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# Cortisol Patterns for Young Children Displaying Disruptive Behavior: Links to a Teacher-Child, Relationship-Focused Intervention

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**Abstract** Supportive and close relationships that young children have with teachers have lasting effects on children's behavior and academic success, and this is particularly true for children with challenging behaviors. These relationships are also important for children's developing stress response system, and children in child care may be more likely to display atypical cortisol patterns at child care. However, warm, supportive relationships with teachers may buffer these negative effects of child care. While many relationship-focused early childhood interventions demonstrate changes in child behavior, associations with children's stress response system are unknown. This study assessed children's activity in the hypothalamic-pituitary-adrenal axis via salivary cortisol as a function of their participation in a dyadic intervention intended to improve a teacher's interaction quality with a particular child. Seventy teachers and 113 preschool children participated who were part of a larger study of teachers and children were randomly assigned at the classroom level across three intervention conditions: *Banking Time*, Time-Control Comparison (Child Time), and Business-as-Usual. At the end of the school year, children in the *Banking Time* condition displayed a significantly greater decline in cortisol across the morning during preschool compared to children in Business-as-Usual condition. These pilot results are among the first to provide preliminary evidence that school-based interventions that promote sensitive and responsive interactions may improve young children's activity in the stress response system within the child care/early education context.

**Keywords** Cortisol · Teacher-child relationships · Preschool · Socioemotional interventions · Disruptive behaviors

In the early years of life, activity in the hypothalamic-pituitary-adrenal (HPA) axis is in part influenced and shaped by environmental and relational experiences (Gunnar and Quevedo 2007; Romeo and McEwen 2006). For an increasingly large number of children, these relational and environmental experiences that shape the developing HPA axis occur in early care and education settings. Sixty-one percent of children under five spend time in formal early care and education settings (Laughlin 2013), a setting that may increase the risk for atypical activity in the stress response system (Vermeer and van IJzendoorn 2006). In recent years, research has focused on understanding how characteristics of early childhood classrooms and interactions within those settings are associated with patterns of activity in the HPA axis as measured by salivary cortisol (e.g., Hatfield et al. 2013; Vermeer and van IJzendoorn 2006). These deviations have been attributed to a variety of stimulations (e.g., large class size), which may contribute to a hyper-aroused stress response system at child care, as compared to activity for children at home (Watamura et al. 2009). Yet, no prevention/intervention programs have been designed to directly address this issue.

Children in early care and education settings who display challenging behaviors may experience a higher risk for adverse effects. Research by Alink and colleagues (2008) suggest that children and adolescents displaying disruptive behaviors are more likely to show deviations in the typical pattern of cortisol activity. Moreover, children with disruptive

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behaviors are at increased risk for relational (Baker et al. 2008) and academic deficits (Hamre and Pianta 2001) and are more likely to continue to display challenging behaviors into adolescence (Miner and Clarke-Stewart 2008). Estimates reveal that 11 % of children and adolescents are diagnosed with attention deficit hyperactivity disorder (ADHD; Visser et al. 2014); community samples suggest that the prevalence may be even higher (Visser et al. 2014). Alarmingly, preschool children displaying these types of disruptive behaviors are three times more likely to be expelled from preschool compared to children in kindergarten through high school (Gilliam 2005). Combined, these results suggest that children with disruptive behavior who attend early care and education programs may be at dual risk for deleterious developmental outcomes.

In an effort to boost academic and socioemotional outcomes for behaviorally at-risk children, several interventions have been developed to improve classroom interactions and teacher-child relationships and have shown improved child behavior (e.g., Driscoll and Pianta 2010; Vancraeyveldt et al. 2015). *Banking Time* (Pianta and Hamre 2001) is a dyadic intervention intended to improve a teacher's relationship with a specific child and is successful in changing child behavior. The current study builds upon these child effects and employed a quasi-experimental design to estimate the effects of *Banking Time* on cortisol patterns of children who display disruptive behaviors. To our knowledge, this is the first study to examine a teacher-child intervention on children's cortisol patterns in the early education setting.

## HPA Axis Functioning in Early Childhood

Cortisol is a steroid hormone produced by the HPA axis, one component of the stress response system, and allows for a biological view into the child's experience of his/her environment and interactions. Cortisol levels vary diurnally with levels highest in the morning and gradual decline throughout the day (Gunnar and Donzella 2002). Cortisol impacts brain functioning and behavior (Bohus et al. 1982) as well as regulates important bodily functions (e.g., immune system; Palacios and Sugawara 1982) and emotional expression (Oberlander et al. 2008). Activity in the HPA axis can be measured non-invasively via saliva (Granger et al. 2006); salivary cortisol is strongly correlated with serum cortisol (Charmandari et al. 2005). Atypical patterns of HPA axis activity in early childhood have been linked to disruptions in short-term memory (Bugental et al. 2010), problem behaviors (Alink et al. 2008), higher risk of subsequent mental health problems (Shirtcliff et al. 2005), and physical illness (Watamura et al. 2010).

Early childhood marks an important time frame in which the stress response system is malleable and highly influenced the environment (Charmandari et al. 2005; Gunnar and Quevedo 2007; Romeo and McEwen 2006). In particular, caregiver-child interactions influence the development of the HPA axis; children whose caregivers are less nurturing and/or neglectful tend to display deviant patterns of activity (Gunnar and Donzella 2002). Child care attendance is also repeatedly linked to aberrant cortisol patterns in children (for a review see Vermeer and van IJzendoorn 2006) most often displayed as a rise in cortisol across the day while in child care. This association between child care and cortisol is present even after accounting for global classroom quality (e.g., Watamura et al. 2009). However, a number of research studies have extended the conceptualization of quality and examined aspects of classroom process quality, focusing on the interactions between adults and children. Children in classrooms where teachers utilized more rigid, controlling management techniques and provide lower cognitive stimulation displayed higher cortisol levels across the day (Dettling et al. 2000). On the other hand, children in classrooms characterized by highly supportive, sensitive teacher-child interactions were found to display cortisol patterns that were similar to the expected diurnal rhythm (Groeneveld et al. 2010; Hatfield et al. 2013). These findings suggest that high-quality teacher-child interactions characterized by warmth, responsiveness, and sensitivity may protect children's rising cortisol patterns, which has been linked to negative outcomes (e.g., Shirtcliff et al. 2005).

## Teacher-Child Relationships in Early Childhood

Close and supportive teacher-child relationships are critical for children's academic and socioemotional success. A close teacher-child relationship, especially in early childhood, predicts fewer concurrent disruptive behaviors (Howes 2000), as well as fewer challenging behaviors through third grade, even after controlling for negative parenting (Silver et al. 2005). Further, children's positive engagement with their teachers predicts increases of appropriate, positive emotion regulation strategies (Williford et al. 2013b), creating a foundation for later school success (Blair 2002). In direct contrast to the benefits of a close teacher-child relationship, a conflictual teacher-child relationship is defined by frustration and negative interactions. Conflict in the teacher-child relationship in kindergarten was associated with decreased academic success and increased intensity of challenging behaviors into middle childhood (Hamre and Pianta 2001).

Beyond academic, social, and emotional benefits, close teacher-child relationships support typical activity in children's stress response system. Children with a close teacher-child relationship are also more likely to demonstrate lower salivary alpha-amylase (sAA) levels, a surrogate biomarker for the sympathetic nervous system (Granger et al. 2006), while in child care (Mize et al. 2005). Children with sensitive and nurturing teachers are more likely to display a decline in cortisol at child care (Groeneveld et al. 2010). Hatfield and colleagues (2013) observed teacher-child interactions in preschool settings and collected saliva samples at three times over 2 days from children. The authors found that children in classrooms with teachers that displayed more positive, sensitive, and close relationships with children were more likely to display typical patterns of sAA and a decline in cortisol across the day at child care. Process quality (e.g., relationships) is emerging as the most salient indicator of children's activity in the stress response system, especially when compared to other indicators of classroom quality that are not focused on relationships and interactions.

Over the last decade, many teacher-focused classroom interventions have been implemented with a variety of success in enhancing the behavior of young children. Recently, Head Start CARES introduced findings regarding three intervention programs designed to improve children's social and emotional skills: the Incredible Years Teacher Training Program (IY), Preschool Promoting Alternative Thinking Strategies (PATHS), and Tools of the Mind (Morris et al. 2014). Results suggest that all of these programs improve emotion knowledge, but only IY and PATHS afforded improvements in social skills and social problem-solving skills. Similarly, a teacher's participation in the school-based program Playing-2-together resulted in lower levels of disruptive behaviors in preschool children (Vancraeyveldt et al. 2015). Teacher-focused classroom interventions for young children that investigate links to children's activity in the stress response system are less prevalent. However, parent- and family-focused interventions identify mechanisms to support young children's activity in the stress response system. For example, Dozier et al. (2008) found positive effects on children's ability to regulate physiological arousal following a relationship-focused intervention for children in foster care. These studies suggest children's activity in the HPA axis is malleable to relationship-focused interventions and warrant exploration as to how teacher-focused interventions may also affect these outcomes. The current study explored the effect of a teacher-child relationship-focused intervention, Banking Time, on cortisol levels for children with disruptive behaviors.

## Banking Time

Banking Time (Pianta and Hamre 2001) is designed to foster sensitive, responsive interactions between a teacher and a child, creating a relationship the child and teacher can use as a resource during times of challenge in the classroom (e.g., when the child is asked to comply with non-preferred task). The teacher and child participate in child-directed, one-on-one play sessions. The teacher's behavior during these sessions are tightly constrained and teachers are directed to (a) allow the child to lead the sessions, (b) carefully observe and narrate the child's behavior, (c) describe the child's positive and negative emotions, and (d) be available as an emotional resource to the child. Two preliminary studies outline the link between implementation of Banking Time and preschool children's social-emotional gains. In one study, information about Banking Time was available to teachers who were participating in a web-based teacher professional development intervention. Teachers' use of Banking Time was linked with teacher-reported closer relationships with the target students (Driscoll et al. 2011). In a subsequent study, teachers were randomly assigned to Banking Time or Business-as-usual (BAU), and teachers who participated in Banking Time reported increased closeness in their relationships with children, improvements in children's frustration tolerance and classroom task orientation, and decreases in children's conduct problems (Driscoll and Pianta 2010).

Most recently, Williford and colleagues (in press) conducted a randomized controlled trial to test the impact of Banking Time on improvement in disruptive behaviors in a sample of preschool children who displayed elevated disruptive behaviors. Classrooms were randomly assigned to one of three conditions (Banking Time, time-controlled comparison (Child Time), and BAU). Teachers participating in Banking Time reported that children decreased in their disruptive behaviors. A similar, but not statistically significant pattern, was seen for teachers who participated in Child Time. In addition, teachers assigned to implement Banking Time were observed to display lower directiveness and negativity during a standardized interaction task at post-condition.

In this study, we assessed differences in children's activity in the HPA axis as a function of the treatment assignments described above within a sub-sample of the larger efficacy trial. It was the intention of this study to examine how participation in this intervention may influence children's activity in the stress response system.

## Aims and Hypotheses

The current study provides a unique mechanism of understanding whether an intervention focused on improving teacher-child interaction quality is associated with decreases in children's activity in the HPA axis within an at-risk sample of children who display elevated disruptive behaviors. Because the targeted strategies central to Banking Time are focused on sensitivity and emotional support, we expected children who participated in Banking Time would display more typical cortisol patterns at the end of the year compared to children who had not been selected to participate in Banking Time.

## Methods

### Participants

The participants for the current study were drawn from a larger sample of children who participated in an efficacy trial examining the impact of Banking Time. Preschool programs were recruited from two urban/suburban sites on the east coast; after obtaining director or principal approval, teachers were invited to participate. Preschool classrooms were eligible if 80 % of the enrolled children were eligible for kindergarten in 2 years or less and taught the same students 5 days a week. After an initial meeting where teachers signed an informed consent form, teachers were randomly assigned to one of the three intervention groups: BAU, Child Time, or Banking Time. Child participants were identified in two steps. First, at the beginning of the school year, teachers completed a behavior rating scale on all children in the classroom and attempted to obtain parental consent from all children's parents. Sixty-nine percent of parents agreed to participate. Second, the three children (two boys and one girl) whose teacher rated as displaying the highest level of disruptive behaviors (via a total summed score) were selected from children with parental consent. Nearly all (88 %) of the selected children were rated by their teachers as one of the two boys or girl evidencing the most disruptive behavior. Selected children's total disruptive score ($M = 28.48$) was significantly higher compared to non-selected children ($M = 10.8$; $t(2369) = -24.921$, $p < 0.001$). The selected children were randomized into one of three 7-week treatment/assessment windows (fall, winter, spring) during the school year. During each window, the teacher and the selected child would either engage in the assigned intervention (Banking Time or Child Time) or normal classroom activities (BAU). The larger sample consisted of three cohorts (2010–2011, 2011–2012, 2012–2013) with a total sample size of 183 classrooms and 440 children. Participants in the current study were a subsample of those children participating in the second cohort (2011–2012; 291 children within 73 classrooms).

The supplemental saliva consenting process occurred in late fall of the school year after initial recruitment and continued through the start of the final intervention window. Three of the 73 teachers opted not to participate in the supplemental saliva collection. Of the 291 children participating in the larger study (cohort 2011–2012), parents of 113 children consented to the saliva collection. The supplemental saliva collection sample was compared to the full sample on a variety of child and family demographics. Children in the two samples did not significantly differ by income, intervention assignment, age, disruptive behavior at beginning of school year, or gender. The only significant difference between the larger sample and the subsample was that children in the saliva collection subsample were less likely to be African American ($t(250) = 2.37$, $p = 0.02$).

The 113 children (69 % male) were on average 49 months of age ($SD = 5.86$ months). Thirty-four percent of children were identified by their parent as African American, 40 % Caucasian, 8 % Latino, 2 % Asian, and 16 % multiracial or other ethnicity. Children came from mostly low-income families; 25 % of families earned less than $15,000, 38 % earned $15,001 to $35,000, 16 % earned $35,001 to $75,000, and 19 % of families earned over $75,000. Maternal education ranged from 4 % without a high school diploma to 7 % with a graduate degree; 25 % of mothers achieved a Bachelor's degree.

Children ($n = 113$) were well distributed across the treatment conditions (Banking Time $n = 39$, Child Time $n = 35$, BAU $n = 39$). Within the sample, 48 % of children had been randomized into the first intervention cycle (fall), 32 % in the second cycle (winter), and 20 % in the third/final 7-week cycle (spring).

### Procedures

Data for this study were collected throughout the school year. Teachers completed baseline student behavior surveys 3 weeks into the beginning of the school year. Parents completed a demographic questionnaire after indicating consent to participate. Teachers and children participated in Banking Time sessions in 7-week cycles. The research staff collected children's saliva samples at child care twice in the morning in the winter (beginning of second intervention cycle) and spring (end of the third/final intervention cycle). Data collectors aimed to collect the first sample between 8:30 and 9:00 a.m. and the second sample in late morning between 12:00 and 12:30 p.m.

### Treatment Conditions

Banking Time (Pianta and Hamre 2001) sessions are a set of time-limited (10–15 min), one-on-one meetings between a teacher and a child that take place within the school setting and occur two to three times per week. For the current study, teachers implemented Banking Time with one child during each window (7 weeks). Teachers were instructed to find time that they could work with the child privately outside of the classroom (e.g., have another staff member substitute for the teacher). During each Banking Time session, a teacher and child participated in an activity led by the child. Teachers were instructed to implement critical skills designed to change *how* teachers interacted with children: (1) observing the child's behaviors and expressed emotions, (2) narrating the child's actions and allowing the child to lead the activity, (3) accurately labeling the child's feelings and emotions to understand the child's perspective, and (4) developing relational themes to focus on important aspects of the teacher-child relationship. Teachers were also instructed to limit questioning and refrain from teaching skills during the session. Teachers were provided with a consultant to increase teachers' implementation fidelity. Teachers and consultants had a face-to-face meeting once every 2 weeks and a brief phone meeting on the off-weeks. Teachers videotaped their individual Banking Time sessions once a week and sent this footage to their consultant. The consultant used this footage in the face-to-face meetings with the teacher, reviewing and reflecting upon sections of the videotaped session in order to improve the teacher's implementation and problem solve additional teacher questions/concerns.

In Child Time comparison classrooms, teachers spent individual time with three children using the same schedule described above. Teachers had access to a consultant that spent time with teachers at the same frequency as those in Banking Time. These consultants encouraged teachers to spend time with children but did not provide guidance on how to spend the time.

In the BAU control classrooms, teachers and children were assessed but no treatment was provided.

## Measures

### *Challenging Behaviors*

Teachers were asked to complete two rating scales. The ADHD Rating Scale-IV (ADHD RS-IV; DuPaul et al. 1998) is an 18-item scale that directly corresponds to the DSM-IV symptoms of attention deficit hyperactivity disorder (APA 1994). The Oppositional Defiant Disorder Rating Scale (ODDRS; Hommersen et al. 2006) is modeled after the ADHD RS-IV and contains eight items corresponding to the DSM-IV criteria for ODD (APA 1994). A sum of all items from both scales was used to rank children on behavior problems ($\alpha = 0.96$).

### *Saliva Collection*

Saliva samples were collected with the Salimetrics™ children's swab and stored below 0 °F until shipped. Frozen samples were shipped overnight on dry ice to Johns Hopkins Center for Interdisciplinary Salivary Bioscience Research. Cortisol assays were conducted in duplicate. The inter-assay coefficient of variability (CV) for the assays was 4.89 %, within the acceptable range (<15 %). The intra-assay CV indicates the extent to which duplicate assays were similar and should be less than 10 %. In the current study, the intra-assay CV is 6.57 %. All research staff was trained to collect saliva by the first author.

At least one saliva sample was available for 86 of the 113 consented children. In winter, 54 children participated ($M_{\text{collection time}} = $ 8:50 a.m., $SD = 36$ min). In the late morning, 54 children provided a second sample ($M_{\text{collection time}} = $ 11:32 a.m., $SD = 28$ min). In spring, the first morning collection occurred, on average, at 9:03 a.m. ($SD = 32$ min) for 69 children, and 67 children provided samples in the late morning ($M_{\text{collection time}} = $ 11:42 a.m., $SD = 30$ min).

Twenty-seven of the 113 consented children were missing all samples; 15 of those children were missing because they were no longer participating in the study when the first saliva sample was collected (e.g., child left the child care program) or were replaced with a higher-ranking child before the start of the intervention. The remaining were missing because of absences ($n = 7$) or unknown reasons ($n = 5$). In the winter, children were primarily missing saliva samples because the parent returned the informed consent form after winter data collection ($n = 20$). Children were also missing winter saliva samples due to absences ($n = 5$) or declining to assent to saliva collection ($n = 1$). Finally, in the spring, 15 children were missing saliva samples because the child or teacher left the program before data collection ($n = 7$), the child was absent ($n = 5$), or for unknown reasons ($n = 3$). Finally, a small number of children ($n = 7$) were missing one of the two saliva samples at either winter or spring. This occurred because either the child arrived after or left before saliva collection occurred ($n = 2$), the child refused ($n = 2$), or the child did not provide enough saliva for assay ($n = 3$). Total sample size by time and treatment group is presented in Table 1. Procedures for handling missing data are described below.

**Table 1** Descriptives for cortisol by intervention assignment

| | BAU ($n = 39$) | | | Child Time ($n = 35$) | | | Banking Time ($n = 39$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | $n$ | Mean | SD | $n$ | Mean | SD | $n$ | Mean | SD |
| Winter | | | | | | | | | |
| Cortisol time 1 | 20 | 0.20 | 0.16 | 17 | 0.25 | 0.25 | 18 | 0.22 | 0.11 |
| Cortisol time 2 | 20 | 0.16 | 0.10 | 16 | 0.18 | 0.16 | 18 | 0.14 | 0.06 |
| Change in cortisol | 20 | −0.03 | 0.18 | 15 | −0.09 | 0.21 | 18 | −0.08 | 0.09 |
| Spring | | | | | | | | | |
| Cortisol time 1 | 26 | 0.36 | 0.99 | 19 | 0.21 | 0.16 | 22 | 0.27 | 0.47 |
| Cortisol time 2 | 27 | 0.57 | 1.95 | 18 | 0.18 | 0.08 | 22 | 0.13 | 0.08 |
| Change in cortisol | 25 | 0.22 | 1.02 | 18 | −0.01 | 0.11 | 21 | −0.15 | 0.42 |

### Data Analysis

Analyses focused on whether children in classrooms assigned to Banking Time, Child Time, or BAU displayed differences in cortisol patterns at the end of the year. Given the variation in classroom schedules and child arrival times, saliva samples were collected during various times within the scheduled time frame as noted above. Thus, to account for possible differences in child cortisol levels due to time of collection, regression models were estimated for each collection. Time of saliva collection did not predict differences in cortisol at times 1, 2, 3, or 4 ($\beta = -2.30$ to 0.05; all $p$'s >0.10). Thus, time was not included in the regression models. Change in cortisol at child care was calculated for each child by subtracting late morning cortisol level from early morning cortisol level. This is calculated in accordance with previous work (e.g., Gunnar et al. 2010). One hundred thirteen children were nested within 70 classrooms. The unconditional model predicting spring change in cortisol displayed an intraclass correlation of 0.03 and a design effect of 0.01, thus models did not account for nesting (Muthén and Satorra 1995).

In line with experimental design and intent-to-treat analysis, all 113 children who consented to saliva collection were included in analyses (Murnane and Willett 2011). To address possible patterns of missingness in saliva samples, three groups were created: missing all samples ($n = 27$), missing winter samples ($n = 15$), and missing spring samples ($n = 26$). $T$ tests were executed to examine if gender, maternal education, child age, income, or disruptive behavior was related to missingness. Results indicated that data were missing at random (MAR), that is, missing data patterns were predicted by measured variables (Enders 2010) with children missing winter samples being more likely to be male ($t(111) = -2.18$, $p < 0.05$) and children missing spring samples being more likely to have higher disruptive behavior scores at baseline ($t(100) = -2.41$, $p < 0.05$). No other significant differences were detected. Full information maximum likelihood was used to address missing data with the assumption that data was MAR (Enders 2010); this estimation method reduces bias in analyses (Enders and Bandalos 2001). Child ethnicity, disruptive behavior, gender, child age, intervention cycle, and family income were included in the model due to the associations with missingness and to increase precision of the model estimates. The model also included children's change in cortisol in the winter in order to provide stronger evidence that differences in cortisol patterns were related to the intervention.

## Results

Descriptive statistics for cortisol variables by treatment group are presented in Table 1. On average, children in all groups displayed a decline in cortisol levels in winter (pre), but only children in the Banking Time and Child Time groups demonstrated a decline in cortisol at post. Bivariate correlations (Table 2) indicate moderate correlations between early morning and late morning cortisol levels in the winter and strong correlations between early morning and late morning cortisol levels in the spring. Other than family income, none of the covariates were significantly correlated with winter or spring change in cortisol.

Two regression models employing full information maximum likelihood were executed with Mplus 6.0 (Múthen and Múthen 1998–2010) to estimate the effect of treatment assignment on children's change in morning cortisol levels. In model one, intervention assignment was dummy coded into two variables (Banking Time = 1, BAU = 0; Child Time = 1, BAU = 0) to understand the effects of Banking Time and Child Time compared to BAU. Model two explored the difference between Banking Time and BAU compared to Child Time

**Table 2** Correlations

| | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Winter cortisol early morning | – | | | | | | | | | | |
| 2. Winter cortisol late morning | 0.43** | – | | | | | | | | | |
| 3. Spring cortisol early morning | −0.01 | 0.13 | – | | | | | | | | |
| 4. Spring cortisol late morning | −0.04 | 0.10 | 0.92** | – | | | | | | | |
| 5. Winter rise in cortisol | −0.78** | 0.23 | 0.08 | 0.11 | – | | | | | | |
| 6. Spring rise in cortisol | −0.06 | 0.12 | 0.69** | 0.92** | 0.13 | – | | | | | |
| 7. Family income | −0.31* | −0.16 | 0.09 | 0.18 | 0.26 | 0.25 | – | | | | |
| 8. Child age | −0.05 | −0.20 | −0.05 | 0.01 | −0.11 | 0.07 | −0.16 | – | | | |
| 9. Male | −0.15 | 0.11 | 0.11 | 0.08 | 0.08 | 0.03 | −0.10 | 0.15 | – | | |
| 10. Child Time condition | 0.12 | 0.10 | −0.07 | −0.07 | −0.10 | −0.04 | 0.04 | −0.07 | −0.02 | – | |
| 11. Banking Time condition | −0.12 | −0.12 | −0.02 | −0.02 | −0.06 | −0.18 | −0.04 | 0.01 | −0.01 | −0.49 | – |
| 12. Baseline disruptive behavior total score | 0.03 | 0.03 | 0.16 | 0.16 | 0.00 | 0.00 | −0.29** | −0.08 | 0.19 | 0.02 | 0.03 |

*$p < 0.01$; **$p < 0.05$

(Banking Time = 1, Child Time = 0; BAU = 1, Child Time = 0). Results from these models are presented in Table 3; the model accounted for 23 % of the variation in spring change in cortisol across the morning. Intervention assignment predicted differences in cortisol patterns in the spring (post-intervention) such that children who participated in Banking Time displayed, on average, a decline in cortisol across the morning compared to children in the BAU group. No significant differences emerged between children in Child Time compared to children in Banking Time or BAU.

Cohen's *d* was calculated using the means and standard deviations for spring change in cortisol (Table 1). Cohen's *d* was estimated at −0.47 for Banking Time compared to BAU, indicating a moderate magnitude (Cohen 1988). Banking Time also had a moderate effect on children's change in cortisol compared to Child Time ($d = -0.43$). The effect size for Child Time compared to BAU was −0.32. Recall that regression analyses only displayed a significant difference between cortisol levels for children in Banking Time and BAU.

## Discussion

For young children in early care and education programs, a sensitive and responsive teacher-child relationship is important for the healthy development of children's stress response system (Romeo and McEwen 2006). However, children with disruptive behavior problems may be at dual risk given their tendency to display aberrant activity in the HPA axis (Alink et al. 2008) and have conflictual relationships with teachers (Hamre and Pianta 2001). The current study used a quasi-experimental design to investigate the effect of a teacher-child relationship-focused intervention, Banking Time, on children's activity in the HPA axis in a sample of preschool children who displayed elevated disruptive behaviors.

The goal of Banking Time is to foster a responsive teacher-child relationship by qualitatively changing the proximal exchanges that occur between a teacher and child (Pianta and Hamre 2001). For example, teachers are instructed to label the child's feelings and emotions during one-on-one play. At the end of the year, children whose teacher participated in Banking Time displayed a decline in cortisol across the morning compared to children who were assigned to BAU. The effect size of the difference was moderate (Cohen 1988). The declining pattern of cortisol throughout the day for children who participated in Banking Time compared to BAU may place children at lower risk for later mental, physical, and cognitive deficits (e.g., Bohus et al. 1982; Bugental et al. 2010; Oberlander et al. 2008; Palacios and Sugawara 1982).

It is noteworthy that in the full sample, the intent-to-treat results indicated that teacher-reported disruptive behaviors decreased for children in Banking Time compared to the children in BAU, and a trend level effect for children in Child Time. Only teachers in the Banking Time condition were observed to display reduced negativity and directiveness in their interactions with children (Williford et al. in press). Engaging in these emotionally supportive behaviors may help children

**Table 3** Regression model predicting spring change in cortisol across the morning ($n = 113$)

| Covariates | Model 1 | | | | | Model 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *B* | *SE* | *β* | *SE* | *d* | *B* | *SE* | *β* | *SE* | *d* |
| African American | −0.20 | 0.22 | −0.13 | 0.14 | | | | | | |
| Caucasian | −0.34 | 0.24 | −0.23 | 0.16 | | | | | | |
| Male | 0.12 | 0.18 | 0.08 | 0.12 | | | | | | |
| Child age | 0.01 | 0.01 | 0.06 | 0.11 | | | | | | |
| Family Income | 0.09* | 0.04 | 0.35 | 0.14 | | | | | | |
| Disruptive behavior | 0.02 | 0.01 | 0.14 | 0.12 | | | | | | |
| Intervention cycle[a] | 0.20 | 0.11 | 0.21 | 0.11 | | | | | | |
| Winter change in cortisol | 0.13 | 0.61 | 0.03 | 0.14 | | | | | | |
| Treatment condition[b] | | | | | | | | | | |
| Child Time | −0.19 | 0.20 | −0.12 | 0.13 | −0.32 | | | | | |
| Banking Time | −0.43* | 0.19 | −0.28 | 0.12 | −0.47 | | | | | |
| Treatment condition[c] | | | | | | | | | | |
| Banking Time | | | | | | −0.24 | 0.21 | −0.16 | 0.14 | −0.43 |

*$p < 0.05$

[a] Intervention cycle (first/fall, second/winter, or third/spring)

[b] Reference group is BAU

[c] Reference group is Child Time

feel more secure in the classroom, which is then reflected in their cortisol levels. Hatfield and colleagues (2013) report similar associations between classroom-level emotional support and children's cortisol.

In contrast to Banking Time, teachers participating in Child Time were encouraged to spend time playing with the child without prescriptive instructions. In the spring (post-intervention), children in both treatment groups displayed a decline in morning cortisol, and there was no significant difference in children's cortisol change between the two treatment groups. This suggests that the general focus of building a positive, close teacher-child relationship for children with challenging behaviors has a positive impact on activity in the HPA axis. However, the impact of Child Time, when compared to BAU, was not significant (Table 3), which may indicate that one or more fundamental components of Banking Time are necessary to have the largest impact on children's cortisol patterns.

### Limitations and Future Directions

This study has four major limitations. First, our sample size is small and all saliva samples were missing for 27 children. The sample size limits the power to detect and generalize effects. Although FIML was used to handle missing data and analyses to explore patterns of missingness were conducted, it is possible that unobserved variables were related to missingness. Second, multiple collection points of saliva within and across days likely provide a more robust estimate of cortisol levels. Additionally, previous research identifies a rise in cortisol from morning to afternoon for children (e.g., Groeneveld et al. 2010), and this study does not include an afternoon saliva sample. Future studies should aim to collect saliva samples at more time points across the day and over multiple days. However, note that there is some evidence that cortisol levels at child care are fairly stable when collected within 1 week (e.g., $r = 0.61–0.99$; Hatfield et al. 2013). Third, parents and children consented to saliva collection after randomization, providing a quasi-experimental rather than an experimental design. Finally, saliva was not collected at baseline (fall of the school year) due to timing of funding. Thus, children in the study were exposed to Banking Time or Child Time prior to the start of data collection, either as a target child or a future target child that was enrolled in the classroom. To minimize this effect, we used winter cortisol change as a proxy for baseline cortisol levels and included intervention window in the analyses.

With the quasi-experimental design, we are limited in interpreting causality of the intervention on children's cortisol patterns. Future work with randomized control trials of Banking Time is essential before recommendations for prevention science may be articulated. Additionally, work should focus on replication and identification of the essential mechanisms and behaviors within *Banking Time* that support a decline in cortisol levels across the day for young children in child care. Further, these results suggest that teachers in Child Time also influenced children's cortisol patterns; the identification of parallels between teacher behaviors in these treatment groups may identify the essential behaviors to best support children's stress response system. Similarly, investigating changes in classroom process quality as a moderator of intervention effects could also refine the associations with cortisol patterns between the treatment groups. Through identifying essential ingredients and identifying the conditions under which to best support children's HPA axis, early childhood teachers will be able to afford biological and behavioral benefits for young children with challenging behaviors.

## Conclusion

Warm, sensitive teacher-child interactions are linked with gains in academic and social-emotional skills and research indicates that children make more equitable school readiness gains in classrooms where teachers are highly responsive to children (Williford et al. 2013a). Further, responsive and sensitive teacher interactions are associated with a normative decline in cortisol across the day (Hatfield et al. 2013). However, children who display challenging behaviors may be less likely to benefit from these classrooms due to a conflictual relationship with his/her teacher. Given that children with externalizing behavior problems are at a heightened risk of mental and physical illness, the benefits that a relationship-focused intervention, Banking Time, affords for their HPA axis is paramount. The findings warrant continued examination of how classroom-based social and emotional interventions may support children's developing HPA axis.

**Compliance with Ethical Standards**

**Ethical Approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

**Conflicts of Interest** The authors declare that they have no conflict of interest.

**Informed Consent** Informed consent was obtained from all individual participants included in the study.

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