Children and Youth Services Review 108 (2020) 104587

Contents lists available at ScienceDirect

Children and Youth Services Review

journal homepage: www.elsevier.com/locate/childyouth

# Executive function and early adversity in internationally adopted children

María Peñarrubia[a,*], Jesús Palacios[b], Maite Román[b]

[a] Department of Psychology, University Loyola (Spain), Avda. de las Universidades s/n, Dos Hermanas 41704, Seville, Spain
[b] Department of Developmental and Educational Psychology, University of Seville (Spain), C/Camilo Jose Cela s/n, Seville 41018, Spain

ARTICLE INFO

*Keywords:*
Executive functions
Deprived children
Childhood development
International adoption

ABSTRACT

*Background:* A history of early adversity, including lack of stable, sensitive and supportive caregivers, abuse and institutionalization, has negative influences over cognitive development. However, previous research has shown heterogeneous patterns of impairment in executive processes among children adopted internationally.
*Method:* Executive processes were examined in post-institutionalized children adopted into Spanish families from Russian institutions. Four tasks of the neuropsychological battery CANTAB were used to assess selective attention, planning, inhibitory control and working memory. The sample included 27 adopted children (74.1% male), aged 8–13 years ($M$ = 10.35; $SD$ = 1.34) at time of study, and 37 non-adopted children in the comparison group (54.1% male), aged 8–13 years ($M$ = 11.00; $SD$ = 1.40). Almost half of the adoptees (48.6%) were institutionalized at birth and had no preadoptive family experience.
*Results:* Adopted children displayed poorer performance in attention, planning and working memory. A younger entry into the institutions was related to better results in attention and inhibition, although no significant correlations were found between length of institutionalization, adoption placement variables and executive performance. The group of adoptees with family experience before institutionalization showed lower performance in inhibition –compared to adoptees institutionalized at birth and the control group–, and lower scores in attention and planning than the control group.
*Conclusions:* Although adoption offers a protective context that promotes cognitive development, difficulties in executive processes are still evident after an average of seven years in the adoptive family. Adoptive parents should be equipped with strategies to satisfy their child's needs, and targeted interventions could be implemented to prevent future difficulties in their development.

## 1. Introduction

Many children around the world spend their early lives in abusive and depriving familial and institutional contexts. Their adversities may include prenatal risks, abuse and institutionalization, together with a lack of key elements of what an expectable environment should provide for an adequate development (Greenough, Black, & Wallace, 1987): access to a stable and sensitive caregiver, adequate nutrition, as well as sensory, social and cognitive stimulation. When children exposed to early familial and institutional deprivation are adopted by a supportive family, a unique opportunity is offered to analyse the impact of early adversities on their development and to study their post-adoption recovery (Rutter, 2007). The present study adds to the existing knowledge about these processes in the domain of executive functioning (EF).

As a consequence of accumulated adversity, when children are placed in adoptive families, developmental delays and difficulties are common (Berens & Nelson, 2015). Research interest is currently focused in identifying the underlying mechanisms –neurocognitive, relational or emotional– that link early institutionalization with increased risk of negative long-term outcomes (Merz, Harlé, Noble, & McCall, 2016). Studies of institutionally reared children show that early deprivation can have long-term consequences for neurocognitive functioning, including EF, our object of study herein (Cardona, Manesa, Escobar, López, & Ibáñez, 2012; Nelson, Bos, Gunnar, & Sonuga-Barke, 2011; Sonuga-Barke et al., 2017).

EF is a conceptual umbrella that encompasses interrelated and independent high-level cognitive processes underlying flexible, goal-directed behaviour that ultimately facilitates adaptation (Anderson & Reidy, 2012). Although there is a wide range of definitions, EF can be conceptualized as a single phenomenon that encompasses the efficiency and effectiveness with which individuals acquire knowledge and problem-solving across different areas, including attention and emotional

*Abbreviations:* EF, Executive Function

* Corresponding author.
*E-mail addresses:* mgpenarrubia@uloyola.es (M. Peñarrubia), jp@us.es (J. Palacios), maiteroman@us.es (M. Román).

https://doi.org/10.1016/j.childyouth.2019.104587
Received 9 July 2019; Received in revised form 29 October 2019; Accepted 29 October 2019
Available online 23 November 2019
0190-7409/ 

regulation; behaviour initiation and inhibition; goal setting; planning and organization; flexibility; working memory and self-regulatory processes (Goldstein, Naglieri, Princiotta, & Otero, 2014). They are essential skills for mental health, academic and life achievement, as well as cognitive, social and psychological development (Diamond, 2013). EF is related to the prefrontal cortex, which has an extended growth pattern until the second decade of life (Simmonds, Hallquist, & Luna, 2017). Although with a large inter-individual variability in developmental trajectories, this prolonged development implies a high sensitivity to environmental influences, either positive or negative.

Through direct assessment of the children or using parent and teacher rating scales, in the last 15 years several studies have assessed EF in post-institutionalized children. Our review of extant research will refer only to previous studies involving direct assessment of children, as well as the specific EF components included in this work: selective attention, planning, inhibition and working memory. Findings across previous research indicate EF difficulties in internationally adopted children, with strong evidence for inhibitory control and working memory (see Merz et al., 2016, for a review). Some studies have reported difficulties in selective attention (Chugani et al., 2001) and planning (Bauer, Hanson, Pierson, Davidson, & Pollak, 2009; Beckett, Castle, Rutter, & Sonuga-Barke, 2010; Hanson et al., 2013), while other research did not confirm significant differences with the comparison samples (Pollak et al., 2010). Although heterogeneous data could be due to the wide diversity in samples and methods of study, previous literature suggest that post-institutionalized children are at greater risk of EF deficits.

Difficulties in attention, inhibition and planning have been related to longer stays in institutions and an older age at the time of adoption (Beckett et al., 2010; Loman et al., 2013; Pollak et al., 2010). Nevertheless, the risk of having difficulties with working memory and planning did not increase with age at adoption (Bos, Fox, Zeanah, & Nelson, 2009; Pollak et al., 2010), and either global EF difficulties were related to length of institutionalization in late-adopted children using the Behavior Rating Inventory of Executive Function (BRIEF) (Helder, Mulder, & Gunnoe, 2015). Regarding preadoptive family experience, longer stays have been associated with better performance in inhibitory control, cognitive flexibility and working memory (Hostinar, Stellern, Schaefer, Carlson, & Gunnar, 2012), but, to the best of our knowledge, no research has so far compared EF performance in children with and without family experience prior to institutionalization. Since some infants spend some significant time in their biological family, while others are placed in institutional care since they are born, analysing the differences between these two groups could add to our present knowledge.

Once these children are adopted, the new family context can potentially facilitate the adoptees' recovery in all areas of development (Palacios, Román, Moreno, León, & Peñarrubia, 2014). Adoptive parents offer emotional and cognitive resources that may serve to overcome developmental delays and difficulties, acting as protective factors that can buffer the negative consequences of adverse experiences and help recovery (Juffer, van IJzendoorn, & Palacios, 2011). As far as we know, scarce research has linked the recovery in EF to post-adoptive characteristics (e.g. length of time in the adoptive family). The Bucharest Early Intervention Project (BEIP) followed children randomly assigned to foster care intervention a group of children then compared with peers who continued in institutions. Both groups exposed to early adversity performed worse in planning, working memory and inhibitory control than the community comparison group, and no significant differences were found between institutionalized and foster children (Bick, Zeanah, Fox, & Nelson, 2018; Bos et al., 2009; Lamm, Troller-Renfee, Zeanah, Nelson, & Fox, 2018; McDermott et al., 2013), with the exception of certain facets of response monitoring where children in foster care performed better than institutionalized children (McDermott et al., 2013). These results could point out that, although postadoption family experience benefit the cognitive development of adoptive children, their exposition to early adversity can have long-lasting negative consequences.

For many years, the Russian Federation has been one of the main countries of origin for Spanish families wanting to adopt internationally (Observatorio de la Infancia, 2018). Because little is known from research about these adoptions, particularly as they move from childhood into adolescence, the aims of this research were (1) to study EF performance in a group of adoptees born in the Russian Federation, adopted into Spanish families and studied at late-childhood and early adolescence; (2) to analysis EF performance in connection with some pre- and post-adoption circumstances (time in the birth family, length of institutional care, age at placement, time after adoption); and (3) to compare EF outcomes according to the preadoptive trajectories of development: children who lived with their biological families before being institutionalized and children institutionalized at birth.

According to what is already known, we expect that, (1) compared with a group without early adversity, adopted children will show a worse performance in EF. We speculate that (2) an earlier age at placement and longer time in the adoptive family will be beneficial for the recovery from the negative consequences of early adversity, including EF performance. The exposure to negative pre-institutional family experience will be probably associated with risk factors such as neglect and maltreatment. Since Russian children are adopted from institutions, the early negative influences in the family will be followed by institutional adversities. We speculate that (3) adoptees with these two sources of adversity (in the family and in institutions) will show worse EF performance than those children institutionalized at birth.

The sample was recruited from the longitudinal study carried on at the University of Seville since 2007. This project follows up the processes of recovery of a group of 148 children in three different times, in the first data collection they were 4–8 years of age, 8–13 in the second one and 13–18 in the third one. This sample is made up of three subgroups of international adoptees, children in the Spanish residential care system and a control group. The research included contents related to physical, neuropsychological, cognitive, social and emotional development. EF was not part of the goals of the study in the first phase and was added as one of the main areas for the second phase, reported here.

## 2. Methods

### 2.1. Participants

This study is part of the second follow-up of two groups of children studied previously (Román, Palacios, Moreno, & López, 2012). In this study EF performance was examined in 8- to 13-year-old children internationally adopted in comparison with a group of age-matched non-institutionalized children. Due to difficulties contacting the families or their refusal to participate in the second follow-up, and because data from the group of children in residential care were not included in this paper, the initial sample ($N$ = 148) was reduced to 64 children: 32 children adopted by Spanish families from institutional care in Russian orphanages, and a control group formed by 38 children who lived with their biological families and had no relation to child protection services. At the time of assessment, nine adopted children had been diagnosed with Attention Deficit Hyperactivity Disorder. The only exclusion criteria applied was being under some pharmacological treatment during the evaluation, a situation that could interfere with cognitive performance, so five adopted and one non-adopted children were excluded from data analysis.

For those reasons, the final sample was composed by 27 adopted children (74.1% boys) and 37 children in the control group (54.1% boys). The average age at the time of the assessment was 10.35 years ($SD$ = 1.34) in the adopted children, and 11.00 years ($SD$ = 1.40) in the control group. There were no differences between the adopted and non-adopted groups in terms of gender, $\chi^2$ = 2.67, $p$ = .123, and

**Table 1**
Sociodemographic characteristics of adopted children according to their preadoptive trajectories.

| | Institutionalized at birth ($n$ = 13) | | | Pre-institutionalization family experience ($n$ = 14) | | | Statistical tests |
|---|---|---|---|---|---|---|---|
| | *M* | *SD* | Min, Max | *M* | *SD* | Min, Max | |
| Age at institutionalization (months) | 0.00 | 0.00 | 0, 0 | 18.36 | 20.16 | 1, 62 | $U = 0.00^{***}$, $r = -0.90$ |
| Length of institutionalization (months) | 36.14 | 16.49 | 12, 62 | 20.71 | 8.55 | 9, 36 | $t(17.72) = -3.02^{**}$, $d = -1.43$ |
| Age at placement (years) | 3.00 | 1.36 | 1.00, 5.00 | 3.27 | 1.47 | 1.08, 6.00 | $t(25) = 0.49^{ns}$ |
| Length of adoptive experience (years) | 7.46 | 1.28 | 5.50, 10.00 | 7.00 | 0.92 | 5.67, 8.67 | $t(25) = -1.07^{ns}$ |
| Age at assessment (years) | 10.47 | 1.13 | 8.50, 12.25 | 10.24 | 1.54 | 8.17, 13.25 | $t(25) = -0.44^{ns}$ |

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; $^{ns}$ = not significant.

children's age, $U = 388.00$, $z = -1.52$, $p = .129$.

Children were adopted at an average age of 3.14 years ($SD = 1.39$), and had been with their families an average of 7.22 years ($SD = 1.11$). All of the children had lived in an institution prior their adoption, entering at an average age of 9.52 months ($SD = 17.05$), and staying in the institution an average of 28.14 months ($SD = 14.96$). Regarding preadoptive family experience, 48.1% ($n = 13$) of the children were institutionalized at birth and 51.9% ($n = 14$) of the children had lived for some time with their biological families prior to their institutionalization. Comparing the characteristics of adopted children according to their early family experience, adoptees institutionalized at birth had not only an earlier entry, but also a more prolonged institutionalization than those children who lived with their biological families, with large effect sizes. There were no significant differences between groups in the average age at the arrival to the adoptive families and the length of adoptive family experience (see Table 1).

### 2.2. Instruments

EF was assessed with the Cambridge Neuropsychological Testing Automated Battery (CANTAB), a computerized series of neuropsychological tests applied in a touchscreen that facilitate a standardized administration and record of the participant's response speed and accuracy (Fray, Robbins, & Sahakian, 1996). The CANTAB offers other strengths: it has been used extensively with children, the tasks require non-verbal responses, and the tests are designed to be visually attractive and interesting, especially for children, in order to maintain motivation (Luciana & Nelson, 2002). The five tasks applied were administered in the same order, taking approximately 60 minutes.

#### 2.2.1. Motor Screening Task (MOT)

MOT screens for visual, movement and comprehension difficulties, by requiring children to touch a flashing cross at different locations on the screen as quickly as possible. The goal is to detect potential sensory-motor deficits or lack of comprehension that would limit the collection of valid data. These outcomes were not used in data analysis.

#### 2.2.2. Rapid Visual Information Processing (RVP)

RVP is a test of visual sustained and selective attention. A white box appears in the centre of the screen, inside which digits appear in a pseudo-random order (rate of 100 digits per minute). Children are required to detect a target sequence of digits (3-5-7), with a permanent reminder in the screen, using a press pad. Performance was measured using the probability of false alarm (lower scores show a better performance).

#### 2.2.3. Stockings of Cambridge (SOC)

SOC is a version of the Tower of London spatial planning task. Children are shown two displays, each of which contains three coloured balls held in stockings suspended from a beam. The child has to use the balls in the lower display to match the pattern in the upper display, following some rules and using the fewest number of moves possible. Test performance was measured by the number of moves executed to complete problems that can be resolved in five moves (lower scores reflect a better planning).

#### 2.2.4. Stop Signal Task (SST)

SST assesses inhibitory control. In the centre of the screen appears an equally probable right- and left-pointing arrow, and children are instructed to respond as quickly as possible. On 25% of the trials, an auditory stop-signal of a 1000 Hz tone and 100 ms of duration appears after the arrow, indicating not to respond. This task utilizes a tracking procedure, in which the delay between the presentation of the arrow and the stop-signal changes after every trial with a stop-signal. Five blocks of 64 trials were administered. Performance was measured by the stop-signal reaction time that reflects the time required to stop a response that is already in the process of being executed (lower times show a better inhibition).

#### 2.2.5. Spatial Working Memory (SWM)

SWM evaluates the child's ability to retain spatial information and manipulate it in working memory. A number of coloured squares are displayed in the screen, and the child is required to locate a blue token hidden in every box, following the rule that after a token has been found in a box, that box will not contain any tokens in the future. The number of boxes increases gradually, until a total of eight boxes. The child's score was measured upon the number of errors –touching boxes that have already been found to be empty or revisiting boxes that have already found to contain a token-, thus lower scores show a better performance.

Finally, for the adopted parents, an interview was performed, if necessary corroborated by an inspection of the child's files, to obtain information about the child's history. Questions were asked about family experience before adoption, age on entrance and duration of institutionalization, age at adoption, and time with the adoptive family.

### 2.3. Recruitment and screening

Data presented in this study were collected in the second wave of a longitudinal research carried on at the University of Seville. Contact with families in this second wave was made by ordinary mail and by telephone. The recruitment in the first data collection was made through two Collaborating Agencies for International Adoption in Spain, and through the random selection of 10 schools in Seville from neighbourhoods with different socio-economic levels, and requesting the families' collaboration. Inclusion criteria in the first wave were: children aged between four and eight years old, and, for the group of adopted children, having been adopted in Russian Federation and having spent at least nine months in their adoptive family at the time of the data collection.

#### 2.3.1. Ethical considerations

The Institutional Ethics Review Board of the University of Seville, following the Spanish and European normative, approved both studies. The children's parents gave written informed consent for participation in both studies.

## 3. Results

### 3.1. Preliminary analysis

Before conducting the analysis, data distribution was explored. The CANTAB tests MOT; RVP; SOC; SST; and age at assessment, length of experience with biological family and age at entry into institutional care were non-normally distributed (Shapiro-Wilk tests, $ps < 0.05$). Therefore, non-parametric tests were conducted in those cases. The children's age at the time of the study did not affect the executive outcomes assessed and were not included in the group comparisons.

The screening test (MOT) showed no significant differences in the response latency between adopted children ($M = 879.44$, $SD = 339.38$) and the control group ($M = 812.67$, $SD = 198.98$), $U = 495.50$, $z = -0.54$, $p = .957$. No differences were found either when the control group was compared with children institutionalized at birth ($M = 931.77$, $SD = 398.56$) and adoptees with preadoptive family experience ($M = 830.86$, $SD = 280.08$), $H(2) = 0.42$, $p = .812$. These results showed that children in both groups understood the instructions and were able to use the touchscreen system, just like other previous studies with post-institutionalized children (Bos et al., 2009; Merz, McCall, Wright, & Luna, 2013).

### 3.2. EF in internationally adopted children

The first question addressed was whether adopted children performed differently on EF measures than the comparison group of non-adopted children. Results of independent sample contrasts in the key-outcome measures from the four CANTAB tests applied are reported in Table 2. Analysis revealed that adopted children displayed a poorer performance than the control group in attention (RVP), planning (SOC) and working memory (SWM), with medium effect sizes; non-significant differences appeared in the inhibitory task (SST).

#### 3.2.1. Placement variables.

To analyse the relation between early adversity experiences and EF performance in the adoptive group, four placement variables were taken into account: age at entry into institutional care and adoption and length of institutional and adoptive care. The age of entry into institutional care was significantly related to attention (RVP; $r_s = .48$, $p = .012$) and inhibition (SST; $r_s = .48$, $p = .012$), pointing that children placed at a younger age at the baby home showed better results in attention and inhibition. No significant correlations were observed in other EF domains in connection with placement variables (Table 3).

Nevertheless, placement variables were, as expected, highly correlated with each other (Table 3), and, for that reason, parametric and non-parametric partial correlations were implemented to analyse the relation between placement variables and EF performance. The age at entry into institutional care was significantly correlated with attention (RVP; $\varrho = .49$, $p = .012$) and inhibition (SST; $\varrho = .51$, $p = .007$), after controlling length of institutionalization. Both results pointed that children placed at a younger age at the baby home showed better results in attention and inhibition. No more significant correlations were found between placement variables and EF scores, after controlling related placement variables.

### 3.3. EF and preadoptive trajectories of development

The third question addressed was focused on analysing different patterns of EF outcomes depending of the preadoptive trajectories of development: the group of children institutionalized at birth and those children who lived with their biological families before being institutionalized. Results of key-outcome measures in EF are reported in Table 4; contrast tests were applied, revealing significant differences in attention (RVP), planning (SOC) and inhibition (SST). Pairwise comparisons with adjusted $p$-values showed that there were significant differences between children with family experience before entering the institution and the other comparison groups in attention, planning and inhibitory control. Specifically, children with preadoptive family experience showed a lower performance than the control group in attention (RVP; $p = .000$) and planning (SOC; $p = .013$), with medium and large effect sizes. Furthermore, children with preadoptive family experience obtained worse scores in inhibition (SST) in comparison with the control group ($p = .022$) and adoptees institutionalized at birth ($p = .041$), with medium effect sizes. Finally, no significant differences were found in the working memory task (SWM).

## 4. Discussion

The purpose of this study was to investigate the effects of early deprivation on the development of EF among 8- to 13-year-old children adopted from institutional settings in the Russian Federation into Spanish families after different pre-adoption trajectories.

We first investigated whether internationally adopted children performed differently on EF in comparison with non-adopted children. Findings revealed lower performances in selective attention, planning and working memory tasks among post-institutionalized children. These findings are consistent with previous work on the effects of early institutional deprivation (Bauer et al., 2009; Beckett et al., 2010), and highlight the long-lasting consequences of early adversity. Other studies have reported different patterns of outcomes, such as a worse performance in inhibition and normative outcomes in attention, planning and working memory (Merz et al., 2013; Pollak et al., 2010). Nevertheless, this could be explained by differences in the samples included in both studies: Pollak et al. (2010) studied a younger sample of children (8–9 years old) adopted from Asia and Eastern Europe, and Merz et al. (2013) assessed older children (almost 13 years old) adopted from high quality institutions in Russia. The different pattern of results across previous literature could also be due to the use of different assessment procedures –including different neuropsychological tasks or caregiver's reports-.

The normative results in inhibition found in this study could be explained because adopted children recurred to a conservative strategy, responded slower until the stop signal appeared, and thus reduced errors and maximized efficiency by not having to inhibit the response (Logan & Cowan, 1984). It can be hypothesized that variables related to the institutional context (rigid timetables and routines, controlled environment) can hinder the development of processes like planning and allow the development of inhibitory control –the child has to learn to

**Table 2**
Executive function outcomes in adopted and non-adopted children.

| CANTAB tasks | Adopted children *M (SD)* | Control group *M (SD)* | Statistical tests |
|---|---|---|---|
| Probability of false alarm (RVP) | 0.04 (0.06) | 0.00 (0.00) | $U = 248.50^{***}$, $r = -0.44$ |
| Moves in 5-moves problems (SOC) | 7.88 (1.73) | 6.92 (1.20) | $U = 340.00^{*}$, $r = -0.27$ |
| Stop signal reaction time (SST) | 251.04 (88.52) | 217.88 (72.44) | $U = 377.00^{ns}$, $r = -0.19$ |
| Errors in working memory (SWM) | 20.37 (10.05) | 15.57 (7.11) | $t(44.22) = -2.13^{*}$, $r = 0.34$ |

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$; $^{ns}$ = not significant.

**Table 3**
Correlations between placement variables and executive function outcomes in the adopted group.

| | Age at institutionalization | Length of institutionalization | Age at placement | Length of adoptive experience |
|---|---|---|---|---|
| Probability of false alarm (RVP) | .48* | −.11$^{ns}$ | .08$^{ns}$ | −.27$^{ns}$ |
| Moves in 5-moves problems (SOC) | .14$^{ns}$ | .03$^{ns}$ | −.16$^{ns}$ | .04$^{ns}$ |
| Stop signal reaction time (SST) | .48* | −.05$^{ns}$ | .34$^{ns}$ | −.27$^{ns}$ |
| Errors in working memory (SWM) | −.20$^{ns}$ | .19$^{ns}$ | −.23$^{ns}$ | .09$^{ns}$ |
| Length of institutionalization | −.48* | – | – | – |
| Age at placement | .29$^{ns}$ | .41* | – | – |
| Length of adoptive experience | −.23$^{ns}$ | −.34$^{ns}$ | −.45* | – |
| Age at assessment | .10$^{ns}$ | .16$^{ns}$ | .65*** | .38$^{ns}$ |

*$p < .05$; **$p < .01$; ***$p < .001$; $^{ns}$ = not significant.

**Table 4**
Executive outcomes in adopted children according to preadoptive trajectories of development.

| CANTAB tasks | EXP *M (SD)* | INST *M (SD)* | CG *M (SD)* | Statistical tests | Post-hoc comparisons |
|---|---|---|---|---|---|
| Probability of false alarm (RVP) | 0.07 (0.08) | 0.01 (0.01) | 0.00 (0.00) | $H(2) = 16.89$*** | EXP > CG***, $r = 0.57$ |
| Moves in 5-moves problems (SOC) | 8.29 (1.79) | 7.44 (1.62) | 6.92 (1.20) | $H(2) = 8.14$* | EXP > CG*, $r = 0.40$ |
| Stop signal reaction time (SST) | 289.33 (89.16) | 209.80 (69.38) | 217.88 (72.44) | $H(2) = 8.89$* | EXP > CG*, $r = 0.37$; EXP > INST*, $r = 0.48$ |
| Errors in working memory (SWM) | 19.29 (9.87) | 21.54 (10.50) | 15.57 (7.11) | $F(2, 21.69) = 2.25^{ns}$ | |

*Note:* EXP = Adoptees with preadoptive family experience; INST = Adoptees institutionalized at birth; CG = Control group.
*$p < .05$; **$p < .01$; ***$p < .001$; $^{ns}$ = not significant.

wait to the lunchtime, playtime, etc.–. Other possible explanations could point out to the low sample size of this study, or a lack of sensibility of the Stop Signal Task to detect differences between groups. Future lines of research could include higher sample sizes and a broader set of inhibition tasks. Finally, the developmental and physiological trajectories can be different for every executive process and, depending on the timing and the individual experiences of every child, specific processes could be damaged or preserved.

With respect to the second goal, the relation of EF outcomes with pre- and post-adoption characteristics, children placed at a younger age in institutional care showed better results in attention and inhibitory control, while no more significant relations were found between EF outcomes and placement variables. Scarce literature has reported the relation between age at entry into institutional care and EF performance in internationally adopted children. A possible explanation could point to the impact of the experience with the biological family. Although adoption reports or adoptive families frequently cannot provide information about specific experiences that children faced in their biological families, previous literature has highlighted that looked after children often experience threatening situations such as neglect, abuse and persistent maltreatment before out-of-home placement (Oswald, Heil, & Goldbeck, 2010). The exposition to these types of adverse experiences has been related to worse EF outcomes (Beers & De Bellis, 2002; Hughes & Ensor, 2009). Therefore, it could be hypothesized that the relation found in the current study between age at entry into institutional care and performance in attention and inhibition tasks could be influenced by shorter expositions to deprivation in the biological family.

Previous research has found that length of institutional care and age at adoption were associated to attention and inhibition (Colvert et al., 2008; Eigsti, Weitzman, Schuh, de Marchena, & Casey, 2011; Loman et al., 2013; Pollak et al., 2010), although other studies found no significant correlations in inhibition, planning and working memory (Bos et al., 2009; Loman et al., 2013; Pollak et al., 2010). Inconsistent results between this current research and previous studies –which highlighted the relation of placement variables with EF performance– could be due to differences in the characteristics of the institutions. Therefore, institutions providing better care could have a lower impact on EF development, and a longer duration of institutional experience would not correspond to a decrease in EF. In addition, the time passed since leaving the institution and the benefits of adoption could influence the relationship between length of institutionalization and EF.

In accordance with the third goal, we compare EF outcomes according to the preadoptive trajectories of development. The group of adoptees who lived in their biological family before being institutionalized showed lower performances in attention, inhibition and planning tasks. No previous literature is available, but several hypotheses can be raised. As mentioned above, adoptees with preadoptive family experience were probably exposed to a combination of different types of adversity, including a likely exposition to a depriving family context before being separated from their families and facing the loss of main caregivers. Besides the hindering effects of the exposition to a depriving family context, previous research has shown that prolonged separations from main caregivers lead to activation of stress mechanisms and a challenging situation for the immature stress system of the child (Loman & Gunnar, 2010). In contrast, adoptees institutionalized at birth did not experience any of those adversities but were exposed for longer periods to institutional care. Although growing up in institutional care has the potential for many detrimental consequences, some aspects of EF –such as inhibitory control– could be promoted in institutional environments, whereas adoptees who lived with their biological families could have been exposed to a combination and accumulation of risk factors, which could have a higher impact on EF development.

Regarding the specific results found in this study, on one hand, there were significant differences in working memory between adopted and non-adopted children. When the adoptive group was split according to preadoptive family experience, both subgroups obtained similar scores in working memory, although no significant differences were found between both subgroups and the control group, maybe due to the small sample sizes of subgroups. On the other hand, no significant differences in inhibition were found between adopted and non-adopted children. When the adoptive group was split according to preadoptive family experience, each subgroup showed very different average scores: adoptees institutionalized at birth obtained a similar score than the control group, while adoptees with family experience obtained significantly worse scores. It could be guessed that the average score for the entire group of adopted children masked the largely different average scores of each subgroup and, for that reason, no significant differences were found between adopted and non-adopted children, whereas the comparisons between the three groups showed significant differences. Nevertheless, given the low sample sizes resulting after

splitting the adopted group, these results should be considered with caution, and future lines of research should include larger sample sizes.

### 4.1. Limitations, future research and practical implications

This study had a number of limitations. The sample size was reduced, but within the range of studies using neuropsychological measures. Nevertheless, splitting the group of adopted children led to a smaller sample size, and consequently, results should be considered with caution. Because the adopted sample came exclusively from Russia, the results may not be representative of children adopted from other countries with different characteristics. The results obtained could be influenced by differences in testing conditions, such as different examiners, testing contexts or levels of fatigue. Lastly, the difficulty in adequately evaluating preadoptive experiences of adversity for each child and rule out the influence of potential confounding risk factors (e.g. genetic and prenatal care, specific experiences faced in the biological family), is a common situation in child protection research (McCall, 2011).

Future lines of research would include longer sample sizes and a longitudinal evaluation of EF, from the placement into the adoptive family until adulthood, to trace the complete sequence of development, following the English and Romanian Adoptee Study (ERA) and BEIP projects. This research team has implemented recently a third longitudinal assessment, when the sample was between 13- and 18 years old, and the corresponding EF results will be available soon. Furthermore, samples in other studies should be expanded to include children adopted from other countries and with distinct developmental characteristics. It could be implemented a wider assessment battery, including informants like parents and teachers, and another executive processes, like cognitive flexibility and processing speed.

Several implications can be derived from the current study. The difficulties in EF processes that the adopted children showed, as a group, after having spent various years in the adoptive family, justify the need to prepare the adoptive parents so that their expectations about the child's abilities and limitations are more realistic and equip them with strategies that allow them to most adequately satisfy their child's needs (Palacios, 2007). Additionally, adoptees with preadoptive trajectories marked by an accumulation of risk factors, such as having live adverse experiences with the biological family before being institutionalized, should be evaluated early for EF difficulties. Support for EF recovery should be provided for those adoptees in need to help prevent future difficulties. Although little is known about effective intervention with adopted children, different interventions targeting EF have been proven effective with other populations (e.g. computer-based training programs, mindfulness training, and school programs). This study has highlighted that those adoptees who lived with their biological families before being institutionalized showed higher difficulties in EF performance. These findings could point the need to improve the effectiveness of social services and other care-related professionals in the sending countries, to enhance early detection of children exposed to depriving family contexts. Other measures could imply the promotion of alternative protection policies to institutional care, such as the placement in foster families, and, if institutionalization is unavoidable, improve the quality of institutions and decrease the length of institutional care.

### 4.2. Conclusions

To our knowledge, this is the first paper to demonstrate the EF performance in children adopted in Russian Federation into Spanish families. This research supports and extends previous findings of deficits in executive processes among post-institutionalized children, and highlights the heterogeneous impact of early psychosocial deprivation on the development of executive skills in adoptees in their late childhood and early adolescence. Findings showed that children who lived with their biological families before being placed in institutional care obtained worse results in EF performance. Although it would be necessary to delve into what other factors could be influencing these results, the exposition to accumulated risk factors can have a higher deleterious impact on EF development. This finding adds to previous literature that only examined older-adopted children by specifying the age at adoption or length of institutionalization, and improve our comprehension about risk and protection factors involved in the cognitive development of post-institutionalized children.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

The authors disclosed receipt of the following financial support for the research: This work was supported by the Spanish Ministry of Economy and Competitiveness [grant numbers SEJ2006-12216, PSI2010-19287], the Spanish Ministry of Economy, Industry and Competitiveness [grant number PSI2015-67757-R], and the European Regional Development Fund (ERDF).

## References

Anderson, P., & Reidy, N. (2012). Assessing executive function in preschoolers. *Neuropsychology Review, 22*(4), 345–360. https://doi.org/10.1007/s11065-012-9220-3.

Bauer, P., Hanson, J., Pierson, R., Davidson, R., & Pollak, S. (2009). Cerebellar volume and cognitive functioning in children who experienced early deprivation. *Biological Psychiatry, 66*(12), 1100–1106. https://doi.org/10.1016/j.biopsych.2009.06.014.

Beckett, C., Castle, J., Rutter, M., & Sonuga-Barke, E. (2010). Institutional deprivation, specific cognitive functions, and scholastic achievement: English and Romanian Adoptee study findings. *Monographs of the Society for Research in Child Development, 75*(1), 125–142. https://doi.org/10.1111/j.1540-5834.2010.00553.x.

Beers, S., & De Bellis, M. (2002). Neuropsychological function in children with maltreatment related posttraumatic stress disorder. *The American Journal of Psychiatry, 159*(3), 483–486. https://doi.org/10.1176/appi.ajp.159.3.483.

Berens, A., & Nelson, C. (2015). The science of early adversity: Is there a role for large institutions in the care of vulnerable children? *The Lancet, 386*, 388–398. https://doi.org/10.1016/S0140-6736(14)61131-4.

Bick, J., Zeanah, C., Fox, N., & Nelson, C. (2018). Memory and executive functioning in 12-year-old children with histories of institutional rearing. *Child Development, 89*(2), 495–508. https://doi.org/10.1111/cdev.12952.

Bos, K., Fox, N., Zeanah, C., & Nelson, C. (2009). Effects of early psychosocial deprivation on the development of memory and executive function. *Frontiers in Behavioral Neuroscience, 3*, 1–6. https://doi.org/10.3389/neuro.08.016.2009.

Cardona, J., Manesa, F., Escobar, J., López, J., & Ibáñez, A. (2012). Potential consequences of abandonment in preschool-age: Neuropsychological findings in institutionalized children. *Behavioural Neurology, 25*, 291–301. https://doi.org/10.3233/BEN-2012-110205.

Chugani, H., Behen, M., Muzik, O., Juhász, C., Nagy, F., & Chugani, D. (2001). Local brain functional activity following early deprivation: A study of post-institutionalized Romanian orphans. *Neuroimage, 14*(6), 1290–1301. https://doi.org/10.1006/nimg.2001.0917.

Colvert, E., Rutter, M., Kreppner, J., Beckett, C., Castle, J., Groothues, C., ... Sonuga-Barke, E. (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. https://doi.org/10.1007/s10802-008-9232-x.

Diamond, A. (2013). Executive functions. *The Annual Review of Psychology, 64*, 135–168. https://doi.org/10.1146/annurev-psych-113011-143750.

Eigsti, I., Weitzman, C., Schuh, J., de Marchena, A., & Casey, B. (2011). Language and cognitive outcomes in internationally adopted children. *Development and Psychopathology, 23*(2), 629–646. https://doi.org/10.1017/S0954579411000204.

Fray, P., Robbins, T., & Sahakian, B. J. (1996). Neuropsychiatric applications of CANTAB. *International Journal of Geriatric Psychiatry, 11*(4), 329–336 doi:AID-GPS453 > 3.0.CO;2-6.

Goldstein, S., Naglieri, J., Princiotta, D., & Otero, T. (2014). Introduction: a history of executive functioning as a theoretical and clinical construct. In S. Goldstein, & J. Naglieri (Eds.). *Handbook of executive functioning* (pp. 3–12). New York: Springer.

Greenough, W., Black, J., & Wallace, C. (1987). Experience and brain development. *Child Development, 539–559*. https://doi.org/10.2307/1130197.

Hanson, J. L., Adluru, N., Chung, M. K., Alexander, A. L., Davidson, R. J., & Pollak, S. D. (2013). Early neglect is associated with alterations in white matter integrity and

cognitive functioning. *Child Development, 84*(5), 1566–1578. https://doi.org/10.1111/cdev.12069.
Helder, E., Mulder, E., & Gunnoe, M. (2015). A longitudinal investigation of children internationally adopted at school age. *Child Neuropsychology, 22*(1), 39–64. https://doi.org/10.1080/09297049.2014.967669.
Hostinar, C., Stellern, S., Schaefer, C., Carlson, S., & Gunnar, M. (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*(2), 17208–17212. https://doi.org/10.1073/pnas.1121246109.
Hughes, C., & Ensor, R. (2009). How do families help or hinder the emergence of early executive function? *New Directions for Child and Adolescent Development, 2009*(123), 35–50. https://doi.org/10.1002/cd.234.
Juffer, F., van IJzendoorn, M., & Palacios, J. (2011). Recuperación de niños y niñas tras su adopción [Children's recovery after adoption]. *Infancia y Aprendizaje, 34*(1), 3–18. https://doi.org/10.1174/021037011794390102.
Lamm, C., Troller-Renfee, S., Zeanah, C., Nelson, C., & Fox, N. (2018). Impact of early institutionalization on attention mechanisms underlying the inhibition of a planned action. *Neuropsychologia, 117*, 339–346. https://doi.org/10.1016/j.neuropsychologia.2018.06.008.
Logan, G., & Cowan, W. (1984). On the ability to inhibit thought and action: A theory of an act of control. *Psychological Review, 91*(3), 295–327 doi:dx.doi.org/10.1037/0033-295X.91.3.295.
Loman, M., & Gunnar, M. (2010). Early experience and the development of stress reactivity and regulation in children. *Neuroscience and Biobehavioral Reviews, 34*(6), 867–876. https://doi.org/10.1016/j.neubiorev.2009.05.007.
Loman, M., Johnson, A., Westerlund, A., Pollak, S., Nelson, C., & Gunnar, M. (2013). The effect of early deprivation on executive attention in middle childhood. *Journal of Child Psychology and Psychiatry, 54*(1), 37–45. https://doi.org/10.1111/j.1469-7610.2012.02602.x.
Luciana, M., & Nelson, C. (2002). Assessment of neuropsychological function through use of the Cambridge Neuropsychological Testing Automated Battery: Performance in 4- to 12-year-old children. *Developmental Neuropsychology, 22*(3), 595–624. https://doi.org/10.1207/S15326942DN2203_3.
McCall, R. (2011). Research, practice, and policy perspectives on issues of children without permanent parental care. *Monographs of the Society for Research in Child Development, 76*(4), 223–272. https://doi.org/10.1111/j.1540-5834.2011.00634.x.
McDermott, J., Troller-Renfree, S., Vanderwert, R., Nelson, C., Zeanah, C., & Fox, N. (2013). Psychosocial deprivation, executive functions, and the emergence of socio-emotional behavior problems. *Frontiers in Human Neuroscience, 7*, 1–11. https://doi.org/10.3389/fnhum.2013.00167.
Merz, E., Harlé, K., Noble, K., & McCall, R. (2016). Executive Function in previously institutionalized children. *Child Development Perspectives, 10*(2), 105–110. https://doi.org/10.1111/cdep.12170.
Merz, E., McCall, R., Wright, A., & Luna, B. (2013). Inhibitory control and working memory in post-institutionalized children. *Journal of Abnormal Child Psychology, 41*(6), 879–890. https://doi.org/10.1007/s10802-013-9737-9.
Nelson, C., Bos, K., Gunnar, M., & Sonuga-Barke, E. (2011). The neurobiological toll of early human deprivation. *Monographs of the Society for Research in Child Development, 76*(4), 127–146. https://doi.org/10.1111/j.1540-5834.2011.00630.x.
Observatorio de la Infancia (2018). *Boletín de datos estadísticos de medidas de protección a la infancia. Boletín 20. Datos 2017. [Statistical data bulletin of child protection measures. Bulleting #20. 2017 data]*. Madrid: Ministerio de Sanidad, Consumo y Bienestar Social https://www.observatoriodelainfancia.es/ficherosoia/documentos/5655_d_BoletinProteccion20Provisional.pdf.
Oswald, S., Heil, K., & Goldbeck, L. (2010). History of maltreatment and mental health problems in foster children: A review of the literature. *Journal of Pediatric Psychology, 35*(5), 462–472. https://doi.org/10.1093/jpepsy/jsp114.
Palacios, J. (2007). Después de la adopción: Necesidades y niveles de apoyo [After adoption: Needs and support levels]. *Anuario de Psicología, 38*(2), 181–198.
Palacios, J., Román, M., Moreno, C., León, E., & Peñarrubia, M. (2014). Differential plasticity in the recovery of adopted children after early adversity. *Child Development Perspectives, 8*(3), 169–174. https://doi.org/10.1111/cdep.12083.
Pollak, S., Nelson, C., Schlaak, M., Roeber, B., Wewerka, S., Wiik, K., ... Gunnar, M. (2010). Neurodevelopmental effects of early deprivation in post-institutionalized children. *Child Development, 81*(1), 224–236. https://doi.org/10.1111/j.1467-8624.2009.01391.x.
Román, M., Palacios, J., Moreno, C., & López, A. (2012). Attachment representations in internationally adopted children. *Attachment & Human Development, 14*(6), 585–600. https://doi.org/10.1080/14616734.2012.727257.
Rutter, M. (2007). Proceeding from observed correlation to causal inference: The use of natural experiments. *Perspectives on Psychological Science, 2*(4), 377–395. https://doi.org/10.1111/j.1745-6916.2007.00050.x.
Simmonds, D., Hallquist, M., & Luna, B. (2017). Protracted development of executive and mnemonic brain systems underlying working memory in adolescence: A longitudinal fMRI study. *Neuroimage, 157*, 695–704. https://doi.org/10.1016/j.neuroimage.2017.01.016.
Sonuga-Barke, E., Kennedy, M., Kumsta, R., Knights, N., Golm, D., Rutter, M., et al. (2017). Child-to-adult neurodevelopmental and mental health trajectories after early life deprivation: the young adult follow-up of the longitudinal English and Romanian Adoptees study. *The Lancet*. https://doi.org/10.1016/S0140-6736(17)30045-4.