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To cite this article: Alexandra Ursache, Kimberly G. Noble & Clancy Blair (2015) Socioeconomic Status, Subjective Social Status, and Perceived Stress: Associations with Stress Physiology and Executive Functioning, Behavioral Medicine, 41:3, 145-154, DOI: [10.1080/08964289.2015.1024604](https://doi.org/10.1080/08964289.2015.1024604)

To link to this article: <http://dx.doi.org/10.1080/08964289.2015.1024604>



Published online: 02 Sep 2015.



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Socioeconomic Status, Subjective Social Status, and Perceived Stress: Associations with Stress Physiology and Executive Functioning

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Several studies have investigated associations between socioeconomic status (SES) and indicators of children's physiological and cognitive self-regulation. Although objective measures of family SES may be good proxies for families' experiences of disadvantage, less is known about subjective aspects of families' experiences. We hypothesize that subjective social status (SSS) and perceived stress may be important independent predictors of children's stress physiology and executive functioning (EF). Eighty-two children from diverse SES backgrounds were administered EF measures and provided saliva samples for cortisol assay. Caregivers reported on objective SES, SSS, and perceived stress. Results suggest that SES and SSS are both independently and positively related to EF. In models predicting stress physiology, higher perceived stress was associated with lower baseline cortisol. Moreover, SES and age interacted to predict cortisol levels such that among younger children, lower SES was associated with higher cortisol, whereas among older children, lower SES was associated with lower cortisol. Results highlight the importance of considering both objective and subjective indicators of families' SES and stressful experiences in relation to multiple aspects of children's self-regulation.

Keywords: socioeconomic status, subjective social status, perceived stress, cortisol, executive function

INTRODUCTION

In the emerging literature linking poverty to children's executive functioning (EF) and stress physiology, children's exposures to poverty have most often been captured through objective measures of family socioeconomic status (SES), including parental income, education, and occupational prestige. The experience of stress, and resultant alterations in stress physiology, are frequently hypothesized to be key mechanisms linking poverty to EF performance.^{1,2}

Few studies, however, have considered the role of subjective experience in the development of stress physiology and EF, over and above objective indicators of poverty. As such, the current study extends prior work examining relations of SES to children's executive functioning and stress physiology by examining the extent to which parental subjective social status and perceived stress may explain unique variance in these self-regulatory processes.

Poverty and EF

Several studies have demonstrated that children from lower SES families perform worse on assessments of nearly all aspects of executive functioning.^{3–7} Although objective

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indicators of SES such as income, education level, and occupation may serve as good proxies for the stressful experiences of children living in poverty, subjective indicators such as subjective social status may capture additional aspects of how families experience poverty. Subjective social status is a measure of how people rank themselves in the broader social hierarchy. When families rank their own social status, they may be providing a broader picture of the economic and social resources they can offer their children by taking into account additional SES-related factors such as wealth or social capital, which are not captured in traditional SES measures. In addition, even among families who are similar in terms of objective measures of SES, there is likely to be variation in families' perceptions of their status within the social system. For example, some individuals who are raised in high SES households in high SES neighborhoods and interact only with other high SES families may see themselves as somewhat average in terms of social status. It is possible that parents' feelings of being lower in social status may in turn be transmitted to children in subtle ways as children observe their parents interacting with others and as children engage in comparisons between their own and their friends' or classmates' families. Perceptions of being less powerful than others^{8,9} have been associated with difficulties in multiple aspects of executive functioning in adults, but no studies have investigated these relations in children.

Furthermore, links between poverty and children's self-regulation may be accounted for by increased family stress.^{1,10} It may therefore be important to examine more direct indicators of the extent to which families perceive their lives as stressful. Perceived stress is defined as the extent to which people feel that their lives are uncontrollable, unpredictable, or overwhelming, and it has been found to be related to declines in working memory^{11,12} and to deficits in attention set shifting.^{13,14} Parental perceptions of high stress may translate to higher stress for their children. Thus, we might expect parents' subjective social status and perceived stress to be associated with children's executive functioning and stress physiology over and above objective facets of SES.

Poverty and Stress Physiology

Links between poverty and children's self-regulation may be mediated by stress physiology, which has most often been measured by salivary cortisol, an indicator of hypothalamic-adrenal-pituitary (HPA) axis system functioning.^{6,10,15–22} Cortisol levels follow a diurnal rhythm characterized by an increase about 30 minutes after awakening and a subsequent decline throughout the day, reaching nadir late at night.²³ Cumulative wear and tear on the stress response system, or allostatic load, can cause dysregulation of the cortisol response, which may manifest either as hypocortisolism or as hypercortisolism.^{17,24} In addition

to playing a role in children's self-regulation,⁶ there is some evidence that dysregulated cortisol levels in the form of both hypocortisolism and hypercortisolism may be related to health problems such as depression and antisocial behaviors^{23,25} in children, although the direction of these relations is not clear. Moreover, given links between stress and inflammatory disease in adults, future research on cortisol in children may hold promise for understanding the onset of juvenile inflammatory diseases as well as the onset of chronic adult diseases such as cardiovascular disease and metabolic syndrome.²⁵

Several studies have demonstrated that lower SES is associated with a pattern of hypercortisolism as evidenced by higher resting cortisol levels,⁶ higher basal morning cortisol levels,^{15,21} higher overnight cortisol levels,¹⁰ and greater increases in daily cortisol output over a 2-year period.¹⁶ Other studies, however, have reported a pattern of hypocortisolism in the face of poverty, as evidenced by lower basal cortisol,^{17,18,20} lower cortisol levels across a public speaking task,¹⁹ and attenuated reactivity to stress paradigms.¹⁷ Thus, while the exact relation between SES and cortisol production in children is not completely clear, the literature is clear that socioeconomic disadvantage tends to be related to some form of dysregulation of the HPA axis.

Several studies have examined the relation between subjective aspects of social status and stress physiology. Most relevantly, one study found evidence that lower maternal subjective social status was associated with higher cortisol levels in children,²⁶ and neuroimaging work has demonstrated that perceived parental social status is associated with alterations in an area of the prefrontal cortex important for regulation of the stress response.²⁷ Parental perceived stress is also likely related to children's stress physiology. Acute stressors that are perceived as uncontrollable and socially evaluative reliably induce a cortisol response in the laboratory,²⁸ and from an allostatic load perspective, repeated activation of the stress response system may lead to dysregulated physiology. Consistent with this perspective, one meta-analysis found that higher subjective distress was related to greater cortisol daily output in adults.²⁹ Similarly, in children, chronic home life stress has been associated with a flatter diurnal pattern.³⁰ Some evidence has shown a hyporesponsive pattern, however, in that maternal depressive symptoms have been linked to lower cortisol levels.³¹

One possible explanation for these disparate results with regard to the directionality of the cortisol findings may stem from differences in the age of the samples studied. Extensive work suggests that stress may differentially affect the brain at different points in the lifespan.³² Specifically, pubertal development may play an important role in age-based differences in basal cortisol³³ and may alter the way that stressful experiences are manifest in HPA axis functioning.³⁴ Consistent with this perspective, Lupien

et al.¹⁵ found that lower SES was related to higher cortisol among elementary school children, but not among high school students. Furthermore, in the studies reviewed above, those that found evidence of elevated cortisol levels among disadvantaged children tended to study samples of younger, preadolescent children^{6,10,15,21} (but see Chen et al.¹⁶ for an exception). Those that found patterns of hypocortisolism in children tended to use samples of older, postpubescent children^{19,20} (but see Badanes et al.¹⁷ for an exception). Thus, based on the limited evidence available to date, it may be possible that the relations among lower SES, lower subjective social status, higher perceived stress, and cortisol levels would differ as a function of age such that younger children may exhibit positive associations, whereas older children may exhibit inverse associations.

The Present Study

The present study examines ways in which objective SES, subjective social status, and perceived stress are related to children's executive functioning and cortisol levels. We hypothesize that higher SES will be associated with higher executive functioning and that subjective experiences such as higher subjective social status and lower perceived stress will also be related to higher executive functioning above and beyond the effects of objective SES. With regard to stress physiology, we hypothesize that lower SES, lower subjective social status, and higher perceived stress will be related to higher cortisol levels. However, given some evidence that the relation between SES and cortisol may be dependent on age, we explore whether age moderates these relations.

METHODS

Sample and Procedures

A convenience sample of 82 participants was recruited through community advertisements in New York City. In order to obtain a socioeconomically diverse sample, children were recruited from community organizations and private schools that either had high tuition levels or were based in lower-income communities. We also recruited children from community flyers and by telephoning those who had expressed prior interest in participating in research. A series of questionnaires was obtained from one parent for each child. Children were seen individually by a researcher either at the school or community organization from which they were recruited ($n = 53$), or, when they were recruited from community flyers or by telephone, they were brought to the lab by a parent ($n = 29$). Children provided 3 saliva samples and completed a battery of computerized tasks as described below. All protocols were approved by the Institutional Review Board at New York

University. Parents provided written informed consent, and children gave verbal assent after the researchers described the protocols to them.

Measures

SES

Items from the MacArthur Network Sociodemographic Questionnaire were used to measure objective aspects of SES such as household income, occupation, and education. Income was divided into 9 brackets ranging from (1 = less than \$5,000 to 9 = \$100,000 and greater). Parents reported total combined family income by indicating which bracket best described their income over the past 12 months. To more closely approximate families' incomes, we then assigned an estimated income value equal to the mean income value in the bracket reported. Income was top coded at \$100,000 for those who reported that their income fell in bracket 9. Occupations were coded using the Hollingshead coding system.³⁵ Education was coded as the highest degree attained (0 = less than high school, 1 = high school diploma or GED, 2 = associate's degree, 3 = bachelor's degree, 4 = graduate degree). Correlations among the income, occupational prestige, and education measures were high ($r = .59-.62$) and statistically significant (all p 's < .001). A composite measure of SES was created by z-scoring and then averaging measures of household income, education, and occupational prestige.

Subjective Social Status

Parental subjective social status was captured through an item on the MacArthur Network Sociodemographic Questionnaire (2000) that asks participants to rank themselves by indicating their own place on a 10-rung ladder in relation to others in the United States. This item attempts to also capture the psychological aspects of social status by asking participants to think about their education, job, and income status relative to other people in the United States. Higher scores indicate higher subjective social status.

Perceived Stress

The Perceived Stress Scale (PSS), completed by parents, is a 10-item global measure of perceived stress.³⁶ The PSS asks participants to report on how often they experienced certain stress related feelings and thoughts during the past month. The scale is a 5-point scale ranging from "never" to "very often." We reverse coded items as appropriate and created a mean score across the 10 items ($\alpha = .83$). Higher scores indicate higher perceived stress.

Speed of Processing

In the simple reaction-time task, children are told to press the space bar whenever they see a star on the screen. Speed of processing was calculated as the mean latency to respond across all trials such that higher scores indicate slower processing speed.

Executive Functioning

Children participated in two executive functioning tasks: the Hearts and Flowers task and the Multiple Source Interference Task (MSIT). The Hearts and Flowers task taps all 3 components of executive functioning including working memory, inhibition, and attention set shifting.³⁷ Participants are told that when a heart appears on the screen, they should press the button that is on the same side as the heart, and when a flower appears on the screen, they should press the button that is on the opposite side of the flower. The first 20 trials were only heart trials, the next 20 trials were only flower trials, and the next 122 trials were mixed hearts and flowers. In this modified version of the task, flower trials were preceded by 1, 3, or 5 heart trials in the mixed section. Trials were excluded from analysis if the response latency was less than 200 ms as this indicates that participants were responding anticipatorily. Performance on the Hearts and Flowers task was measured by percent accuracy on the flowers trials in the mixed block of hearts and flowers trials.

The Multiple Source Interference Task is a Stroop-like task that measures inhibitory control.³⁸ In this task, 3 numbers are presented on the screen. Children place their pointer finger on the “1” key, their middle finger on the “2,” and their ring finger on the “3.” They are told to press the number that is different from the other numbers. For example, if the numbers “100” are presented on the screen, children must press “1.” In congruent trials, the different number is in the same position as the button that must be pressed. For example, in “100” the number 1 is in the first position. In incongruent trials, the different number is in a position that is not the same as the position as the button that must be pressed. For example, in “112” the “2” is in the third position. Thus, in incongruent trials, children must inhibit the tendency to respond to the different number based on its position and instead respond based on its value. Trials were excluded from analysis if the response latency was less than 200 ms as this indicates that participants were responding anticipatorily. Performance on the MSIT was measured as percent accuracy on the incongruent trials. Scores on the Hearts and Flowers and MSIT tasks were fairly strongly correlated ($r = .46, p < .001$). Because of the high correlation, and to reduce measurement error, a composite EF score was created by averaging scores on the Hearts and Flowers task and the MSIT.

Stress Physiology

Saliva samples were collected using absorbent hydrocellulose sponges at 3 points during the child assessment. The first sample was collected immediately after child assent, the second sample was collected 20 minutes after the child met the researcher, and the third sample was collected 40 minutes after meeting the researcher. Samples were transported in coolers and were then frozen and stored before being sent for cortisol assay at Johns Hopkins University. Cortisol was assayed in duplicate, and the mean value of cortisol across the two assays was used. Cortisol values were natural log transformed, and outliers greater than 3 standard deviations from the mean were removed. Mean levels of cortisol across all 3 time points were used for analyses.

Analytic Plan

Regression analyses were used to examine the extent to which both objective and subjective facets of families' experiences in poverty were related to children's EF and stress physiology. First, we examined the relations between SES, subjective social status, perceived stress, and EF, respectively, controlling for age, sex, and processing speed. Next, we examined the relations between SES, subjective social status, and perceived stress and cortisol, respectively, controlling for age, sex, and time of day. To then test the hypothesis that the relation between SES and cortisol might be dependent on age, we tested the SES \times age interaction. We also tested interactions of SSS \times age and perceived stress \times age. As an additional robustness check of our analyses, we also include model specifications in which we control for location of assessment (laboratory versus the school or center from which they were recruited).

Descriptive statistics are presented for the entire sample. For each regression analysis, however, the sample was limited to the participants who had data on the outcome variable of interest. Regression analyses were run using a robust maximum likelihood estimator in Mplus 6.12. Continuous predictors were mean centered for the cortisol analyses, and standardized estimates were obtained using the STDYX output in Mplus. Full information maximum likelihood was used to deal with possible bias arising from missing predictor values.

RESULTS

Descriptive Statistics

Descriptive statistics for the primary analysis variables are shown in Table 1. Child age ranged from 6–12 years of age ($M = 114.15$ months, $SD = 14.72$). Child race was reported for 79 of the 82 participants. Of these, 20.3%

TABLE 1
Descriptive Statistics for the Primary Analysis Variables

	<i>N</i>	Mean	SD
Sex (male = 1)	82	56%	—
Age (months)	82	114.15	14.72
African American	79	20.25%	—
Hispanic	79	25.32%	—
Biracial	79	20.25%	—
White	79	34.18%	—
SES	82	-0.04	0.87
Subjective Social Status	76	6.14	1.74
Caregiver Perceived Stress	78	1.53	0.63
Reaction Time (ms)	82	361.96	55.40
EF	81	0.63	0.17
(ln) Cortisol 1 ($\mu\text{g/dL}$)	79	-2.61	0.55
(ln) Cortisol 2 ($\mu\text{g/dL}$)	79	-2.58	0.43
(ln) Cortisol 3 ($\mu\text{g/dL}$)	80	-2.73	0.49
Cortisol Mean	81	-2.64	0.44
Time of Day (hr elapsed)	82	14.66	2.46

identified as African American, 25.3% as Hispanic, 34.2% as white, and 20.3% as biracial. All children's caregivers provided their education level: 7.3% had caregivers with less than a high school degree, 20.7% had caregivers with a high school diploma or GED, 12.2% had caregivers with an associate's degree, 42.7% had caregivers with a bachelor's degree, and 17.1% had caregivers who had a graduate degree. Of those reporting, 74 children had female caregivers and 4 had male caregivers, and 39% of the children were in single-parent families. Estimated household income was reported for 81 children and ranged from \$8,500 to over \$100,000; 36% of children were in households with incomes of less than \$30,000, and 36% of children were in households with incomes of over \$87,500. Composite SES scores ranged from -1.85 to 1.39 ($M = -0.04$, $SD = 0.87$).

Lab- versus Center-Based Data Collection

In order to examine whether there were differences on measures of interest between those who were tested in the

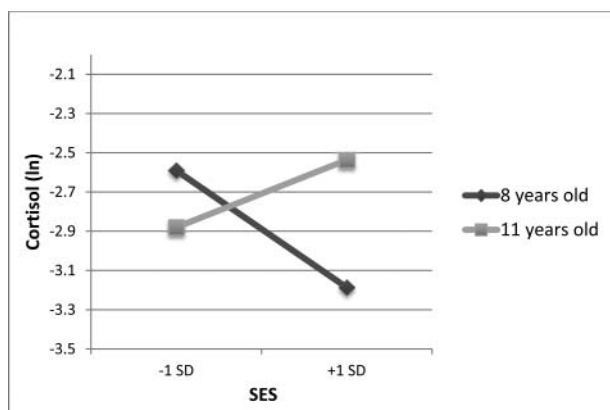


FIGURE 1 Age Moderates the Relation of SES to Cortisol.

lab versus those who were tested in a center, we conducted a series of *t* tests. Results demonstrated that children tested in the lab came from higher SES households ($t(80) = 4.416$, $p < .001$) and performed better on measures of executive functioning ($t(79) = 2.904$, $p = .005$). Children tested in the lab also tended to be assessed later in the day, likely reflecting the fact that they were all tested after school ($t(79.9) = 3.802$, $p < .001$). There were no differences on child age ($p = .071$), sex ($p = .902$), subjective social status ($p = .412$), perceived stress ($p = .485$), or average cortisol levels ($p = .421$).

Correlation Analyses

As shown in Table 2, child age was related to reaction time ($r = -.30$, $p < .01$) and EF ($r = .22$, $p < .05$), but it was unrelated to child sex, child race, household SES, subjective social status, perceived stress, or cortisol. SES was not significantly correlated with perceived stress or subjective social status. Subjective social status and perceived stress were also uncorrelated. Both SES ($r = .31$, $p < .01$) and subjective social status ($r = .24$, $p < .05$) were positively correlated with executive functioning.

Next we used partial correlations to control for location of assessment. The pattern of results was largely qualitatively similar to that presented in Table 2. However, SES was no longer significantly associated with being African American ($r = -.17$, $p > .10$) and became marginally associated with subjective social status ($r = .20$, $p < .10$). The correlations of EF with age ($r = .17$, $p > .10$) and reaction time ($r = -.17$, $p > .10$) did not reach significance, and the correlations of EF with SES ($r = .21$, $p < .10$) and with being Hispanic ($r = .20$, $p < .10$) were marginally significant.

Associations of SES, Social Status, and Perceived Stress, with EF

Results of Model B, shown in Table 3, indicated that both objective SES and subjective social status were associated with EF. Objective SES was positively related to EF ($B = .07$, $SE = .02$, $p = .002$) with a moderate effect size of .34 such that every standard deviation increase in SES was associated with a .34 standard deviation increase in EF score. Parental subjective social status was also marginally positively related to child EF ($B = .02$, $SE = .01$, $p = .074$). Parental perceived stress was not related to child EF. As expected, older children had higher EF scores ($B = .003$, $SE = .001$, $p = .011$). Sex, race, and processing speed were unrelated to EF.

In Model C, Table 3, we also controlled for location of assessment. Results of this analysis were qualitatively similar to those from Model B. The effect of subjective social status, however, reached statistical significance ($B = 0.03$, $SE = 0.01$, $p = .037$). Being assessed in the lab compared

TABLE 2
Bivariate Correlations

	1	2	3	4	5	6	7	8	9	10	11
1. Sex											
2. Child Age	-0.13										
3. African American	-0.19 [†]	0.08									
4. Hispanic	0.05	-0.13	-.29**								
5. Biracial	0.01	0.01	-.25*	-.29**							
6. White	0.11	0.04	-.36**	-.42**	-.36**						
7. SES	-0.09	0.02	-.23*	-.32**	0.16	.35**					
8. SSS	0.06	-0.15	-.27*	.30**	0.12	-0.14	0.14				
9. Perceived Stress	0.11	0.07	-0.07	0.04	-0.11	0.12	-0.08	-0.03			
10. Reaction Time	-.25*	-.30**	0.06	0.01	0.10	-0.15	-0.11	0.07	0.04		
11. EF	0.09	.22*	-0.11	0.10	-0.13	0.11	.31**	.24*	-0.10	-.21 [†]	
12. Cortisol Mean	0.17	0.001	0.08	-0.13	-0.10	0.13	0.07	-0.02	-.24*	0.03	0.25*

[†] $p \leq .10$; * $p \leq 0.05$; ** $p \leq 0.01$.

to being assessed in a school or center was also positively associated with EF ($B = 0.09$, $SE = 0.04$, $p = .016$).

Associations of SES, Social Status, and Perceived Stress with Cortisol

We first used regression analyses to examine the relations of child and family characteristics to mean cortisol. As shown in Model E, Table 4, perceived stress significantly predicted mean cortisol ($B = -0.18$, $SE = 0.07$, $p = .014$) with an effect size of -0.26 such that each standard deviation increase in parental perceived stress was related to a $.26$ standard deviation reduction in cortisol. No other child or family characteristics were associated with mean cortisol. After controlling for location of assessment in Model F, results remained qualitatively similar. Being assessed in the lab compared to being assessed in a school or center was also positively associated with cortisol ($B = 0.28$, $SE = 0.12$, $p = .013$).

Next, to examine whether the relation of SES, SSS, or perceived stress to cortisol was dependent on age, we

examined the interaction of each of those aspects of families' experiences with age in three separate models, controlling for child and family characteristics and location of assessment. Results indicated a significant interaction of age by SES (see Figure 1) ($B = 0.02$, $SE = 0.003$, $p < .001$) but not by SSS ($B = -0.002$, $SE = 0.002$, $p = .487$) or perceived stress ($B = -0.01$, $SE = 0.005$, $p = .228$). Analysis of the simple slopes at 8 and 11 years of age indicated that for younger children, lower SES was associated with higher cortisol ($B = -0.34$, $SE = 0.09$, $p < .001$), whereas for older children, lower SES was associated with lower cortisol ($B = 0.19$, $SE = 0.08$, $p = .019$).

DISCUSSION

This is the first study to examine ways in which subjective aspects of social status and perceived stress are related to children's executive functioning and stress physiology over and above objective measures of SES. Results

TABLE 3
Regression Models Predicting EF

	Model A			Model B				Model C			
	Estimate	SE	<i>p</i> value	Estimate	SE	<i>p</i> value	Std. est.	Estimate	SE	<i>p</i> value	Std. est.
Age	0.003	0.001	0.042	0.003	0.001	0.011	0.27	0.003	0.001	0.015	0.24
Sex	0.05	0.04	0.241	0.05	0.04	0.205	0.14	0.05	0.04	0.174	0.15
Reaction Time	-0.02	0.03	0.572	-0.02	0.03	0.622	-0.05	-0.01	0.03	0.788	-0.03
African American	0.01	0.05	0.856	0.01	0.05	0.900	0.01	0.03	0.04	0.467	0.08
Hispanic	0.08	0.04	0.051	0.04	0.04	0.332	0.11	0.06	0.04	0.121	0.16
Biracial	-0.05	0.06	0.390	-0.08	0.06	0.166	-0.18	-0.07	0.06	0.219	-0.16
SES	0.08	0.02	<.001	0.07	0.02	0.002	0.34	0.05	0.02	0.037	0.25
SSS				0.02	0.01	0.074	0.23	0.03	0.01	0.037	0.26
Perceived Stress				-0.03	0.03	0.278	-0.11	-0.04	0.03	0.153	-0.14
Lab Assessment								0.09	0.04	0.016	0.26
Intercept	0.35	0.23	0.135	0.22	0.22	0.317	1.32	0.19	0.20	0.363	1.11

TABLE 4
Regression Analyses Predicting Mean Cortisol

	Model D			Model E				Model F			
	Estimate	SE	<i>p</i> value	Estimate	SE	<i>p</i> value	Std. est.	Estimate	SE	<i>p</i> value	Std. est.
Age	0.002	0.004	0.620	0.002	0.003	0.564	0.07	0.001	0.003	0.663	0.05
Sex	0.14	0.10	0.162	0.16	0.10	0.085	0.19	0.14	0.09	0.142	0.15
African American	-0.03	0.15	0.843	-0.05	0.13	0.689	-0.05	-0.04	0.13	0.745	-0.04
Hispanic	-0.06	0.12	0.610	-0.10	0.13	0.433	-0.10	0.02	0.13	0.866	0.02
Biracial	-0.13	0.14	0.344	-0.18	0.15	0.213	-0.17	-0.14	0.15	0.351	-0.12
Time of Day	-0.05	0.02	0.020	-0.04	0.02	0.028	-0.24	-0.07	0.02	0.001	-0.42
SES	0.02	0.06	0.767	-0.003	0.06	0.964	-0.01	-0.07	0.07	0.312	-0.14
SSS				0.003	0.03	0.916	0.01	0.01	0.03	0.835	0.02
Perceived Stress				-0.18	0.07	0.014	-0.26	-0.19	0.07	0.005	-0.27
Lab Assessment								0.28	0.12	0.013	0.31
Intercept	-2.67	0.10	< .001	-2.66	0.11	< .001	-6.06	-2.79	0.11	< .001	-6.35

demonstrated that both subjective social status and objective SES, which were uncorrelated in this data set, account for unique variance in executive functioning scores. The effect of objective SES was of medium strength, while the effect of subjective social status was slightly weaker and only marginally significant after controlling for objective SES and other child characteristics. After controlling for location of assessment, however, the effect of subjective social status also emerged as significant and the effect size of SES decreased but remained significant. Despite this slight difference in magnitude of effects, however, these results provide some initial evidence that both objective and subjective aspects of families' experiences in poverty are important correlates of children's EF.

With regard to stress physiology, we did not find any direct relations of SES or subjective social status to cortisol. Our results did, however, demonstrate that higher parental perceived stress was related to lower levels of cortisol in children.³ Moreover, age, which was not correlated with cortisol or with SES, moderated the relation of SES to cortisol such that lower SES was associated with higher cortisol for younger children, but with lower cortisol among older children. This finding provides preliminary evidence that the relation of SES to cortisol levels may change later in childhood as further discussed below.

There are several possible reasons why subjective social status and perceived stress may be related to stress physiology and executive functioning over and above more objective indicators of SES. Interestingly, SES and subjective social status were uncorrelated in our sample. Correlational analyses suggest that the racial/ethnic diversity of the sample may have played a role in this null relation as some racial/ethnic groups were more likely to rate themselves as higher or lower in subjective social status, despite showing the opposite patterns of SES. It is possible that subjective social status is able to capture aspects of SES that the objective indicators of educational attainment, occupational prestige, and income cannot. For example, parents may be

considering additional factors such as family wealth, standard of living, and financial security when ranking themselves on the SES ladder.³⁹ Including subjective social status may therefore offer a more global perspective of family resources that could relate to child outcomes in meaningful ways. Additionally, measures of people's perceptions of their experiences may capture aspects of stressful inequalities not reflected in objective measures of SES. Among people who have similar levels of material resources, there is likely to be variation in how people respond psychologically. Subjective social status may thus reflect the ways in which people see their own relative hierarchical position or social standing in relation to other people, such that some may view the situation in a more positive light perhaps by comparing themselves to others who have less than they do, whereas others may view similar situations in a more negative light and compare themselves to those who are much more well off. It may be that parental perceptions of social status would influence how children view themselves in relation to others, making them feel superior or inferior, and thus lead to differences in their stress physiology and in how well they perform on complex cognitive tasks. Although we found support for this hypothesis with regard to EF, we did not find any relation of parental subjective social status to cortisol, which differs from previous work that reported a positive association with cortisol in children.²⁶

Alternatively or in addition, measures of perceived stress may capture subtle variation in social capital resources. Although people within a given level of objective SES may face similar challenges, their ability to deal with these challenges may differ based on their own feelings of competence as well as on their ability to take advantage of resources, such as family or friend networks, that are not captured in objective assessments of SES. Of note, perceived stress was unrelated to SES and subjective social status. Thus, although somewhat consistent with prior work,³¹ our finding that higher perceived stress was

associated with lower cortisol should be interpreted with caution. Although researchers tend to think of the ways in which low SES environments might be stressful, some work has demonstrated that high SES environments might be stressful for children because of high expectations for achievement as well as physical and emotional isolation from parents.⁴⁰ In future work with larger sample sizes, it would be interesting to investigate ways in which the kinds of stress experienced by high and low SES parents may differ and thus may be associated with child outcomes in different ways.

There are several mechanistic pathways through which parental SES, subjective social status, and perceived stress may in turn influence children's stress physiology and executive functioning. Differences in parenting behaviors are one possible common pathway by which children's self-regulation could be shaped. Several studies have demonstrated that contexts of poverty are associated with less supportive parenting behaviors.^{6,41,42} Moreover, a lack of positive parenting has been shown to mediate low-income related deficits in EF in early childhood.⁶ Similarly, even in middle childhood, parental responsiveness and family companionship have been shown to mediate relations of SES to inhibitory control and working memory.³ Thus, although not investigated in this study, SES, subjective social status, and perceived stress may influence more proximal processes of parent child interactions, which could mediate children's self-regulatory outcomes.

Our finding of no main effect of SES on cortisol is surprising given a body of literature that has tended to find that lower SES is associated with a pattern of either hyper- or hypocortisolism. There are several possible reasons, however, why we did not find either of these mean patterns in the current study. First, much of the previous work has compared groups of children who fall within narrow SES ranges,^{10,15,21} whereas this study examines children along a gradient of SES. One large longitudinal study of 1,292 children did, however, find an association along a gradient of SES,⁶ which may suggest that our study was underpowered.

Second, in most previous studies that found that socioeconomic disadvantage was associated with hypercortisolism, samples were primarily preadolescent children (but see Chen et al¹⁶ for an exception). In contrast, much of the work suggesting a pattern of hypocortisolism has been done in older samples of adolescents²⁰ and college undergraduates.¹⁹ Our sample spanned this age range. Consistent with these past findings, our analysis revealed a significant SES \times age interaction such that, for the younger children, lower SES was associated with higher cortisol, whereas among older children, lower SES was associated with lower cortisol. Thus it may be that a pattern of hypocortisolism can develop later in adolescence and adulthood following an earlier period of hypercortisolism. The upregulation of cortisol may occur in early childhood in response to adversity,⁴³ whereas later downregulation may occur over a

longer period of chronic stress.^{43–45} Investigating the extent to which puberty may play a role in this transition is an important direction for future research as we did not measure any biological indicators of puberty in this study and as the oldest children (11- and 12-year-olds) in our study may or may not have gone through puberty.

Limitations

This study is limited by the relatively small sample size. While the findings are of substantial interest, much future work is needed to replicate them in larger samples. Many larger studies, however, have focused specifically on low-income families without including higher SES children, or have compared groups of low vs high SES children without examining SES as a gradient. Our sample is thus unique in representing a broad range of SES, and future studies should aim for at least this level of socioeconomic diversity. A second issue concerning the sample is that although a broad range of socioeconomic backgrounds are represented, there are also correlations between race and SES. Although the small sample size and race–SES correlations preclude us from definitively disentangling the effects of race and SES in these analyses, we note that there was overlap in SES across groups and that all analyses controlled for race as has been commonly done in past studies. Race, however, was not correlated with cortisol or EF, thus suggesting that the SES differences in those measures are less likely to be confounded. An important direction for our future work is to explore these questions in a sample that has racial diversity across the SES spectrum. A third limitation of the study is that saliva samples were collected on only one day. Collecting samples on multiple days would have facilitated more stable estimates of children's traits such as cortisol levels. We did, however, collect samples at 3 time points, and we used information from all 3 time points to construct our measures of cortisol output, which may have helped to reduce noise from measurement error or other factors that could have influenced measurement at a specific time point. Along similar lines, because the majority of children were seen in school or afterschool contexts, we were unfortunately unable to control for medications or food that they may have consumed prior to collection of the saliva samples. A fourth limitation is that children were assessed in different contexts. To address this limitation, we controlled for whether children were assessed in the laboratory versus a school/center context. The moderate correlation between SES and assessment location may have diminished the effect size of SES and future studies to examine the effect of assessment location would benefit from a study design in which those constructs are uncorrelated. Finally, this study is limited in its ability to provide causal inference because of its cross-sectional design. Future work would benefit from a longitudinal

design examining the ways in which changes in family circumstances are related to changes in EF as well as ways in which cortisol changes for children from different SES backgrounds as they grow older.

CONCLUSIONS

Despite these limitations, this study offers a unique contribution to the literature by providing evidence for the importance of considering both objective and subjective indicators of families' SES and stressful experiences in relation to both cognitive and physiological aspects of children's self-regulation and, as such, raises several directions for productive future research. Moreover, the study suggests the practical importance of taking into account multiple facets of children's experiences of poverty when evaluating self-regulatory problems in clinical and school settings and suggests that these facets of families' experiences will also need to be considered when designing interventions to improve children's self-regulatory outcomes.

FUNDING

The first author's role in this research was supported by the Institute of Education Sciences, US Department of Education, through Grant R305B080019 to New York University. The opinions expressed are those of the authors and do not represent views of the Institute of the US Department of Education. The first author's role in this research was also supported by funding from the Neuroepidemiology Training Program at Columbia University (NIH/NINDS T32-NS07153).

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