Biological Sensitivity to Family Income: Differential Effects on Early Executive Functioning

Jelena Obradović and Ximena A. Portilla
Stanford University

Parissa J. Ballard
University of California, San Francisco and University of California, Berkeley

The study examined how the interplay between children’s cortisol response and family income is related to executive function (EF) skills. The sample included one hundred and two 5- to 6-year-olds (64% minority). EF skills were measured using laboratory tasks and observer ratings. Physiological reactivity was assessed via cortisol response during a laboratory visit. A consistent, positive association between family income and EF skills emerged only for children who showed high cortisol response, a marker of biological sensitivity to context. In contrast, family income was not related to EF skills in children who displayed low cortisol response. Follow-up analyses revealed a disordinal interaction, suggesting that differential susceptibility can be detected at the level of basic cognitive and self-regulatory skills that support adaptive functioning.

A growing number of empirical studies support the differential susceptibility theory (DST) by showing that children who are behaviorally or biologically more reactive tend to be more affected by both positive and negative contextual influences (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011). Physiological stress reactivity has been reconceptualized as a marker of biological sensitivity to context, rather than vulnerability, as highly sensitive children may thrive in supportive environments but be at risk for maladaptation in adverse environments (Belsky & Pluess, 2009; Obradović & Boyce, 2009). However, extant studies have focused on broad indices of competence and psychopathology, and have not investigated whether biological sensitivity can also be detected at the level of specific cognitive and self-regulatory skills that support adaptive functioning. Since we know that children’s early executive functions (EFs) are critical for adaptation (Obradović, Portilla, & Boyce, 2012) and are affected by socioeconomic adversity (Lawson et al., 2014), one key question is how biological sensitivity can moderate links between adversity and EFs. Thus, the goal of the current study is to extend prior research by examining how the interplay between young children’s physiological responsivity and family income relates to their performance on executive functioning tasks and to concurrently observed self-regulation behaviors. Furthermore, the study aims to advance our limited understanding of the association between physiological arousal and EFs in young children.

Socioeconomic Disparities and EFs

EFs are a set of higher order cognitive skills that help children self-regulate attention, behavior, and emotions. As the building blocks of various age-salient competences, EFs have substantial implications for children’s social, emotional, and cognitive development (Best & Miller, 2010). Strong EFs can help children engage in prosocial activities, exhibit fewer behavioral problems, learn specific literacy and mathematic skills, have better general study habits, and attain higher school engagement.
(Diamond, 2013; Obradović et al., 2012). These skills may be especially important for promoting resilience in contexts of high risk and adversity (Buckner, Mezzacappa, & Beardslee, 2003; Obradović, 2010).

When compared to more advantaged peers, children from disadvantaged socioeconomic backgrounds perform worse on EF tasks (Howse, Lange, Farran, & Boyles, 2003; Mezzacappa, 2004; Noble, McCandliss, & Farah, 2007; Sarsour et al., 2011) and are reported to have lower EF skills in real-life settings (Piotrowski, Lapierre, & Linebarber, 2013; Sekman, McClelland, Acock, & Morrison, 2010). Researchers have begun to identify how proximal experiences, such as the quality of parenting and home environment, may explain the negative effects of socioeconomic disadvantage on EFs (Hackman, Gallop, Evans, & Farah, 2015; Lengua et al., 2014; Li-Grining, 2007; Noble, Houston, Kan, & Sowell, 2012; Roy, McCoy, & Raver, 2014; Sarsour et al., 2011). Specifically, recent studies have shown that parenting quality (i.e., sensitivity, scaffolding, and limit setting) and home enrichment may mediate the effects of family income on EF skills in early childhood (Hackman et al., 2015; Lengua et al., 2014). However, other studies show that the effect of family income persists even after controlling for covariates such as race, language, parent education, marital status, parenting quality, and different aspects of home environment (Evans & Rosenbaum, 2008; Piotrowski et al., 2013; Raver, Blair, & Willoughby, 2013; Sarsour et al., 2011). Using a nationally representative sample, Piotrowski et al. (2013) found that family income was the only family-level variable associated with self-regulation skills over and above other individual and parenting covariates. The authors argued that family economic climate may be more relevant than parental educational background for the development of self-regulation skills, as low-income families may lack resources that promote the practice of EF skills. While there is a need to identify specific experiences that explain the deleterious effects of family financial difficulties on emerging EFs, it is also important to investigate whether children vary in their susceptibility to economic disparities.

**Cortisol Reactivity and EFs**

Recently, Blair and Raver (2012) proposed a theoretical model that identifies stress hormones as a primary mechanism through which early adverse experiences and caregiving quality influence the development of self-regulation and EF skills. Biological response to adversity is complex and multifaceted, but one of the central physiological systems involved is the hypothalamic–pituitary–adrenal axis (HPAA). The HPAA is activated by challenging or stressful experiences and, via cortisol secretion, prepares the body for coping with chronic adversity exposure. Early childhood experiences of socioeconomic adversity have been linked to heightened cortisol levels in children (Chen, Cohen, & Miller, 2010; Evans & English, 2002; Gustafsson, Gustafsson, & Nelson, 2006; Lupien, King, Meaney, & McEwen, 2001), which in turn have been associated with various indices of maladaptive behavior (Gunnar & Quevedo, 2007; Obradović, 2012). Moreover, animal models and adult research show that elevated cortisol levels may directly undermine the maturation and activity of brain regions known to support cognitive and EF skills (Arnsen, 2009; Blair, 2010; Lupien, McEwen, Gunnar, & Heim, 2009). Despite the relevance of HPAA activity for understanding how early adversity may compromise the development of EFs, surprisingly few studies have examined the link between cortisol levels and EFs in young children. One such study found that higher baseline cortisol levels in infancy were associated with lower performance on EF tasks at age 3 (Blair et al., 2011).

On the other hand, studies have found that elevated cortisol in response to laboratory procedures may be related to better performance on EF tasks. In a small sample of 6-year-olds, Davis, Bruce, and Gunnar (2002) reported a positive association between an average of four cortisol samples collected during a laboratory visit and performance on EF tasks. Similarly, Spinrad et al. (2009) found positive relations between cortisol reactivity (i.e., difference score) to a social stressor and maternal report of EF behaviors in preschool children. Furthermore, a study of low-income Head Start students showed that children with higher EF skills and higher teacher-reported self-regulation responded with a moderate increase and subsequent decrease in cortisol levels during laboratory assessments (Blair, Granger, & Razza, 2005). Together, these findings suggest that moderately elevated levels of arousal may help children cope with laboratory challenges and perform better on cognitive tasks, which is consistent with the inverted U-curve association between stress hormones and cognition demonstrated in adults and animal models (Blair, 2010; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007). However, these studies did not consider differences in family adversity, and thus it remains unclear whether heightened cortisol response is related to...
better EF skills in all children. Given the evidence that poverty, heightened cortisol, and lower EF skills are interrelated, we need to better understand the interactive effect of cortisol response and socioeconomic background on EF skills.

**Differential Susceptibility and EFs**

DST (Ellis et al., 2011) provides a valuable conceptual framework for examining how the interplay between cortisol responsivity and family background relates to children's EF skills. Individual differences in salivary cortisol response, as measured by basal laboratory levels, reactivity to laboratory challenges, and evening home levels, have been shown to act as a biological marker of differential susceptibility, and to moderate the effects of family and peer contexts on children's behavior (Chen et al., 2015; Laurent et al., 2013; Obradović, Bush, Stamperdahl, Adler, & Boyce, 2010; Rudolph, Troop-Gordon, & Granger, 2010). Consistent with DST, these studies demonstrate that heightened cortisol levels are promotive for children from more advantaged backgrounds, but a risk factor for children from more disadvantaged backgrounds. In contrast, lower cortisol levels may buffer children from contextual effects. Most of this work focuses on broad indices of functioning, such as emotional and behavioral problems, which are influenced by various factors, including EF skills.

Two recent studies provide initial evidence of a differential susceptibility effect on EFs in young children. Raver et al. (2013) showed that economic hardship was linked to EFs only in preschoolers who displayed high temperamental reactivity in infancy. Similarly, in a small sample of 3- to 5-year-olds, exposure to maltreatment was associated with inhibitory control only in children with high parasympathetic arousal during a parent-child interaction (Skowron, Cipriano-Essel, Gatzke-Kopp, Teti, & Ammerman, 2014). In both studies, significant interactions were consistent with DST, rather than the diathesis-stress model, in that children's EFs were susceptible to both positive and negative family experiences. Extending this work to examine the interactive effect of cortisol responsivity and family adversity will clarify how influences at multiple levels—from biological to societal forces—affect early EF skills that support general adaptation.

**Current Study**

The goal of the current study was to examine how the interplay between children's cortisol response and family income predicts EFs in 5- to 6-year-olds. Following the principles of DST, we hypothesized that higher levels of cortisol response during the laboratory visit would be related to greater EF skills in children from more affluent families and to lower EF skills in children from less affluent families. Furthermore, we expected that for children who exhibited lower levels of cortisol response, EFs would not vary as much by family income. We used a cumulative measure of salivary cortisol output during the laboratory visit as an index of differential susceptibility. Given recent findings showing the relevance of family economic resources for the development of self-regulation and EF skills, we focused on testing differential susceptibility to family income after controlling for observed parenting quality. We conducted a comprehensive assessment of children's EF skills using direct measures of both emotionally neutral (“cool”) and emotionally laden (“hot”) EFs, as well as the assessor's observations of contextualized EF skills during the laboratory visit. We did not hypothesize that the interactive effects would vary across these different EFs measures. We accounted for age and vocabulary effects.

**Method**

**Participants**

Participants included 102 kindergarten children (\(M_{age} = 5.61\) years, \(SD = 0.56\); 51.96% females) who participated in a laboratory study along with their primary caregiver, from June 2011 to August 2012 (\(M_{age} = 38.9\) years, \(SD = 6.8\), range = 24–60). Families were recruited by advertisements at community centers, schools, and libraries, and were eligible if they had a child entering kindergarten or first grade. The sample was racially diverse, with caregivers reporting the children as 36% White, 26% Hispanic/Latino, 20% Asian, 4% Black, and 14% Multiracial/Other. Ninety-three percent of caregivers were female and 17% were single parents. Seventeen percent reported educational attainment of a high school diploma or less, and 42% had earned a graduate or professional degree. Accordingly, 23% of the families reported household income of less than $50,000, while 36% reported a household income greater than $200,000, which reflects the higher cost of living in the San Francisco Bay Area.

**Procedure**

Primary caregivers (hereafter referred to as parents) and their children visited a university...
laboratory to complete a 3-hr protocol. Parents completed an in-person survey with a trained interviewer, which assessed demographic information, family functioning, parenting strategies, and child functioning. The survey was administered in English or Spanish, depending on parent preference. Meanwhile, in a separate room, children completed a battery of EF tasks, a vocabulary test, and a series of laboratory challenges designed to elicit physiological reactivity. All children were assessed in English. At the end of the session, children and parents reunited to complete a set of five interaction tasks. Detailed descriptions of the stress reactivity protocol and parent–child interaction tasks are presented in the online Appendix S1.

**Measures**

Descriptive statistics for all analysis variables are presented in Table 1. For more information regarding the EF and parenting measures, see Appendix S1.

**Cortisol**

We collected four salivary samples throughout the laboratory session, at the following times: T1 upon the child’s arrival to the laboratory, soon after completing the consent process; T2 after the EF battery \((M_{T2-T1} = 45.99 \text{ min}, SD = 7.16)\); T3 after the vocabulary test and stress reactivity protocol \((M_{T3-T2} = 66 \text{ min}, SD = 10.10)\); T4 after the parent-child interaction \((M_{T4-T3} = 51.41 \text{ min}, SD = 14.03)\). Saliva samples were stored at \(-20^\circ\text{C}\) until analysis. Cortisol levels were determined using a competitive solid phase time-resolved fluorescence immunoassay with fluromeric endpoint detection (DELFIA). All samples were analyzed as duplicates. The average intra-assay coefficient of variation was 6.8% \((SD = 4.8\%)\), and the corresponding average interassay coefficient of variation was between 7.1% and 9.0%.

We used all four cortisol measures (see Table 1) to calculate area under the curve (AUC) as a cumulative index of total cortisol output in response to various laboratory challenges (see Appendix S1). Since children vary in their timing of peak response and recovery, using four cortisol measures provides a more accurate single score index of overall response that takes into account variable time intervals between the samples. We calculated AUC with respect to ground (AUCg; see Pruessner, Kirschbaum, Meinschmidt, & Hellhammer, 2003, for the formula) to include variability in initial cortisol levels, an important source of individual differences. Initial cortisol levels have been shown to reflect anticipatory cortisol response to upcoming challenges (Kestler & Lewis, 2009) and to act as a marker of differential susceptibility (Chen et al., 2015). To remove variation in cortisol levels that is due to diurnal rhythm, we regressed log-transformed AUCg scores on the time of the first sample collection and used standardized residual factor scores to test main and interactive effects. Given lengthy laboratory procedures that varied across participants, we separately controlled for the length of the session in the analyses.

**EF Skills**

Inhibitory control was assessed using the Flanker task with separate fish and arrow stimuli test blocks (Zelazo et al., 2013). The child was presented with a picture of a middle fish/arrow flanked by two fish/arrows on either side and asked to press a button corresponding with the direction of the middle stimuli. Each block had 13 congruent and 7 incongruent intermixed test trials. Ten children did not advance to the arrow test block due to their poor performance on the fish test block. The total score represents the percentage of correct responses across valid incongruent trials. Working memory was measured using the Backward Digit Span task (Flanagan & Kaufman, 2009). The child was told a series of digits and asked to repeat the digits in reverse; thus, the child needed to remember the sequence of digits (i.e., storage) while reversing the order of digits (i.e., competing processing requirement). Each level consisted of two trials of equal length, and the number of digits increased until the child failed both trials within a level. The total score represents the sum of all correct trials. A cool EF skills score was created by averaging standardized inhibitory control and working memory accuracy scores \((r = .49; p < .001)\).

Delay of gratification skills were assessed with two separate tasks (Kochanska, Murray, Jacques, Koenig, & Vandengeest, 1996). During the Dinky Toys (DT) task, the child was instructed to keep hands in her lap and to verbally choose a toy from a box filled with “dinky” toys, such as stamps, bubbles, and balls. The child had up to 120 s to decide on a toy. During the Gift Wrap (GW) task, the child was instructed to sit facing away from a table and refrain from peeking while the assessor noisily wrapped a gift for 60 s. Afterward, the child was left alone with the gift for 180 s and told not to peek. For each task, two independent raters coded (a) the worst trans-
Table 1
Bivariate Correlations and Descriptive Statistics

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Note. Descriptive statistics for variables 1–10 are presented in the original metric. SRS_InAUCg = standardized residual score derived from regressing log-transformed AUCg scores on the time of the first sample collection; EF = executive function; Interaction term = Income × SRS_InAUCg. *p < .05. **p < .01. ***p < .001.
gression (DT: 0 = none, 1 = move hands, 2 = point, 3 = touch, 4 = grab; GW: 0 = none, 1 = peeks, 2 = turns body), (b) number of transgressions, and (c) latency to the first transgression, with great reliability (DT: \( \kappa = 1.00 \); intraclass correlation coefficient [ICC] = 0.98–1.00; GW: \( \kappa = 1.00 \); ICC = 0.94–0.97). A hot EF skills score was created by averaging six DT and GW codes after each score was standardized, and reverse coded as needed (\( \alpha = .89 \)).

The assessor rated the child’s observed EF skills during laboratory assessments on 4-point scale items from the Preschool Self-Regulation Assessment Assessor Report (Smith-Donald, Raver, Hayes, & Richardson, 2007). The composite score was a standardized average of 13 items (\( \alpha = .96 \)) that captured attention, inhibitory control, and emotion regulation skills. Twenty percent of cases were double coded to establish reliability (ICC = 0.82–1.00).

**Income**

Parents reported total household income on a scale that ranged from 1 (0–$5,000) to 11 (≥ $200,000), which was converted to the midpoint of each dollar range and expressed in thousands of dollars (1 = 2.5K, 2 = 8.5K, . . ., 10 = 175K, 11 = 200K).

**Covariates**

Child age and sex were reported by the parent. Vocabulary was measured using the standardized score on the Peabody Picture Vocabulary Test–IV (Dunn & Dunn, 2007). Global parenting quality was a standardized average of six observational codes: parent positive responsiveness, harshness and hostility (reversed), quality of assistance, support of autonomy, structure and limit setting, and overall parenting during parent-child interaction tasks (\( \alpha = .91 \)). Each rating was coded by two independent observers on a 5-point scale (ICC = 0.69–0.82).

**Results**

Bivariate correlations among study variables are presented in Table 1. Since child sex was not correlated with any variables, it was excluded from regression analyses to preserve power. Child age, vocabulary, parenting quality, and family income were positively correlated with all measures of EF skills.

Standard regression analyses were employed to test the interactive effect of family income and cortisol response on three indices of EF skills. Family income was mean-centered to preserve the original metric in thousands of dollars, while all other predictors were standardized. Results revealed consistent significant interactive effects of income and cortisol response across EF skills (see Table 2). Significant interactions were further probed using the simple slopes technique (Aiken & West, 1991) by testing the relations between income and EFs for children with high (i.e., 1 SD above the mean) and low (i.e., 1 SD below the mean) cortisol response.

Family income was significantly associated with EF skills only for children with high cortisol response (cool EF: \( \beta = .00657, p < .001 \); hot EF: \( \beta = .00335, p = .014 \); observed EF: \( \beta = .00314, p = .077 \)), but not for children with low cortisol response (cool EF: \( \beta = .00175, p = .214 \); hot EF: \( \beta = -.00126, p = .375 \); observed EF: \( \beta = -.00148 \),

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<th>Table 2</th>
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<tbody>
<tr>
<td>Results for Standard Regression Model With Unstandardized Coefficients</td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>Constant</td>
</tr>
<tr>
<td>Family income</td>
</tr>
<tr>
<td>Cortisol</td>
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<tr>
<td>Cortisol × Income</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>Vocabulary</td>
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<tr>
<td>Length of session</td>
</tr>
<tr>
<td>Parenting composite</td>
</tr>
<tr>
<td>Total ( R^2 )</td>
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</tbody>
</table>

**Note.** EF = executive function.

\( \dagger p < .10. \) \( * p < .05. \) \( ** p < .01. \) \( *** p < .001. \)
In comparison to children with low cortisol response, children with high cortisol response displayed higher EF skills if they came from higher income families, but lower EF skills if they came from lower income families (see Figure 1). The level of EF skills did not vary by family income for children who displayed low cortisol response. In addition, older age and greater parenting quality uniquely predicted higher EF skills across all three measures, whereas greater vocabulary and longer session predicted only higher hot EFs. The main effect of family income was significant only for cool EFs.

Additionally, we followed the Widaman et al. (2012) procedure to test whether interactions had an ordinal or disordinal form. The disordinal form, characterized by a crossover point and its CI within the observed range of the contextual predictor (i.e., family income), corroborates our hypotheses based on DST. In contrast, the ordinal form, with a crossover point outside this range, supports the diathesis–stress model.

We first calculated a point estimate of the crossover point of the interaction, (C), with the parameters estimated from the standard regression model using the equation \( \hat{C} = -\frac{B_2}{B_3} \) (Aiken & West, 1991). We then reparameterized the linear regression model and ran a nonlinear regression to determine the SE and associated 95% CI of the estimated crossover point \( \hat{C} \). The estimate of the crossover point from the standard regression model was approximately 0.20–0.25 SD below the observed mean (\( \hat{C} = -13.363 \) for cool EF; \( \hat{C} = -19.260 \) for hot EF; \( \hat{C} = -18.660 \) for observed EF). Results from fitting the reparameterized equation yielded the following estimates: \( \hat{C} = -13.363 \) (SE = 28.491), 95% CI [-70.029, 43.304] for cool EF; \( \hat{C} = -19.258 \) (SE = 30.069), 95% CI [-79.063, 40.548] for hot EF; and \( \hat{C} = -18.658 \) (SE = 39.537), 95% CI [-97.296, 59.979] for observed EF. All point and interval estimates fell completely within the observed range of family income (mean-centered range = -122.541 to 74.959), indicating that the interaction effects were clearly disordinal and consistent with DST. More detailed description of these analyses and complete estimates for both models are provided in Appendix S1.

**Discussion**

Consistent with the principles of DST (Ellis et al., 2011), the current study demonstrated that cortisol response to laboratory challenges and family income had an interactive effect on all three indices of EF skills in young children. Specifically, children who exhibited higher cortisol response were more susceptible to family income and displayed greater EF skills if they came from higher income families and poorer EF skills if they came from lower income families. In contrast, family income was not related to EF skills in children who displayed lower cortisol response. These findings corroborate and extend recent studies of behavioral and parasympathetic reactivity as markers of differential susceptibility to context for early EFs (Raver et al., 2013;
Skowron et al., 2014). Higher cortisol response may distinguish children who are affected more strongly by family financial climate, such as access (or lack of access) to specific resources (e.g., educational toys, extracurricular programs, high-quality child care) that can promote the development of EF skills (Piotrowski et al., 2013; Sektnan et al., 2010). Lower cortisol response, on the other hand, seems to buffer children from these contextual effects.

Point and interval estimates of the crossover points were well within the range of observed income values for all EF measures, indicating a disordinal interaction form that supports heightened susceptibility to both positive and negative environmental influences. Moreover, point estimates revealed that the change in the association between cortisol and EFs emerged around an annual family income of $100,000. Although our community sample is economically diverse, lower income families did not live in poverty, suggesting that the impact of economic inequality can be detected across a wide range of incomes. This is consistent with the recent evidence of widening achievement gaps between children from middle- and high-income families (Rear don, 2011). Future studies need to take into consideration geographic differences in cost of living when examining effects of family income on child development. For example, a higher cost of living has been linked to lower parental investment and lower school resources only in low-income families (Chien & Mistry, 2013). Our study also underscores a need to develop more nuanced indices of family investment in stimulating experiences, both in and outside the home, that could promote early cognitive and self-regulatory skills.

In contrast to previous studies that link laboratory assessments of physiological response to adult report of children’s overall adaptation, our study design allowed a test of the concurrent association between children’s physiological arousal and EFs. We found that heightened cortisol response promoted better EF performance in children from economically more advantaged backgrounds, but undermined EF performance in those from economically less advantaged backgrounds. This finding parallels recent studies that show that the effect of physiological arousal on cognitive assessments is not uniform and can be highly contextual. For example, college students who were taught to reappraise their heightened arousal as a performance-enhancing experience had better test results than students who did not reappraise arousal (Jamieson, Mendes, Blackstock, & Schmader, 2010). Furthermore, elevated cortisol was associated with worse math performance in highly anxious students, whereas the opposite was true for students who reported low math anxiety (Mattarella-Micke, Mateo, Kozak, Foster, & Bellock, 2011).

Although our sample was exposed to the same laboratory context, family economic disparities may have affected children’s subjective experiences of the testing environment. Highly susceptible children from disadvantaged families may have experienced it as more threatening or challenging, whereas highly susceptible children from advantaged families may have experienced it as more fun and exciting. Consequently, these differences may have affected children’s performance anxiety and interpretation of physiological arousal. While DST focuses on the effects of broader contexts in which children live and grow, it is important that we examine whether its principles extend to learning and testing environments. Given the increasing prevalence of high-stakes testing in elementary schools, future research needs to address how the effect of physiological arousal on cognitive assessments and outcomes may vary as a function of contextual influences and subjective experiences. By experimentally manipulating the testing environment or children’s subjective appraisal of the context and accompanying arousal, we may identify innovative ways to help biologically sensitive children from disadvantaged backgrounds harness their susceptibility to promote learning and test performance.

Although the findings were robust across different types of EFs and measurement approaches, our study has several limitations. First, the sample was small with a mean family income higher than the national average. Second, the study was cross-sectional, limiting our understanding of directionality. Third, while we controlled for parenting quality, we did not identify specific mechanisms that explain how variability in family income contributes to EFs in early childhood. Identifying specific processes through which economic inequality undermines longitudinal development of EF skills would provide better targets for early prevention and intervention.

Conclusion

Heightened biological sensitivity to context has been interpreted as a promotive factor in nurturing and supportive contexts, and as a vulnerability factor in adverse contexts, yet very little is known about the specific processes through which this
susceptibility operates on long-term adaptation. The current study reveals that the interplay between physiological response and family environment can be detected at the level of basic cognitive and self-regulatory skills that support competencies in many domains of functioning. Investigating more micro-level interactions of physiological response, behavior, and contextual experiences will advance our understanding of how biological processes contribute to children's differential susceptibility and whether these processes can be manipulated to promote resilience.

References


**Supporting Information**

Additional supporting information may be found in the online version of this article at the publisher’s website:

**Appendix S1.** Procedure, Measures, and Analysis