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Higher cortisol is associated with poorer executive functioning in preschool children: The role of parenting stress, parent coping and quality of daycare

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Abstract

Child executive functions (cognitive flexibility, inhibitory control, working memory) are key to success in school. Cortisol, the primary stress hormone, is known to affect cognition; however, there is limited information about how child cortisol levels, parenting factors and child care context relate to executive functions in young children. The aim of this study was to examine relationships between child cortisol, parenting stress, parent coping, and daycare quality in relation to executive functions in children aged 3–5 years. We hypothesized that (1) poorer executive functioning would be related to higher child cortisol and higher parenting stress, and (2) positive daycare quality and positive parent coping style would buffer the effects of child cortisol and parenting stress on executive functions. A total of 101 children (53 girls, 48 boys, mean age 4.24 years ±0.74) with complete data on all measures were included. Three saliva samples to measure cortisol were collected at the child's daycare/preschool in one morning. Parents completed the Behavior Rating Inventory of Executive Function – Preschool Version (BRIEF-P), Parenting Stress Index (PSI), and Ways of Coping Questionnaire (WCQ). The Early Childhood Environment Rating Scale – Revised (ECERS-R) was used to measure the quality of daycare. It was found that children with poorer executive functioning had higher levels of salivary cortisol, and their parents reported higher parenting stress. However, parent coping style and quality of daycare did not

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modulate these relationships. Identifying ways to promote child executive functioning is an important direction for improving school readiness.

Keywords

Child stress; Executive function; BRIEF-P; Daycare; Coping; Parenting stress; Cortisol

Executive functions are key to school readiness and academic performance. Development of executive functions has been found to be more related to school readiness than entry-level reading skills, math skills (Blair & Razza, 2007), and intelligence (McClelland, Morrison, & Holmes, 2000), and also predicts a variety of skills involved in academic success in kindergarten and later in childhood (Espy, 2004). Also called cognitive control, executive functions are a highly complex set of processes essential for regulating behavior, planning and problem-solving (Miller & Cohen, 2001). Executive functions are often considered as comprising primarily inhibitory control (resisting distractions), working memory (mentally holding and using information), and cognitive flexibility (adjusting to change) (Diamond, 2006). However, abilities under the umbrella of executive functioning may also include strategic planning, abstract reasoning and decision-making (Alexander & Stuss, 2006; Bechara & Van Der Linden, 2005).

Studies of executive functions in preschool-age children are advancing our understanding of the cognitive abilities that underlie academic success (Espy, 2004). For example, inhibitory control and attention-shifting in preschool are related to a wide range of math and literacy abilities in kindergarten (Blair & Razza, 2007). Further, working memory in preschool children aged 4.5 years was found to predict math achievement in the third year of primary school (3 years later), while executive function skills in the same children in preschool predicted learning in general in grade 3 (Bull, Espy, & Wiebe, 2008). Alternatively, deficits in emotional and/or behavioral executive functioning have been linked to such negative outcomes as aggressive behavior in healthy children (Ellis, Weiss, & Lochman, 2009; Raaijmakers et al., 2008). In school-age children there is considerable evidence that executive functions reflect several subdomains (e.g., Diamond, 2006), whereas in preschoolers executive functions may reflect more general cognitive control (Espy, 2004).

Cortisol, Caregivers and Neuropsychology

Cortisol is the primary biomarker of stress in humans (Gunnar, Bruce, & Hickman, 2001) and high levels of salivary cortisol have been associated with poorer cognitive performance across the lifespan (Lupien et al., 2005; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007). For adults, the impact of stress on cognitive functions is well established. For example, lower performance on tasks of declarative memory and attention are associated with higher cortisol in adults (Elzinga Bernet, Bakker, & Bremner, 2005; McCormick, Lewis, Somley, & Kahan, 2007). Higher stress, as measured with salivary cortisol, has also been demonstrated to impact adult decision-making (Starcke, Wolf, Markowitsch, & Brand, 2008), executive functions (Stawski et al., 2011), and dual-performance activities (Plessow, Schade, Kirschbaum, & Fischer, 2012). Stress and neuropsychology in children has received attention (e.g., Chen, Raine, Soyfer, & Granger, 2015; Hostinar, Johnson, & Gunnar, 2015); however, the literature remains limited.

Children aged 9–12 years with high daily perceived stress had lower morning cortisol levels, and demonstrated significantly poorer scores for speed of memory and continuity of attention (Maldonado et al., 2008). Somewhat consistent with those findings, Quas, Bauer, and Boyce (2004) found a link between cortisol reactivity and short-term memory for children aged 4–6 years . Using parent-reported indicators of executive functions, Miller, Chen, and Zhou (2007) found relationships between markers of regulatory capacity and early school adjustment. Furthermore, Blair, Granger, and Peters Razza (2005) reported that the pattern of cortisol expression was associated with measures of executive functions and self-regulation, confirming the importance of child stress and regulatory capacities.

Parenting stress is known to be a moderator of the relationship between cortisol and attention in infancy (Tu et al., 2007), and it is therefore likely that parenting/ caregiver stress may influence cortisol levels and/or executive functions at preschool age. Brummelte, Grunau, Synnes, Whitfield, and Petrie-Thomas (2011) reported that increased parenting stress over time in toddlers born very preterm may reflect realistic concerns regarding their developmental progress. Geoffroy, Cote, Parent, and Seguin (2006) examined the impact of daycare on cortisol levels for infants, preschoolers, and school-age children across 11 published studies and found that cortisol levels were higher during daycare hours, but that this effect was only evident for children in low-quality care. The effect was also found to be greater for preschoolers and children with difficult temperaments, compared to infants, school-age children, and children with less difficult temperaments. In a published abstract, Alwin (2006) reported few differences between the cortisol levels of children aged 3–18 months when in the home versus a daycare environment and increased cortisol levels in children with distress-prone temperaments and/or of older ages. Also, positive engagement with a caregiver was found to have a buffering effect on cortisol secretion. Moreover, Vermeer and van Ijzendoorn (2006) concluded that cortisol secretion was especially prominent in children attending daycare at less than 36 months of age.

McLuckie (2013) provides a published abstract that describes a strong link between parenting stress and parent-reported child difficulties with emotional control and inhibition. A lesser, but still important, relationship was also found between child initiation and self-monitoring, and parenting stress. In another recent abstract, Cutuli (2012) evaluated the relationship between salivary cortisol, executive functions, living context and parenting behavior. His results suggested no relationship between cortisol levels and high rates of stressful and/or negative life events, or positive parenting behavior. In contrast, in interactive situations, harsh, hostile, or insensitive parenting behaviors were related to increased child cortisol. In addition, initial cortisol levels were found to be negatively associated with executive functions.

Given the previous studies that have shown that child cortisol levels are sensitive to aspects of childcare (e.g., quality of the childcare setting; Geoffroy et al., 2006) and since young children spend many daytime hours in childcare, we thought it important to examine the relationship of cortisol levels during childcare in relation to child executive functions.

Aims of the Current Study

There is a notable lack of research on the relationships between parenting/ caregiver self-reported stress and cortisol, and parenting/caregiver stress and child executive functioning. To our knowledge, Cutuli's (2012) dissertation abstract is the only available information describing the relationship among these three variables. The aim of the present study was to address these identified gaps in the literature by examining relationships between child cortisol, parenting stress, parent coping, and quality of daycare, in relation to executive functions in children aged 3–5 years. In particular, we were interested in evaluating these relationships using an ecologically valid (report) measure of child executive functions. To our knowledge, all available studies involving child cortisol and executive functions have only been tested with performance-based tasks rather than a parent-reported questionnaire of everyday functioning (Isquith, Gioia, & Espy, 2004). Parent report was chosen in order to reflect typical executive functioning across environments, including those with less structure than that provided during child care hours (e.g., home, community). Using the Behavior Rating Inventory of Executive Function – Preschool Version (BRIEF-P) as a measure of executive functions, we hypothesized that poorer parent ratings of child executive functions would be related to higher child cortisol, higher parenting stress and poorer quality of daycare, and that a positive parental coping style would buffer the effects of child cortisol and parenting stress on executive functions.

METHODS

Participants

Children were recruited from 17 daycares/preschools in three communities in the interior of the province of British Columbia, Canada. A total of 150 parents gave informed consent. Saliva samples were collected from 148 children, since two children did not attend daycare/ preschool on the days of saliva sample collection. One child diagnosed with Autism Spectrum Disorder (ASD) was also excluded, as previous literature suggests higher stress levels for parents of children with ASD (e.g., Sharpley, Bitsika, & Efremidis, 1997). Further, salivary cortisol assays were insufficient on one or more samples from eight children. For the questionnaire data, of the 147 respective potential parent participants, 109 parents (74%) returned completed questionnaires. Taking both physiological and questionnaire data together, we achieved complete data (3 assays and completed parent questionnaires) for a total of 101 children (53 girls, 48 boys, mean age 4.24 years ±0.74).

Measures and Procedure

Child Salivary Cortisol—We collected three saliva samples in the mid-to-late morning on one day at the child's daycare/preschool. The average time of day was 10:42 am for the first sample, 11:02 am for the second sample, and 11:19 am for the third sample, with a mean collection time of 37 min (±11) for all three samples, and an average of 18 min (±6) between the samples. We chose mid-to-late morning to avoid mealtimes and naps, and it appeared to be the most optimal time to reflect the child's inherent stress level during a time of day important for focused learning. Since salivary cortisol fluctuates, we collected three samples. No child had anything to eat or drink for at least 30 min before the first saliva sample, or during the entire sample collection period. Between samples, children returned to their usual daily activities. Samples were collected in small groups by a research assistant in the presence of at least one daycare staff member. Each child was given a sorbette (Salimetrics®) to place under the tongue for at least 60 seconds. After absorption, the sorbette was placed into an eppendorf tube and kept at 4°C until it was spun to extract saliva. Extracted saliva was then stored frozen at −20°C until assayed. The Salimetrics high sensitivity salivary cortisol enzyme immunoassay kit was used for quantitative determination of salivary cortisol levels. All samples were assayed in duplicates. The intra-assay coefficient of variation was 4.38% and the intra-assay variability was 6.62%, similar to that reported by the kit manufacturer.

Parent Questionnaires—Parents were given three questionnaires at the end of the day on which saliva samples were collected from their children and were asked to complete and return them by mail.

The BRIEF-P (Gioia, Espy, & Isquith, 2003) was developed for children aged 2–5 years and was used to measure executive functions. The BRIEF-P parent response measure is designed to evaluate a child's executive function capabilities in "real world" settings (Gioia et al., 2003). It contains 63 items that yield five theoretically and empirically derived clinical scales: Inhibit (control of impulses and modulation of behavior), Shift (flexible transition between situations), Emotional Control (modulation of emotional responses), Working Memory (holding of information in mind for completing a task or making the appropriate response), and Plan/Organize (anticipation of future events, use of goals or instructions to guide behavior in context and thinking ahead). These scales yield an overall Global Executive Composite score and three index scores: Inhibitory Self-Control, Flexibility, and Emergent Metacognition, which we used in the present study. The BRIEF-P is sensitive to individual variation in the general population (Isquith et al., 2004) and has been previously used to assess differences in executive functioning in clinical populations of preschool children (Ganesalingam et al., 2011; Mahone & Hoffman, 2007). To our knowledge, the BRIEF-P is the only standardized executive functions questionnaire designed specifically for use with preschoolers. With respect to questionnaire measures such as the BRIEF for school-age children, and the BRIEF-P, concerns have been raised regarding the low to moderate correlations between parent ratings of child executive functions and neuropsychological testing (Anderson, 2001; Anderson, Anderson, Northam, Jacobs, & Mikiewicz, 2002; Denckla, 2002). Despite these findings, the increased ecological validity of parent and teacher reports has been considered an important and non-dismissible contributor to the assessment of executive functions (Gioia & Isquith, 2004; Gioia, Isquith, Guy, & Kenworthy, 2001). Moreover, preschool executive functioning abilities assessed via parent/caregiver report using the BRIEF-P predict early mathematics achievement (Clark, Pritchard, & Woodward, 2010) and the BRIEF parent/teacher forms effectively discriminate children with Attention Deficit Hyperactivity Disorder and other problems (Mahone et al., 2002; McCandless & O'Laughlin, 2007). Therefore, parent and teacher reports are viewed as providing ecologically valid measures of child executive functions. In this study we only used the parent version.

The Parenting Stress Index (PSI; Abidin, 1995) long form was used to examine aspects of stress that stem from the parenting role. The PSI is the most widely used measure of parenting stress in parents of young children with a variety of health, developmental and behavioral problems (e.g., Brummelte et al., 2011; Collett, Cloonan, Speltz, Anderka, & Werler, 2012; Faught, Bierl, Barton, & Kemp, 2007; Fite, Stoppelbein, & Greening, 2008; Glenn, Cunningham, Poole, Reeves, & Weindling, 2009; Tu et al., 2007; Webster, Majnemer, Platt, & Shevell, 2008). The PSI long form contains 120 items comprising three domains: Child Domain, Parent Domain, and Life Stress Domain. The Parent Domain assesses aspects of stress related to the parent's functioning, and is composed by seven subscales: Competence, Isolation, Attachment, Health, Role Restriction, Depression, and Spouse. The Life Stress Domain provides an index of the amount of stress experienced by the parent outside the parent-child relationship. The Child Domain reflects stress that stems from child characteristics that make it difficult for parents to fulfill their parenting roles. Only the Parent Domain and Life Stress PSI subscales were used for the present study.

The Ways of Coping Questionnaire (WCQ; Folkman & Lazarus, 1988) was used to measure parent coping. The WCQ is a 66-item inventory listing a wide range of thoughts and behaviors used to deal with stressful situations, yielding eight coping scales: Confrontative Coping, Distancing, Self-Controlling, Seeking Social Support, Accepting Responsibility, Escape-Avoidance, Planful Problem Solving, and Positive Reappraisal. The internal consistency coefficients ranged from .68 to .79 for the subscales (Folkman & Lazarus, 1988). The WCQ is one of the most widely used measures of parent coping (e.g., Aikens, Fischer, Namey, & Rudick, 1997; Folkman & Moskowitz, 2000; LaMontange & Pawlak, 1990; Pisula & Kossakowska, 2010).

The Early Childhood Environment Rating Scale – Revised (ECERS-R; Harms, Clifford, & Cryer, 1998) was used to measure quality of daycare. The ECERS-R appears to be the most frequently used measure of global quality in early childhood settings (Cassidy, Hestenes, Hegde, Hestenes, & Mims, 2005). It contains 43 items grouped into seven subscales: Personal Care Routines, Space and Furnishings, Language Reasoning, Activities, Program Structure, Interactions, and Parents and Staff. Cronbach's alpha for the subscales ranged from .71 to .88 (Harms et al., 1998). For the present study, the Language Reasoning, Activities, Program Structure, and Interactions subscales were selected a priori as of most interest to examine in relation to executive functions. The ECERS-R data was collected as part of a larger study (Maggi, Roberts, MacLennan, & D'Angiulli, 2011) and the data was linked to the new data collected for the present study.

Data Analysis

Two-way repeated measures analyses of covariance (ANCOVAs) were carried out to test relationships between the level of executive functioning (median split "higher" versus "lower"), sex (boys, girls) and cortisol (across the three samples), with maternal education and parenting stress (PSI Parent Domain and PSI Life Stress) as covariates. Generalized linear modeling (GZLM) was performed to examine relationships between executive functions, cortisol, quality of daycare and parent coping, adjusted for parenting stress, mother education and child sex. Data analyses were carried out using SPSS version 18.

RESULTS

Participant Description

The characteristics of the sample are shown on Table 1. Parent participants were 97% mothers; the remaining 3% were primary caregiving fathers. Level of maternal education was used as a marker of socioeconomic status (SES). These families were from smaller cities and towns, not a major metropolitan area, and thereby represented generally lower SES, as 35% had 8th grade education or less. Only 10% were college graduates, and 2% had advanced education. Low education was not accounted for by immigration status, since 93% of the parents were born in Canada. Of the seven parents born outside Canada, all but one had resided there for more than 10 years, and four for more than 20 years.

Data Reduction

To reduce the number of measures from the WCQ, a principal components analysis (PCA) was conducted on the means of the scores of the eight scales of the WCQ. The PCA yielded two eigenvalues > 1 which were interpreted as a positive coping vector (eigenvalue 3.76, accounting for 47% of the variance) and a negative coping vector (eigenvalue 1.05, accounting for 13% of the variance), accounting for 60% of the variance overall. The loadings for each of the WCQ subscales on the two PCA components are shown in Table 2. Since Self-Control, Seeking Social Support, Planful Problem Solving, Positive Reappraisal and Distancing all loaded positively on component 1 and negatively on component 2, the first component was viewed as relatively positive coping and the second as relatively negative coping.

Cortisol, Executive Functions and Gender

Cortisol values are shown in Table 3. To examine the level of executive functioning in relation to cortisol and gender, median splits were applied to the BRIEF-P Global Executive Composite score and each Index score (Inhibitory Self-Control, Flexibility, and Emergent Metacognition; see Table 4). Two-way repeated measures ANCOVAs were carried out with cortisol across time as a repeated measures factor (Samples 1,2,3) and each executive function level (higher, lower) and sex (boys, girls) as between-subjects factors. There is a reported relationship between family context and child stress (Cutuli, 2012); consequently, in order to elucidate associations between cortisol and executive functions, we adjusted for mother education and parenting stress (PSI Parent Domain and PSI Life Stress) as covariates.

Global Executive Composite—Cortisol levels did not differ across samples ($F[2, 188] < 1$, $p = .67$). Children with lower executive functions had significantly higher cortisol levels ($F[1, 94] = 4.44$, $p = .038$). Children with higher child cortisol had parents with greater parenting stress ($F[1, 94] = 6.32$, $p = .014$), but not life stress ($F[1, 94] < 1$, $p = .48$), or maternal education ($F[1, 94] = 1.38$, $p = .24$). Sex was not significant ($F[1, 94] = 2.07$, $p = .15$). No interaction effects were statistically significant (each $p > .41$). Cortisol in relation to the level of child global executive function is shown in Figure 1.

Inhibitory Self-Control—Cortisol levels did not differ across the samples (F[2, 188] < 1, p = .60), and did not differ by level of inhibitory self-control (F[1, 94] = 1.73, p = .19). Children with higher child cortisol also had parents with higher parenting stress (F[1, 94] = 5.04, p = .027), but not life stress (F[1, 94] < 1, p = .52), or maternal education (F[1, 94] = 1.85, p = .18). Gender was not significant (F[1, 94] = 1.97, p = .16). No interaction effects were statistically significant (each p > .36).

Flexibility—Cortisol levels did not differ across the samples (F[2, 188] < 1, p = .58). Cortisol levels trended toward a relationship with higher, as compared with lower, flexibility scores (F[1, 94] = 3.72, p = .057). Children with higher child cortisol also had parents with higher parenting stress (F[1, 94] = 6.24, p = .014), but not life stress (F[1, 94] = 1.14, p = .29) or maternal education (F[1, 94] = 1.89, p = .17). Sex was not significant (F[1, 94] = 1.36, p = .25). No interaction effects were statistically significant (each p > .34).

Emergent Metacognition—Cortisol levels did not differ across the samples (F[2, 188] < 1, p = .55). Children with poorer emergent metacognition had a trend towards higher cortisol levels (F[1, 94] = 2.87, p = .094). Children with higher child cortisol also had parents with higher parenting stress (F[1, 94] = 5.27, p = .024), but not life stress (F[1, 94] = < 1, p = .56), or maternal education (F[1, 94] = 1.43, p = .24). Sex was not significant (F[1, 94] = 1.69, p = .20). No interaction effects were statistically significant (each p > .29).

Executive Functions in relation to Quality of Daycare and Parent Coping

To examine the relationships between executive functions, cortisol, quality of day-care and parent coping, adjusted for parenting stress, maternal education and sex, GZLM was performed following the GENLIN procedure in SPSS 18 that permits examination of effects with non-independent measures and potential confounders. Since the ANCOVAs above showed no difference in cortisol levels across the three samples, the average cortisol level was used in all further analyses. The Positive and Negative parent coping scores generated from the PCA above were used in the GENLIN analyses. Each outcome measure (BRIEF-P Global Executive Composite, Inhibitory Self-Control, Flexibility, and Emergent Metacognition Index scores) was entered as a continuous measure.

Global Executive Composite—The omnibus test of the model was significant (χ^2[11] = 47.40, p < .001), suggesting that further interpretation of variables was appropriate. Children with lower executive functions differed from children with higher executive functions in that the lower executive functions children trended toward higher cortisol (χ^2[1] = 3.43, p < .064), and had lower maternal education (χ^2[11] = 5.59, p < .018), higher parenting stress (χ^2[11] = 29.69, p < .001), and lower quality daycare/preschool for the language reasoning domain (χ^2[11] = 3.83, p < .050). In contrast, no differences were found for child sex, life stress, parenting coping, or daycare/preschool quality for the activities, interaction and program structure domains.

Inhibitory Self-Control—The omnibus test of the model was significant (χ^2[11] = 45.91, p < .001), suggesting that further interpretation of variables was appropriate. Children with lower executive functions differed from children with higher executive functions in that the lower executive functions children trended toward higher cortisol ($\chi^2[1] = 3.31$, $p < .069$), higher parent life stress ($\chi^2[11] = 2.92$, $p < .088$), and lower quality of daycare on the interaction domain ($\chi^2[11] = 2.75$, $p < .098$). In addition, lower executive functions children had lower maternal education ($\chi^2[11] = 5.55$, $p < .018$), higher parenting stress ($\chi^2[11] = 25.55$, $p < .001$), and less daycare quality for the language reasoning domain ($\chi^2[11] = 3.83$, $p < .050$). In contrast, no differences were found for child sex, parenting coping, or daycare quality for the activities or program structure domains.

Flexibility—The omnibus test of the model was significant ($\chi^2[11] = 51.51$, $p < .001$), suggesting that further interpretation of variables was appropriate. Children with lower executive functions differed from children with higher executive functioning in that the lower executive functions children had higher cortisol ($\chi^2[1] = 7.23$, $p < .007$), higher parenting stress ($\chi^2[11] = 36.48$, $p < .001$), and higher parent life stress ($\chi^2[11] = 5.48$, $p < .019$). In contrast, no differences were found for child sex, maternal education, parent coping, or daycare/preschool quality for any domain.

Emergent Metacognition—The omnibus test of the model was significant ($\chi^2[11] = 34.49$, $p < .001$) suggesting that further interpretation of variables was appropriate. Children with lower executive functions had mothers with lower maternal education ($\chi^2[11] = 4.51$, $p < .034$) and higher parenting stress ($\chi^2[11] = 23.27$, $p < .001$) relative to children with higher executive functions. In contrast, no differences were found for child sex, cortisol level, parent life stress, parent coping, or daycare quality for any domain.

DISCUSSION

Our primary finding was that children with poorer overall executive functioning had higher salivary cortisol levels, and their parents self-reported higher parenting stress. These results were consistent across domains of executive functioning using an ecologically valid measure of parent-reported child executive functioning (Gioia et al., 2003). However, this relationship between poorer executive functioning and higher cortisol appeared particularly compelling for children with lower scores for Flexibility. We found no differences in child executive functioning in relation to child sex.

Further, when maternal education, parent coping and daycare quality were included in the model, there was a trend suggesting that children with less Inhibitory Self-Control and Flexibility may also have parents with higher life stress. While only a trend was revealed, this may suggest that, when coping skills and other confounding factors are accounted for, parents of children with poor self-control and flexibility experience greater parenting stress, and that this parenting stress may become an aspect of increased life stress overall. Finally, for children with poor Inhibitory Self-Control, reduced language reasoning and other effects related to poor daycare quality were evident.

Our results, using the BRIEF-P as a measure of everyday executive functioning, are generally in agreement with previous literature that has utilized direct testing of child executive functions. Specifically, we found that children with lower executive functioning also had higher rates of salivary cortisol, consistent with Maldonado et al. (2008), and that salivary cortisol varied as a function of behavioral measures of executive functioning, which can perhaps equate to a proxy for early school adjustment (Blair et al., 2005; Miller & Cohen, 2001). Moreover, the present study confirms and extends previous work that found a relationship between parenting stress and child executive functioning (McLuckie, 2013), and our present findings in a sample of preschool-age children from the general population support the previous link between parenting stress and child cortisol that we reported in infants born very prematurely (Tu et al., 2007). However, unlike the findings of Geoffroy et al. (2006) and Alwin (2006), we found minimal differences in cortisol levels as a function of daycare/preschool quality; however, those studies found an effect in the late afternoon whereas we examined cortisol only earlier in the day.

Limitations

The cross-sectional nature of our data restricts our ability to interpret the directionality of our findings as to whether parent stress results in increased child cortisol, whether increased child cortisol results in greater parent stress, or whether this relationship is bidirectional. Similarly, we are unable to determine the directionality for the impacts of poor executive functions. It may be that lower child executive functioning contributes to family stress, family stress contributes to lower executive functioning, or both. Future longitudinal research will be necessary in order to determine the directionality of such relationships. Other limitations were the lack of additional corroborating data to supplement parent-report questionnaires, such as teacher report of child executive functions.

Conclusion

The current study contributed to understanding executive functioning in pre-school children as it relates to child salivary cortisol and parenting stress. The present findings, in combination with previous research, suggest the importance of promoting child executive functioning skills as a means of decreasing child and parenting stress. Our data provide associations; therefore, it is hard to determine whether the higher child cortisol levels are a result of greater parenting stress, or whether higher cortisol levels are an inherent aspect of poor executive functioning and present regardless of parenting stress levels. Cutuli's (2012) work suggests that higher child cortisol levels were only found when in the actual presence of a harsh or hostile caregiver. Consequently, one possibility is that raising a child who displays low flexibility may lead to increased parenting stress, in turn increasing the possibility for increased harshness or hostility in parenting, and subsequently higher rates of child stress, as reflected via salivary cortisol. An equally plausible possibility is that there may be joint similarities in parent and child characteristics. Future studies would benefit from including more measures of parent factors, such as maternal and paternal cognitive flexibilty and cortisol levels to elucidate these parent-child relationships.

Recent perspectives on environmental contributions to executive functioning provide hope for techniques to train executive functioning generally, similar to more established methods in training specific skills such as attention and memory. For example, Harvard University's Center on the Developing Child has created a series of working papers regarding the development of executive functioning in early childhood (Center on the Developing Child at Harvard University, 2011). It is proposed that through training, as any other learned skill, increased executive functioning can lead to improved parent and child outcomes, including reduced stress and cortisol (Diamond, Barnett, Thomas, & Munro, 2007). Future research should continue to elucidate the links among these important variables in the child-parent dyad and consider new and innovative approaches to improving executive functions skills and development throughout early childhood.

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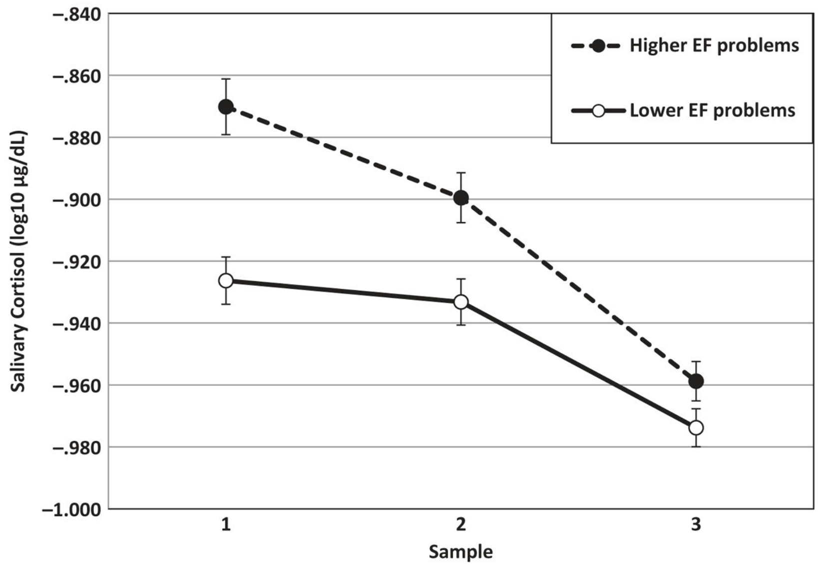

Figure 1.
Child cortisol across three samples at daycare/preschool by Global Executive Composite score median spilt on the BRIEF-P (mean ± SE). Children with Higher EF problems (lower executive functioning) had higher cortisol values. All values are log-transformed, as used in the statistical analysis.

Table 1

General Characteristics of All Study Participants by Global Executive Composite Score Median Split.

	All *n* = 101		Higher Global Executive Composite Score (Higher EF Problems) *n* = 50		Lower Global Executive Composite Score (Lower EF Problems) *n* = 51	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
	4.24	0.74	4.22	0.79	4.26	0.68
Age (years)	*n*	%	*n*	%	*n*	%
Children						
Sex						
Female	53	52.5	26	52.0	27	52.9
Male	48	47.5	24	48.0	24	47.1
Child Attends						
Daycare	53	52.5	23	46.0	30	58.8
Preschool	38	37.6	21	42.0	17	33.3
Kindergarten	10	9.9	6	12.0	4	7.8
	Mean	*SD*	Mean	*SD*	Mean	*SD*
	34.25	5.01	34.11	6.55	34.83	5.45
Age (years)	*n*	%	*n*	%	*n*	%
Parents						
Relationship with child						
Mother	98	97.0	49	98.0	49	96.1
Father	3	3.0	1	2.0	2	3.9
Marital Status						
Married	69	68.3	34	68.0	35	68.6
Single	6	5.9	3	6.0	3	5.9
Divorced	5	5.0	2	4.0	3	5.9
Widowed	1	1.0	1	2.0	0	0.0
Separated	9	8.9	5	10.0	4	7.8

	All $n = 101$		Higher Global Executive Composite Score (Higher EF Problems) $n = 50$		Lower Global Executive Composite Score (Lower EF Problems) $n = 51$	
Common Law	11	10.9	5	10.0	6	11.8
Level of Education						
1st to 8th grade	35	34.7	13	26.0	22	43.1
9th to 12th grade	26	25.7	15	30.0	11	21.6
Vocational or some college	28	27.7	16	32.0	12	23.5
College graduate	10	9.9	6	12.0	4	7.8
Graduate or professional school	2	2.0	0	0.0	2	3.9
Born in Canada						
Yes	94	93.1	47	94.0	47	92.2
No	7	6.9	3	6.0	4	7.8

Note. EF = executive functions.

Table 2

Component Loadings from Principal Components Analysis of the Ways of Coping Scales Completed by a Parent.

	Component	
Ways of Coping Scales	**1**	**2**
Confrontative Coping	.531	.633
Self-Controlling Coping	.814	−.029
Seeking Social Support	.512	−.385
Accepting Responsibility	.782	.140
Escape-Avoidance	.703	.489
Planful Problem Solving	.609	−.328
Positive Reappraisal	.789	−.290
Distancing	.672	−.208

Note. 96 parents completed the WCQ. The mean response for each of the eight scales was entered in the principal components analysis.

Table 3

Salivary Cortisol Levels **(μg/dL)** across Three Samples of All Study Participants and by Global Executive Composite Score Median Split.

	All		Higher Global Executive Composite Score (Higher EF Problems)		Lower Global Executive Composite Score (Lower EF Problems)	
	n **= 101**		***n*** **= 50**		***n*** **= 51**	
Sample	**Mean**	***SD***	**Mean**	***SD***	**Mean**	***SD***
1	.127	.06	.135	.06	.118	.05
2	.121	.06	.126	.06	.117	.05
3	.108	.04	.110	.04	.106	.04

Note. EF = executive functions. All cortisol samples were collected in the mid-to-late morning.

Table 4

Descriptive Statistics of Executive Functions, Parenting Stress, Parent Coping and Quality of Daycare for All Study Participants and by Global Executive Composite Score Median Split.

	All			Higher Global Executive Composite Score (Higher EF Problems)			Lower Global Executive Composite Score (Lower EF Problems)		
	***n* = 101**			***n* = 50**			***n* = 51**		
Questionnaire	**Range**	**Mean**	***SD***	**Range**	**Mean**	***SD***	**Range**	**Mean**	***SD***
BRIEF-P*									
Inhibitory Self-Control Index score	35–90	49.11	10.15	44–90	56.54	8.99	35–51	41.82	4.20
Flexibility Index score	35–92	49.15	10.17	40–92	55.08	10.57	35–57	43.33	5.26
Emergent Metacognition Index score	33–90	49.38	10.89	42–90	57.74	9.34	33–49	41.18	3.61
Global Executive Composite score	33–91	49.03	10.96	47–91	57.42	9.51	33–46	40.80	3.52
PSI*									
Parent Domain	58–192	114.98	23.39	77–192	123.98	24.71	58–160	106.16	18.32
Life Stress	0–53	11.23	9.95	0–53	11.96	11.09	0–32	10.51	8.73
ECERS-R									
Language Reasoning	4.25–6.75	5.91	0.75	4.25–6.75	5.77	0.80	4.25–6.75	6.05	0.69
Activities	3.88–6.10	5.17	0.69	3.88–6.10	5.19	0.70	3.88–6.00	5.16	0.69
Program Structure	5.66–7.00	6.58	0.40	5.66–7.00	6.60	0.43	5.66–7.00	6.57	0.37
Interactions	4.40–7.00	6.58	0.29	4.40–7.00	6.52	0.36	6.20–7.00	6.63	0.19
	n = 96			*n* = 48			*n* = 48		
	Range	Mean	*SD*	Range	Mean	*SD*	Range	Mean	*SD*
WCQ* (relative scores)									
Confrontative Coping	0–0.54	0.13	0.08	0–0.28	0.12	0.62	0–0.54	0.14	0.09
Distancing	0–0.25	0.10	0.06	0–0.24	0.10	0.06	0–0.25	0.10	0.06
Self-Controlling Coping	0.03–0.29	0.15	0.05	0.03–0.29	0.15	0.05	0.03–0.25	0.14	0.05
Seeking Social Support	0–0.47	0.16	0.09	0–0.44	0.16	0.09	0.02–0.47	0.16	0.10
Accepting Responsibility	0–0.25	0.10	0.07	0–0.25	0.11	0.06	0–0.23	0.09	0.07
Escape-Avoidance	0–0.20	0.07	0.05	0–0.19	0.78	0.05	0–0.20	0.07	0.05
Planful Problem Solving	0–0.52	0.18	0.08	0.04–0.34	0.17	0.06	0–0.52	0.19	0.10

	All			Higher Global Executive Composite Score (Higher EF Problems)			Lower Global Executive Composite Score (Lower EF Problems)		
	n = 101			*n* = 50			*n* = 51		
Questionnaire	**Range**	**Mean**	***SD***	**Range**	**Mean**	***SD***	**Range**	**Mean**	***SD***
Positive Reappraisal	0–0.28	0.11	0.05	0–0.28	0.10	0.06	0–0.25	0.11	0.05

Note.

*Questionnaire completed by parent. EF = executive functions.