelson, 2009). In this way, the RCT tested the effects of foster care on child development by comparing children randomly assigned to the foster care intervention versus care as usual conditions (FCG versus CAUG). A policy of non-interference was adopted, such that Romanian child protection authorities made all decisions with regard to children's placements; several children experienced changes in their placements over the course of the study (Supplementary Figure 1). Given evidence that children exposed to early institutionalization show atypical development across multiple domains (Gunnar, Bruce, & Grotevant, 2000), an additional, age- and sex-matched cohort of never-institutionalized children reared in their biological families (never-institutionalized group, NIG; n=72) was recruited from local pediatric clinics to serve as a community comparison group.

The design of the original trial and ethical safeguards of BEIP have been discussed in detail elsewhere (Millum & Emanuel, 2007; Zeanah, Fox, & Nelson, 2012). All study protocols and procedures were approved by the Institutional Review Boards at the three principal investigators' universities and later by the Ethics Committee at Bucharest University. The study was initiated in collaboration with the Ministry of Health in Romania. For each child, signed informed consent was obtained from the child's legal guardian. Written or verbal assent was also obtained, depending upon the cognitive ability of the child, at ages 8, 12 and 16 years.

2.2. Participants

Children were assessed at 30 months, 42 months, and 54 months as part of the original trial. At the conclusion of the RCT (54 months), support for the foster care network was transferred to local child protection authorities. Data for the current study were obtained from follow-up assessments conducted at 8-year, 12-year, and 16-year timepoints. Participants who were enrolled at the 8-year timepoint and contributed data on the Social Skills Rating System (Gresham & Elliott, 1990) self-regulation subscale at least once were included in the current analyses, yielding a final sample of 220 children (58 CAUG, 62 FCG, 100 NIG). 215 children (55 CAUG, 60 FCG, and 100 NIG) contributed data at age 8; 157 children (53 CAUG, 54 FCG, and 50 NIG) contributed data at age 12; and 134 children (45 CAUG, 48 FCG, 41 NIG) contributed data at age 16 by 8/25/2018. It is important to note that while some CAUG children still remained institutionalized at the 8-, 12-, and 16-year timepoints, others had been placed into family-based care arrangements (e.g., government

foster care, adoption, reunited with biological family) (see Supplementary Figure 1 for further details). An intent-to-treat approach was employed, such that participants' original group assignments were employed for all analyses, regardless of subsequent changes in placement over the course of the study. Demographics, baseline characteristics, and full-scale IQ for CAUG, FCG, and NIG participants included in the current study are reported in Table 1.

2.3. Measures

Self-regulation at 8, 12, and 16 years.—Self-regulation in social situations was assessed using the Social Skills Rating System (SSRS), a standardized questionnaire evaluating social skills performance, at the 8, 12, and 16-year time points (Gresham & Elliott, 1990). The SSRS Self-control subscale assesses a child's ability to appropriately modulate his/her reactions in social contexts (e.g., responding appropriately to teasing and refusing unreasonable requests from others). Children's primary caregivers and/or teachers responded to items on a three-point scale from 0 ("never") to 2 ("very often"). To account for children's actual age at assessment in our growth curve model, parent and teacher ratings were residualized for the child's age in months. Ratings were then averaged to generate an age-residualized composite score across informants at the 8, 12, and 16-year timepoints. Previous work has indicated good test-retest reliability of the SSRS and convergent validity with other measures of social function (Gresham, Elliott, Vance, & Cook, 2011). In the current study, caregiver- and teacher-report measures of self-regulation (SSRS self-control subscale) showed good internal consistency at ages 8 (parent-report: α=0.83; teacher-report: α=0.84), 12 (parent-report: α =0.84; teacher-report: α=0.86), and 16 (parent-report: α=0.87; teacher-report: α=0.83).

General psychopathology at 16 years.—Psychopathology was measured using the Internalizing and Externalizing/ADHD Scales of the MacArthur Health and Behavior Questionnaire (HBQ) (Essex et al., 2002a). Teacher- and parent-report versions of the MacArthur HBQ have demonstrated good reliability and validity in assessment of psychopathology from childhood (Ablow et al., 1999; Essex et al., 2002b; Luby et al., 2002) into adolescence (Pitula et al., 2014; Shirtcliff & Essex, 2008; Wade et al., 2018) in both typical and institutionally-reared samples. In addition, the HBQ has been shown to better capture internalizing symptoms relative to other measures of childhood psychopathology (e.g., the Diagnostic Instrument for Screening Children-IV) (Luby et al., 2002). In the current study, caregivers and/or teachers rated behaviors on a three-point scale from 0 ("never or not true") to 2 ("often or very true"); ratings were then combined to generate a multi-informant composite score for each subscale. Subscales included depression, overanxious, social anxiety/withdrawal, oppositional defiant, conduct problems, overt aggression, relational aggression, and ADHD. Composite subscale scores were then subjected to latent bifactor models to estimate general psychopathology, internalizing, and externalizing factors, as described previously (Wade et al, 2018). Factor scores for the latent general psychopathology factor (i.e., "p factor") at age 16 were saved and used as a manifest outcome variable for the current study.

Peer difficulties.—Children's peer difficulties were evaluated using the Peer Relations Scale of the HBQ at the 16-year timepoint. Caregivers and/or teachers rated each child's experiences in the domains of Peer Acceptance/Rejection, Bullying by Peers, and Relational Victimization on a scale from 1 ("not at all") to 4 ("very much"). Prior research using caregiver- and parent-report forms of the MacArthur HBQ to assess peer relations in post-institutionalized adolescents indicates good internal consistency of peer relations subscales in adolescence (Pitula et al., 2014) and associations with mental health (Humphreys et al., 2018; Pitula et al., 2014) and disorders of attachment (Guyon-Harris, Humphreys, Fox, Nelson, & Zeanah, 2019), suggesting reliability and validity of these subscales at older ages. Given the highly intercorrelated ratings among these domains and between informants, confirmatory factor analysis was carried out on multi-informant ratings across these domains to identify one latent Peer Difficulties factor. Robust maximum likelihood estimation was employed. Modification indices indicated that the single-factor model would be improved by including residual correlations of Peer Victimization (teacher-rated) with Bullying by Peers (teacher-rated), Acceptance/Rejection (teacher-rated) with Bullying by Peers (teacher-rated), Peer Acceptance/Rejection with Peer Victimization (teacher-rated), and Peer Acceptance/Rejection with Peer Victimization (parent-rated); these residual correlations were added to the final model. Model fit was good, $\chi^2(5) = 1.55$, p=0.91, RMSEA<.001, CFI=1.00, SRMR = 0.009 (Hu & Bentler, 1999). Factor scores from this model were saved and used as manifest mediator variables at age 16.

IQ.—Full-scale IQ scores were entered as a covariate in the growth models to control for the effects of general cognitive ability on self-regulatory development. IQ was assessed at the 8-year timepoint using the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2003). A full-[ISP] scale IQ composite score was calculated for each participant based on all 10 WISC-IV subtests. All IQ assessments were administered by trained and reliable Romanian psychologists in the BEIP laboratory. IQ outcomes at age 8 years have been previously reported (Fox, Almas, Degnan, Nelson, & Zeanah, 2011).

2.4. Statistical analysis

Using Mplus v7 statistical software (Muthen & Muthen), we conducted multigroup latent growth modeling (LGM) for SSRS self-control scores using Bayesian estimation. This approach allowed us to examine growth parameters (intercepts and slopes) within and between CAUG, FCG, and NIG groups. In addition, sex and general cognitive ability (WISC-IV Full Scale IQ score) were controlled for in each model, as these variables have been shown to modulate social skills in prior developmental studies (Gresham & Elliott, 1990; Skuse et al., 2009). Missing data were handled using Bayesian estimation. This method is similar to full-information maximum likelihood estimation, which provides less biased parameter estimates and better model fit compared to other common methods for treating missing data, such as listwise or pairwise deletion (Enders & Bandalos, 2001). Bayesian posterior predictive checking using chi-square indicated good model fit, indicated by a posterior predictive p-value greater than .05 (p=.165) and a 95% confidence interval including zero (−15.00 to 42.91). For LGM results, one-tailed p-values based on posterior distributions for parameter estimates and 95% Bayesian credibility intervals are reported. Individual growth parameters (intercepts and slopes) for self-regulation were then saved

from the latent growth model for secondary analyses. Plausible values were generated using 50 draws (imputations) from the Bayesian posterior distribution.

To evaluate the effects of the foster care intervention on mental health in adolescence directly and indirectly through growth in self-regulation and peer difficulties in adolescence, we tested a serial mediation model (Model 6) using the PROCESS tool for SPSS (PROCESS v. 3.3., Hayes, 2012). For FCG relative to CAUG, we hypothesized that greater growth in self-regulation over the course of adolescence would be associated with reduced peer difficulties and, in turn, reduced general psychopathology at age 16. Slopes for self-regulation (ages 8 to 16) and peer difficulties (age 16) were entered as mediators (process model: group → growth in self-regulation → peer difficulties → psychopathology). PROCESS employs ordinary-least-squares path analysis to estimate coefficients for direct and direct effects (Hayes, 2012). FCG and CAUG children with sufficient HBQ data at age 16 to extract factor scores for both peer difficulties and psychopathology as described above were included in serial mediation analysis (n=88). Follow-up analyses of indirect effects were bootstrapped (10000 bootstrap samples) to obtain the 95% confidence intervals used for statistical inference (Preacher & Hayes, 2008).

Lastly, we conducted secondary analyses to examine possible effects of age at placement and number of caregiving disruptions on growth in self-regulation within FCG from middle childhood into adolescence. Age of placement was defined as the age in months at which FCG children were removed from institutional care and placed into their initial foster care placement as part of the BEIP RCT. Caregiving disruptions were defined as the number of times a child transitioned from a given caregiving placement (e.g., from foster parents back to biological family) from birth to the 8 year timepoint (Almas et al., 2018). Prior studies have indicated significant effects of placement before versus after approximately two years of age on critical domains of development, including cognition (Fox et al., 2011; Nelson et al., 2007), brain activity (Marshall, Reeb, Fox, Nelson, & Zeanah, 2008; Vanderwert, Marshall, Nelson, Zeanah, & Fox, 2010). Therefore, independent samples *t*-tests were carried out to compare growth parameters (intercepts and slopes) for self-regulation in FCG children placed in foster care before versus after 24 months of age. Correlations were carried out to investigate whether age of foster care placement and the number of caregiving disruptions were related to these growth parameters among children who were previously-institutionalized (FCG and CAUG). Due to non-normality of distributions for age of placement and caregiving disruptions variables and heteroscedasticity, non-parametric Spearman correlations were used for these analyses.

3. RESULTS

3.1. Latent growth model: self-regulation from 8 to 16

Within- and between-group comparisons of LGM parameters (i.e., intercepts and slopes) are reported in Table 2. At age 8 (model intercept), NIG demonstrated significantly higher self-regulation skills relative to both CAUG and FCG; CAUG and FCG did not significantly differ from each other. However, FCG showed a modest increase in rate of change (slope) from 8 to 16 years, while NIG remained stably high and CAUG did not increase significantly. By the 12-year timepoint, both NIG and FCG had higher self-regulation skills

than CAUG, and only a modest, trend-level difference remained between NIG and FCG (p=.058). At the 16-year timepoint, no significant differences in self-regulation remained between NIG and FCG, and both FCG and NIG showed modestly higher self-regulation than CAUG. Model-estimated trajectories of self-regulation for CAUG, FCG, and NIG are illustrated in Figure 1.

3.2. Serial mediation model

Using serial mediation analysis, we tested whether greater growth in self-regulation (slope from age 8 to 16) and lower peer difficulties in adolescence sequentially mediated the effects of foster care intervention on adolescent general psychopathology. All paths for the process model and their corresponding coefficients are depicted in Figure 2. The total effect (c) of the foster care intervention on psychopathology at age 16 was not significant (b=−0.34, t=−1.67, p=.100), nor was the direct effect (c') controlling for effects of the mediators (b=−0.13, t=−0.89, p=.377). However, two indirect paths were significant. The specific indirect effect through growth in self-regulation was significant (point estimate: −0.11; CI =−0.23 to −0.02), as was the specific indirect effect through growth in self-regulation and a subsequent reduction in peer difficulties (point estimate: −0.10; CI=−0.23 to −0.01).

3.4. Follow-up analyses

Age at placement.—Children's age at placement into foster care was not significantly correlated with growth parameters [intercept: r_s =−0.11, p=.403; slope: r_s=0.09, p=0.476]. Similarly, no significant differences in growth parameters were observed between FCG children placed in foster care before versus after 24 months of age [intercept: t(58)=0.49, p=.628; slope: t(58)=−0.45, p=.658].

Caregiving disruptions.—Across FCG and CAUG, the number of caregiving disruptions from birth to age 8 were negatively correlated with growth in self-regulation over adolescence (slope from 8 to 16 years) [r_s=−0.25, p=.006]. In other words, more disruptions were associated with less growth in self-regulation over time. Caregiving disruptions were also associated with lower self-regulation at age 8 (intercept) across FCG and CAUG [r_s=−0.18, p=.044]. Follow-up analyses examining each group separately revealed trend-level negative associations between caregiving disruptions and growth parameters in CAUG (slope: r_s=−0.26, p=.090; intercept: r_s=−0.24, p=.073) and non-significant associations in FCG (slope: r_s=−0.21, p=.110; intercept: r_s=−0.10, p=.452), suggesting that caregiving disruptions may be more closely related to growth parameters within CAUG.

4. DISCUSSION

Using longitudinal data from the Bucharest Early Intervention Project (BEIP), we examined developmental trajectories of self-regulation from middle childhood into adolescence among institutionally-reared children randomized to foster care (FCG) or to remain in institutional care (CAUG), as well as a never-institutionalized community comparison sample (NIG). Our results indicate that early caregiving experiences can set children on significantly different developmental trajectories for self-regulation. While NIG children demonstrated stably high levels of self-regulation from ages 8 through 16, CAUG children evinced stable low levels

of self-regulation. Building upon prior work suggesting long-term impairment of executive control (Sonuga-Barke et al., 2017; Wade, Fox, et al., 2019), our results indicate disruption of everyday self-regulatory function in children exposed to prolonged institutional care.

We tested whether early removal from institutional care can mitigate the harmful effects of early deprivation on trajectories of self-regulation. Results revealed that institutionally-reared children (CAUG and FCG) were rated as having significantly lower self-regulation in social contexts than NIG at age 8. There was no evidence of an intervention effect at this age, as FCG and CAUG children did not differ significantly on self-regulation. However, FCG children showed a modest increase in self-regulation from ages 8 to 16. By age 16, both FCG and NIG showed better self-regulation than CAUG, and there was no significant difference between FCG and NIG. Secondary analyses indicated similar trajectories of growth for FCG children placed in foster care before and after 2 years of age, although our power to detect age-of-placement effects may be limited by the modest size of our FCG sample. Together, results indicate a time-elapsed intervention effect whereby the effects of foster care on self-regulation emerge over the course of adolescence, with FCG "catching up" to NIG by age 16. Although prior research indicates moderate stability of individual differences in self-control from early in life (Coyne & Wright, 2014) into adulthood (Moffitt et al., 2011), this continuity is far from complete across development. Our findings add to evidence that environmental influences, including parental warmth (Ng-Knight et al., 2016) and negative life events (Duckworth, Kim, & Tsukayama, 2012) impact growth trajectories for self-control over adolescence. Given that teenagers may be uniquely prone to lapses in self-control in the presence of social incentives (Casey, Jones, & Somerville, 2011; Somerville, Jones, & Casey, 2010), growth in self-regulation may play a particularly important role in supporting adolescent well-being.

We also evaluated growth in self-regulation from ages 8 to 16 as a potential mechanism by which foster care intervention reduces general vulnerability to psychopathology among institutionally-reared children over adolescence (Wade et al., 2018). As hypothesized, placement into foster care supported greater growth in self-regulation from middle childhood into adolescence, which was associated with fewer peer difficulties at age 16 and, in turn, reduced general psychopathology at age 16. Another indirect path was also observed whereby growth in self-regulation alone mediated the intervention effect. Given the randomized design of BEIP, our results provide compelling evidence that self-regulation in social contexts is a pivotal mechanism by which foster care can reduce psychiatric risk in post-institutionalized adolescents. Extending recent work linking self-regulatory processes with general psychopathology in children (Martel et al., 2017) and adolescents (Castellanos-Ryan et al., 2016; Wade, Zeanah, et al., 2019), our findings suggest that interventions targeting self-regulation in everyday settings could help reduce risk for a broad array of mental health problems among institutionally-reared youth. Moreover, our findings suggest that *growth* in self-regulation over adolescence is a key mechanism for remediating the harmful effects of psychosocial deprivation. These findings are in line with preliminary evidence suggesting that individuals demonstrating increases in self-control from childhood into young adulthood have better outcomes across a number of psychosocial domains (Moffitt et al., 2011).

There are several limitations of the current work. We relied upon caregiver- and teacher-report measures to evaluate youth self-regulation, peer relations, and psychopathology. This limits our ability to assess behaviors and symptoms that may be less evident to such observers, such as internalizing psychopathology (Klein, Dougherty, & Olino, 2005; Van der Ende, Verhulst, & Tiemeier, 2012) or certain peer interactions (Kramer et al., 2004). Since both psychopathology and peer difficulties were assessed by teacher and caregiver ratings using the HBQ, parameter estimates could be inflated due to shared measurement variance; however, both p factor and peer difficulties factor scores were computed based on aggregated data from multiple raters (teacher and caregiver) across multiple subscales, reducing this risk. Notably, caregivers, and perhaps also teachers, may have been aware of children's caregiving placement history. Therefore, it is possible that informants' beliefs regarding the effects of institutionalization may have influenced their ratings of children's symptoms and behaviors. Future research should integrate ratings by multiple informants (including self-report) and objective measures as part of a multi-method approach to evaluating developmental pathways linking self-regulation, peer relations, and psychopathology.

Our modest sample size may have limited power to detect significant effects in the current study, including timing effects for the intervention. In addition, we conducted intent-to-treat analyses using original group assignments for all participants. Although this method facilitated unbiased, conservative estimation of intervention effects, it did not account for the subsequent changes in caregiving placement experienced by several children in the FCG and CAUG groups. Our secondary analyses indicate that experiencing more caregiving disruptions (up to age 8) may be associated with flatter trajectories of growth in self-regulation over adolescence among post-[ISP] institutionalized children (FCG and CAUG). Further research employing larger post-[ISP] institutionalized samples are needed to confirm this link and to examine how caregiving stability might influence growth in self-regulation. In addition, our mediation analyses focused on evaluating specific developmental pathways linking foster care intervention to reductions in psychopathology at age 16 via growth in self-regulation over adolescence (ages 8 to 16) and peer difficulties at age 16. It is important to note that peer difficulties were assessed simultaneously with the outcome (psychopathology) at age 16 in the current study, limiting our ability to evaluate the role of peer difficulties in exacerbating risk for psychopathology *later* in development. Furthermore, a growing body of research indicates that *positive* peer relationships may buffer the harmful effects of maltreatment on risk for psychopathology (Rosario, Salzinger, Feldman, & Ng-Mak, 2008; Yule, Houston, & Grych, 2019). Investigating the role of both positive and negative peer relations in modulating risk for psychopathology among institutionally-reared children is a promising direction for future work. Lastly, transactional models highlight the importance of examining both contemporaneous and longitudinal relations between different systems in order to understand their cumulative effects on child development (Sameroff & Mackenzie, 2003). Future studies employing developmental cascade models and multi-informant methodology can further elucidate how psychopathology, self-regulation, caregiver-child interactions, and peer interactions reciprocally influence each other over development in post-institutionalized samples.

Conclusions

The present study adds to a growing literature on the effects of early psychosocial deprivation on growth in self-regulation and its consequences for adolescent psychopathology. While children exposed to prolonged institutional care show stably poor self-regulation within social contexts from ages 8 to 16 years, children randomized to high-quality foster care placements demonstrate modest growth, eventually "catching up" to never-institutionalized children by age 16. In turn, this growth in self-regulation helps explain the beneficial effects of foster care on mental health among post-institutionalized adolescents. Together, these findings reveal that early placement into family-based care supports less problematic developmental trajectories of selfregulation, ultimately contributing to better psychosocial outcomes. Intervention effects may not fully emerge until later in adolescence, a unique period of neurobehavioral reorganization (Casey et al., 2011; Giedd et al., 1999). Growth in self-regulation over this developmental period may be a promising target for future interventions seeking to remediate long-term effects of profound neglect and deprivation. In the context of prior work tying childhood self-regulation to several indices of psychosocial well-being (Moffitt et al., 2011), fostering gradual improvement in self-regulation over development may have wide-ranging beneficial effects on multiple domains of competence for children reared in alternative care settings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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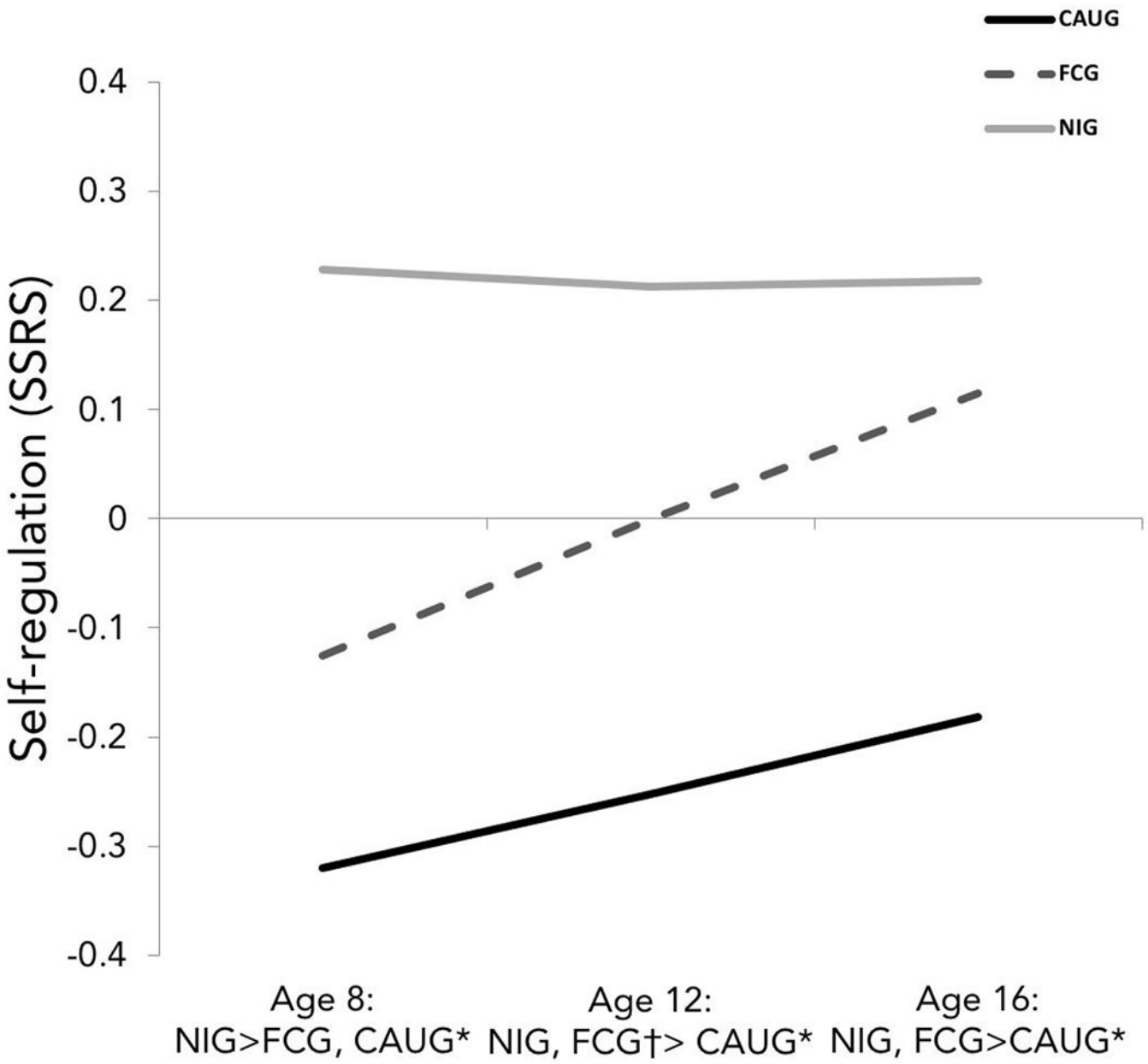

Figure 1.

Group-level trajectories of self-regulation from ages 8 to 16. Plotted values reflect model-estimated means of intercept at ages 8, 12, and 16, controlling for sex and IQ. SSRS self-regulation subscale scores reflect the composite of teacher- and parent-report scores residualized for participants' actual ages (in months) at assessment for each timepoint. Group comparisons at each timepoint are reported †p<.10, *p<.05.

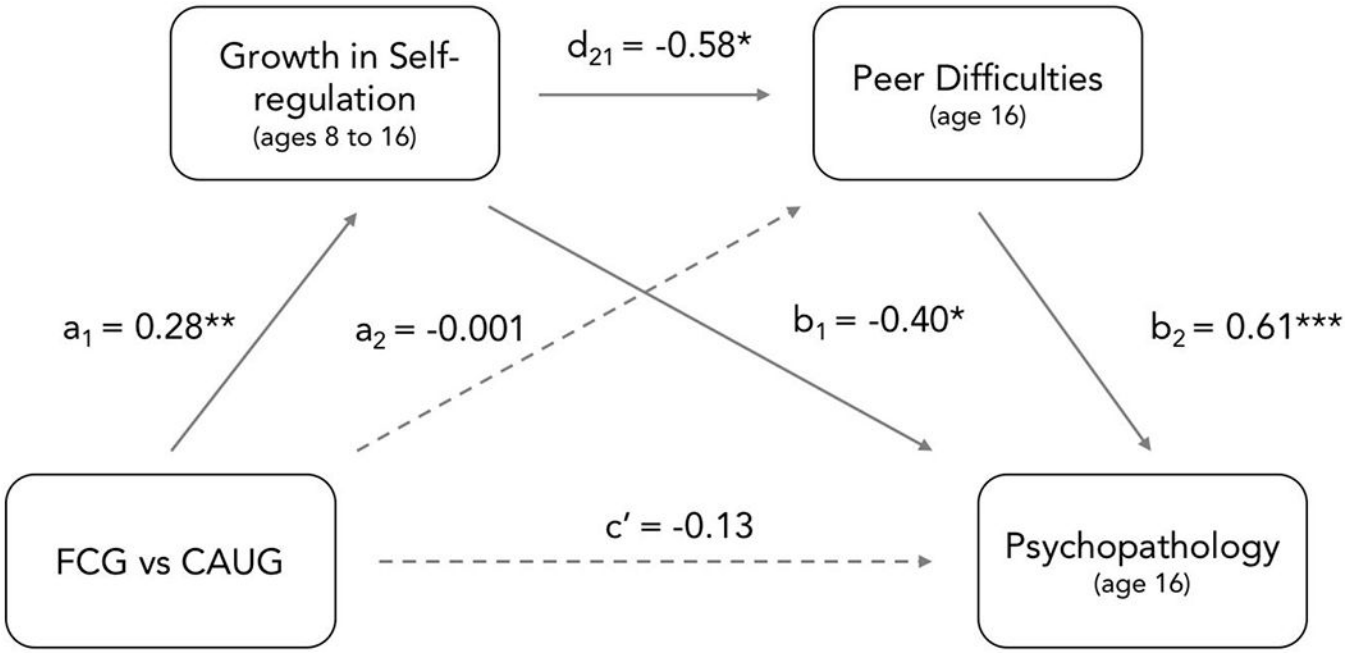

Figure 2.

Serial mediation model with growth in self-regulation (slope ages 8 to 16) and peer difficulties (age 16) as proposed mediators of the foster care intervention on adolescent psychopathology (age 16). Solid arrows are significant paths, while dashed lines are non-significant. ***$p < .001$, **$p < .01$, *$p < .05$.

Table 1.

Participant demographics

	CAUG	FCG	NIG
N	58	62	100
Sex (%)			
Male	51.7	51.6	49.0
Female	48.3	48.4	51.0
Ethnicity (%)			
Romanian	48.3	58.1	91.0
Roma	36.2	29.0	8.0
Unknown	13.8	11.3	0
Other	1.7	1.6	1.0
Age entered institution (mo)	2.6 (3.8)	2.7 (4.1)	-
Age entered foster care (mo)	-	22.7 (7.1)	-
Full-scale IQ (age 8) *	75.9 (14.1)	80.3 (16.0)	100.26 (15.8)

Notes. CAUG = care as usual group; FCG = foster care group; NIG = never-institutionalized group.

* NIG>FCG, CAUG (p<.05)

Table 2.

Growth parameter estimates for self-regulation: Within- and between-group effects

Within-group effects			
	CAUG intercept [95% CI]	**FCG intercept [95% CI]**	**NIG intercept [95% CI]**
Slope (8 to 16 yrs)	0.07 [−0.07, 0.21], p=.179	0.13 [−0.01, 0.26], p=.036 *	−0.02 [−0.18, 0.15], p=.388
Intercept (age 8)	−0.32 [−0.54, −0.10] p=.003 **	−0.13 [−0.33, 0.07], p=.105	0.23 [0.06, 0.41], p=.004 **
Intercept (age 12)	−0.25 [−0.45, −0.06], p=.005 **	−0.001 [−0.18, 0.18], p=.498	0.21 [0.04, 0.39], p=.008 **
Intercept (age 16)	−0.18 [−0.45, 0.09], p=.093	0.12 [−0.14, 0.37], p=.179	0.22 [−0.06, 0.49], p=.056
Between-group differences			
	FCG > CAUG [95% CI]	**NIG > CAUG [95% CI]**	**NIG > FCG [95% CI]**
Slope (8 to 16 yrs)	0.06 [−0.12, 0.24], p=.276	−0.10 [−0.32, 0.16], p=.224	−0.15 [−0.37, 0.09], p=.102
Intercept (age 8)	0.195 [−0.08, 0.48], p=.086	0.55 [0.24, 0.86], p<.001 ***	0.35 [0.07, 0.64], p=.007 **
Intercept (age 12)	0.25 [0.01, 0.50], p=.020 *	0.46 [0.18, 0.76], p=.001 **	0.21 [−0.05, 0.49], p=.058
Intercept (age 16)	0.30 [−0.04, 0.65], p=.039 *	0.40 [−0.02, 0.82], p=.033 *	0.10 [−0.30, 0.49], p=.310

Effects are based on one-tailed directional tests and control for sex and IQ (Wechsler Intelligence Scale for Children-IV, Full Scale IQ). Coefficients reflect unstandardized estimates at the mean of sex and IQ.

*** $p < .001$,

** $p < .01$,

* $p < .05$.