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Eleanor D. Brown
West Chester University of Pennsylvania, ebrown@wcupa.edu

Mallory L. Garnett
West Chester University of Pennsylvania

Kate E. Anderson
West Chester University of Pennsylvania

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Eleanor D. Brown, Mallory L. Garnett, and Kate E. Anderson
West Chester University

Jean-Philippe Laurenceau
University of Delaware

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This within-subjects experimental study investigated the influence of the arts on cortisol for economically disadvantaged children. Participants were 310 children, ages 3–5 years, who attended a Head Start preschool and were randomly assigned to participate in different schedules of arts and homeroom classes on different days of the week. Cortisol was sampled at morning baseline and after arts and homeroom classes on two different days at start, middle, and end of the year. For music, dance, and visual arts, grouped and separately, results of piecewise hierarchical linear modeling with time-varying predictors suggested cortisol was lower after an arts versus homeroom class at middle and end of the year but not start of the year. Implications concern the impact of arts on cortisol for children facing poverty risks.

Fourteen years ago, Lupien, King, Meaney, and McEwen (2001) asked whether poverty could get under the skin. The answer was yes. Poverty influences physiological systems that respond to stress, as indexed by the hormone cortisol. The result is a host of negative emotional, cognitive, and physical health outcomes for economically disadvantaged children. We now ask whether the arts can "get under the skin" and promote healthy cortisol functioning for young children facing poverty risks.

Physiological Stress Response and Cortisol

The hypothalamic–pituitary–adrenal (HPA) axis is one of two systems that coordinate physiological stress response (Charmandari, Tsigos, & Chrousos, 2005; Gunnar & Quevedo, 2007). The activity of this system can be indexed by its endproducts, glucocorticoids. The primary glucocorticoid is cortisol, which can be measured noninvasively via small samples of saliva. Basal or resting cortisol follows a diurnal pattern that typically includes a morning peak followed by a gradual decrease over the course of the day. Resting cortisol supports the daily functioning of the organism including metabolism and learning, and the higher morning levels motivate the organism to search for carbohydrates and novel experiences (Charmandari et al., 2005; Gunnar & Quevedo, 2007).

Cortisol reactivity involves elevations of cortisol that are superimposed on the baseline in response to acute stress. Peak cortisol response can be measured 20–25 min after the onset of an acute stressor (Gunnar & Adam, 2012). The rise in cortisol results in the mobilization of energy resources to meet the demands of the stressful situation. Cortisol also provides the negative feedback inhibition to the pituitary and hypothalamus that is necessary for the termination of stress response by the sympathetic nervous system (Charmandari et al., 2005). Because of cortisol's powerful effects, tight regulation of this hormone, including efficient engagement and termination of stress response, matters critically for healthy functioning (McEwen, 2013).

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Correspondence concerning this article should be addressed to Eleanor D. Brown, Department of Psychology, Peoples Building Room 30, West Chester University, West Chester, PA 19383. Electronic mail may be sent to ebrown@wcupa.edu.

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Poverty and Cortisol

Repeated or chronic exposure to stress is associated with wear and tear on the HPA system that results in cortisol dysregulation (Gunnar & Vazquez, 2001; McEwen, 2013; Miller, Chen, & Zhou, 2007). Research suggests that for children who face poverty-related stress, this typically manifests as elevated basal cortisol (Blair et al., 2011). Lupien et al.'s (2001) seminal study, for example, found that 6- to 10-year-old children of low socioeconomic status (SES) showed higher cortisol levels than their high SES counterparts. Subsequent studies have demonstrated the importance of contextual poverty risks for explaining SES effects. For a sample of rural, school-age children, for example, Evans (2003), found that a cumulative index of poverty-related risks, including aspects of the physical environment, such as household noise, and crowding and psychosocial factors, such as turmoil and violence, related to higher levels of cortisol as well as other markers of allostatic load or tax on physiological systems that respond to stress.

The impact of poverty on stress physiology begins early. Blair and investigators from the Family Life Project, for example, have demonstrated that poverty-related risks predict elevated cortisol levels for children ages 7 through 48 months (Blair, Berry, Mills-Koonce, & Granger, 2013; Blair et al., 2011). Furthermore, effects of exposure to poverty can accumulate and have long-term effects on physiological functioning. In a study by Chen, Cohen, and Miller (2010), low SES related to greater increases in basal cortisol over a 2-year period, and this effect was partially mediated by children's perception of threat and by family chaos. Additionally, Evans and Kim (2012) demonstrated that the proportion of childhood spent in poverty from birth to age 9 years was linked to elevated allostatic load, including as indicated by cortisol, in 17-year-olds, and that cumulative risk exposure at age 13 years mediated this relationship.

Cortisol Dysregulation

Chronic elevations in cortisol pose problems for multiple domains of development. Elevated cortisol levels are linked to physical health problems such as immunosuppression (McEwen & Gianaros, 2010); cognitive difficulties, for example, childhood executive functioning problems (Blair et al., 2011); and emotional difficulties, including early childhood fear or withdrawal (Fortunato, Dribin, Granger, & Buss, 2008). Research suggests that chronically elevated cortisol alters neuronal connections in brain areas such as the hippocampus, prefrontal cortex, and amygdala (McEwen, 2013).

Chronically elevated cortisol in childhood additionally alters the development of physiological stress response systems. A study by Miller et al. (2009) used genome-wide transcriptional profiling with an adult sample and found that low SES in childhood was associated not only with elevated basal cortisol but also with upregulation of genes associated with adrenergic neural receptor function and downregulation of genes associated with glucocorticoid receptor function. These adjustments are consistent with a pattern of higher cortisol reactivity and less prototypically effective regulation, expected for individuals exposed to childhood poverty (Miller et al., 2009), and provide an example of the dynamic adjustments involved in allostasis, or the interactive maintenance of equilibrium by multiple physiological systems, including the HPA (McEwen, 2013; McEwen & Stellar, 1993).

Indeed, dynamic adjustments in physiological functioning sometimes result in attenuated HPA responsiveness (Susman, 2006). Thus, individuals who have faced abuse, neglect, trauma, or other severe and chronic stress, including some children growing up in poverty, may show muted cortisol reactivity as well as flattened or low basal levels across the day known as hypocortisolism (Fernald, Burke, & Gunnar, 2008; Fries, Hesse, Hellhammer, & Hellhammer, 2005; Gunnar & Vazquez, 2001; Kliewer, Reid-Quiñones, Shields, & Foutz, 2009; Raison & Miller, 2003; Roisman et al., 2009). The adaptation of flattened cortisol may offer protection from some of the negative effects of chronically elevated cortisol, but also comes at a cost (Fries et al., 2005). For example, a lack of moderate cortisol rise in response to challenge compromises child cognitive functioning (Blair, Granger, & Razza, 2005). Also, hypocortisolism has been linked in numerous investigations to child externalizing behavior problems (e.g., Alink et al., 2008; Haltigan, Roisman, Susman, Barnett-Walker, & Monahan, 2011; Shirtcliff, Granger, Booth, & Johnson, 2005), and in some cases to internalizing problems (e.g., Miller et al., 2007). The consequences of childhood cortisol dysregulation suggest the importance of prevention and early intervention.

Promoting Cortisol Regulation

Several lines of investigation suggest possibilities for promoting healthy HPA functioning for economically disadvantaged children. First, there is evidence that alleviating income impoverishment may promote cortisol regulation. Fernald and Gunnar (2009), for example, conducted a quasi-experimental study of a large-scale poverty alleviation (i.e., cash transfer) program in Mexico, and found that children who had been in this "Oportunidades" program had lower salivary cortisol levels when compared with those who had not participated in the program, while controlling for a wide range of individual, household, and community-level variables. The effect of Oportunidades on cortisol was greater for children of mothers with high depressive symptoms, a result that speaks to the importance of parenting factors.

Second, and relatedly, parent–child attachment relations matter critically for healthy cortisol regulation (e.g., Gunnar & Quevedo, 2008) and quasi-experimental studies with children in foster care have suggested that intervening to promote positive parent–child relationships can alleviate the HPA burden typically associated with parental separations (e.g., Dozier, Peloso, Lewis, Laurenceau, & Levine, 2008). In the 2008 study by Dozier et al., for example, morning cortisol levels of foster care children participating in such an intervention were lower than those of a control group of foster care children and similar to the levels of children who had not been placed in foster care. Research additionally suggests that secure attachment may buffer children from the cortisol elevations associated with the transition to center-based child care (Ahnert, Gunnar, Lamb, & Barthel, 2004).

Third, early childhood education and center-based care matters for children's cortisol levels, and some research suggests possibilities for promoting cortisol regulation in this context (Vermeer & IJzendoorn, 2006). Children generally show higher cortisol levels in day care or preschool compared with at home, with an atypical increase from midmorning to midafternoon (e.g., Dettling, Parker, Lane, Sebanc, & Gunnar, 2000; Vermeer & IJzendoorn, 2006; Watamura, Coe, Laudenslager, & Robertson, 2010). Also, a 2009 study of adolescents by Roisman et al. demonstrated that more time in child-care centers in the first 3 years of life uniquely predicted basal cortisol levels indicative of attenuated HPA responsiveness following early stress. The Roisman et al. study accounted for demographic variables, and results did not differ based on measured aspects of child-care quality. Some research with preschool age (i.e., 3- to 5-year-old) children, however, has indicated that settings that include substantial stimulation from an adult caregiver may promote lower and more typical cortisol trajectories for this age group (e.g., Dettling et al., 2000). Additionally, some research suggests that effects may differ for those facing different levels of poverty risk (Berry et al., 2014), and that economically disadvantaged children in center-based care may be more likely than their middle-income counterparts to demonstrate typical patterns of decreasing cortisol across the morning (Rappolt-Schlichtmann et al., 2009).

Fourth, there is evidence that self-regulation, or the ability to control attention, emotions, and behavior in the service of goal-directed activity (Dich, Doan, & Evans, 2015), may offer some protection from the impact of poverty-related risks on HPA functioning. In a sample of economically disadvantaged African American youth, Kliewer et al. (2009) found that multiple poverty risks were associated with depressed cortisol levels, but that youth with good emotion regulation skills showed no difference across low and high levels of risk. In a different sample of youth facing multiple poverty risks, Dich et al. (2015) found that negative emotionality prospectively predicted increases in allostatic load from ages 9 to 17 years, but only for children with low levels of self-regulation. Moreover, a recent cluster randomized controlled study by Blair and Raver (2014) suggested that a kindergarten curriculum targeting self-regulatory skills promoted cortisol regulation for children in high-poverty schools, despite no main effect on cortisol across school type. The impact of emotion regulation and other self-regulatory skills suggests the potential benefits of the arts for children's HPA functioning.

The Arts and Self-Regulation

Robust empirical evidence supports the emotion regulation benefits of arts-based practices. Multiple studies with children and young adults, for example, suggest that drawing can lead to short-term mood improvement after the induction of negative mood (e.g., Dalebroux, Goldstein, & Winner, 2008; Drake & Winner, 2013). Additionally, a study by Winsler, Duceene, and Koury (2011) documented an advantage in self-regulation for young children who participated in a music program compared with peers who did not participate and suggested that an increase in self-regulatory private speech correspondent to music participation might serve as one mechanism of this effect.

Emotional benefits of the arts have been demonstrated in several investigations with children facing poverty risks. In a study by Lobo and Winsler

(2006), for example, children attending Head Start preschool were randomly assigned to participate in either an 8-week creative dance and movement program or a control group with free playtime. Those participating in the creative dance and movement program showed greater improvement with regard to social skills as well as internalizing and externalizing problems as rated by parents and teachers who were blind to children's group membership. Brown and Sax (2013) studied Settlement Music School's Kaleidoscope Preschool, a Head Start site where children participate in music, dance, and visual arts classes each day as well as regular early learning or homeroom. Children at Kaleidoscope showed greater expression of positive emotions in arts versus regular homeroom classes and, compared to peers attending a matched comparison site that was not arts enriched, showed greater growth in emotion regulation skills over the course of the year.

The Arts and Cortisol

Although no studies we know of have examined the potential influence of the arts on cortisol levels for children facing poverty risks, studies with middle and heterogeneous income samples of adults suggest potential benefits. Various types of music therapy have been linked to cortisol reduction for adults with mood disturbance (Chen, Sung, Lee, & Chang, 2015; McKinney, Antoni, Kumar, Tims, & McCabe, 1997). Music listening has also been associated with lower cortisol levels for healthy adults facing stressful situations, including medical procedures (Uedo et al., 2004), college examinations (Linnemann, Ditzen, Strahler, Doerr, & Nater, 2015), and laboratory-based stress tests (Khalfa, Bella, Roy, Peretz, & Lupien, 2003).

Different arts modalities may have different effects. One study by Toyoshima, Fukui, and Kuda (2011) reported cortisol reductions associated with piano playing, clay molding, and calligraphy for respective groups of college students and noted the greatest reductions were linked to piano. Also, within a given modality, different arts activities may have different effects. In a study of dance and movement, for example, West, Otte, Geher, Johnson, and Mohr (2004), contrasted the cortisol-reducing effects of Hatha yoga with the cortisol arousal associated with African dance. Additionally, different doses of the arts may be associated with different effects. A unique study of music and cortisol for a heterogeneous income sample of children in Sweden found that, across the school year, those assigned to a once per week music class did not show significant differences in daily cortisol compared with control groups (Lindblad, Hogmark, & Theorell, 2007), perhaps because this dose of arts participation was insufficient.

Present Study

The present study examined the impact of music, dance, and visual arts classes on cortisol for children attending Settlement Music School's Kaleidoscope Preschool Arts Enrichment Program, a Head Start site. The inclusion of music, dance, and visual arts facilitated investigation of the potentially different impact of these arts modalities. The focus on Head Start promoted understanding diversity within the ecology of poverty and identifying mechanisms for reducing cortisol for children facing poverty-related stress.

All Head Start programs include some integration of the arts. Creative arts expression is one of ten domains included in the U.S. Department of Health and Human Service's Administration for Children and Families' Office of Head Start (2011) curriculum framework. Moreover, the Creative Curriculum (Dodge & Colker, 1992) is widely used in Head Start preschools and guides the integration of arts activities into homeroom classes. Settlement's Kaleidoscope Preschool is unique, however, in its full integration of the arts.

In addition to homeroom classes based on the Creative Curriculum, children at Kaleidoscope receive multiple arts classes each day taught in fully equipped artist studios by credentialed artist teachers for music, dance, and visual arts. While the lead homeroom teachers have bachelor's degrees and certification in early childhood education, the arts teachers have bachelor's degrees in their respective arts areas and certification in either arts or early childhood education, with the exception of the visual arts teacher who has a master's degree. Lead and assistant homeroom teachers alternate in accompanying the children to their arts classes such that the adult to child ratio remains constant. All classes are 45 min in length and include a combination of individual, small group, and large group activities, fine and gross motor activities, and free versus teacher-directed activities. The arts classes are designed to foster skill development in the arts as well as in other Head Start domains such as language, mathematics, and science.

Most Head Starts base instruction around early learning themes, but the repetition of these themes in arts as well as regular early learning classes is unique to Kaleidoscope, where the themes represent a common organizing principle. For the theme of "self-expression," a typical Head Start might give children opportunities in homeroom to practice labeling facial expressions of emotions as well as express themselves and change their emotional state through creating journals. At Kaleidoscope, children receive additional opportunities to explore the theme in arts classes. The visual arts class might allow children to express themselves through media such as painting or collage, for example, as well as discuss how pieces of visual art make them feel. In music, children might use their voices and other instruments to reproduce sounds that humans and other animals make to express emotions. Also, in dance, children might use creative movement to perform different emotions for their classmates to identify. In the various arts classes, children participate in guided exploration of how to use sound, movement, and visual media, respectively, to express and change their emotional state.

Also in common with most Head Starts, Kaleidoscope incorporates varied cultural traditions and provides opportunities for skill development in core early childhood domains of math, science, language, literacy, and social and cultural learning. Again Kaleidoscope is unique, however, in using multiple arts as well as early learning classes to accomplish these goals. For example, in autumn, Indian cultural traditions might be included as children learn about Diwali, the "festival of lights." At Kaleidoscope, children might develop language and literacy skills such as vocabulary, by learning Hindi vocabulary in early learning classes; writing prerequisites, by copying Indian mandala designs in visual arts; and reading prerequisites, by following Indian song-stories in music and dance, singing and moving in response to pictorial cues. To develop math skills, children might learn about patterns by repeating their mandala designs with variation in visual arts, as well as clapping and moving to the beat in music and dance. In this way, core school readiness skills are practiced through multiple modes of learning.

Because of its unique preparedness to offer high-quality music, dance, and visual arts classes within the Head Start framework, Kaleidoscope provided an ideal setting for examining the impact of these arts classes on cortisol for young, economically disadvantaged preschool children. The present study sought to answer the question: Can arts classes change cortisol? In a within-subjects experiment, children were randomly assigned, by preschool class, to participate in music, dance, and visual arts classes at different times on different days. Cortisol was measured at morning baseline as well as at midmorning, noon, and afternoon, just following the respective arts and homeroom classes. Assessments were conducted on two different days, at start, middle, and end of the year time points. We hypothesized that, compared with homeroom classes, participation in arts classes would be associated with unique, and greater than usual, within-persons reductions in cortisol.

Method

Participants

This investigation included 310 children who attended Settlement Music School's Kaleidoscope Preschool Arts Enrichment Program, located in the Queen Village neighborhood of Philadelphia, Pennsylvania, USA, in one of four school year cohorts between 2008 and 2012, as well as their primary caregivers. Mean age of the children was 4 years, 1 month (SD = 6.71 months). Of the children, 52.3% were female, and 54.5% were African American, 15.2% Latino or Hispanic American, 10.3% Asian American, and 20.0% Caucasian or European American. Approximately 30.0% represented the first generation in their family born in the United States, 68.1% were monolingual English language learners, and 31.9% were dual language learners, with Spanish (14.8% of total sample) representing the most common other language.

Mean family size was 2 adults (range = 1–6, SD = 0.83) and 3 children (range = 1–7, SD = 1.2). Mean family annual income was $12,638 (range = 0–50,000, SD = 11,959). Information about income and family size was combined to compute income to needs ratios, which were compared to federal poverty guidelines for the appropriate years: 79% of the families were poor and 100% were low-income, with income to needs ratios < 2 times the poverty threshold.

Procedure

Ethical standards were followed in the conduct of this study, and all procedures were approved by the appropriate institutional review boards. Recruitment took place in September, at the start of the preschool year. Parents or caregivers of children enrolling in the preschool for the first time were provided a description of the study as part of their preschool orientation, and were given the opportunity to ask questions of a trained research assistant as well as sign letters of informed consent. Necessary translation was provided for school orientation and research activities. Two children regularly taking medication known to influence cortisol (e.g., antiseizure medication) were excluded. Participation rates were over 95% for each year.

The first study component involved a demographic interview with parents or caregivers, conducted at the preschool by trained research assistants in September, at the start of the preschool year. Parents were provided multiple opportunities to complete these interviews, including during preschool orientation and adjacent to school drop-off and pick-up times during the first several weeks of the school year.

The second study component included assessments of child salivary cortisol on 2 days of the week during September, January, and June. On these days, cortisol was sampled in duplicate at four times across the day, resulting in a total of 48 samples per child. Cortisol was sampled at 9 a.m. (after arrival at preschool and before breakfast), 10:30 a.m. (or midmorning), noon (before lunch), and 1:30 p.m. (afternoon). While the 9 a.m. assessment time was included to tap baseline cortisol before exposure to preschool classes on a given day, the midmorning, noon, and afternoon assessments directly followed participation in a 45-min homeroom or arts class and were included to measure the impact of class type on cortisol. The timing of cortisol assessment was based on current standards (Gunnar & Adam, 2012).

Children were randomly assigned, by preschool class, to a weekly schedule that included different numbers of arts versus homeroom classes and different timing of these classes on different days of the week. No child received more than one class of the same arts modality in 1 day, and the overall exposure to each arts modality was the same: Each child received each type of arts class four times per week. There were five preschool classes, grouped by child age, and each included 12–20 children, with the lowest number in the youngest age class. Within each class, children were randomly assigned to two cortisol assessment days at start, middle, and end of the year. Approximately equal numbers of children in a given preschool class were assigned to a cortisol assessment day on each of the 5-week days, which included different schedules of arts and homeroom classes. In 17 cases, children participating in the cortisol assessments missed a scheduled assessment day because they were absent from school or because they had taken medication or eaten breakfast just prior to coming to school. In these cases, their assessment was rescheduled for the same day of the week during the following week.

In sum, the design included four class types (homeroom, music, dance, and visual arts), five preschool classes grouped by age, three times of the year (start, middle, and end), two assessment days at each time of the year, and four cortisol assessments within each day (early morning, midmorning, noon, and afternoon). The balancing was sufficient to ensure that we could compare each arts class to homeroom at the relevant times of the day (i.e., midmorning, noon, and afternoon) and that children from each preschool class contributed observations to those within-persons comparisons. It was incomplete in that every child did not contribute observations to every arts versus homeroom comparison at every relevant time point.

Piecewise latent growth curve modeling (Flora, 2008) was used to model children's average trajectories of cortisol across the day. This type of modeling is standard for accounting for the impact of time of the day on cortisol (Gunnar & Adam, 2012), and is described further in the Results section. The number of children and within-persons observations contributing to each comparison of arts versus homeroom classes is also included in the Results section.

Measures

Demographic Interview

This interview provided information about standard indicators such as child age, sex, race and ethnicity, family size, and family income.

Cortisol

Salivary assays were used to measure child cortisol. Under the direction and supervision of a research assistant, children held two sorbettes (small sponges) under their tongue for approximately 1 min to collect saliva. The research assistant then checked the sorbettes for sufficient saliva volume and repeated the sampling as necessary before placing them in a conical tube to be frozen (20°C) until shipped on dry ice overnight to Salimetrics, LLC, State Collect, PA, for analysis.

The analysis by Salimetrics, LLC followed standard procedures described by Blair et al. (2005), namely using a 510-k cleared high-sensitive enzyme immunoassay, a biochemical test for the concentration of cortisol in saliva. The test uses 25 μl of saliva (for singlet determinations), has a lower limit of sensitivity of 0.007 μg/dl (micrograms per deciliter), range of sensitivity from 0.007 to 1.8 μg/dl, and average intra- and interassay coefficients of variation < 15% and 10%, respectively. In nine cases, singlet determinations were used in analyses because the duplicate could not be tested due to insufficient saliva volume. In three other cases, both sorbettes contained insufficient volume for testing, resulting in missing observations. In all other cases, the average of the duplicate tests was used, with a criterion of no more than 7% error in agreement. A total of 7,437 cortisol observations from 310 children were available for further statistical analyses.

Class Type

Children's class schedule was coded numerically and used to construct several variables that captured the class a child attended before each of their 24 cortisol assessments. In each variable, the focal class was coded as 1 and the comparison(s) as 0. For example, in a variable that facilitated comparison of homeroom to all three arts classes, homeroom was coded as 1 and the arts classes as 0. In other variables that facilitated comparison of homeroom to a single arts class, the respective focal arts class (e.g., music) was coded as 1 and homeroom was coded as 0, whereas the arts classes not involved in this comparison (e.g., dance and visual arts) were coded as missing. Data for class type were always coded as missing at the first (i.e., 9 a.m. baseline) time point of cortisol analysis, when children had just arrived at school and had not yet participated in a class.

Results

Preliminary Analyses

Mean raw cortisol measured in micrograms per deciliter (N = 7,437 observations from 310 participants) was 0.18 (SD = 0.34) and log cortisol was −0.87 (SD = 0.28). Table 1 displays raw and log cortisol values at each time of the day, for each time of the year. In accordance with standard procedures (e.g., Blair et al., 2011), the log transformation was applied to correct for positive skew in the cortisol values, and log cortisol was used in subsequent analyses. The within-persons variance of log cortisol was 0.07 and the between-persons variance of log cortisol was 0.01, resulting in an interclass correlation coefficient of 0.13, indicating that 13% of the total variability in log cortisol comes from children differing from each other in average levels of log cortisol.

To model children's trajectories, we first plotted the raw data over time for each participant as well as the means at each time point across all children. The visualization of the raw data over time allowed us to detect potential nonlinear trends in trajectories. It was clear via visual inspection that the functional form of change included (a) a sharp decrease in log cortisol from the initial early morning assessment to the midmorning assessment just after an arts or homeroom class and (b) a more gradual increase in log cortisol beginning midmorning and tailing off by the afternoon assessment. Therefore, we used piecewise latent growth curve modeling (Flora, 2008) to allow the shape of change within each of these phases to differ based on change parameters separately estimated for each piece to capture the appropriate functional form of change. Linear change appropriately captured the decreasing pattern from early to midmorning, and we refer to this piece of the trajectory as Piece 1L. In contrast, from midmorning to afternoon, cortisol followed a U-shaped pattern of change which was better captured by a quadratic functional form, parameterized as Piece 2L and Piece 2Q. Time was

Table 1
Average Cortisol Across Time at Arts Integrated Head Start Preschool (7,437 Observations From 310 Participants)

	Cortisol, M (SD)	
Time point of assessment	Raw	Log
Start of the year		
Early morning[a]	.28 (.61)	−.73 (.34)
Midmorning	.19 (.49)	−.93 (.32)
Noon	.18 (.34)	−.86 (.28)
Afternoon	.20 (.54)	−.87 (.28)
Middle of the year		
Early morning	.26 (.36)	−.68 (.27)
Midmorning	.14 (.19)	−.95 (.24)
Noon	.16 (.14)	−.88 (.24)
Afternoon	.15 (.12)	−.89 (.22)
End of the year		
Early morning	.26 (.42)	−.72 (.25)
Midmorning	.12 (.32)	−1.02 (.27)
Noon	.14 (.12)	−.93 (.25)
Afternoon	.14 (.12)	−.92 (.21)

Note. Cortisol is measured in μg/dl (micrograms per deciliter). Start of the year = September, middle of the year = January, end of the year = June. Early morning = 9 a.m., midmorning = 10:30 a.m., noon = 12 p.m., afternoon = 1:30 p.m. [a]n = 309.

coded in minutes (early morning = 0 min, midmorning = 90 min, noon = 180 min, and afternoon = 270 min).

Modeling children's cortisol trajectories clarified the functional form of change in cortisol across the day and facilitated controlling for the impact of time of the day in core analyses (Gunnar & Adam, 2012). Specifically, core analyses examining the impact of arts versus homeroom classes required controlling for average cortisol at midmorning, noon, and afternoon time points, as these assessments fell just after arts or homeroom classes. Thus, Piece 2L and 2Q were entered as controls in these analyses. Additionally, because children differed from each other on initial levels of cortisol, we included initial, early morning, or baseline cortisol assessment (i.e., the first time point of Piece 1L) as a control and potential moderator of effects.

Core Analyses

Hierarchical linear modeling (HLMv7; Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011) was used for core analyses in which cortisol samples at various times of the day were "nested" within children. HLM estimates model fixed effect coefficients as well as lower level or Level 1 (within-persons) and upper level or Level 2 (between-persons) random effects. HLM employs full maximum likelihood for valid estimation of parameters in the presence of missing data on outcome variables at particular time points, making the missing at random (MAR) assumption and case-wise deletion to handle missing data on predictors at particular time points. More specifically, MAR refers to the probability that missing a cortisol score at a particular time point may be related to cortisol scores from previous time points and to predictors such as age and sex, but not to the missing cortisol scores at that particular time point (Enders, 2010).

We used piecewise latent growth curve modeling to analyze the dependent variable of cortisol at midmorning, noon, and afternoon time points as a function of both a nonlinear functional form of time and a time-varying independent variable of class type (i.e., arts vs. homeroom). We examined music, dance, and visual arts classes grouped (vs. homeroom) and each art class separately (vs. homeroom) as person mean-centered binary time-varying predictors. The class type time-varying predictors were person mean centered to allow for the estimation of within-persons effects (Bolger & Laurenceau, 2013). Random effects were estimated for both the intercept fixed effect and class type fixed effect. We also examined average initial, early morning cortisol levels as a control variable and potential moderator of the within-persons link between class type and cortisol. In preliminary models, we tested demographic variables of age, sex, race and ethnicity, and income to needs ratio as potential between-persons moderators. With average initial, early morning cortisol accounted for, these demographic variables did not show statistically significant effects and their inclusion or exclusion did not change the pattern of results for the focal predictors: thus, they were not included in final models.

We extended the piecewise growth model to examine effects at start, middle, and end of the year time points of assessment. We then used contrast coefficients to determine whether differences in the effects at the three times of the year were significant, so as to justify separate reporting by time of the year. Across analyses for the arts classes grouped as well as separately, contrast coefficients suggested a similar pattern: effects at the start of the year differed from those at the middle and end of the year, which did not differ significantly from each other. For this reason, we reported the results of analyses that were constrained such that start of the year effects were examined separately from middle and end of the year effects, which were combined.

Table 2 displays the results of the resultant HLM for participation in a homeroom versus arts class (dichotomously coded with 1 = homeroom and 0 = arts) as a predictor of cortisol (Level 1 = 5,560 observations, Level 2 = 309 participants). At the start of the year, participation in an arts class did not show a significant effect on cortisol ($\beta = -.02$, $SE = .01$, $p = .125$). For middle and end of the year time points, however, as hypothesized, participation in an arts class was associated on average with lower cortisol than participation in a homeroom class ($\beta = .03$, $SE = .01$, $p < .001$). The effects did not differ significantly based on initial cortisol levels at any time of the year (p = .862, .080, .308, respectively).

Additional hierarchical linear models tested the impact of each type of arts class versus homeroom (dichotomously coded with 1 = *the focal arts class* and 0 = *homeroom*). In these additional models, the effects associated with time (Piece 2L, and 2Q) and season (start, middle, and end of the year) were functionally the same as those in the first (see Table 2). Effects for focal predictors also followed a similar pattern, and did not differ significantly based on initial cortisol levels. For music (Level 1 = 3,447 observations, Level 2 = 309 participants),

Table 2
Results of Hierarchical Linear Model for Homeroom Versus Arts Classes Predicting Log Cortisol (5,560 Observations From 309 Participants)

Fixed effects for slopes	Coefficient	*SE*	*p*-Value
Start of the year	−.91	.01	< .001
Initial cortisol	.21	.03	< .001
Middle of the year	−.96	.01	< .001
Initial cortisol	.07	.03	.005
End of the year	−1.03	.01	< .001
Initial cortisol	.06	.03	.050
Start of the year Piece 2 linear	.00	.00	< .001
Start of the year Piece 2 quadratic	−.00	.00	< .001
Middle of the year Piece 2 linear	.00	.00	< .001
Middle of the year Piece 2 quadratic	−.00	.00	< .001
End of the year Piece 2 linear	.00	.00	< .001
End of the year Piece 2 quadratic	−.00	.00	< .001
Start of the year homeroom	−.02	.01	.125
Initial cortisol	.01	.04	.862
Middle and end of the year homeroom	.03	.01	< .001
Initial cortisol (for middle of the year homeroom)	.05	.03	.080
Initial cortisol (for end of the year homeroom)	−.03	.03	.308

Note. df = 307. Cortisol is measured in μ/dl (micrograms per deciliter). Start of the year = September, middle of the year = January, end of the year = June. Initial cortisol = average, initial, early morning (9 a.m.) cortisol, entered as a control and potential between-persons moderator of within-persons effects. Piece 2 linear and Piece 2 quadratic capture linear and quadratic change across midmorning (10 a.m.), noon, and afternoon (1:30 p.m.) time points of assessment. Homeroom is coded dichotomously and is person-mean centered in this model such that the effects reflect the average within-persons cortisol change associated with participation in homeroom versus an arts class. The standard deviation of the corresponding random effect was .01, suggesting that 95% of these effects fall between .00 and .04.

at start of the year, there was not a significant effect on cortisol (β = .02, *SE* = .02, *p* = .228). For the middle and end of the year time points, however, as hypothesized, participation in a music class predicted lower cortisol than participation in homeroom (β = −.05, *SE* = .01, *p* = < .001).

Similarly for dance (Level 1 = 3,367 observations, Level 2 = 309 participants), at start of the year, there was not a significant effect on cortisol (β = .00, *SE* = .02, *p* = .980), yet for the middle and end of the year time points, as hypothesized, participation in a dance class predicted lower cortisol than participation in homeroom (β = −.03, *SE* = .01, *p* = .004). For visual arts (Level 1 = 3,489 observations, Level 2 = 309 participants), at the start of the year, participation in visual arts did not predict significantly lower cortisol than homeroom: In fact, at a marginally significant level, the direction of effect was the opposite (β = .03, *SE* = .02, *p* = .051). For middle and end of the year time points of assessment, however, participation in visual arts predicted significantly lower cortisol than participation in homeroom (β = −.02, *SE* = .01, *p* = .023).

Discussion

The present investigation examined the impact of music, dance, and visual arts classes on physiological stress response for children attending Head Start preschools. No prior research we know of examines the arts and cortisol for economically disadvantaged children. Results suggest that the arts can "get under the skin" and reduce cortisol for children facing poverty risks.

We hypothesized that participation in arts compared to homeroom classes would relate to unique reductions in cortisol for children attending a Head Start preschool. Results generally support this hypothesis, revealing lower cortisol after participation in music, dance, and visual arts compared with homeroom classes. This suggests that the arts classes as implemented at Settlement Music School's Kaleidoscope Preschool, where children receive music, dance, and visual arts in fully equipped arts studios and taught by credentialed artist teachers, have value added beyond the limited integration of the arts found in typical homeroom classes based on the Creative Curriculum (Dodge & Colker, 1992). Support for the hypothesis is qualified, however, by the finding that significant effects for the arts classes were not apparent at the start of the preschool year, but rather emerged by the middle of the year and were maintained at year's end. This suggests that physiological benefits of arts programming may not be manifested upon children's initial exposure and may depend on children's adjustment or accumulated skill acquisition.

Specific Arts Modalities

Results of the present study suggest cortisol benefits of music, dance, and visual arts classes. In examining the impact of music, specifically, we found lower average cortisol after music compared to homeroom classes. This result is consistent with studies showing lower cortisol after music listening (e.g., Khalfa et al., 2003) and piano playing (Toyoshima et al., 2011) for heterogeneous income samples of adults. Although some kinds of music, for example, in video games, might lead to cortisol elevations (Hébert, Béland, Dionne-Fournelle, Crête, & Lupien, 2005), the present research adds to evidence that music can be used to lower cortisol.

Cortisol levels also were lower on average after dance or creative movement compared to homeroom. This result is consistent with research demonstrating lower cortisol after movement activities such as yoga for heterogeneous income samples of adults (e.g., West et al., 2004). West et al. (2004) showed that whereas yoga is associated with decreased cortisol, some vigorous forms of dance are associated with short-term elevations. Some dance activities may have led to short-term elevations in cortisol for children in the present study, but the average effect associated with their dance classes was a reduction.

Finally, cortisol levels were also lower after visual arts classes compared with homeroom. This result is consistent with results of Toyoshima et al. (2011), whose study of college students provided evidence of cortisol benefits associated with clay molding and calligraphy as well as piano playing. Although different visual arts activities may be associated differently with emotional change (e.g., Drake & Winner, 2013), the present results attest to the potential for the visual arts to predict reduced cortisol for children facing poverty risks. The present results should be interpreted cautiously, however, given different effects at different times of the year.

Effects of the Arts by Time of the Year

The present findings suggest the arts classes did not predict lower cortisol levels at the start of the school year, when children were just adjusting to preschool and to the various classes. In fact, at the September time point of assessment, the analysis for visual arts, although only marginally significant ($p = .051$), suggested the opposite direction of effect for this modality. By the middle of the preschool year, however, the beneficial effects of arts programming emerged: Participation in music, dance, and visual arts each predicted lower cortisol than participation in homeroom.

There are at least two plausible explanations for the difference in effects of the arts by time of the year. One concerns the impact of adjustment to preschool programming on stress physiology. A recent study showed that the rise in cortisol from midmorning to afternoon, which typically marks children's trajectories in child care but not at home, tends to increase across the first weeks of adjustment to preschool (Bernard, Peloso, Laurenceau, Zhang, & Dozier, 2015). All children in the present study were within these first few weeks of preschool at the time of their start of the year cortisol assessments, and it is possible that any benefits of arts programming for stress physiology were swamped by the stress of adjusting to new classes, teachers, and routines. Moreover, although the children in the arts preschool attended multiple arts classes each day, they still spent more time in homeroom each day than in any individual arts class, perhaps facilitating earlier adjustment to homeroom and the homeroom teachers compared with the arts classes and teachers. The homeroom may also have been more similar to day care or home settings that children spent time in prior to preschool entry, and may have included routines and activities (e.g., sitting down at a table to complete a puzzle) more likely to be familiar than those in the arts classes (e.g., taking shoes and socks off to dance with scarves).

A second explanation is that the cortisol benefits associated with the arts depended on children's acquisition of artistic skills or self-regulatory strategies. Cortisol regulation may have resulted from engaging with the arts in particular ways. Research suggests that experts and novices engage differently with the arts, including on a physiological level. For example, Sherwin and Sajda (2013) documented that experts differently recruit action-related neural structures in certain music listening tasks. In the present study, children's development of particular artistic expertise may have facilitated the type of engagement that fostered physiological regulation. Much as in the case of artistic expertise, children's development of self-regulatory strategies they might eventually use in the service of cortisol regulation may have resulted from accumulated arts participation. Indeed, self-regulation stands out as a potential mechanism of the effect of the arts on cortisol.

Self-Regulation as a Potential Mechanism of Effect

Self-regulatory strategies stand out as a possible mechanism for arts' impact on stress physiology. The prefrontal cortex plays a critical role in self-regulation and is rich in receptors for cortisol, and a robust research literature suggests bidirectional effects of cortisol and self-regulation. Blair et al. (2011), for example, have demonstrated both the impact of cortisol dysregulation on self-regulation and the potential for an intervention targeting self-regulatory skills to enhance the regulation of physiological stress response systems (Blair & Raver, 2014). Arts classes may predict reduced cortisol because these classes offer opportunities for children to learn and employ self-regulatory skills. Winsler et al. (2011) found that, compared to a control group, young children in Kindermusik showed better self-regulation. They used more private speech, which seemed to enhance their performance on self-regulatory tasks, and were also more likely to use other strategies such as singing or humming to themselves, seemingly in an effort to control their behavior. Winsler et al. suggested that exposing children to music and movement experiences, such as stop and start, slow and fast, and loud and soft, may have facilitated improvement in self-regulatory skills.

Additionally, in a prior study of children attending Settlement Music School's Kaleidoscope Preschool Arts Enrichment Program, Brown and Sax (2013) found an advantage in growth in emotion regulation skills across the school year for children attending Settlement's Kaleidoscope Preschool Arts Enrichment Program compared with those attending a matched comparison site. The authors argued that the types of emotion training found in preschool emotions based prevention programs (e.g., Izard, Trentacosta, King, & Mostow, 2004) can also be found in arts education, which can be used to teach children to demonstrate, label, and compare intensities of emotion expressions, identify causes and consequences of emotions, and practice strategies for regulating emotions. If cortisol reductions depend on emotion training that is embedded in arts programming, it would make sense that the reductions would not necessarily appear with children's first exposure to arts classes.

Limitations and Future Directions

The present study makes a useful contribution as an initial study of arts and cortisol for children facing poverty risks and is also limited, raising perhaps more questions than it answers. A focus on young, economically disadvantaged children was important for the present study. This focus promoted understanding of how we might reduce cortisol for children facing poverty risks during a developmental stage in which the HPA system is relatively plastic. Research with heterogeneous income samples of adults, however, suggests that arts-based practices may reduce cortisol even beyond these age and income boundaries and the possibilities should be further investigated. Additionally, the possibility for the arts to influence HPA functioning for individuals who manifest the hypocortisolism associated with severe or chronic stress and trauma should be explored. Moreover, the present study focused on cortisol as measured during a limited portion of the day at an arts integrated Head Start preschool. Future studies might include further measurements of cortisol, comparisons of days at arts-integrated preschool versus at home, comparisons of arts integrated with traditional Head Starts, and additional indicators of physiological stress response.

The present study found that music, dance, and visual classes at Settlement related to reductions in cortisol as compared with homeroom and future research should further explore how different arts activities and arts components might influence HPA functioning. Future research should aim to disentangle unique characteristics of the arts from those shared in common with other programming and to elucidate the mechanisms of arts' apparent impact on cortisol. Music and dance classes in the present study, for example, included group movement and gross motor activities that could be part of certain physical education programming, and visual arts classes included fine motor and visual–spatial activities similar to those involved in putting puzzles together during a typical homeroom. Additionally, all of the arts classes included elements in common with emotion-based prevention programs (e.g., Izard et al., 2004), such as practice of self-regulatory strategies. Moreover, the arts classes may have differed from homeroom along dimensions not measured in the present investigation, such as the proportion of teacher-directed activities, individual versus small or large group activities, fine versus gross motor activities, or teaching quality. Future studies on arts and other preschool programming in relation to child cortisol could control for such components and identify the "active ingredients" in the arts classes of interest to the present investigation. Overall, the results of the present investigation suggest that the arts can "get under the skin" and influence physiological functioning for children facing poverty risks and raise questions about the mechanisms of effect.

Summary and Conclusions

This research shows that the arts can influence cortisol for children facing poverty risks.

In the ideal world, no child would grow up in poverty. Working toward this ideal requires attention to not only economic inequities but also the many correlated inequities that disadvantage children growing up poor and the opportunities for disrupting the strong predictive relationship between poverty and negative outcomes. This investigation is notable in rigorously demonstrating that a noneconomic intervention can reduce cortisol levels.

In this case, the intervention is the arts. To our knowledge, this is the first investigation to demonstrate arts' influence on cortisol for children. The present investigation focuses on the arts as integrated into a Head Start preschool program, and the findings suggest that intensive integration of the arts may add to the value of Head Start. Further research is needed to elucidate the mechanisms, constraints, and extent of arts' impact. The present research sets the stage for further investigation regarding the arts as a vehicle for promoting equity.

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