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Foster care leads to sustained cognitive gains following severe early deprivation

Kathryn L. Humphreys[a,b,1], Lucy S. King[b], Katherine L. Guyon-Harris[b,c], Margaret A. Sheridan[d], Katie A. McLaughlin[e], Anca Radulescu[f], Charles A. Nelson[g,h], Nathan A. Fox[i], and Charles H. Zeanah[b]

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This study examined longitudinal data from the Bucharest Early Intervention Project, a randomized controlled trial of foster care as an alternative to institutional care following exposure to severe psychosocial deprivation. We report data from 135 participants assessed in early adulthood (age 18 y). We find that 16 y after randomization occurred, those who had been randomized to high-quality foster care had significantly higher IQ scores (9 points, 0.6 SD) than those randomized to care as usual. Mediation analyses provide evidence that the causal effect of the intervention on cognitive ability in early adulthood could be explained, in part, by higher-quality caregiving and attachment security. These findings indicate that early investment in family care as an alternative to institutional care leads to sustained gains in cognitive ability. Fostering caregiving relationships is a likely mechanism of the intervention. In addition, exploratory analyses indicate that stable placements throughout childhood are associated with the greatest long-term gains in cognitive ability. Whether early interventions for infants and young children lead to lasting change has significant implications for decisions to invest in programs aimed at improving children's developmental outcomes.

institutionalization | foster care | intervention | cognitive ability | IQ

Significance

There is evidence that the cognitive abilities of children who experience early, severe psychosocial deprivation are superior for those in family- versus group-based placements. However, it is unknown whether these placements have long-lasting effects. Using data from the Bucharest Early Intervention Project, we found that individuals randomized to foster care following early institutionalization had IQ scores in early adulthood that were, on average, 9.00 points above those of individuals assigned to care as usual. The persistence of causal effects of foster care intervention provides compelling evidence that caregiving relationships influence IQ. Providing long-lasting family placements is the most advantageous strategy to enhance cognitive development among children requiring institutional care.

Cognitive function, including that captured by IQ, is associated with a range of life outcomes, including academic achievement and financial success. Despite the promise of early interventions to bolster cognitive ability among children growing up in low-resource settings, the benefits observed typically fade over time (1), raising the possibility that gains in IQ are transient. Whether the early influences of intervention fade out or are sustained is of theoretical interest (2) and has significant implications for funding allocations for such interventions. Given that individuals with the fewest resources are theorized to benefit the most from environmental enrichment (3), there is perhaps no better test of whether interventions can produce long-lasting changes in cognitive ability than longitudinal follow-up of children exposed to profound deprivation early in life, such as those reared in institutional settings. The degree to which the cognitive impacts of institutional care can be remediated, and whether signs of remediation can be sustained across development, has important policy implications when societies are charged with decisions regarding the care of abandoned or orphaned children (such as the more than 5 million orphaned by coronavirus disease 2019 [COVID-19]) (4). Although there is evidence that the cognitive abilities of children in family placements are superior to those residing in group-based care (5–7), we do not know whether these placements have long-lasting effects into early adulthood, whether quality of caregiving is responsible for this advantage, if placement earlier in life is more advantageous, and whether the same placements need to be sustained over childhood. Here, we demonstrate that, in early adulthood, children randomly assigned to high-quality foster care (foster care group; FCG) in early life demonstrate a 9-point (0.6 SD) IQ advantage over children randomized to care as usual (care as usual group; CAUG).

To provide a causal test of enhanced care following deprivation, the Bucharest Early Intervention Project (BEIP) (5, 8) used a randomized controlled trial (RCT; NCT00747396) design to address urgent decision-making needs regarding the care of tens of thousands of institutionalized children in Romania. Young children living in institutions were assessed at a mean age of 22 mo at baseline and randomized into either the FCG or the CAUG. Because foster care was extremely limited in Bucharest at the outset of the study, the investigators, along with their Romanian collaborators, developed, maintained, and financed a foster care network. The goal of the intervention, grounded in developmental research, was designed to improve caregiving quality (9). The trial concluded when children were aged 54 mo when control over the foster care network was transferred to local government authorities. Analyses using a conservative intent-to-treat (ITT) approach in which the cognitive functioning of those

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[1]To whom correspondence may be addressed. Email: k.humphreys@vanderbilt.edu.

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randomly assigned to the foster care intervention are compared to those assigned to care as usual allow us to make causal inferences about the effect of the intervention. The ITT grouping also allows us to probe plausible mediators, including caregiving quality, explaining the effect of the intervention.

Results

Causal Effects of the Intervention on Cognitive Ability in Early Adulthood. We first examined whether individuals randomly assigned to foster care intervention differed from those randomized to care as usual in full-scale IQ (FSIQ) scores using an ITT analysis (Table 1 and Fig. 1). Individuals randomized to the foster care intervention had FSIQ scores that were, on average, 9.00 points above those of individuals assigned to care as usual. Despite previous evidence that the effects of interventions aimed to increase cognitive ability often fade out (1, 10), the causal effects of the BEIP foster care intervention nearly 14 y following the end of the intervention provide compelling evidence about the persistence of IQ changes through environmental intervention. While no statistically significant differences were found in perceptual reasoning or working memory, those randomized to the foster care intervention had significantly higher scores in verbal comprehension and processing speed than did individuals randomized to care as usual. As a sensitivity analysis, we reconducted the ITT analyses when covarying the developmental quotient (DQ) score from the baseline assessment. Importantly, nine ever institutionalized group (EIG) participants (four FCG and five CAUG) from the current age 18-y analyses of cognitive ability were missing DQ at baseline. This reduction in available sample size reduces statistical power and limits direct comparability with regard to the confidence intervals produced and P values obtained. Nevertheless, individuals randomized to the foster care intervention had higher FSIQ scores at age 18 than individuals assigned to care as usual when covarying for DQ ($B = 7.30$, SE = 3.72, $P = 0.049$).

Caregiving Relationships as a Mechanism of Intervention Effects. We examined caregiving quality in early childhood as a potential mechanism by which the intervention resulted in higher FSIQ scores. As expected (9), caregiving quality was significantly higher in the FCG than in the CAUG ($R^2 = 0.10$; Fig. 2*A*). Consistent with prior research examining the association between caregiving quality and IQ in childhood (6, 11), individuals who experienced higher quality of caregiving in early childhood had significantly higher FSIQ scores in early adulthood ($R^2 = 0.13$; Fig. 2*B*). In a formal test of mediation, we identified a significant indirect effect of the foster care intervention on FSIQ at age 18 y through the quality of early caregiving (indirect effect = 4.44; Fig. 2*C*). The effect of the RCT on FSIQ was no longer significant when including caregiving quality in the model. Several additional mediators (i.e., attachment security, height, weight, head circumference, motor development, and cortisol reactivity to a stressor; *SI Appendix*) were tested in place of caregiving quality. Among these, only attachment security, which was assessed at age 42 mo, was found to be a statistically significant mediator of the ITT effect on FSIQ at age 18 y (indirect effect = 6.42). These findings suggest that the intervention increased cognitive ability by improving the caregiving relationship (caregiving quality explained 49% of the effect of the intervention on FSIQ, whereas attachment security explained 71% of the effect of the intervention on FSIQ) and indicate that higher-quality caregiving relationships were a mechanism through which the intervention influenced cognitive ability in young adulthood.

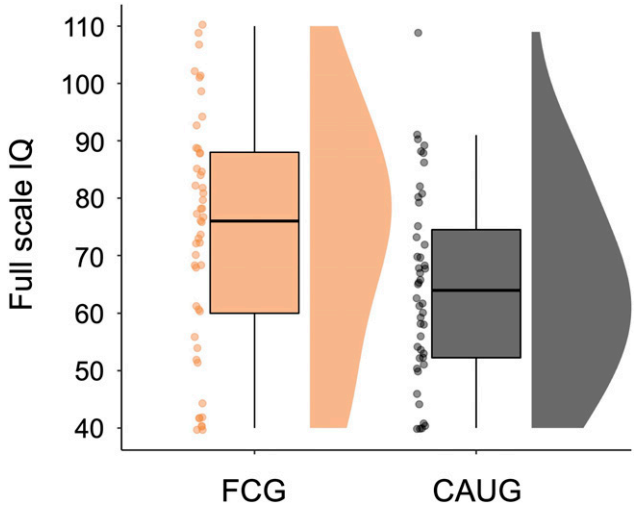

Fig. 1. FSIQ scores at age 18 y as a function of ITT group. Distributions of FSIQ scores at age 18 y within participants randomized to care as usual (CAUG) and participants randomized to the foster care intervention (FCG). Distributions are rotated kernel density plots trimmed to the range of the observed values.

Exploratory Analyses. There was a small negative association between age of placement into foster care and FSIQ at age 18 y ($B = -0.81$, $\beta = -0.25$, SE = 0.42, $P = 0.050$, and $R^2 = 0.06$). Individuals who entered foster care earlier in life tended to have higher FSIQ scores (Fig. 3). Additional exploratory analyses considered stability of placement in foster care through age 18 y and the percentage of childhood (i.e., birth to age 18 y) in institutional care (*SI Appendix*). It is important to note that these analyses are not ITT and examine characteristics other than random assignment to caregiving groups.

Table 1. Results for models comparing cognitive ability at age 18 y between individuals randomized to foster care and to care as usual

	M						
Cognitive ability score	FCG	CAUG	*B*	β	SE	*P*	R^2
FSIQ	73.49	64.65	9.00	0.45	4.04	0.026	0.05
Verbal comprehension	76.37	65.87	11.09	0.57	3.79	0.003	0.08
Processing speed	79.16	71.87	7.75	0.45	3.44	0.024	0.05
Perceptual reasoning	76.82	71.30	6.08	0.31	4.00	0.128	0.02
Working memory	81.76	74.41	7.91	0.39	4.09	0.053	0.04

B, raw estimated mean difference between the two groups; β, standardized estimated mean difference between the two groups; $n = 95$ (49 randomized to foster care).

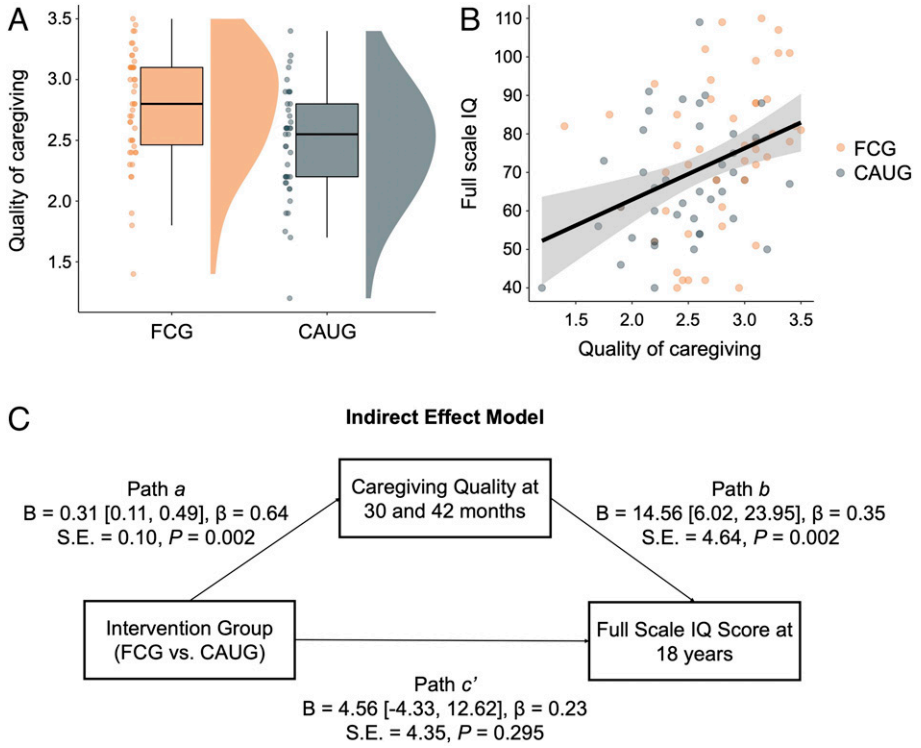

Fig. 2. Quality of caregiving in early life as a potential mechanism explaining the effect of the foster care intervention on FSIQ scores at age 18 y. ITT group was associated with caregiving quality in early life (*A*), and caregiving quality was in turn associated with FSIQ scores at age 18 y (*B*). Distributions are rotated kernel density plots trimmed to the range of the observed values. There was a significant indirect effect for caregiving quality in early life in partially explaining the causal effect of the intervention on IQ scores at age 18 y (*C*).

Comparison with Never-Institutionalized Children. Last, we compared those with a history of institutional care with never-institutionalized individuals, a reference group to allow us to compare our sample to a group of typically developing Romanian children. We found a large effect of history of institutional care on FSIQ score. Participants with any history of institutionalization (i.e., EIG) had FSIQ scores that were, on average, 26.21 points below those of community comparison participants (Table 2). Those individuals with a history of institutional care had lower scores as a group than community comparison participants for all four cognitive domains. Overall, the ever-institutionalized young adults had mean cognitive ability scores that place them in the "very to extremely low" range. The low mean scores for both the CAUG and FCG suggest that even placement into a high-quality caregiving context early in life is not sufficient to fully remediate the lasting impact of psychosocial deprivation on cognitive ability. Furthermore, greater durations of exposure may be more cognitively impairing (*SI Appendix*, Fig. S8).

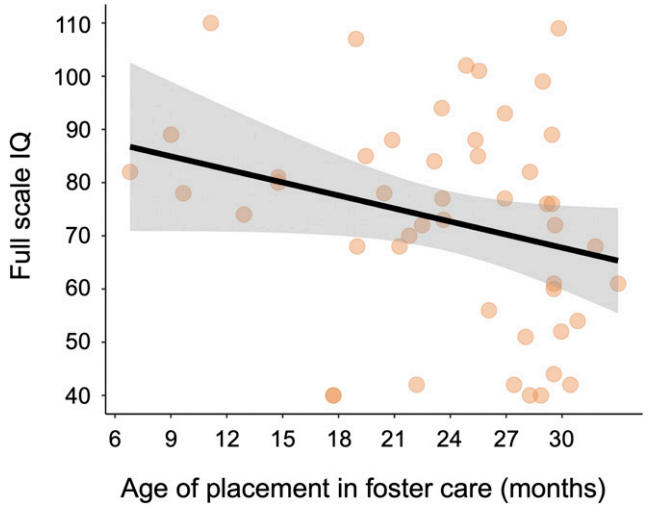

Fig. 3. FSIQ scores at age 18 y as a function of age of placement into foster care among those in the FCG.

Discussion

Whether early interventions promote lasting benefits has meaningful implications for funding allocation to support these resource-intensive interventions. Of relevance to this discussion is the degree to which long-lasting changes in cognitive ability are even possible. While evidence for the environmental influence on intelligence has existed for decades (12), intelligence research recurrently emphasizes high heritability (13) and the ability for IQ to be explained by genotype (14). An emphasis on genetics may imply that the environment is a less valuable target for improving cognitive ability in children, a perspective that is supported by reports of early intervention fade-out (1). Yet, there is also evidence for sustained benefits following enhancement of the early environment. The Carolina Abecedarian Project, which studied high-risk infants randomized to high-quality early education and/or primary school, found that individuals who received the early intervention had higher IQ scores and educational attainment than their counterparts in early adulthood (age 21 y) (15). Similarly, the Perry Preschool Project, which provided high-quality preschool and weekly home visits by teachers, found better executive functioning at age 54 y among those who received the intervention than among those in the comparison condition (16).

Research documenting the cognitive functioning of the BEIP trial participants has reported comparable results from early childhood to early adulthood (mean ITT differences ranging

Table 2. Results for models comparing cognitive ability at age 18 y between individuals with and without a history of institutional care

Cognitive ability score	*M*		*B*	β	SE	*P*	R^2
	NIG	EIG					
FSIQ	94.75	69.21	26.21	1.20	3.01	<0.001	0.30
Verbal comprehension	94.98	71.28	24.07	1.19	2.58	<0.001	0.30
Processing speed	95.65	75.63	20.29	1.11	2.65	<0.001	0.26
Perceptual reasoning	95.98	74.15	22.27	1.05	3.27	<0.001	0.23
Working memory	97.03	78.20	19.12	0.94	3.04	<0.001	0.18

B, raw estimated mean difference between the two groups; β, standardized estimated mean difference between the two groups; $n = 135$ (95 with history of institutional care).

between 5.3 and 8.6 points [5–7]). Data from the early waves of the trial were used as evidence to support the potential for long-lasting effects of early experience (17). Importantly, however, our exploratory analyses on placement stability (*SI Appendix*) indicate that stable family placements were associated with sustained effects of the intervention. However, because stability was not randomly assigned, we are unable to draw causal conclusions. If the association is causal, it suggests that benefits to cognitive ability are likely not merely due to early exposure to family-based care but that care across childhood also matters. The pattern of findings is most in line with the theory that environmental influences on cognitive ability compound over time (18). It is important to acknowledge that the association between placement stability and IQ is challenging to interpret given children and adolescents with lower IQ may be at greater risk for placement instability. Even so, the findings related to age of placement, stability of placement, and proportion of childhood in institutional care each offer some unique information about experience and later outcomes. Taken together, the results of these analyses converge to indicate that institutional care exposure should be minimized.

Perhaps the most important result from the present investigation is one that identifies a likely mechanism for cognitive effects due to the intervention. Importantly, the BEIP was not designed to improve cognitive ability. Instead, the goal was to improve caregiving quality. Indeed, randomization led to differences in quality of care observed in early childhood, and these measures of caregiving quality, in turn, explained nearly half of the variance in IQ differences resulting from the intervention. Further, attachment security, a marker of the child's caregiving relationship, was also a mediator of the intervention, with caregiving quality mediating the association between the intervention and attachment security. These analyses highlight that caregiving relationships in early childhood are likely important, although they are unable to determine the role of caregiving during this developmental period over and above experiences of caregiving later in childhood. Notwithstanding, given the brief nature of the caregiving observations and the amount of time that elapsed between the caregiving and IQ assessments, this finding underscores the power of the environment. Identifying what makes an intervention successful is important given that the mechanisms must transfer to new contexts and populations when scaled implementations occur (19). Notably, higher-quality caregiving interactions likely resulted in changes across domains that may have worked directly or indirectly to shape later cognitive functioning. Of the six alternative mediators tested, only attachment security emerged as a viable substitute mechanism. Our measurement of caregiving quality was a global index, and it may be that specific aspects of caregiving (e.g., activities that promote cognitive stimulation) are the primary drivers of the effect; yet, the sensitivity analyses suggest the potential that it is more emotional aspects of the caregiving relationship (e.g., using one's caregiver as a safe haven/secure base measured through the attachment assessment) that may be most relevant for later cognitive functioning. Other aspects of the child's environment that changed due to the intervention (e.g., nutrition, school, or neighborhood quality) are alternative mechanisms that cannot be ruled out. Nevertheless, our findings suggest that foster care may be most effective when it promotes high-quality caregiving relationships (9); this is in sharp contrast to models of foster care that focus on primarily meeting instrumental care needs.

Regarding the functioning of young adults following exposure to early institutional care, the current findings are consistent with meta-analytic work documenting a large effect of institutional care on IQ (i.e., 20 points) relative to those raised in families (20). This may be particularly true for children who spend more than 6 mo in institutional care (21). One explanation for fade-out following many interventions that are initially successful is that high-quality environments are not sustained over time (1). In other words, the fade-out is explained by a home or school environment that children encounter following the intervention that is less enriched than that experienced during the intervention.

A number of limitations merit consideration. First, the size of the sample is small, and given the nature of the follow-up, we are unable to increase the sample of those ever institutionalized. Small studies are typically the norm for randomized trials requiring intensive interventions and may limit the accuracy of statistical estimates. Second, we were unable to examine several other factors associated with cognitive ability, including prenatal care and pre- or postnatal nutrition. These characteristics would likely not differ between the FCG and CAUG because of the RCT design but may distinguish the EIG and never institutionalized group (NIG) and underscore that the NIG is a comparison but not a "control" group for those placed in institutions. Third, we used the Weschler Intelligence Scale for Children, fourth edition (WISC-IV), rather than an instrument designed for adults, which precluded using specific age-based norms for this follow-up; the use of a liberal substitution approach to including supplemental tests deviates from Wechsler recommendations. These choices were made to respond to the very low scores found among some EIG participants at earlier waves, leading to floor effects. In addition, our use of Tobit models (22) allowed us to include participants with functioning so low that they were unable to complete this cognitive assessment. Fourth, we did not include other aspects of the environment not specifically related to the caregiving relationship that could also contribute to observed ITT differences.

Societies are challenged to provide care for children following maltreatment, abandonment, or parental death, with many

resorting to institutional care (orphanage) settings to meet minimal survival needs (an estimated 5 million children worldwide reside in institutional care [23]). Millions of children worldwide (24), including the more than 5 million children recently orphaned due to the COVID-19 pandemic (4), do not have caregivers. For children unable to live with their parents or families, including minors currently residing in detention centers at the US border, group care is not what best supports children. For all children who reside in institutions, locating family placements and ensuring the stability of those placements will have meaningful long-term benefits on well-being. Yet, attention to the quality of family-based care is needed to ensure that children fully benefit from these placements. The present study indicates that family placements are most effective if they are characterized by stable, high-quality, and responsive care. Supporting caregivers' ability to be psychologically committed and nurturing in their interactions with their children, a goal of the BEIP foster care (9), is likely the active ingredient of the intervention rather than simply residing with a family. The direct policy implication of this work is that eliminating placement in institutional care and providing long-lasting family placements is the most advantageous strategy to enhance cognitive development among children requiring care, a benefit not only to orphaned children but also to the countries in which these children reside.

Materials and Methods

Participants. The participants in this investigation were 135 children (95 [46 CAUG and 49 FCG] of the original trial participants [25] and 40 community comparison children [NIG]; *SI Appendix*, Fig. S1). Participants (47% female/53% male) were assessed at a mean age of 18.74 y (SD = 0.65) as part of the BEIP (*SI Appendix*, Table S1). Following approvals by the institutional review boards of the three principal investigators' universities (University of Minnesota, University of Maryland, and Tulane University; later also Boston Children's Hospital/Harvard Medical School and the Bucharest University Ethics committee) and by the local Commissions on Child Protection in Bucharest, the study commenced in collaboration with the Institute of Maternal and Child Health of the Romanian Ministry of Health. A data safety monitoring board in Bucharest reviewed the assessments for the current follow-up, which was also approved by the Ethics Committee of the University of Bucharest. At study entry, consent was obtained and signed by each child's legal guardian, and assent was obtained from each child. Participant IDs written on slips of paper were drawn randomly from a hat to determine placement into the two groups. Siblings were included on the same slip of paper to allow for joint placement. Analyses comparing these two groups at their baseline assessments indicated that there were no significant differences in age, DQ, height, weight, or head circumference (26). Written (or verbal) informed consent was obtained from all participants at the 18-y assessment. The ethics of this study have been widely discussed (27–29). Participants were provided financial compensation for completing study procedures. Among the EIG, participants included in the current analyses and those who discontinued participation or did not complete the WISC at age 18 y did not significantly differ on cognitive development at baseline, age at baseline, sex, or ethnicity ($P > 0.11$). Similarly, within the FCG and CAUG, participants included in the analysis and participants who discontinued participation or did not complete the WISC did not significantly differ in these characteristics ($P > 0.23$).

Caregiving. Adults interested in serving as foster parents were contacted by study staff, consented to background checks, and received training by a Bucharest-based nongovernmental organization, including about typical behaviors and routines for children living in institutions. The BEIP-sponsored foster care was designed to be affordable, replicable, and grounded in findings from developmental research on enhancing caregiving quality (8, 9). Caregiving quality was assessed at ages 30 and 42 mo via the *Observational Record of the Caregiving Environment* (30), in which caregiver behavior was coded from videotaped interactions between a child and their preferred caregiver. A caregiving quality composite variable, averaged across each wave, was created by averaging qualitative scores of sensitivity, stimulation of development, positive regard for the child, flat affect (reverse coded), and detachment (reverse coded). A detailed report of this measure from this sample is available elsewhere (11). Caregiving quality information was missing from 5 CAUG participants and 3 FCG participants. At age 42 mo, participants completed a strange situation procedure (31), from which attachment security was coded on a scale from 1 (no security evident) to 9 (most secure).

In the intervening years following randomization, many children experienced placement changes (*SI Appendix*, Fig. S1). Many in the CAUG were eventually placed in a newly created government-sponsored foster care. Some of the children randomized to the FCG were later returned to institutional care, while some children from both groups were reunited with their biological parents. Thus, consistent with prior work from our group (18), we created two groups from the 49 FCG children based on their continuous placement with the BEIP-sponsored foster family through age 18 y. These groupings allow us to assess differences related to long-term placement stability. Children assigned to the FCG were considered as having stable foster care placement (FCG-stable; $n = 20$) if they remained with the study-sponsored foster family with whom they were originally placed (or moved to join within 12 mo of the study launch) through age 18 y. Children were considered to have been disrupted (FCG-disrupted; $n = 28$) if they experienced one or more placement changes by age 18 y. Given that one child was reunited with their biological family prior to placement, despite being assigned to the FCG, this individual was not included in analyses examining placement stability.

Cognitive Ability. At age 18 y, cognitive ability was assessed via the WISC-IV (32). The WISC-IV includes 10 subtests, with 5 additional supplemental subtests, and assesses cognitive ability in four domains: verbal comprehension, perceptual reasoning, working memory, and processing speed. A FSIQ composite score was calculated based on the 10 subtest scores with the potential for substitutions from supplemental tests. We took several steps to address potential floor effects in this sample. First, we administered the WISC-IV rather than the Weschler Adult Intelligence Scale (33) and used the oldest possible age norm to standardize scores (i.e., 16 y). Second, trained Romanian psychologists, supervised by US clinical psychologists, provided the supplemental tests in relevant domains if participants obtained a scaled score of 5 or below on one of the 10 primary subtests. Scoring was then determined by taking the higher of the two subscales if a supplemental test was administered. The WISC-IV was translated from English to Romanian, and specific items were altered given cultural context (e.g., names of historical figures). DQ information from the baseline assessments are describe elsewhere (5).

Statistical Analysis. Descriptive analyses and visualizations were performed in R version 4.0.0 (34). Statistical tests were performed in Mplus version 8.4 (35), and statistical significance was inferred on the basis of *P* values. Visualizations of the distributions of FSIQ scores within groups revealed nonnormality characterized by floor effects that differed across groups. Further, five participants were identified by BEIP staff as too cognitively impaired to participate in the WISC-IV (for tables and figures, these participants' scores were imputed to 40). Thus, we used Tobit models (22) estimated using robust weighted least squares for all statistical tests. Tobit models accurately estimate effects on FSIQ in the presence of floor effects and missing data from participants with severe cognitive impairments by estimating parameters under the assumption that values at the lower limit of the assessment indicate true values on the lower tail of a normal distribution.

Data, Materials, and Software Availability. Code, output and the deidentified dataset, with the exception of the age of placement into foster care given that it may allow for participants to be identified, can be found at Open Science Framework (OSF) https://osf.io/yd9se/?view_only=eca2485027ff49d487da424769400ba6 (36). All other data are included in the manuscript and/or *SI Appendix*.

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Author affiliations: [a]Department of Psychology and Human Development, Vanderbilt University, Nashville, TN 37203; [b]Department of Psychiatry and Behavioral Sciences, Tulane University School of Medicine, New Orleans, LA 70112; [c]Department of Pediatrics, University of Pittsburgh School of Medicine, Pittsburgh, PA 15213; [d]Department of Psychology and Neuroscience, University of North Carolina, Chapel Hill, NC 27599; [e]Department of Psychology, Harvard University, Cambridge, MA 02138; [f]Institute of Child Development, Bucharest, 010919 Romania; [g]Department of Pediatrics, Harvard Medical School and Boston Children's Hospital, Boston, MA 02115; [h]Harvard Graduate School of Education, Cambridge, MA 02138; and [i]Department of Human Development and Quantitative Methods, University of Maryland, College Park, MD 20740

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