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Effects of Maltreatment and Early Intervention on Diurnal Cortisol Slope Across the Start of School: A Pilot Study

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Maltreated foster children have a high prevalence of developmental delays, psychosocial maladjustment, and psychiatric symptoms (Klee, Kronstadt, & Zlotnick, 1997; Landsverk, Garland, & Leslie, 2002). Recent work has focused on understanding effects of maltreatment and caregiver transitions on neurobiological systems involved in the stress response, specifically the hypothalamic-pituitary-adrenal (HPA) axis (Bruce, Fisher, Pears, & Levine, 2009; Dozier et al., 2006). The HPA axis—indexed by cortisol levels—displays a diurnal rhythm, typically characterized by relatively high morning levels that decline to near-zero by bedtime (Kirschbaum et al., 1990). This change across the day is referred to as the diurnal cortisol slope. Previous work indicates that young foster children are more likely than their nonmaltreated peers to evidence a flattened diurnal cortisol slope (or less change across the day), resulting from low morning cortisol levels, which may indicate a poorly regulated system (Dozier et al., 2006; Fisher et al., 2006). However, despite the high prevalence of socioemotional difficulties in this population, only a minority of foster children display low morning cortisol levels (Bruce et al., 2009).

Because the HPA axis is also designed to respond to physical and psychological challenges in the environment (Kirschbaum et al., 1990), examining the responsiveness of the system to

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stressors may provide further insight into potential effects of maltreatment and caregiver transitions. Although research with older children and adults has often employed laboratory stressors to measure immediate changes in cortisol levels, research with normative samples of young children has focused on changes in the diurnal cortisol rhythm in response to naturally occurring stressors, such as the start of school (Bruce, Davis, & Gunnar, 2002; Davis, Donzella, Krueger, & Gunnar, 1999; Quas, Murowchick, Bensadoun, & Boyce, 2002; Turner-Cobb, Rixon, & Jessop, 2008). This work provides evidence for a transient perturbation in the diurnal cortisol rhythm in response to the start of school, characterized by a steeper slope on the 1st day of school compared to weekend days later in the year (Bruce et al., 2002). This steeper slope, which has been viewed as a healthy adaptation to a novel, significant event, resulted from higher morning and lower evening cortisol levels on the 1st day of school. However, individual differences appear to play a large role, such that higher temperamental surgency (Bruce et al., 2002; Davis et al., 1999) and lower effortful control (Turner-Cobb et al., 2008) predict a steeper slope beyond the 1st day of school, potentially indicative of greater reactivity or less recovery of the system. Although Gutteling, de Weerth, and Buitelaar (2008) documented effects of prenatal stress on the diurnal cortisol rhythm across the start of school, the effects of severe early life stress, such as maltreatment and caregiver transitions, remain unknown.

Moreover, it is unclear whether comprehensive early preventive intervention programs such as Multidimensional Treatment Foster Care for Preschoolers (MTFC-P; Fisher, Ellis, & Chamberlain, 1999) affect changes in the diurnal cortisol rhythm in response to a naturally occurring stressor. MTFC-P supports foster parents in providing consistent and contingent responses to positive and negative child behaviors. The child's environment thus becomes more predictable, responsive and reinforcing, which has been shown to prevent the development of an increasingly flattened diurnal cortisol rhythm in foster children (Fisher, Stoolmiller, Gunnar, & Burraston, 2007). However, the impact of MTFC-P on the responsiveness of the HPA axis to important life events, such as the start of school, remains untested. Foster children often experience difficulties in school (Pears, Fisher, Bruce, Kim & Yoerger, 2010), and preventive interventions that influence the capacity of the HPA axis to respond to the challenge of the start of school may support a more adaptive transition.

This pilot study examines changes in diurnal cortisol in response to the start of school for three groups of children: foster children who received regular foster care (RFC); foster children who received MTFC-P; and low-income, nonmaltreated children living with their biological parents (community comparison [CC]). We hypothesized that RFC children would show an extended cortisol response, characterized by a steeper slope on the 1st and 5th days compared to the week before school, and that MTFC-P and CC children would show a transient cortisol response, characterized by a steeper slope only on the 1st day of school.

Methods

Participants

Our analyses were focused on a subsample of children recruited from a larger, longitudinal randomized controlled trial of MTFC-P. All of the 3- to 6-years-old children who were entering foster care, reentering foster care, or changing between foster placements and were expected to remain in foster care for more than 3 months were eligible for the trial. After random assignment to MTFC-P or RFC, study staff members contacted caseworkers and foster caregivers to recruit the participants. The CC group was recruited through local advertisements. The recruitment process and larger sample have previously been described in Fisher et al. (2007).

Recruitment of the subsample occurred 2 years after initiation of the MTFC-P trial and targeted all participants enrolled in school (*n* = 61; 31 girls). Thirty-seven children participated: MTFC-P (*n* = 9; 6 girls), RFC (*n* = 7; 1 girl), and CC (*n* = 21; 11 girls). The children were entering kindergarten, first grade, or second grade (*M* age = 73.26 months, *SD* = 10.90, range = 59.89–106.09). The ethnicity breakdown was: 81% European American, 3% African American, 8% Hispanic, 3% Pacific Islander, and 5% Native American. The subsample did not differ significantly from the larger sample, nor did the groups within the subsample, with regard to age, gender, or ethnicity. However, as the RFC group included only 1 female, a gender covariate was included in analyses. The MTFC-P and RFC groups did not differ on important aspects of foster care history, including age at first entry into foster care and number of caregiver transitions.

Procedures

MTFC-P intervention—MTFC-P makes use of a multidisciplinary team: family therapists, foster caregivers, foster caregiver consultants, and behavioral specialists to facilitate development of social and behavioral competencies in foster preschoolers. The main components include training and consultation for foster caregivers, individualized support and a therapeutic playgroup for foster children, and training to facilitate continuity in parenting following permanent placement (see Fisher et al., 1999; Fisher et al., 2007). This preventive intervention has been associated with a range of positive outcomes including reduced risk of disruption in placements (Fisher, Kim, & Pears, 2009), higher levels of secure attachment behaviors (Fisher & Kim, 2007), and maintenance of a more typical diurnal cortisol rhythm (Fisher et al., 2007).

RFC procedures—The RFCchildren received foster care services as usual, including placement in a state foster home and provision of services in accordance with standard policies and procedures. These services commonly include individual child psychotherapy, Head Start or other early childhood education programs, and medical and dental treatment. No attempt was made to influence the type or amount of services given to RFC children or their families.

Measures

Salivary cortisol—Caregivers were trained by study staff to collect saliva samples from their children over the course of the day at three time points: 1 week before the start of school (on 2 consecutive days), on the 1st day of school, and on the 5th day of school. Consistent with previous studies examining diurnal cortisol slope in response to the start of school (Bruce et al., 2002; Davis et al., 1999), these collections occurred thrice daily: morning (30 min after waking), afternoon (4:00 p.m.), and evening (30 min before bedtime). Procedures for saliva collection and cortisol assaying for this sample are detailed in Fisher et al. (2007). Of the 444 possible cortisol samples for all children across all days, 5 samples were missing and 2 samples were excluded due to collection outside of the 30 min sampling window. The cortisol values were highly skewed and thus were log-transformed to normalize the distributions. The slope values for each child on each day were then calculated by regressing cortisol values for a given day on the sampling times. The cortisol values for the 2 days in the week before school were averaged. The wake time for these days (*M* = 7:43 a.m., *SD* = 43 min) was comparable to wake time for the 1st and 5th days of school (*M* = 7:32 a.m., *SD* = 33 min; *M* = 7:31 a.m., *SD* = 37 min).

Results

Descriptive statistics for cortisol measures by day (week before school, 1st day of school, and 5th day of school), time (morning, afternoon, and evening), and group (RFC, MTFC-P, and CC) are presented in Table 1. Diurnal cortisol slope across days was examined using a repeated-measures ANOVA with group as a between-subjects factor and gender as a covariate. Child age and grade level were not included in the final models as they did not affect the results or significantly predict cortisol slope. The Greenhouse-Geisser correction was used when a violation of sphericity was indicated. Neither the main effect of day, $F(2, 66) = .647$, $p = .524$ or group, $F(2, 33) = .661$, $p = .523$, were significant. However, a significant interaction between day and group, $F(4, 66) = 2.86$, $p = .030$, indicated that the groups demonstrated distinct patterns of change in cortisol slope across the days (see Figure 1). For the CC group, post hoc analyses indicated a significant difference in cortisol slope between the week before and the 1st day of school, $t(20) = 3.42$, $p = .003$, with a steeper slope (or greater change) across the 1st day of school. A trend-level difference between the 1st and the 5th days of school, $t(20) = -1.81$, $p = .085$, indicated a steeper slope on the 1st day of school. For the MTFC-P group, a trend-level difference in slope between the week before school and the 1st day of school, $t(8) = 2.07$, $p = .072$, indicated a steeper slope on the 1st day of school. However, for the RFC group, there was a significant difference only between the week before and the 5th day of school, $t(6) = 2.63$, $p = .039$, with a steeper slope on the 5th school day.

Post hoc-analyses indicated that the slope for the RFC group was significantly steeper than the slope for the CC group on the 5th day of school, $t(21.8) = -2.66$, $p = .014$. The slope for the RFC group was also steeper than the slope for the MTFC-P group on the 5th day of school at a trend level, $t(14) = 1.77$, $p = .099$. There were no other significant group differences. Group differences in slope on the 5th day of school were further explored by examining the individual cortisol values. The RFC group demonstrated significantly higher morning cortisol compared to the CC group, $t(18.86) = 2.16$, $p = .044$. No other significant group differences emerged.

Discussion

These preliminary findings are consistent with previous work in that individual (or group) differences in the diurnal cortisol rhythm appear to be more pronounced on the 5th (vs. the 1st) day of school (Bruce et al., 2002; Davis et al., 1999). The RFC group demonstrated a steeper cortisol slope on the 5th day of school, primarily due to higher morning cortisol levels, compared to the CC group. Researchers have hypothesized that individual differences in coping emerge upon repeated exposure to stressors (Bruce et al., 2002; Pruessner et al., 1997), resulting in greater associations between individual characteristics and the cortisol response to later exposures. In addition to differences in temperament (Bruce et al., 2002; Davis et al., 1999), early life stress may influence the response of the HPA axis to the 5th day of school.

These findings also extend the literature on the effects of early preventive intervention for foster children on the HPA axis by examining changes in the diurnal cortisol rhythm in response to a naturally occurring stressor. The blunted diurnal cortisol slope observed in some young foster children (Dozier et al., 2006; Fisher et al., 2006) has been attributed to down regulation of the HPA axis subsequent to heightened HPA activity following early adversity (Loman & Gunnar, 2010). However, the RFC children demonstrated higher morning cortisol levels on the 5th day of school compared to the CC children, suggesting that dysregulation of the HPA axis for foster children might also be characterized by an extended cortisol response to naturally occurring stressors. Alternatively, the findings might suggest that the RFC children demonstrated a delayed HPA axis response to the start of school; this group showed little change from the week before to the 1st day of school, but a significant increase in slope between the week before and the 5th day of school. In line with previous findings (Fisher et al., 2007), this preliminary study indicates that a comprehensive early preventive intervention program has the potential to influence foster children's HPA axis functioning. In contrast to the RFC children, the MTFC-P children appeared more similar to the CC children with a difference in cortisol slope between the week before and the 1st day of school, but not between the week before and the 5th day of school. MTFC-P emphasizes consistency in routines and parenting practices, which has previously been associated with less day-to-day variability in diurnal cortisol levels (Fisher et al., 2007). The school readiness aspect of the therapeutic playgroup might have also contributed to the greater similarity between the MTFC-P and CC children.

Several limitations should be noted. First, the small sample size makes it difficult to generalize from these findings and necessitates replication with a larger sample size. Second, variation in grade level introduced heterogeneity into the sample (although results remained consistent after controlling for grade level). Moreover, due to the small sample size, we were not able to control for individual differences in temperament and other factors likely to influence HPA axis response to the start of school. Nevertheless, as the findings fit well within the broader literature, our results suggest that the cortisol response to naturally occurring stressors represent an important area of investigation for understanding the challenges faced by foster children.

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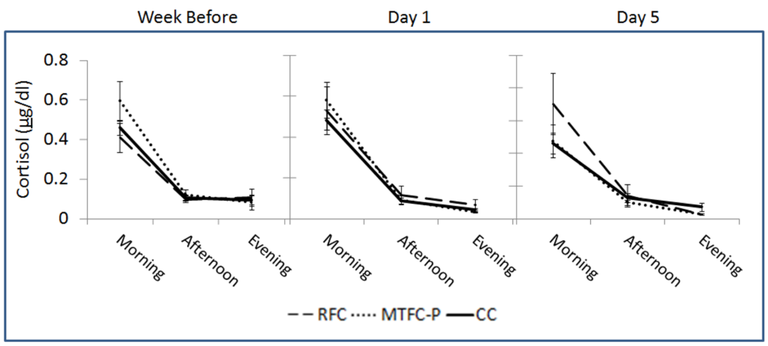

Figure 1.
Morning, afternoon, and evening cortisol (µg/dl) at the week before, the 1st day of, and the 5th of school by group.

Table 1

Descriptive Statistics for Cortisol Values by Day and Group (μg/dl)

	Week before school						1st day of school						5th day of school					
	RFC		MTFC-P		CC		RFC		MTFC-P		CC		RFC		MTFC-P		CC	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Morning	0.41	0.19	0.60	0.30	0.46	0.17	0.53	0.32	0.58	0.26	0.48	0.23	0.70	0.49	0.47	0.30	0.46	0.30
Afternoon	0.10	0.04	0.12	0.07	0.10	0.07	0.12	0.12	0.09	0.07	0.09	0.07	0.14	0.18	0.10	0.05	0.13	0.12
Evening	0.11	0.11	0.08	0.12	0.09	0.10	0.07	0.07	0.03	0.01	0.04	0.04	0.03	0.01	0.03	0.01	0.07	0.11

Note. RFC = regular foster care; MTFC-P = Multidimensional Treatment Foster Care for Preschoolers; CC = community comparison.

Values for the week before school are the average values from 2 consecutive days.