Biological Psychology 122 (2017) 110–120

Contents lists available at ScienceDirect

Biological Psychology

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

The beneficial effects of a positive attention bias amongst children with a history of psychosocial deprivation

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ARTICLE INFO

Article history:
Received 30 June 2015
Received in revised form 23 March 2016
Accepted 14 April 2016
Available online 21 April 2016

Keywords:
Attention bias
Institutionalization
Psychiatric risk
Social behavior
Cortisol reactivity
Early adversity
Internalizing behaviors

ABSTRACT

Children raised in institutions experience psychosocial deprivation that has detrimental influences on attention and mental health. The current study examined patterns of attention biases in children from institutions who were randomized at approximately 21.6 months to receive either a high-quality foster care intervention or care-as-usual. At age 12, children performed a dot-probe task and indices of attention bias were calculated. Additionally, children completed a social stress paradigm and cortisol reactivity was computed. Children randomized into foster care (N = 40) exhibited an attention bias toward positive stimuli but not threat, whereas children who received care-as-usual (N = 40) and a never-institutionalized comparison group (N = 47) showed no bias. Stability of foster care placement was related to positive bias, while instability of foster care placement was related to threat bias. The magnitude of the positive bias was associated with fewer internalizing problems and better coping mechanisms. Within the foster care group, positive attention bias was related to less blunted cortisol reactivity.

1. Introduction

Children abandoned and raised in institutional care experience severe psychosocial deprivation that is associated with increased risk for negative outcomes across physical, neurobiological, social, cognitive, emotional, and behavioral domains (Bakermans-Kranenburg, van Ijzendoorn, & Juffer, 2008; Nelson, Fox, & Zeanah, 2014). These adverse outcomes are thought to be related to a lack of sensitive, contingent caregiving and absence of an "expectable" environment (Nelson, 2015; Nelson et al., 2007).

Given that both cognition and social functioning are influenced by institutional care (Colvert et al., 2008; Pollak et al., 2010; Reeb, Fox, Nelson, & Zeanah, 2009), it is of great interest to identify the mechanisms underlying these outcomes. One hypothesized mechanism is visual attention biases (Troller-Renfree, McDermott, Nelson, Zeanah, & Fox, 2015). Visual attention biases act as "gate keepers," influencing which aspects of the environment enter and are processed by the visual stream (Pérez-Edgar et al., 2011). Visual attention biases are commonly measured by assessing where an individual instantaneously and preferentially allocates attention in the environment. By understanding what stimuli are entering the visual stream, we may better understand how children encode and interact with their social world. Studies have shown that attention biases are useful cognitive endophenotypes that are linked to personality traits, resilience, and vulnerability to psychopathology (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Fox, Ridgewell, & Ashwin, 2009).

Two primary patterns of attention biases have been studied: threat biases and positive biases. Each has been linked to a distinct constellation of social and emotional processing. Individuals who exhibit an attention bias to threat—reflected in faster reaction

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http://dx.doi.org/10.1016/j.biopsycho.2016.04.008
0301-0511/

times to an angry vs. neutral facial expression—exhibit higher levels of anxiety symptoms (Vasey, El-Hag, & Daleiden, 1996), social avoidance (Mogg, Philippot, & Bradley, 2004) and poor emotion regulation skills (Cisler & Koster, 2010) when compared to those without an attention bias to threat. In contrast, a bias toward positive stimuli—reflected in faster reaction times to a happy vs. neutral facial expression—is associated with increased reward sensitivity (Grafton, Ang, & MacLeod, 2012), positive affect (Grafton et al., 2012; Troller-Renfree et al., 2015), prosocial behavior (Derryberry & Reed, 1994; Troller-Renfree et al., 2015), approach behavior (Frewen, Dozois, Joanisse, & Neufeld, 2008), adaptive emotion regulation skills (Joormann & Gotlib, 2007), reduced internalizing symptoms (McCabe & Gotlib, 1995), and lower rates of anxiety (Frewen et al., 2008).

Prior research on attention biases in previously institutionalized children who were 8 years of age revealed that children who were randomized to be removed from institutional care and placed into a high-quality foster care intervention had a significantly larger attention bias towards positive stimuli as compared to children randomized to remain in institutional care (Troller-Renfree et al., 2015). The magnitude of the positive bias was related to a number of adaptive outcomes including better social engagement, more prosocial behavior, fewer signs of externalizing behavior problems, and less emotionally withdrawn behavior. Additionally, children who were randomized to remain in institutional care exhibited an attention bias towards threatening stimuli. These findings provide preliminary evidence for the role of the early caregiving environment in shaping patterns of attention biases towards valenced stimuli. However, much is still unknown about the lasting effects of early environment on attention biases, and their associations with other developmental outcomes.

While only one study has formally examined the effects of early institutionalization and intervention on attention biases, there is evidence suggesting that psychosocial deprivation may disrupt certain aspects of emotion processing. Wismer Fries and Pollak (2004) reported that internationally adopted children who spent some portion of their early years in an institution had deficits in identifying facial expressions as well as matching happy, sad, and fearful faces when compared to non-adopted controls. International adoptees, however, performed as well as non-adopted controls when asked to match angry faces, perhaps suggesting both deficits in processing positive faces and more efficient processing of threatening faces. Parker and Nelson (2005) demonstrated that children who experienced early psychosocial deprivation had enhanced neural processing when viewing fearful faces, but reduced neural amplitudes when processing happy faces when compared to non-institutionalized peers, suggesting again that negatively valenced faces may receive more attentional resources. And Tottenham et al. (2010) found that, when compared to never-institutionalized children, post-institutionalized children performed slower and less accurately on negatively valenced trials of an emotional Go/Nogo paradigm. This behavioral deficit points toward a differential processing of negatively valenced faces and suggests that threatening stimuli may require more resources for processing, thus interrupting other cognitive processes among children who experienced early psychosocial deprivation.

Of particular interest is whether the early environment has lasting effects on attention biases across development. It is not known how stable the attention biases associated with psychosocial deprivation are over time. To our knowledge, no study has assessed the stability of attention biases in children who have experienced early adversity. Indeed, few studies have even assessed whether attention biases are stable over time in typical samples (Schmukle, 2005; White et al., 2016, *in press*). This is an important limitation in the existing literature, as stability in attention biases might be a more powerful predictor of developmental outcomes than the presence of bias at a single point in time. In addition to examining the relations between attention biases and psychosocial outcomes at age 12, we also investigated whether stability of attention biases across time were associated with other key social, emotional, and physiological outcomes in previously institutionalized children.

Of additional interest is whether attention biases in previously institutionalized children are accompanied by a distinct physiological profile. Past work has suggested that attention biases may be linked to distinct patterns of arousal and patterns of physiological reactivity to stress (Fox et al., 2009; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). For instance, induced biases towards negative information appear to increase arousal, while induced biases away from negative information appear to buffer against stress-induced arousal (Mathews & MacLeod, 2002). Early life stress has also been shown to negatively impact physiological reactivity to stress in both animals and humans (Gunnar, Frenn, Wewerka, & Van Ryzin, 2009; Kessler, Chiu, Demler, & Walters, 2005; Liu et al., 1997; McLaughlin et al., 2015; Meyer, Novak, Bowman, & Harlow, 1975). Specifically, previously institutionalized children tend to show blunted or less reactive stress reactivity (Gunnar & Vazquez, 2001; McLaughlin et al., 2015). Blunted profiles of stress reactivity have been related to a myriad of negative physical and mental health outcomes such as immunosuppression, poor mental health, risk for alcoholism, poor antibody response, autoimmune diseases, obesity, and poor emotional regulation (Carroll, Phillips, & Lovallo, 2012; Jansen et al., 1998; Lovallo, 2011; Segerstrom & Miller, 2004). Furthermore, there is evidence suggesting that stress-induced cortisol reactivity is associated with selective attention to emotional stimuli (Ellenbogen, Schwartzman, Stewart, & Walker, 2002). A study by Ellenbogen and colleagues (2002) demonstrated that participants who were exposed to an aversive stressor (repeatedly losing a game against a confederate) elicited a rapid disengagement of attention from negatively valenced words (as measured by a spatial cuing task). These shifts of attention away from negative stimuli were associated with increased negative affect and lower cortisol levels during the recovery phase of the experiment, suggesting that disengagement from negative stimuli affect may regulate emotional and physiological arousal. Given these findings, it is of interest to determine whether attention biases may alter or serve as an index of stress reactivity in children who have experienced early adversity. No previous study has examined whether attention biases predict distinct patterns of physiological reactivity to stress in either child or adult samples of previously institutionalized participants. Additionally, to our knowledge, the relations between positive attention biases and physiological measures of stress reactivity have not been investigated at any age in normative or institutionalized populations.

Consistent with previous research (Troller-Renfree et al., 2015), we hypothesized that at age 12 previously institutionalized children would show an attention bias towards threat, while children who received a foster care intervention would exhibit an attention bias towards positive stimuli. Consistent with prior findings, we predicted that positive attention biases would be larger in the foster care intervention group than the group assigned to remain in institutionalized care with the magnitude of positive biases being associated with a multitude of positive outcomes. We also predicted that at age 12 positive biases would predict less blunted (similar to never institutionalized children's reactivity) physiological reactivity to stress in children who received the foster care intervention. In addition, we predicted that children who had stable foster care placement would have larger positive biases than children who had unstable foster care placement. Finally, we conducted exploratory analyses to investigate whether a stable positive bias across ages 8 and 12 is associated with positive outcomes and length of stay in foster care.

2. Methods

2.1. Participants

The sample was comprised of 136 children, abandoned in infancy and placed into institutions in Bucharest, Romania, and who were part of the Bucharest Early Intervention Project (BEIP; see Fig. 1 for CONSORT diagram). Children enrolled in BEIP were assessed comprehensively before the age of 30 months and subsequently randomized to either receive care as usual (CAUG) or a high quality foster care intervention (FCG). At 12 years, 49 CAUG children (22 female), 49 FCG children (23 female) completed a behavioral dot-probe task to assess attention biases. Attention biases were previously assessed at age 8 years (see Troller-Renfree et al., 2015), but not at any other ages. Additionally, a sample of 48 (26 female) age-matched community-reared children who had never been institutionalized (NIG), were recruited for comparison. Of the 48 NIG participants included in the present study, 25 were recruited from pediatric clinics in Bucharest and 23 were recruited from schools within the Bucharest city limits. The mean age of test was 12.61 years (SD = 0.58) for the CAUG, 12.63 years (SD = 0.53) for the FCG, and 12.68 (SD = 0.39) years for the NIG. By age 12, only 34.5% of the CAUG were still placed in institutional care, with the others placed into government foster care, reunited with their biological family, or adopted. Although many of the institutionalized children at age 12 were no longer in their original randomized placement, the data reported in the present paper use an intent-to-treat approach such that data are analyzed using a child's initial placement group. The intent-to-treat approach allows for the direct assessment of the BEIP randomized clinical trial by comparing the intervention group and the care-as-usual group.

Consistent with previous papers examining foster care stability (Humphreys et al., 2015), children in the FCG who completed the attention bias assessment and had usable data (N = 40) were coded to be in either the Stable or Unstable placement groups. Children were coded into the Stable group if they had continuously remained in the care of their BEIP foster caregiver (N = 21). Children were coded into the Unstable group if they had changed caregivers at least once since their initial placement (N = 18). One FCG participant was not coded into the stable or unstable group due to immediate reintegration with the child's biological family before placement into foster care, and therefore, was not included in any stability analyses. A similar stability approach is not possible in the CAUG given that caregiving transitions (e.g. government foster care, reunion with biological family) were common. In fact, only 3 CAUG participants had both usable dot-probe data and stable placement in institutional care. Percentage of time spent in institutional care was computed by dividing the number of days a child spent in the institution by each child's age in days at the 12 year assessment. Finally, a variable was created reflecting the percentage of time a child had spent in foster care. Two kinds of foster care were combined in the creation of this variable: BEIP foster care and government foster care. BEIP foster care was created as part of the BEIP project and was employed as a high-quality, child-centered intervention and lasted until children were 54 months of age (Smyke, Zeanah, Fox, & Nelson, 2009). Following the conclusion of the BEIP foster care intervention, the BEIP foster care network was turned over to local government entities. Government sponsored foster care did not exist at the genesis of BEIP (Nelson et al., 2014; Tibu, Humphreys, Fox, Nelson, & Zeanah, 2014), but has steadily grown since the inception of the BEIP project. BEIP and Government foster care did differ in quality (Tibu et al., 2014). However, children in the CAUG who were placed into government foster care still benefited from leaving the institution and being placed into a family. We computed the percentage of time spent in foster care for both CAUG and FCG by dividing the number days a child spent in foster care (government or BEIP) by the child's age in days at the 12 year assessment. Partial results from this sample have been reported in two previous publications examining attention biases at age 8 (Troller-Renfree et al., 2015) and cortisol response to stress at age 12 (McLaughlin et al., 2015).[1]

The University Institutional Review Boards of the principal investigators (Fox, Nelson & Zeanah) and the University of Bucharest, Romania approved the study protocol. Consent for participation of institutionalized children was provided by the local Commission on Child Protection for each child participant who lived in their sector of Bucharest.

2.2. Measures and procedures

2.2.1. Dot-probe task

The dot-probe task (Bradley et al., 1999; Mogg, Bradley, de Bono, & Painter, 1997) measures attention biases towards valenced stimuli by assessing children's ability to respond to the location of a stimulus when preceded by a pair of emotional faces (see Fig. 2). Trials began with the presentation of a central fixation cross (+) for 500 ms, followed by the presentation of an emotional face pair for 500 ms. Immediately after the presentation of the face pair, the probe was presented behind one of the images on either the left or right side of the screen (50% probability) directly behind the face until a response was logged or until the max time of 1200 ms was reached. The inter-trial interval was 100 ms. Children were required to respond within 1200 ms of the presentation of the probe. Participants were instructed to respond as quickly and correctly as possible to indicate the orientation of a horizontal or vertical probe.

Emotional face pairs presented were neutral–neutral, happy–neutral, or angry–neutral. Expressions were portrayed by 6 different actors (50% male) taken from the NimStim stimulus set (Tottenham et al., 2009). Prior to the task, a practice block of 12 trials (four happy–neutral, four angry–neutral, four neutral–neutral) was presented to familiarize children with the stimuli and button box. The test trials consisted of 96 trials of each emotion pair (happy–neutral, angry–neutral and neutral–neutral) for a total of 288 test trials presented in a pseudo-random order across three test blocks of 96 trials. Trials were congruent if the probe appeared in the same location as the emotion face (angry or happy) and incongruent if it appeared behind the neutral face.

Stimulus presentation was controlled by computer software (Eprime version 2.0 from Psychology Software Tools, Inc., Sharpsburg, PA). Measures of response time and response accuracy per trial were directly recorded by Eprime program software. Data were subsequently cleaned and both threat and positive biases were calculated using the TAU/NIMH Toolbox (Abend, Pine, & Bar-Haim, 2014; toolbox information available at http://people.socsci.tau.ac.il/mu/anxietytrauma/research/). The TAU/NIMH toolbox removes trials with reaction times shorter than 150 ms or in which an incorrect response was made. In addition, z-scores were calculated by trial type and responses with z-scores greater than |2.5| were removed. After cleaning, reaction times from the happy–neutral and angry–neutral trials were used to create threat and positive attention bias scores.

Consistent with our previous work (Troller-Renfree et al., 2015), bias scores were calculated by subtracting reaction times for trials in which the probe appeared in the location of the emotion face

[1] Participant overlap with stress reactivity measures (McLaughlin et al., 2015) is approximately 90% dot-probe and cortisol data, 1% cortisol data only, and 9% with dot-probe data only. Participant overlap with dot-probe measures at age 8 (Troller-Renfree et al., 2015) is approximately 66% completed 8- and 12-year dot-probe, 20% completed only 8-year dot-probe, and 14% completed only 12-year dot-probe.

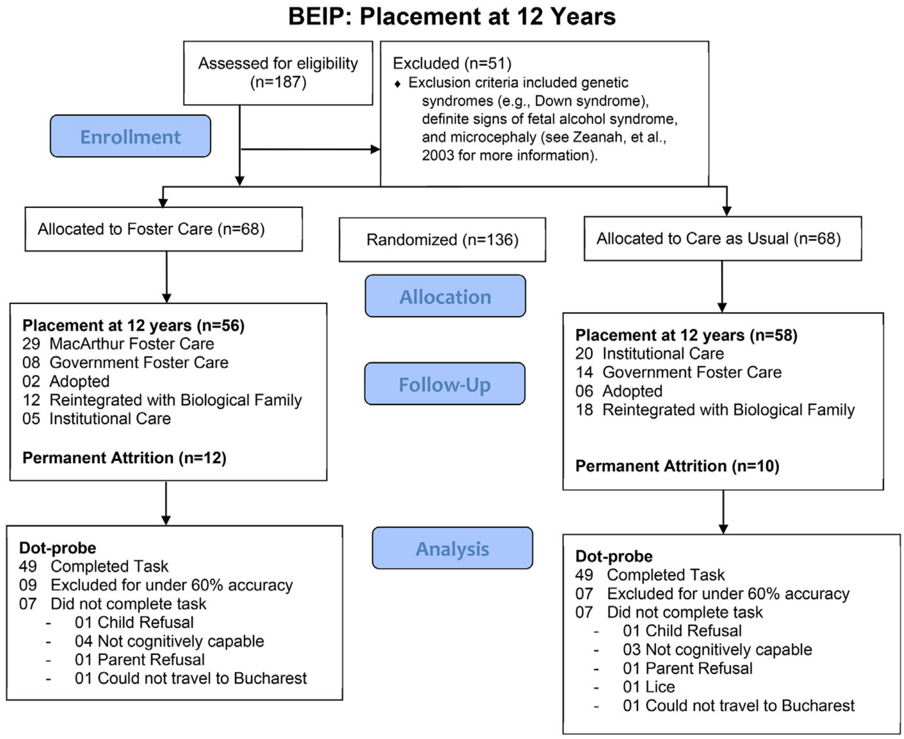

Fig. 1. CONSORT diagram of BEIP sample.

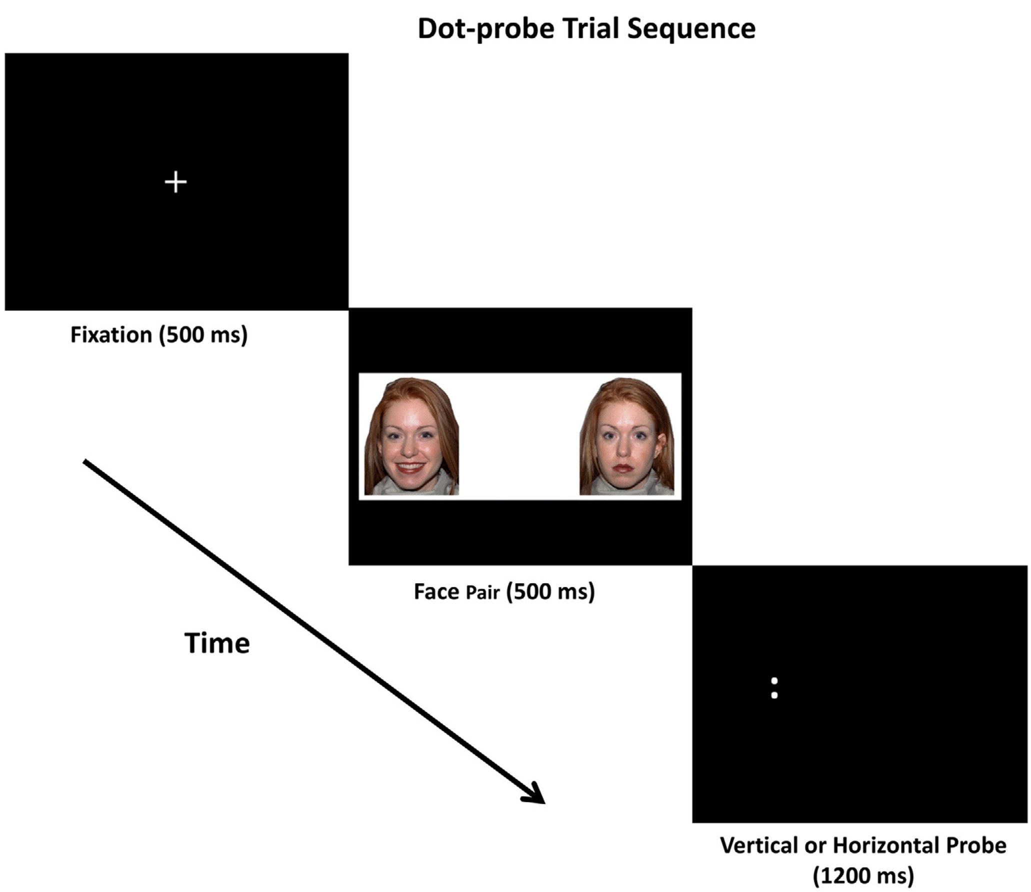

Fig. 2. Dot-probe task.

(i.e. congruent trials) from reaction times on trials in which the probe appeared behind the neutral face (incongruent trials). Positive scores indicate a bias towards threat or positive stimuli, while negative scores indicate a bias away from threat or positive stimuli. A score of 0 indicates that no bias was exhibited.

Finally, to assess the stability of attention biases to threatening and positive stimuli over time, a composite score was created by computing a mean threat (threat bias at 8 years and threat bias at 12 years) and positive (happy bias at 8 years and happy bias at 12 years) bias score from bias scores at the 8 and 12 year assessment points (for more information on 8 year bias computation see Troller-Renfree et al., 2015). Positive composite scores indicate a consistent bias towards threat or happy, while negative bias scores indicate a consistent bias away from threat or happy.

2.2.2. Health and behavior questionnaire (HBQ, MacArthur)

The HBQ was completed separately by each participant's primary caregiver and their teachers at the 12-year assessment. For the present paper, two behavioral subscales of the HBQ were examined: internalizing behaviors and externalizing behaviors. The internalizing scale comprises items related to depression and overanxious behaviors. The externalizing scale comprises measures of oppositional defiance, conduct problems, overt hostility, and relational aggression. Additionally, given our specific hypothesis that attention biases would have unique relationships with anxiety and prosocial behavior (Frewen et al., 2008; Troller-Renfree et al., 2015; Vasey et al., 1996), we included the overanxious and prosocial subscales.

2.2.3. Self-report coping scale (SRC)

The SRC was completed at the 12-year assessment by each participant in response to a hypothetical academic and social stressor (Causey & Dubow, 1992). For each scenario, children responded to 34 items, which were subsequently collapsed into five coping strategy subscales: Seeking Social Support, Problem Solving, Distancing, Internalizing, and Externalizing. The Seeking Social Support composite consists of items such as seeking out friends for advice, getting help from a family member, and talking to a teacher. Problem Solving composite consists of items such as thinking of different ways to solve the problem and trying to understand why the event happened. The Distancing composite consists of items such as make believing nothing happened and forgetting the event. The Internalizing subscale consists of behaviors reflective of internalizing the issue such as going off by oneself, crying, and worrying. Finally, the externalizing subscale consists of items such as taking the problem out on others, yelling, and throwing or hitting items.

2.2.4. Peer Evaluation Task

As previously reported, participants from the present paper also completed a peer evaluation task during a separate laboratory visit at age 12 years (for more information see McLaughlin et al., 2015). The peer evaluation task was adapted from a previously-validated task used with children as young as age 4 years (Howarth, Guyer, & Pérez-Edgar, 2013). In a study visit prior to the physiological reactivity session, participants were told that they would be playing a game to learn how children choose friends in the next study visit. They were then presented with 30 photographs of children along with brief profiles of each child including three pieces of information: favorite sport, favorite food, and favorite music/band/singer. Participants were told that they would have an opportunity to meet one of the other children in a subsequent visit, and were asked to select the 10 children that they were most interested in meeting. Next, participants had their picture taken and provided information on their favorite sport, food, and music/band/singer for their profile. They were told that the other children participating in the study would view their picture and profile and decide if they wanted to meet the participant.

During the test session on a subsequent day, participants were told that each of the 30 children they had previously rated had also seen the participant's photo and profile and decided whether they wanted to meet the participant. Participants were then told that they would learn which of these children wanted to meet them. Trained experimenters delivered feedback about how the participants were ostensibly rated by other children in several phases. The photos of the 30 other children were arranged one two boards, one green and one red. The 10 photos of children that the participant wanted to meet were placed on the green board, and the 20 photos of children the participant did not want to meet were placed on the red board. Children were told that each photo would be moved to a set of two new boards, one green and one red. Photos moved to the green board were children who wanted to meet the participant; photos moved to the red board were children who did not want to meet the participant.

First, the experimenter delivered feedback about 5 of the 10 children the participant wanted to meet. Each of these photos were moved to the red board, indicating that these children did not want to meet the participant. Next, the experimenter delivered feedback about 10 of the 20 children the participant did not want to meet. Half of the photos were moved to the green board, and half were moved to the red board. These two rounds were then repeated for the remaining 5 children the participant wanted to meet, followed by the remaining 10 children the participant did not want to meet. Throughout the feedback phase, evaluators viewed a piece of paper on a clipboard before moving each photo to appear as though they were reading the responses of each of the 30 children who had ostensibly rated the participant. After completing the task, participants rated how stressful they found the peer task on a scale of 1 (not very stressful) to 3 (very stressful). On average ($M = 1.33$, $SD = 0.596$), participants rated the task significantly more stressful than "not very stressful," $t(135) = 6.350$, $p < 0.001$.

2.2.5. Cortisol reactivity to peer evaluation

Participants provided a saliva sample during a baseline resting period prior to beginning the peer evaluation task and a second sample approximately 15 min after the task was finished. All participants completed the tasks at roughly the same time of day. The exact collection times were recorded for both the baseline and peer task collections (missing collection time: $n = 3$). On average, the baseline sample was collected at 1:39 pm ($SD = 42$ min) and peer evaluation task sample was collected at 2:31 pm ($SD = 43$ min). Saliva samples were obtained with cryovial tubes (Immuno-Biological Laboratories [IBL]) using the drool method. Participants expectorated approximately 1.5 ml of saliva into a cryovial with a plastic straw. Saliva samples were stored immediately at $-20\,^{\circ}C$ until they were shipped on dry ice to a laboratory in Boston, MA. Samples were assayed for cortisol using commercially available luminescence immunoassay kits (CLIA; IBL, Hamburg, Germany). Intra-assay (5.11%) and inter-assay (5.37%) coefficients of variance were acceptable. Cortisol values were skewed and were log-transformed prior to analysis.

2.3. Participant inclusion

Consistent with previous work, children who had less than 60% accuracy on the dot-probe task (Troller-Renfree et al., 2015) were excluded from analysis (7CAUG, 9 FCG, 1 NIG). Neither threat ($t(143) = -0.335$, $p = 0.727$) nor positive ($t(143) = -0.384$, $p = 0.706$) bias magnitude differed between included and excluded participants. The final sample for behavioral analysis included 42 (20 female) CAUG children, 40 (19 female) FCG children and 47 (26 female) NIG children. An additional thirty-four participants (13

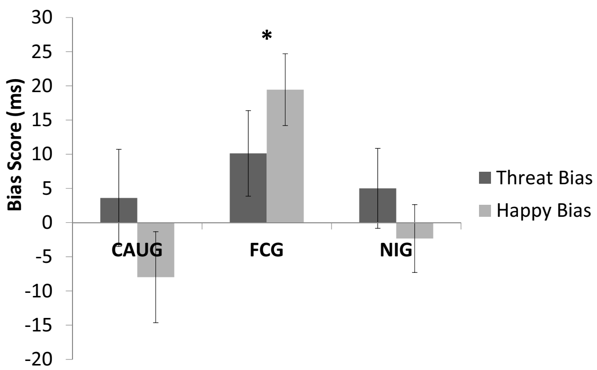

Fig. 3. Bias scores by group.

CAUG, 8 FCG, 13 NIG) were excluded from all analyses using the HBQ due to teacher non-response. Both threat ($t(127) = -0.799$, $p = 0.426$) and happy ($t(127) = 0.083$, $p = .934$) bias scores did not differ between children included and excluded based on teacher report. One CAUG participant was excluded from parent HBQ analyses due to incomplete parent response. An additional two participants (both CAUG) were excluded from all analyses using the SRC due to missing data.

For inclusion in stability analyses, participants must have had completed the dot-probe with at least 60% accuracy at both 8 and 12 years of age (32 CAUG, 35 FCG).

2.4. Data analytic plan

Data were analyzed in six steps: first, following an "intent to treat approach" analyses were conducted with the two randomized groups (CAUG, FCG) examining the size and direction of attention biases at 12 years of age. Second, attention biases at 12 were related to social outcomes. Third, attention biases were related to physiological reactivity. Fourth, group differences in attention biases were related to foster care stability. Fifth, attention biases were examined in a never-institutionalized community sample. Finally, stability of attention biases over time were investigated.

For the comparison of randomized control groups, a 2 Group (CAUG, FCG) by 2 Bias (Threat, Positive) repeated-measures ANOVA was conducted. This omnibus model was subsequently followed-up by two one-way ANOVAs with Group (CAUG, FCG) as a between-subjects variable to assess threat and positive biases separately. Finally, one-sample *t*-tests were conducted for each group to investigate whether positive and threat biases differed from zero within each group.

To examine the relations between attention biases and social outcomes series of bivariate correlations were conducted. Both positive and threat biases from were correlated with measures from the HBQ and SCR.

To examine whether attention biases were associated with cortisol reactivity linear regressions were conducted in Mplus (Muthen & Muthen, 1998-2007) in order to account for missing data. Regressions were conducted for the entire previously institutionalized sample and separately for each group. All regressions controlled for baseline cortisol levels.

Two separate analyses were conducted to examine whether foster care stability impacts patterns of attention biases. First, one-way ANOVAs were conducted separately for both positive and threat biases with Group (CAUG, Unstable, Stable) as a between-subjects variable. Next, one-sample *t*-tests were conducted for each group (CAUG, Unstable, Stable) to determine whether each group had biases significantly different from zero.

To determine whether attention biases were present in a never-institutionalized community sample, two one-sample *t*-tests were conducted to determine if positive or threat bias scores differed from zero. Next, bivariate correlations were conducted to relate attention biases to social outcomes and a linear regression was conducted to examine whether attention biases predicted cortisol reactivity.

Finally, the stability of attention biases over time was investigated by a 2 Group (CAUG, FCG) by 2 Bias (Threat, Positive) repeated measures ANOVA. Next, one-sample *t*-tests were conducted for each group to investigate whether the composite stability bias score was significantly different from zero. Bivariate correlations were conducted to investigate the relations between bias stability and age 12 socio-emotional outcomes. Two linear regressions were conducted to investigate predictors of threat and positive bias stability.

3. Results

3.1. Descriptive statistics

Table 1 presents the means and standard deviations for the measures of interest for all groups.

3.2. Attention biases at age 12 based on group randomization

In order to examine whether there were differences between the FCG and CAUG groups in their biases toward threatening and positive stimuli, a 2 Group (CAUG, FCG) by 2 Bias (Threat, Positive) repeated-measures ANOVA was conducted. There was not a significant main effect of bias ($F(1, 80) = 0.036$, $p = .850$, $\eta^2 < 0.001$). A main effect of group emerged ($F(1, 80) = 6.301$, $p = 0.014$, $\eta^2 = 0.073$). Post-hoc test revealed that the FCG ($M = 14.79$, $SE = 4.84$) showed a larger bias than the CAUG ($M = -2.19$, $SE = 4.72$). The main effect of group was qualified by a marginally significant group by bias interaction ($F(1, 80) = 3.052$. $p = 0.084$, $\eta^2 = 0.037$). Given our a priori hypotheses that there would be between-group differences in magnitude of threat and positive biases, follow-up analyses were conducted for each bias individually in order to probe the marginal group by bias interaction.

To illuminate the relations between group assignment and both positive and threat biases, FCG children were compared to the CAUG children using a one-way ANOVA with Group (CAUG, FCG) as a between subjects variable. Separate analyses were conducted for threat and positive biases. Results indicated that the FCG ($M = 19.45$, $SD = 33.19$) had a significantly larger bias towards positive faces ($F(1, 80) = 10.345$, $p = 0.002$, $\eta^2 = 0.11$) when compared to the CAUG ($M = -7.98$, $SD = 43.13$). There was no significant difference between the CAUG and FCG for the threat bias ($F(1, 80) = 0.470$, $p = 0.495$, $\eta^2 = 0.006$).

To examine whether individual groups displayed significant attention bias patterns, separate one-sample *t*-tests were conducted for each group to determine whether attention biases to both positive and negative faces were significantly different from zero (no bias; see Fig. 3). For the CAUG, analyses revealed no significant biases towards threatening ($t(41) = 0.508$, $p = 0.614$, $d = 0.08$) or positive faces ($t(41) = -1.199$, $p = 0.237$, $d = 0.19$). Within the FCG, analyses revealed a significant bias towards positive ($t(39) = 3.706$, $p = 0.001$, $d = 0.59$) and no significant threat bias ($t(39) = 1.618$, $p = 0.114$, $d = 0.25$).

3.3. Attention bias and social outcomes

To examine whether the magnitude of positive bias was associated with adaptive social outcomes, bias scores from the total sample of previously institutionalized children were correlated

Table 1
Demographics, descriptive statistics, and accuracy by placement group. Means and standard deviations in parentheses.

	CAUG	FCG	NIG	Group Differences
Age	12.63 (0.59)	12.67 (0.55)	12.68 (0.40)	
Gender (% Female)	47.6	47.95	55.3	
Age of placement into Inst. (months)	2.8 (4.13)	2.79 (3.77)	–	
Time in Institutional Care (%)	44.5 (28.27)	14.51 (7.85)	–	CAUG > FCG
Time in Foster Care (%)	28.37 (32.61)	70.89 (25.59)	–	CAUG < FCG
Overall Accuracy (%)	78.69 (8.47)	77.60 (9.69)	81.58 (8.05)	
Threat-Neutral Accuracy (%)	78.21 (9.39)	76.69 (9.15)	80.60 (8.81)	
Happy-Neutral Accuracy (%)	79.23 (9.84)	78.28 (9.48)	81.78 (9.65)	
Neutral–Neutral Accuracy (%)	78.61 (8.42)	77.36 (11.27)	81.42 (8.57)	
Internalizing (HBQ Teacher)	0.48 (0.33)	0.43 (0.29)	0.24 (0.27)	NIG < CAUG & FCG
Externalizing (HBQ Teacher)	0.44 (0.44)	0.45 (0.45)	0.11 (0.20)	CAUG & FCG > NIG
Overanxious (HBQ Teacher)	0.52 (0.37)	0.43 (0.28)	0.35 (0.34)	
Prosocial (HBQ Teacher)	1.06 (0.55)	1.28 (0.61)	1.54 (0.48)	CAUG < NIG
Internalizing (HBQ Parent)	0.43 (0.29)	0.36 (0.26)	0.29 (0.22)	CAUG > NIG
Externalizing (HBQ Parent)	0.50 (0.41)	0.30 (0.32)	0.14 (0.13)	CAUG > FCG & NIG
Overanxious (HBQ Parent)	0.44 (0.27)	0.38 (0.27)	0.37 (0.24)	
Prosocial (HBQ Parent)	1.42 (0.45)	1.61 (0.32)	1.74 (0.24)	CAUG < FCG & NIG
Seeking Social Support (SRC-Academic)	0.71 (0.24)	0.78 (0.26)	0.76 (0.25)	
Self-reliance/Problem Solving (SRC-Academic)	0.75 (0.25)	0.84 (0.19)	0.77 (0.23)	
Distancing (SRC-Academic)	0.34 (0.31)	0.25 (0.24)	0.26 (0.26)	
Internalizing (SRC-Academic)	0.42 (0.21)	0.40 (0.22)	0.39 (0.22)	
Externalizing (SRC-Academic)	0.12 (0.23)	0.06 (0.16)	0.06 (0.11)	
Seeking Social Support (SRC-Social)	0.62 (0.27)	0.75 (0.29)	0.67 (0.25)	
Self-reliance/Problem Solving (SRC-Social)	0.80 (0.26)	0.87 (0.16)	0.81 (0.22)	
Distancing (SRC-Social)	0.35 (0.30)	0.22 (0.24)	0.17 (0.20)	NIG < CAUG
Internalizing (SRC-Social)	0.41 (0.21)	0.30 (0.23)	0.28 (0.21)	NIG < CAUG
Externalizing (SRC-Social)	0.12 (0.23)	0.07 (0.18)	0.06 (0.15)	
Cortisol levels at Baseline ($\log_e$)	1.84 (0.47)	1.66 (0.59)	1.76 (0.56)	
Cortisol levels following peer task ($\log_e$)	1.97 (0.51)	1.93 (0.63)	2.29 (0.56)	CAUG & FCG < NIG

with measures from the HBQ and SRC collected at the 12 year assessment. Results for the HBQ indicate that a positive bias was correlated with fewer internalizing problems ($r(59) = -0.281$, $p = 0.028$) and overanxious behaviors ($r(59) = -0.281$, $p = 0.028$) as reported by each child's primary teacher as well as more prosocial behavior ($r(79) = -0.241$, $p = 0.030$) and marginally less externalizing problems ($r(79) = -0.203$, $p = 0.069$) as reported by each child's primary caregiver. Positive biases were not significantly related to teacher report of externalizing problems and prosocial behavior or parent report of internalizing problems and overanxious behavior. Results for the relation between attention biases and the SRC indicate higher likelihood of seeking social support in response to an academic stressor ($r(78) = 0.259$, $p = 0.020$), more self-reliance and problem solving ($r(78) = 0.230$, $p = 0.040$) in response to an academic stressor, and less distancing in response to both social ($r(78) = -0.337$, $p = 0.002$) and academic ($r(78) = -0.266$, $p = 0.017$) stressors. Positive biases were unrelated to internalizing and externalizing coping strategies for both social and academic stressors as well as seeking social support and problem solving for social stressors. The magnitude of threat bias was unrelated to all outcomes.

3.4. Attention bias and physiological reactivity to stress

To examine whether attention biases in the CAUG and FCG are accompanied with differential patterns of cortisol reactivity under stress, a series of linear regression were conducted. First, analyses were conducted across the entire sample, which revealed that neither threat ($\beta = 0.02$, $t(80) = 2.00$, $p = 0.110$) nor happy biases ($\beta < 0.001$, $t(80) = 0.4$, $p = 0.647$) were associated with cortisol reactivity. Next, analyses were conducted separately for each group given that both patterns of attention biases and cortisol reactivity differed as a function of group. Results for the FCG indicated that positive biases predicted a less blunted (more reactive) cortisol response during a social stress task ($\beta = 0.03$, $t(39) = 1.958$, $p = 0.050$) and threat biases were marginally related to cortisol reactivity ($\beta = 0.03$, $t(39) = 1.821$, $p = 0.069$). In the CAUG positive ($\beta = 0.001$, $t(40) = 0.384$, $p = 0.701$) and threat ($\beta = 0.001$, $t(40) = 0.873$, $p = 0.383$) biases were not related to cortisol reactivity.[2] It is important to note, given our modest sample size, that there was insufficient power to detect group differences with small to medium-small effect sizes. As such, these exploratory results should be interpreted with caution.

3.5. Foster care stability

To examine whether stability of foster care placement influenced the development of attention biases, intent-to-treat was set aside in order to compare FCG children who had stable foster care placement (Stable group) and children who had unstable foster care placements (Unstable group) to those children in the CAUG. To illuminate the relations between caregiving stability and both positive and threat biases, a one-way ANOVA was conducted with Group (CAUG, Unstable, Stable) as a between subjects variable. Results indicated no group differences in threat biases ($F(2, 78) = 1.009$, $p = .369$, $\eta^2 = 0.025$) but significant group differences in positive biases ($F(2, 78) = 5.386$, $p = 0.006$, $\eta^2 = 0.121$). Bonferroni corrected post-hoc tests indicated that the Stable FCG ($M = 24.24$, $SD = 34.34$) had a significantly larger bias towards positive when compared to the CAUG ($M = -7.98$, $SD = 43.13$). No other group differences were revealed.

To examine whether each the two FCG groups (Stable FCG, Unstable FCG) displayed differential attention bias patterns, separate one-sample t-tests were conducted for each group to determine whether attention biases to both positive and negative

[2] Separate moderation analyses were conducted to examine whether attention biases moderated the relation between group and cortisol reactivity. These models failed to reach significance, which was not unexpected given that a sensitivity analysis revealed that these analyses did not have sufficient power to detect medium-small to small effect sizes.

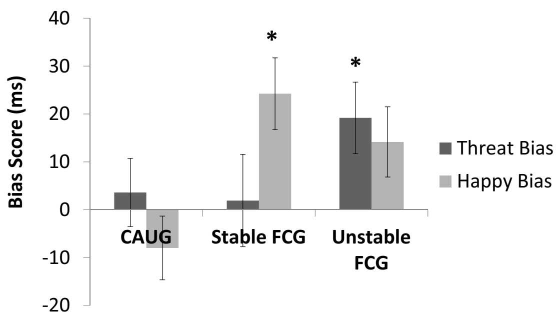

Fig. 4. Bias scores by caregiving stability.

faces were significantly different from zero (see Fig. 4). Children in the Unstable FCG group showed a bias towards threatening faces ($t(17) = 2.452$, $p = 0.025$, $d = 0.58$) and an insignificant positive bias ($t(17) = 1.818$, $p = 0.087$, $d = 0.43$). Within the Stable FCG, analyses revealed a significant bias towards positive ($t(20) = 3.234$, $p = 0.004$, $d = 0.71$) and no significant threat bias ($t(20) = .199$, $p = 0.844$, $d = 0.04$).

3.6. Attention biases in the community sample

In order to examine whether the NIG children exhibited an attention bias, a one-sample *t*-test was conducted to determine whether attention biases to both positive and threat faces were significantly different from zero. The NIG did not have a significant positive ($t(46) = -0.470$, $p = 0.641$, $d = 0.07$) or threat bias ($t(46) = 0.857$, $p = 0.396$, $d = 0.12$). The lack of bias in the NIG is typical for non-anxious and non-selected populations (Bar-Haim et al., 2007).

To examine whether either positive or threat bias magnitude are associated with social outcomes, bias scores from the NIG were correlated with measures from the HBQ and SRC collected at the 12 year assessment. Results indicate that a bias away from threat was correlated with overanxious behaviors ($r(45) = -0.290$, $p = 0.048$) as reported by each child's primary caregiver. Threat biases were not correlated with internalizing, externalizing, or prosocial behaviors as reported by parent or teacher nor overanxious behaviors as reported by teachers. Positive biases were not significantly related to overanxious, prosocial, internalizing, or externalizing behaviors as reported by parent and teacher. Results for the relation between attention biases and the SRC indicated higher likelihood of externalizing coping strategies in response to a social stressor with a bias away from threat ($r(45) = -0.357$, $p = 0.014$). Threat biases were not significantly related to internalizing, seeking social support, self-reliance, and distancing in both academic and social stressors as well as externalizing coping strategies during academic stressors. Positive biases were unrelated to all SRC scales.

Finally, to examine whether attention biases in the NIG are accompanied with differential patterns of cortisol reactivity under stress, a series of linear regression were conducted. Results revealed that both positive ($\beta < 0.001$, $t(45) = 0.36$, $p = 0.807$) and threat ($\beta = -0.001$, $t(45) = -0.826$, $p = 0.409$) biases were not significantly related to patterns of cortisol reactivity.

3.7. Stability of attention biases

To examine whether bias magnitude varied by assessment age, a 2 Group (CAUG, FCG) by 2 Bias (Threat, Positive) by 2 Time (8 Years, 12 Years) repeated-measures ANOVA was conducted. Results revealed a non-significant main effect of time point ($F(1, 65) = 1.740$, $p = 0.192$, $\eta^2 = 0.026$), a non-significant time by group interaction ($F(1, 65) = 0.058$, $p = 0.810$, $\eta^2 = 0.001$), a non-significant time by bias interaction ($F(1, 65) = 2.077$, $p = 0.154$, $\eta^2 = 0.031$), and a non-significant group by bias by time interaction ($F(1, 65) = 0.121$, $p = 0.729$, $\eta^2 = 0.002$). Given that time did not significantly impact bias magnitude, time was collapsed across for all additional analyses. The newly created bias variables collapsing across time points will be henceforth referred to as a bias stability variable.

In order to explore group differences in size and stability of attention bias, a 2 Group (CAUG, FCG) by 2 Bias (Threat, Positive) repeated-measures ANOVA was conducted with an 8 and 12 year bias composite as a dependent variable. There was not a significant main effect of bias ($F(1, 65) = 1.700$, $p = 0.197$, $\eta^2 = 0.025$). A main effect of group emerged ($F(1, 65) = 5.897$, $p = 0.018$, $\eta^2 = 0.083$), which was qualified by a significant group by bias interaction ($F(1, 65) = 7.699$. $p = 0.007$, $\eta^2 = 0.106$). Follow-up analyses with bonferroni correction revealed that the FCG (M = 20.17, SD = 23.14) had a significantly larger positive bias than the CAUG (M = −10.62, SD = 42.98; $F(1, 65) = 13.657$, $p < .001$), but the two groups did not differ in their threat bias (CAUG: M = 13.43, SD = 33.04; FCG: M = 11.50, SD = 35.59; $F(1, 65) = .052$, $p = 0.820$). Additionally, within the CAUG, their threat bias was significantly larger than their positive bias ($F(1, 65) = 7.961$. $p = 0.006$). There was no difference in bias magnitude within the FCG ($F(1, 65) = 1.132$ $p = 0.291$).

To examine whether individual groups displayed consistent attention bias patterns, one-sample *t*-tests were conducted for each group using a composite positive and threat bias scores (8 and 12 years). For the CAUG, analyses revealed a significant bias towards threatening ($t(31) = 2.299$, $p = 0.028$, $d = 0.41$), but no bias for positive faces ($t(31) = -1.398$, $p = 0.172$, $d = 0.25$). Within the FCG, analyses revealed a significant bias towards positive ($t(34) = 5.157$, $p < 0.001$, $d = 0.87$) and a marginally significant threat bias ($t(34) = 1.912$, $p = 0.064$, $d = 0.31$). For comparison, the NIG did not show a stable bias for happy ($t(30) = -0.638$, $p = 0.528$, $d = .11$) or threatening faces ($t(30) = -0.054$, $p = 0.957$, $d < 0.01$).

To examine whether stability of bias was associated with adaptive social outcomes positive and threat composites were correlated with measures from the HBQ and SRC. Results indicated that a consistent positive bias was associated with more prosocial behavior ($r(64) = 0.263$, $p = 0.033$) and fewer externalizing problems ($r(64) = -0.327$, $p = 0.007$) as reported by each child's primary caregiver. Additionally, a consistent positive bias was associated with less distancing in social situations ($r(63) = -0.273$, $p = 0.028$). No other measures reached significance. A stable threat bias was not associated with any of the measures on the HBQ and SCR.

Finally, two linear regressions were conducted in order to determine whether consistent happy and threat biases could be predicted by time spent in the institution or foster care. Results indicated that a high, consistent happy bias was significantly predicted by percentage of time in foster care ($\beta = .371$, $t(65) = 2.585$, $p = 0.012$), but not predicted by percentage of time in institutional care ($\beta = -0.037$, $t(65) = -0.408$, $p = .685$; Model $R^2 = 0.124$). While a bias towards threat was significantly predicted by percentage of time spent in institutional care ($\beta = 0.354$, $t(65) = 2.415$, $p = 0.019$), but not by percentage of time spent in foster care ($\beta = 0.138$, $t(65) = 0.938$, $p = 0.352$; Model $R^2 = 0.088$).

4. Discussion

Findings from the present study provide important insights into the impact of psychosocial deprivation on attention biases and the social and physiological patterns that accompany these attention biases. First, at age 12, we replicated previous findings at age 8 suggesting that children randomized to be removed from institutional care and placed into foster care exhibited a bias towards positive stimuli. Positive biases were related to a number of positive outcomes including fewer internalizing problems, reduced anxiety, and better coping strategies. Additionally at age 12, among children who received the foster care intervention, positive biases were related to less blunted (or more reactive) cortisol reactivity during a social stressor, which may indicate stress responses more similar to the NIG. Finally, foster care stability was linked to a significant positive bias while foster care instability was related to a significant threat bias. Consistent with past results, the community population did not exhibit any bias.

A major strength of the present study is the replication of past results showing that children who received a foster care intervention show a selective processing for positive stimuli, which is associated with better mental health and wellbeing (Troller-Renfree et al., 2015). Building upon past findings, the present study identified that stability of foster care placement following early institutionalization as a major factor in the development of positive biases. This result suggests that consistent and high-quality care giving following early psychosocial deprivation may be one mechanism though which positive outcomes may be established. Though specifics of the caregiving environment were not identified, the present data suggest that aspects of the caregiving environment (i.e. parent-to-child attachment, parental support, and parent-child relationship quality) may be integral to the development of positive biases following early deprivation. Additionally, the presence of an attention bias towards threat, which has been related to a variety of negative outcomes (i.e. increased internalizing issues and poor emotion regulation; Cisler & Koster, 2010; Vasey et al., 1996), in foster care children with unstable placements at age 12 further suggests that caregiving environments have a strong influence on children's selective attention to threatening and positive stimuli.

The results of the current study further suggest that attention biases towards positive stimuli may be associated with more normative patterns of stress reactivity as measured by cortisol levels during a social stress task. Overall, FCG children with a large positive bias showed less blunted cortisol reactivity (exhibited the expected peak in cortisol levels following a social stressor), whereas FCG children with a smaller positive bias showed a bunted pattern of reactivity (exhibited a smaller or no peak in cortisol levels following a social stressor). This less blunted cortisol reactivity in typically developing children as compared to child exposed to early adversity has been observed in a number of studies (Gunnar et al., 2009; McLaughlin et al., 2015) and suggests that positive attention biases may serve as a protective factor for children who have experienced institutionalized care. To our knowledge, this is the first study to link positive attention biases to cortisol reactivity, however, previous work has suggested that positive affect is associated with distinct patterns of diurnal cortisol output (Steptoe, Dockray, & Wardle, 2009). Studies examining the relation between positive affect and cortisol output have found both that individuals show lower cortisol when they express greater positive affect (Davydov, Shapiro, Goldstein, & Chicz-DeMet, 2005; Hoppmann & Klumb, 2006; Jacobs et al., 2007) and that happy individuals show lower levels of cortisol output throughout the day (Steptoe, O'Donnell, Badrick, Kumari, & Marmot, 2008; Steptoe, Wardle, & Marmot, 2005). These patterns of lower daily cortisol output associated with positive affect and happiness have favorable associations with heart rate, blood pressure, and inflammatory markers such as interleukin-6 (Steptoe et al., 2009). Furthermore, the relation between positive biases and less blunted stress reactivity may be explained by better emotion regulation and aversions to negative stimuli, both of which have been associated with positive affectivity (Isaacowitz, 2005; Wadlinger & Isaacowitz, 2008). While the mechanisms underlying the relations between positive biases and cortisol reactivity are unknown, these results suggest that positive biases may be an important biomarker for not only better psychiatric and social outcomes, but also a good index of physiological functioning during stress in children who have experienced early institutional care followed by a foster care intervention.

Unlike previous findings from this sample when children were 8 years of age, children randomized to remain in the institution did not present with a bias towards threatening stimuli at age 12. While unexpected, there may be a number of reasons for the lack of bias towards threating stimuli in the CAUG. First, analyses were conducted within an intent-to-treat framework, which does not account for the fact that only five CAUG children in the present paper have been continuously institutionalized. Data from the present paper suggest that caregiving instability may be a major factor in producing attention biases towards threat and less than half of the CAUG experienced caregiving disruptions between 8 and 12 years of age. Additionally, our results suggest that placement outside of an institutional setting may improve children's attention biases, thus leading to a reduced threat bias in the CAUG and suggesting that biases may be improved after children are removed from adverse environments. Finally, a number of studies have shown that attention biases towards threatening information are relatively unstable across assessments (Kappenman, Farrens, Luck, & Proudfit, 2014).

Interestingly, neither the CAUG nor the NIG exhibited a positive or threat bias and neither showed a relation between bias and cortisol reactivity to a social stressor. The lack of positive bias across the CAUG and NIG groups suggests that there may be something specific about the experience of early psychosocial deprivation followed by a high-quality foster care intervention that produces positive attention biases that goes beyond the solely presence or absence of institutional care. Given the lack of bias in both the CAUG and NIG, it is rather unsurprising that bias is unrelated to cortisol reactivity given that there is very little variation in the bias scores across both groups and that, to our knowledge, a lack of bias has not been associated with a distinct behavioral and physiological profile. It is important to note, however, that similar patterns of attention biases in these two groups does not mean that they have similar patterns of socioemotional and physiological functioning, but rather suggests that attention biases are not indexing the same risk and protective factors in the CAUG and NIG as they are in the FCG.

Finally, the present study is the first to assess stability of attention biases over time in a sample of previously institutionalized children. Results showed that children in the CAUG had a bias towards threatening information across time, while children in the FCG had a significant positive bias across the two assessment points. Additionally, a stable, high positive bias was related to a constellation of protective outcomes. These findings suggest that stability of attention biases over time may provide a valuable index of risk and protective factors. In addition, our stability measures of threat and happy biases were independently predicted by percentage of time spent in differential caregiving environments. Specifically, consistent biases towards positive stimuli were predicted by the percentage of time a child spent in foster care (government or BEIP), while consistent biases towards threat were predicted by the percentage of time a child spent in institutionalized care. These findings hint towards separable underlying mechanisms that produce maladaptive threat biases and protective positive biases. Future studies should aim to investigate specific aspects of the institutional and foster care environments that produce stable patterns of visual attention biases.

It is worth providing several cautionary notes to the present findings. First, for analyses conducted with data only from the 12-year assessment, bias data, social outcomes, and stress reactivity were all measured concurrently. The simultaneous collection of these measures limits the temporal claims that can be made as to whether the development of positive attention bias precedes, follows, or develops concurrently with adaptive social and physiological profiles. Additionally, the interaction term of our initial intent-to-treat omnibus model was only marginally significant, so comparative effects between the CAUG and FCG should be interpreted with caution. Furthermore, given our small sample size, we were underpowered to detect the expected moderation effects for between-group differences in attention biases and their relation to cortisol reactivity. Given this limitation, it is not possible to confirm whether differential relations between positive biases and cortisol reactivity exist between groups and thus the exploratory cortisol reactivity analyses should be interpreted with caution. Future studies should aim to replicate these effects with larger samples. While another randomized clinical trial of institutionalized children may not be possible or ethical, studies examining children who have experienced early deprivation and stress (e.g. maltreated children and post-institutionalized adoptees) may be able to examine similar questions in larger, better controlled populations. Additionally, given the small effect sizes associated with the mental health analyses, it is important to recognize that attention biases are just one of many processes associated with mental wellbeing. Finally, it is important to consider that results from the intent-to-treat analyses may be conservative estimates given that many children in the CAUG and FCG were no longer in their initial randomized placement.

The present paper provides evidence for the importance of positive attention bias in previously institutionalized children who have received a foster care intervention. In addition, it provides important new evidence suggesting that stability of foster care placement is important for the development of positive attention biases and that positive attention biases are accompanied by a distinct physiological profile during a social stressor. For children who have experienced early psychosocial deprivation, these results emphasize the importance of stable family placement for the promoting adaptive attention bias associated with positive social, mental health, and physiological outcomes.

Financial disclosures: The authors report no biomedical financial interests or potential conflicts of interest.

Acknowledgements

Research reported in this publication was supported by the Binder Family, John D. and Catherine T. MacArthur Foundation, the National Institute of Mental Health of the National Institutes of Health under Award Number R01MH091363 (to CAN), K01MH092526 (to KAM), and by a National Science Foundation Graduate Research Fellowship (DGE1322106) to STR. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. Special thanks to Jill DeJames, Alana Ebert-Zavos, Brady K. Stevens, and Nicole Ruszkay for their assistance.

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