



Effects of foster care intervention and caregiving quality on the bidirectional development of executive functions and social skills following institutional rearing

Selin Zeytinoglu¹ | Alva Tang¹ | Charles H. Zeanah² | Charles A. Nelson^{3,4} |
 Alisa N. Almas⁵ | Nathan A. Fox¹

¹Department of Human Development and Quantitative Methodology, University of Maryland, College Park, Maryland, USA

²Tulane University School of Medicine, New Orleans, Louisiana, USA

³Boston Children's Hospital, Harvard Medical School, Boston, Massachusetts, USA

⁴Harvard Graduate School of Education, Cambridge, Massachusetts, USA

⁵School of Population and Public Health, University of British Columbia, Vancouver, BC, USA

Correspondence

Selin Zeytinoglu, University of Maryland, Department of Human Development and Quantitative Methodology, 3304 Benjamin Building, College Park, MD 20742, USA.

Email: selin@umd.edu

Abstract

Institutional rearing negatively impacts the development of children's social skills and executive functions (EF). However, little is known about whether childhood social skills mediate the effects of the foster care intervention (FCG) and foster caregiving quality following early institutional rearing on EF and social skills in adolescence. We examined (a) whether children's social skills at 8 years mediate the impact of the FCG on the development of EF at ages 12 and 16 years, and (b) whether social skills and EF at ages 8 and 12 mediate the relation between caregiving quality in foster care at 42 months and subsequent social skills and EF at age 16. Participants included abandoned children from Romanian institutions, who were randomly assigned to a FCG ($n = 68$) or care as usual ($n = 68$), and a never-institutionalized group ($n = 135$). At ages 8, 12, and 16, social skills were assessed via caregiver and teacher reports and EF were assessed via the Cambridge Neuropsychological Test Automated Battery. Caregiving quality of foster caregivers was observed at 42 months. FCG predicted better social skills at 8 years, which in turn predicted better EF in adolescence. Higher caregiver quality in foster care at 42 months predicted better social skills at 8 and 12 years, and better EF at 12 years, which in turn predicted 16-year EF and social skills. These findings suggest that interventions targeting caregiving quality within foster care home environments may have long-lasting positive effects on children's social skills and EF.

KEYWORDS

caregiving quality, deprivation, early intervention, executive functions, social skills

1 | INTRODUCTION

Children raised in institutions often lack responsive caregiving and adequate cognitive and social stimulation (Smyke et al., 2007). Such early deprivation leads to ongoing challenges in both the social and

cognitive domains across childhood and adolescence. Indeed, lags in cognitive development, particularly executive functions (EF; Hostinar et al., 2012; Loman et al., 2013; Merz & McCall, 2011; van IJzendoorn et al., 2011; Wade et al., 2019), and poor social skills (Almas et al., 2012; Guyon-Harris et al., 2019; Pitula et al., 2019; Zeanah et al.,

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2022 The Authors. *Developmental Science* published by John Wiley & Sons Ltd.



2002) are widely reported across studies of institutionalized children. Given that EF and social skills can develop in a bidirectional manner (Holmes et al., 2016; Perry et al., 2018; Riggs et al., 2006; van Lier & Deater-Deckard, 2016), it is important to identify whether and how intervention strategies and caregiving quality can ameliorate or reverse adverse developmental pathways to EF and social skills in previously institutionalized children. The present study used a longitudinal randomized controlled trial (RCT) to examine whether childhood social skills mediate the effects from the foster care intervention (FCG) following early institutional rearing to subsequent EF and social skills, and whether the paths from foster care caregiver quality to EF and social skills in adolescence are mediated by childhood EF and social skills.

EF and social skills are distinct developmental domains. EF are cognitive processes, such as working memory and attention shifting, that guide goal-directed behaviors (Diamond, 2013). Social skills include a range of abilities that guide the processing of the social interactions and social behaviors (Beauchamp & Anderson, 2010), including cooperation and prosocial behaviors (Merrell & Gimpel, 2014). Importantly, both EF and social skills improve throughout middle childhood and adolescence (Blakemore & Choudhury, 2006; Gathercole et al., 2004; Merrell & Gimpel, 2014) and are functionally connected, such that successful development in one domain depends on the prior successful development in the other (Beauchamp & Anderson, 2010; Perry et al., 2018; Yeates et al., 2007).

The notion that EF and social skills develop in a bidirectional manner is supported by longitudinal studies examining typically developing children. Social information processing perspectives assert that EF influence children's ability to process social information and engage in positive social interactions, such that children with better EF are more likely to generate effective social responses compared to those with worse EF performance (Yeates et al., 2007). EF have also been proposed to contribute to the development of social skills by supporting the ability to monitor and regulate impulsive behaviors in social situations (Beauchamp & Anderson, 2010). Consistent with these propositions, working memory difficulties have been concurrently associated with poor conflict resolution, aggression and lower social competence in 9–10-year-olds (McQuade et al., 2013). Poor EF also predicted increases in teacher-child conflicts from kindergarten to grade 1 (de Wilde et al., 2016), and increases in peer problems across childhood (Holmes et al., 2016).

On the other hand, effective and frequent use of social skills in social interactions may facilitate the development of EF (Perry et al., 2018). Children who have better social skills have more opportunities to participate in social activities (i.e., play) that facilitate the development of EF compared to those with worse social skills (Bateson et al., 2005; Holmes et al., 2016; Peterson & Flanders, 2005). In partial support of this conceptualization, Holmes et al. (2016) showed that peer problems at 6 years of age predicted EF difficulties at 9–10 years; whereas peer problems at 9–10 years did not predict EF difficulties at 15 years. These age-specific findings may be because social skills in early childhood increase opportunities for social activities and problem solving that facilitate the development of EF, whereas social skills in middle childhood may facilitate different types of social activities (i.e.,

Research Highlights

- Compared to children remaining in institutions, children randomized to foster care showed better social skills, which predicted better executive functioning and social skills in adolescence.
- Foster caregiver quality predicted childhood social skills and preadolescent executive functioning, which were predictive of subsequent social and executive functioning.
- Interventions targeting high quality caregiving within foster care homes may have long-lasting positive effects on children's social skills and executive functioning.

going to social events) that may not necessarily affect the development of EF.

Despite the aforementioned research, most of this work focused on early to middle childhood, and relatively little research has been extended into adolescence, a period of considerable change in social cognition and behaviors (Blakemore, 2008; Crone & Dahl, 2012). Additionally, the prior studies were largely based on typically developing children. Only one study has shown that the path from early adversity, including socioeconomic disadvantage and familial risk, to subsequent EF development was mediated by social skills in early childhood (Perry et al., 2018). As such, the mechanisms that mediate the long-term impact of early institutional rearing and high-quality FCG following institutionalization on EF and social skills in adolescence remain unknown. Even within a high-quality FCG program, there are variations in the quality of caregiving children received, such that some caregivers engaged in more positive, responsive and stimulating caregiving behaviors compared to others. Thus, it is also critical to understand if the pathways from caregiving quality to EF and social skills in adolescence are mediated by early improvements in these skills during childhood years (Blaisdell et al., 2019; Humphreys et al., 2017).

A long history of research suggests that responsive and sensitive caregiving behaviors facilitate the development of EF and positive social functioning by allowing caregivers to act as external regulators of children's emotions and behaviors, providing opportunities for them to gradually build internal capacities to regulate themselves (Bernier et al., 2012; Lind et al., 2017; Sameroff, 2010). In fact, emotionally supportive and sensitive caregiving behaviors have been shown to lead to better EF (Bernier et al., 2012; Valcan et al., 2018; Zeytinoglu et al., 2019) and social skills (Ayoub et al., 2011), and buffer children from the harmful effects of early adverse experiences (Asok et al., 2013; Belsky & Fearon, 2002; Laucht et al., 2001). Similarly, interventions targeting parent-child attachment relationships improves children's EF and social competence, which might be explained by enhanced caregiving quality (Lind et al., 2017, 2020). As such, caregiving quality in foster homes may be an early modifiable mechanism that explains individual differences in the bidirectional development of social skills and EF.



The present study was conducted as part of the Bucharest Early Intervention Project (BEIP), a longitudinal RCT of foster care as an alternative to institutional care (Zeanah et al., 2003). Participants included adolescents who were abandoned to institutions as infants: one group was randomized to foster care after 6–31 months of institutional rearing and another group was randomized to care as usual. As previously shown in this sample, children with a history of institutional rearing experience EF problems throughout middle childhood and adolescence (Bick et al., 2018; Bos et al., 2009; Wade et al., 2019) and social skills problems at age 8 reflected in teacher-report (Almas et al., 2012) and observed behaviors with an unfamiliar peer (Almas et al., 2015) compared to children without a history of institutional care. Even though FCG had a positive impact in improving the foster care children's social skills at age 8 (Almas et al., 2012, 2015), there were no foster care effects on EF, as measured by the Cambridge Neuropsychological Test Automated Battery (CANTAB), at either ages 8-, 12-, or 16-years (Wade et al., 2019).

The current study had two goals. First, we examined whether FCG impacted the reciprocal longitudinal relations between social skills and EF from early school years (8 years) through adolescence (16 years). Based on our previous findings (Almas et al., 2015), we hypothesized that the FCG would predict better social skills at 8 years as assessed via parent and teacher reports, which, in turn, would predict better EF as assessed using laboratory tasks at 12 and 16 years. Second, within the foster care group, we examined the role of caregiving quality on the longitudinal relations between social skills and EF from childhood to adolescence. We hypothesized that higher foster caregiving quality at 42 months of age would predict better EF and social skills, which in turn would mutually influence the development of one another.

2 | METHODS

2.1 | Participants

Participants were from the ongoing BEIP project ([clinicaltrials.gov identifier: NCT00747396](https://clinicaltrials.gov/ct2/show/NCT00747396)), a longitudinal RCT examining the effects of institutional rearing and FCG on children's development. BEIP commenced in April 2001. The adolescent follow-up at age 16 years was completed in September 2018. As part of recruitment, 187 infants between the ages of 6–31 months (mean = 22 months) living in one of six institutions in Bucharest, Romania, completed a battery of pediatric examinations. Amongst these infants, 51 of them were excluded based on signs of genetic abnormalities or fetal alcohol syndrome. The remaining 136 were randomly assigned to either a care as usual group (CAUG; $n = 68$) or a FCG group (FCG; $n = 68$). The FCG is described in Zeanah et al. (2003). Baseline characteristics of participants in CAUG and FCG (together referred as ever-institutionalized group, EIG) are presented in Table S1. In addition, an age- and sex-matched sample of 72 typically developing never-institutionalized children (NIG) living with their biological families was recruited from pediatric clinics in Bucharest to serve a comparison group. Due to discontinuation, additional never-institutionalized participants (also matched on age and sex

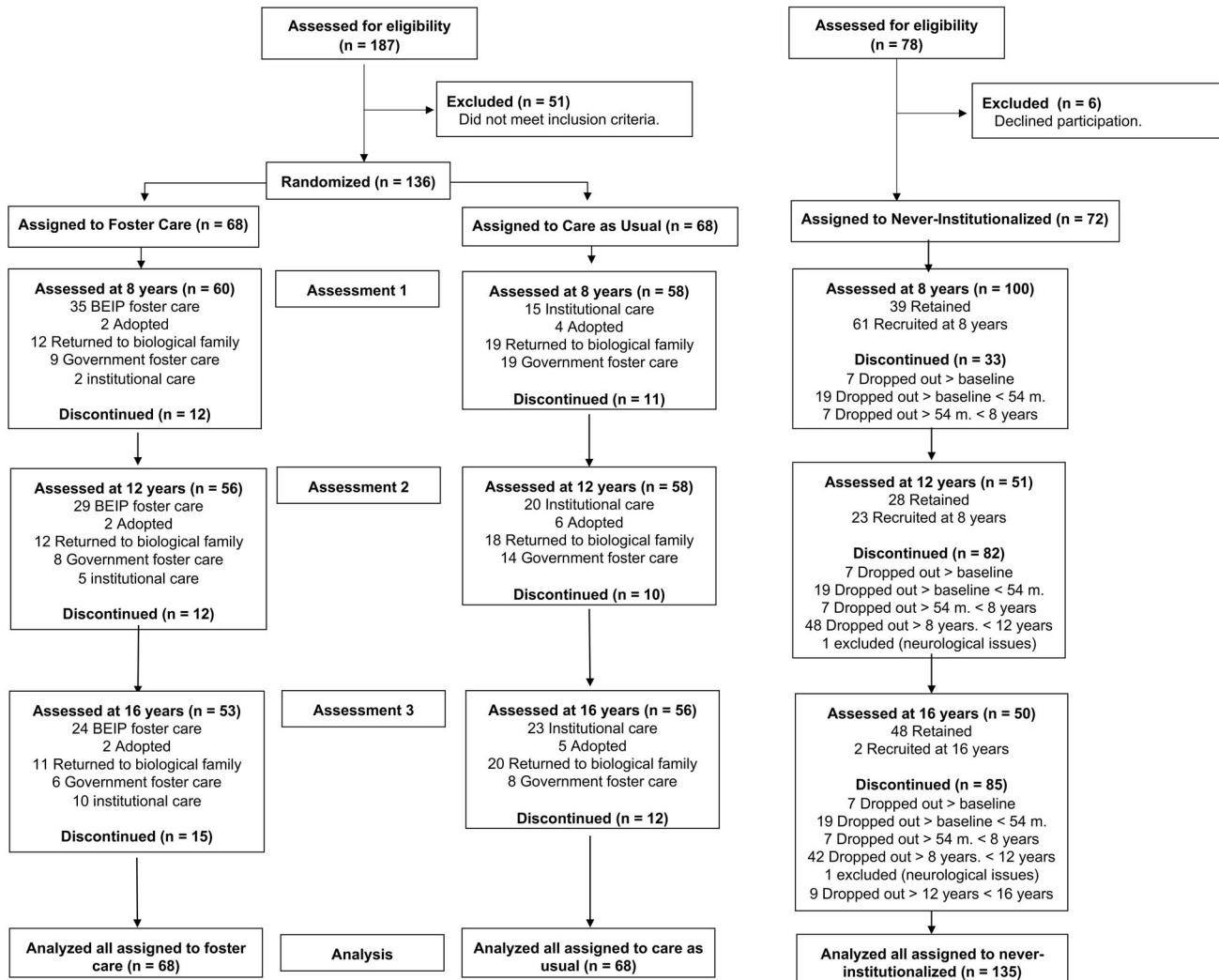
to the institutional group) were recruited at age 8 ($n = 61$) and age 16 ($n = 2$), which allowed for collecting a comparable amount of data from this comparison group. As shown in Table S2, the NIG participants recruited at baseline did not differ from NIG participants recruited later on any of the study variables. Thus, data from all NIG participants were included in this study. Demographic information in the current sample is presented in Table S3. The CONSORT diagram showing group assignment and participant flow is presented in Figure 1. All study procedures were approved by the Institutional Review Boards of the universities of the principal investigators. Signed consent was obtained from each child's legal guardian. Verbal or written assent was obtained from child participants.

The outcome variables, EF and social skills, were assessed at ages 8, 12, and 16. A total of 222 children (58 CAUG, 62 FCG, and 102 NIG) had data from one or more assessments. Information on available data for study variables is reported in Table S5. Participants who had available data did not differ from those with missing data on sex, $\chi^2 = 2.36$, $p = .27$, though more NIG children had missing data, $\chi^2 = 8.149$, $p = .017$.

2.2 | Measures

2.2.1 | EF (8, 12, and 16 years)

EF were assessed via four tasks from the CANTAB (described in detail in Bick et al., 2018 and on CANTAB's website). Briefly, (a) Delayed match to sample (DMS) assesses attention and short-term visual memory. Participants were shown a pattern and then asked to choose the pattern (out of four patterns) that matched the original pattern. Accuracy scores (percent correct) were used. Higher correct scores indicated better attention and short-term visual memory. (b) Paired-associate learning (PAL) assesses visual-spatial memory and new learning. Participants were asked to remember patterns associated with different locations on the screen. A series of boxes were opened one at a time. After all the boxes have been opened and closed, the participants were asked to identify the previous location of the pattern presented on the screen. Mean number of errors to success were calculated. Higher scores reflected worse PAL. (c) Stockings of Cambridge (SOC) is a spatial planning and problem-solving task. Participants were asked to copy a pattern shown on the screen by moving colored circles one at a time, using the fewest number of moves possible. Minimum number of moves were scored. Lower scores indicated better planning and problem-solving. (d) Spatial working memory (SWM) assesses SWM, requiring participants to search through boxes to find a hidden token. Total number of errors were calculated. Lower scores indicated better SWM. Scores from PAL and SWM were reversed so that higher values reflected better EF. As shown in Figure S1, results from confirmatory factor analysis showed that these four EF indicators loaded well onto the EF factor at each assessment. The Cronbach alphas of the EF composites were acceptable ($\alpha = .67$ at ages 8 and 12; $\alpha = .65$ at age 16) and the interitem correlations between the EF indicators were within optimal range (IIC = .32 at ages 8 and 16, and .33 at age 12;

**INSTITUTIONAL REARING****COMMUNITY CONTROLS****FIGURE 1** CONSORT flow diagram presenting participants over time

Piedmont, 2014). At each assessment, the scores from these 4 assessments were standardized and averaged. Higher scores indicated better EF.

2.2.2 | Social skills (8, 12, and 16 years)

Social skills were measured using parent/caregiver (38 items) and teacher report (30 items) on the Social Skills Rating System (SSRS; Gresham & Elliot, 1990). Items ranged from a scale of 0(never) to 3(very often). The SSRS has been shown to be a valid and reliable measure of social skills (Gresham & Elliot, 1990). The social skills composite scores yielded good internal reliability at all assessments ($\alpha = .89\text{--}93$). Parent and teacher-report assessments were positively correlated at each assessment ($r = .22\text{--}.47$; $p = .024\text{--}.000$). Scores were standardized and averaged to create a social skills composite at each assessment.

2.2.3 | Caregiving quality within foster care (42 months)

Caregiving quality was assessed at age 42 months using Observational Record of the Caregiving Environment (ORCE), an observational measure of caregiver behavior coded from videotaped caregiver-child interactions (NICHD early child care research network, 1996). An overall caregiving quality construct was created by averaging scores for sensitivity, stimulation of development, positive regard for the child, flat affect (reverse coded), and detachment (reverse coded). We followed the reliability procedures reported in Zeanah et al. (2005). Two trained coders double coded 40% of videos that were randomly selected after the initial 10 reliability files. Inter-rater reliability was high as indicated by intraclass correlation coefficients ranging from .88 to .99 ($M = .95$) based on estimations from two-way random effects models. Differences in coding were resolved via discussions. Internal

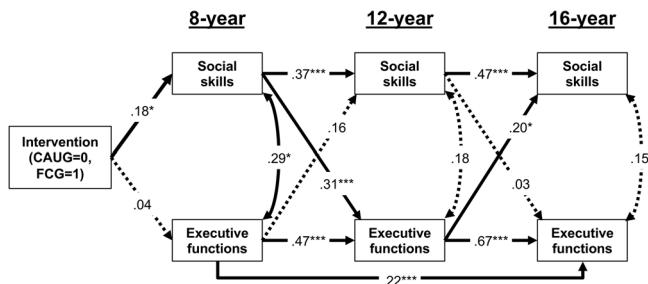


FIGURE 2 Standardized estimates from the longitudinal path model examining the effects of foster care intervention (0 = care as usual group, 1 = foster care group) on EF and social skills. EF were assessed via laboratory tasks and social skills were assessed via caregiver and teacher reports. $n = 136$. *** $p < .005$. ** $p < .01$. * $p < .05$

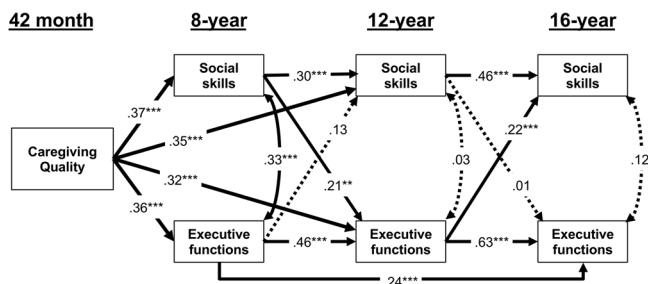


FIGURE 3 Standardized estimates from the longitudinal path model examining the effects of foster care caregiving quality on EF and social skills. Caregiving quality was observed during a child-caregiver social interaction, EF were assessed via laboratory tasks, and social skills were assessed via caregiver and teacher reports. $N = 68$. *** $p < .005$. ** $p < .01$. * $p < .05$

reliability was also high ($\alpha = .86$). A detailed description of the use of this measure in BEIP is available in Smyke et al. (2007).

3 | RESULTS

3.1 | Data analytic strategy

To test the aims, autoregressive cross-lagged path models were conducted in Mplus (Version 8; Muthén & Muthén, 2012). As reported in the supplementary materials (see Figure S2), we first examined the effects of early institutional rearing (1 = EIG, 0 = NIG) on the cross-lagged relations between EF and social skills across middle childhood and adolescence. This allowed us to establish whether institutional care had negative effects on children's EF and social skills. Second, we used an intent-to-treat analytic approach (based on participants' original placement) to examine the effect of the FCG (1 = FCG, 0 = CAUG) on the cross-lagged relations between social skills and EF in ever-institutionalized children (see Figure 2). Third, we examined whether the caregiving quality within foster care predicted EF and social skills within a cross-lagged path model (see Figure 3). In addition to these hypothesized paths, we also tested whether the inclusion of the autoregressive paths from age 8 to 16 and the paths from the contextual

("exogenous") variables—institutionalization, intervention, and caregiving quality—to the 12-year outcomes improved model fit using chi-square difference tests. The paths that improved model fit were included in the final models to better represent the data and the model comparison results were reported in the Supplement (p. 9). All variables were mean centered prior to model testing. Full information maximum likelihood estimation was used to handle missing data and to provide parameter estimates using all available data (Enders & Bandalos, 2001). Statistical significance of indirect effects was evaluated with bias-corrected bootstrapped (1000 draws) confidence intervals because they have been shown to increase accuracy and reduce Type I error rates (MacKinnon et al., 2004). Based on previous work showing gender differences in social skills (e.g., Almas et al., 2019), we examined gender as a covariate.

3.2 | Preliminary analyses

Descriptive statistics are presented in Table S4. Bivariate correlations among the study variables are presented in Table S4. As reported in Table S4, children in the FCG had better social skills as reported by their parent and better performance in SOC problem-solving compared to those in the CAUG. For all other assessments, the differences between these two groups were not significant. Ever-institutionalized children (CAUG and FCG combined) showed worse EF and social skills than children in the NIG across all assessments. As shown in Table S4, boys showed poorer social skills at 8, 12, and 16 years than girls. Thus, gender was included as a covariate predicting social skills at all assessments in the path models.

3.3 | Primary analyses

3.3.1 | Effects of institutional rearing on cross-lagged relations between social skills and EF

As reported in Figure S1, institutionalization predicted poorer social skills and EF at 8 years and poorer EF at 12 years. There were cross-lagged relations, such that better EF at 8 years predicted better social skills at 12 years, better EF at 12 years predicted better social skills at 16 years, and better social skills at 8 years predicted better EF at 12 years. As reported in Table S6, there were serial indirect effects from institutionalization to 16-year outcomes through the cross-lagged relations between EF and social skills, suggesting that institutional care impacted EF and social skills at 16 years via transactional pathways between social skills and EF.

3.3.2 | Foster care intervention effects on cross-lagged relations between social skills and EF

The model examining the effect of the FCG fit the data well, RMSEA = .03 (90% CI = .00-.10); CFI = .99. Standardized results for the direct paths are presented in Figure 2 and indirect paths are



presented in Table S6. There was an intervention effect on social skills at 8 years, such that children who were randomized to foster care showed better social skills than children who remained in the institutions. Social skills at 8 years predicted EF at 12 years, which in turn predicted social skills at 16 years. The indirect effects from intervention to 12-year outcomes through social skills at 8 years were significant ($B = .08$, $SE = .05$, $CI [.002, .215]$, for 12-year EF; $B = .13$, $SE = .08$, $CI [.005, .309]$, for 12-year social skills). There was a significant serial indirect effect from intervention to EF at 16 years via social skills at 8 years and EF at 12 years ($B = .06$, $SE = .04$, $CI [.002, .157]$). There was also a significant serial indirect effect from intervention to social skills at 16 years through social skills at 8 and 12 years ($B = .06$, $SE = .04$, $CI [.002, .161]$). As previously reported (Wade et al., 2019), there was no intervention effect on EF at 8 years and thus intervention effects on 12- or 16-year outcomes were not mediated by EF at 8 years.

3.3.3 | Effects of foster care caregiving quality on the cascading relations between social skills and EF

This model examining the effect of foster care caregiving quality fit the data well, $RMSEA = .00$ [$90\% CI = .00-.07$]; $CFI = 1.00$. Standardized path coefficients are presented in Figure 3. Higher caregiving quality predicted better social skills and EF at 8 and 12 years. In terms of the cross-lagged paths, better social skills at 8 years predicted better EF at 12 years, and better EF at 12 years predicted better social skills at 16 years. As reported in Table S5, there was a significant indirect effect from caregiving quality to EF at 12 years through social skills at 8 years ($B = .07$, $SE = .03$, $CI [.005, .153]$). There was a serial indirect effect from caregiving quality to EF at 16 years through social skills at 8 years and EF at 12 years ($B = .04$, $SE = .02$, $CI [.003, .101]$). There was a serial indirect effect from caregiving quality to social skills 16 years through EF at 8 and 12 years ($B = .04$, $SE = .02$, $CI [.008, .099]$) and an indirect effect through EF at 12 years ($B = .08$, $SE = .04$, $CI [.019, .159]$).

4 | DISCUSSION

In this study, we examined whether a FCG following institutional rearing and caregiving quality within the foster care homes in early childhood predicted the longitudinal developmental cascades between social skills and EF from childhood (age 8) through adolescence (age 16). There were several noteworthy findings. First, replicating previous research, we observed a positive impact of the FCG on children's social skills at 8 years (Almas et al., 2015), suggesting that children who were removed from the institutions and placed in socially enriched home environments showed better social skills compared to those who remained in institutions. Importantly, this positive intervention effect on children's social skills at 8 years had cascading effects on children's EF development in adolescence and also predicted better social skills in adolescence. These findings highlight that FCG in early childhood has long-term indirect effects on EF and social skills in adolescence through its positive effects on childhood social skills.

Second, our findings emphasize the importance of the quality of care children receive in their foster homes. Our results showed that, for children in foster care, higher caregiving quality was associated with better social skills in childhood, which in turn was associated with better EF during adolescence. Likewise, higher caregiving quality was associated with better EF skills in middle childhood, which then had cascading effects on children's social skills in late adolescence. These findings suggest that individual differences in caregiving quality that foster children receive is an important factor underlying the positive development of previously institutionalized children. These findings have important policy implications: training foster parents in sensitive parenting could lead to improvements not only in the social domain, but in the cognitive domain as well (Fisher et al., 2016; Humphreys et al., in press; Korom et al., 2021; Lind et al., 2017, 2020, 2021).

Our findings also highlight that institutional rearing may lead to poor EF in adolescence by impairing children's social skills in childhood years. Due to their poor social skills, children who experience institutional care may have fewer opportunities to participate in social activities (i.e., play) that may facilitate the development of EF. Moreover, consistent with previous findings, institutional rearing was associated with EF difficulties at 8 and 12 years (Colvert et al., 2008; Loman et al., 2013), and these EF difficulties, in turn, predicted poorer social skills in adolescence. This may be because children with poor EF may have difficulty keeping track of others' emotions and social cues, regulating their emotions and behaviors, and solving social problems (Beauchamp & Anderson, 2010; McQuade et al., 2013; Yeates et al., 2007).

Our findings highlight that social skills especially during childhood play an important role in the healthy development of EF in preadolescence. However, social skills at 12 years did not predict EF at 16 years in our models. This finding could be explained by the developmental changes in the nature of social interactions and activities in adolescence. As children transition into adolescence, social skills may facilitate various forms of social interactions (i.e., intimacy) that may not necessarily facilitate growth in EF. These findings are consistent with previous work showing that peer relations at 6 years predicted EF at 9–10 years, while peer relations at 9–10 years did not predict EF at 15 years in typically developing children (Holmes et al., 2016).

The strengths of this study included a multi-wave longitudinal design that allowed examining the mediating pathways from FCG following institutional rearing and foster caregiving to the development of EF and social skills. We also used independent measures including an observed composite measure of EF and a multi-reporter measure of social skills, which reduce informant bias. However, there were several limitations. First, the models tested included multiple parameters. Thus, it is possible that our relatively small sample limited power to detect certain effects. Second, although we demonstrated several significant effects, most of them, particularly the indirect effects, were small in magnitude. Replication of these associations in larger samples of post-institutionalized children is warranted. Third, this study had missing data largely due to its longitudinal design. To mitigate bias, we used the best-practice statistical approaches to include all available data; however, future studies with larger samples and increased



efforts to retain the sample are needed to assess the robustness of the effects reported. Finally, caregiving quality was only measured in early childhood. It would be important to examine the stability of caregiving quality and its relations to EF and social skills development.

To conclude, this study extends knowledge on the developmental mechanisms by which early foster care following institutionalization affects children's social and cognitive functioning across middle childhood and adolescence. Our findings highlight the potential value in targeting caregiving quality in interventions aimed at ameliorating the negative effects of institutional rearing or severe neglect. By highlighting the cascading effects on both children's social skills and their EF, as well as their dynamic influences on each other, we have shown that efforts to improve children's skills in both areas is important for short- and long-term development.

ACKNOWLEDGMENTS

This research was supported by the John D. and Catherine T. MacArthur Foundation, the Binder Family Foundation, the Jacobs Foundation, and the National Institute of Mental Health (NIMH; R01MH091363) to C.A.N., the Palix Foundation to C.H.Z., and the NIMH fellowship grant (F32-MH127869) to S. Z. The funding sources had no role in the design of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

CONFLICT OF INTEREST

The authors have no conflicts of interest to report.

DATA AVAILABILITY STATEMENT

Data that support the findings are available from the authors upon reasonable request.

ETHICS APPROVAL

All study procedures have been approved by the universities' institutional review boards.

ORCID

Selin Zeytinoglu <https://orcid.org/0000-0002-2736-4061>

REFERENCES

- Almas, A. N., Degnan, K. A., Radulescu, A., Nelson, C. A., Zeanah, C. H., & Fox, N. A. (2012). Effects of early intervention and the moderating effects of brain activity on institutionalized children's social skills at age 8. *Proceedings of the National Academy of Sciences*, 109, 17228–17231.
- Almas, A. N., Degnan, K. A., Walker, O. L., Radulescu, A., Nelson, C. A., Zeanah, C. H., & Fox, N. A. (2015). The effects of early institutionalization and foster care intervention on children's social behaviors at the age of eight. *Social Development*, 24(2), 225–239.
- Almas, A. N., Papp, L. J., Woodbury, M. R., Nelson, C. A., Zeanah, C. H., & Fox, N. A. (2020). The impact of caregiving disruptions of previously institutionalized children on multiple outcomes in late childhood. *Child Development*, 91(1), 96–109.
- Asok, A., Bernard, K., Roth, T. L., Rosen, J. B., & Dozier, M. (2013). Parental responsiveness moderates the association between early-life stress and reduced telomere length. *Development and Psychopathology*, 25(3), 577–585.
- Ayoub, C., Vallotton, C. D., & Mastergeorge, A. M. (2011). Developmental pathways to integrated social skills: The roles of parenting and early intervention. *Child Development*, 82(2), 583–600.
- Bateson, P. (2005). *The role of play in the evolution of great apes and humans*. Guilford Press.
- Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: An integrative framework for the development of social skills. *Psychological Bulletin*, 136(1), 39–64.
- Belsky, J. A. Y., & Fearon, R. P. (2002). Infant-mother attachment security, contextual risk, and early development: A moderation analysis. *Development and Psychopathology*, 14(2), 293–310.
- Bernier, A., Carlson, S. M., Deschênes, M., & Matte-Gagné, C. (2012). Social factors in the development of early executive functioning: A closer look at the caregiving environment. *Developmental Science*, 15(1), 12–24.
- Bick, J., Zeanah, C. H., Fox, N. A., & Nelson, C. A. (2018). Memory and executive functioning in 12-year-old children with a history of institutional rearing. *Child Development*, 89(2), 495–508.
- Blaisdell, K. N., Imhof, A. M., & Fisher, P. A. (2019). Early adversity, child neglect, and stress neurobiology: From observations of impact to empirical evaluations of mechanisms. *International Journal of Developmental Neuroscience*, 78, 139–146.
- Blakemore, S. J. (2008). The social brain in adolescence. *Nature Reviews Neuroscience*, 9, 267–277.
- Blakemore, S. J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry*, 47(3–4), 296–312.
- Bos, K. J., Fox, N., Zeanah, C. H., & Nelson Iii, C. a. (2009). Effects of early psychosocial deprivation on the development of memory and executive function. *Frontiers in Behavioral Neuroscience*, 3, 16.
- Colvert, E., Rutter, M., Kreppner, J., Beckett, C., Castle, J., Groothues, C., Hawkins, A., Stevens, S., & Sonuga-Barke, E. J. S. (2008). Do theory of mind and executive function deficits underlie the adverse outcomes associated with profound early deprivation?: Findings from the English and Romanian adoptees study. *Journal of Abnormal Child Psychology*, 36(7), 1057–1068.
- Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social-affective engagement and goal flexibility. *Nature Reviews Neuroscience*, 13(9), 636–650.
- de Wilde, A., Koot, H. M., & van Lier, P. A. C. (2016). Developmental links between children's working memory and their social relations with teachers and peers in the early school years. *Journal of Abnormal Child Psychology*, 44(1), 19–30.
- Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, 64, 135–168.
- Enders, C. K., & Bandalos, D. L. (2001). The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling*, 8(3), 430–457.
- Fisher, P. A., Beauchamp, K. G., Roos, L. E., Noll, L. K., Flannery, J., & Delker, B. C. (2016). The neurobiology of intervention and prevention in early adversity. *Annual Review of Clinical Psychology*, 12, 331–357.
- Gathercole, S. E., Pickering, S. J., Ambridge, B., & Wearing, H. (2004). The structure of working memory from 4 to 15 years of age. *Developmental Psychology*, 40(2), 177–190.
- Gresham, F. M., & Elliott, S. N. (1990). *The social skills rating system*. Circle Pines, MN: American Guidance Service.
- Guyon-Harris, K. L., Humphreys, K. L., Fox, N. A., Nelson, C. A., & Zeanah, C. H. (2019). Signs of attachment disorders and social functioning among early adolescents with a history of institutional care. *Child Abuse and Neglect*, 88, 96–106.
- Holmes, C. J., Kim-Spoon, J., & Deater-Deckard, K. (2016). Linking executive function and peer problems from early childhood through middle adolescence. *Journal of Abnormal Child Psychology*, 44(1), 31–42.



- Hostinar, C. E., Stellern, S. A., Schaefer, C., Carlson, S. M., & Gunnar, M. R. (2012). Associations between early life adversity and executive function in children adopted internationally from orphanages. *Proceedings of the National Academy of Sciences of the United States of America*, 109, pp. 17208–17212.
- Humphreys, K. L., King, L. S., Guyon-Harris, K. L., Sheridan, M. A., McLaughlin, K. A., Radulescu, A., Nelson, C. A., Fox, N. A., & Zeanah, C. H. (in press). Foster care leads to sustained cognitive gains following severe early deprivation. *Proceedings of the National Academy of Sciences*, xx, xx.
- Humphreys, K. L., Nelson, C. A., Fox, N. A., & Zeanah, C. H. (2017). Signs of reactive attachment disorder and disinhibited social engagement disorder at age 12 years: Effects of institutional care history and high-quality foster care. *Development and Psychopathology*, 29(2), 675–684.
- Korom, M., Goldstein, A., Tabachnick, A. R., Palmwood, E. N., Simons, R. F., & Dozier, M. (2021). Early parenting intervention accelerates inhibitory control development among CPS-involved children in middle childhood: A randomized clinical trial. *Developmental Science*, 24(3), e13054.
- Laucht, M., Esser, G., & Schmidt, M. H. (2001). Differential development of infants at risk for psychopathology: The moderating role of early maternal responsiveness. *Developmental Medicine and Child Neurology*, 43(5), 292–300.
- Lind, T., Raby, K. L., Caron, E. B., Roben, C. K., & Dozier, M. (2017). Enhancing executive functioning among toddlers in foster care with an attachment-based intervention. *Development and Psychopathology*, 29(2), 575–586.
- Lind, T., Raby, K. L., Goldstein, A., Bernard, K., Caron, E. B., Yarger, H. A., Wallin, A., & Dozier, M. (2020). Improving social-emotional competence in internationally adopted children with the Attachment and Biobehavioral Catch-up intervention. *Development and Psychopathology*, 33(3), 957–969.
- Lind, T., Raby, K. L., Goldstein, A., Bernard, K., Caron, E. B., Yarger, H. A., Wallin, A., & Dozier, M. (2021). Improving social-emotional competence in internationally adopted children with the attachment and biobehavioral catch-up intervention. *Development and Psychopathology*, 33(3), 957–969.
- Loman, M. M., Johnson, A. E., Westerlund, A., Pollak, S. D., Nelson, C. A., & Gunnar, M. R. (2013). The effect of early deprivation on executive attention in middle childhood. *Journal of Child Psychology and Psychiatry*, 54, 37–45.
- MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research*, 39(1), 99–128.
- McQuade, J. D., Murray-Close, D., Shoulberg, E. K., & Hoza, B. (2013). Working memory and social functioning in children. *Journal of Experimental Child Psychology*, 115(3), 422–435.
- Merrell, K. W., & Gimpel, G. (2014). *Social skills of children and adolescents: Conceptualization, assessment, treatment*. Psychology Press.
- Merz, E. C., & McCall, R. B. (2011). Parent ratings of executive functioning in children adopted from psychosocially depriving institutions. *Journal of Child Psychology and Psychiatry*, 52, 537–546.
- Muthén, L. K., & Muthén, B. O. (2012). *Statistical analysis with latent variables using Mplus*. Muthén & Muthén.
- Perry, R. E., Braren, S. H., Blair, C., Vernon-Feagans, L., Cox, M., Blair, C., Burchinal, M., Garrett-Peters, P., Greenberg, M., Mills-Koonce, R., & Willoughby, M. (2018). Socioeconomic risk and school readiness: Longitudinal mediation through children's social competence and executive function. *Frontiers in Psychology*, 9, 1544.
- Peterson, J. B., & Flanders, J. L. (2005). Play and the regulation of aggression. In (R. E. Tremblay, W. W. Hartup, & J. Archer Eds.), *Developmental origins of aggression* (pp. 133–157). The Guilford Press.
- Piedmont, R. L. (2014). Inter-item correlations. In (A. C. Michalos Ed.) *Encyclopedia of quality of life and well-being research* (pp. 3303–3304). Springer.
- Pitula, C. E., DePasquale, C. E., Mliner, S. B., & Gunnar, M. R. (2019). Peer problems among postinstitutionalized, internationally adopted children: Relations to hypocortisolism, parenting quality, and ADHD symptoms. *Child Development*, 90(3), e339–e355.
- Riggs, N. R., Jahromi, L. B., Razza, R. P., Dillworth-Bart, J. E., & Mueller, U. (2006). Executive function and the promotion of social-emotional competence. *Journal of Applied Developmental Psychology*, 27(4), 300–309.
- Sameroff, A. (2010). A unified theory of development: A dialectic integration of nature and nurture. *Child Development*, 81(1), 6–22.
- Smyke, A. T., Koga, S. F., Johnson, D. E., Fox, N. A., Marshall, P. J., Nelson, C. A., & Zeanah, C. H. (2007). The caregiving context in institution-reared and family-reared infants and toddlers in Romania. *Journal of Child Psychology and Psychiatry*, 48, 210–218.
- Valcan, D. S., Davis, H., & Pino-Pasternak, D. (2018). Parental behaviours predicting early childhood executive functions: A meta-analysis. *Educational Psychology Review*, 30(3), 607–649.
- van IJzendoorn, M. H., Palacios, J., Sonuga-Barke, E. J. S., Gunnar, M. R., Vorria, P., McCall, R. B., Le Mare, L., Bakermans-Kranenburg, M. J., Dobrova-Krol, N. A., & Juffer, F. (2011). I. Children in institutional care: Delayed development and resilience. *Monographs of the Society for Research in Child Development*, 74, 8–30.
- van Lier, P. A. C., & Deater-Deckard, K. (2016). Children's elementary school social experience and executive functions development: Introduction to a special section. *Journal of Abnormal Child Psychology*, 44, 1–6.
- Wade, M., Fox, N. A., Zeanah, C. H., & Nelson, C. A. (2019). Long-term effects of institutional rearing, foster care, and brain activity on memory and executive functioning. *Proceedings of the National Academy of Sciences of the United States of America*, 116, pp. 1808–1813.
- Yeates, K. O., Bigler, E. D., Dennis, M., Gerhardt, C. A., Rubin, K. H., Stancin, T., & Taylor, H. G. (2007). Social outcomes in childhood brain disorder: A heuristic integration of social neuroscience and developmental psychology. *Psychological Bulletin*, 133(3), 535–556.
- Zeanah, C. H., Nelson, C. A., Fox, N. A., Smyke, A. T., Marshall, P., Parker, S. W., & Koga, S. (2003). Designing research to study the effects of institutionalization on brain and behavioral development: The Bucharest Early Intervention Project. *Development and Psychopathology*, 15(4), 885–907.
- Zeanah, C. H., Smyke, A. T., & Dumitrescu, A. (2002). Attachment disturbances in young children. II: Indiscriminate behavior and institutional care. *Journal of the American Academy of Child and Adolescent Psychiatry*, 41(8), 983–989.
- Zeanah, C. H., Smyke, A. T., Koga, S. F., Carlson, E., & Bucharest Early Intervention Project Core Group. (2005). Attachment in institutionalized and community children in Romania. *Child Development*, 76(5), 1015–1028.
- Zeytinoglu, S., Calkins, S. D., & Leerkes, E. M. (2019). Maternal emotional support but not cognitive support during problem-solving predicts increases in cognitive flexibility in early childhood. *International Journal of Behavioral Development*, 43(1), 12–23.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Zeytinoglu, S., Tang, A., Zeanah, C. H., Nelson, C. A., Almas, A. N., & Fox, N. A. (2022). Effects of Foster Care Intervention and Caregiving Quality on the Bidirectional Development of Executive Functions and Social Skills Following Institutional Rearing. *Developmental Science*, e13309. <https://doi.org/10.1111/desc.13309>