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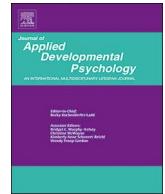


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Unique effects of socioeconomic and emotional parental challenges on children's executive functions

Jenna E. Finch*, Jelena Obradović

Stanford University, 520 Galvez Mall, CERAS #406, Stanford, CA 94305, United States

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ABSTRACT

Socioeconomic disparities undermine the development of children's executive functions (EF), whereas links between parental emotional challenges and EFs have been understudied. In an ethnically-diverse sample of 102 kindergarteners (M age = 5.61 years), linear and quadratic associations emerged between two types of parental challenges and direct assessments of children's EFs. Consistent with previous research, exposure to socioeconomic challenges was associated with lower levels of children's EFs. In contrast, the optimal levels of emotional challenge exposure differed depending on the affective nature of the EFs. Emotional challenges were linked to cool and assessor-rated EFs in a non-linear, inverted U-shaped fashion, whereas hot EFs linearly increased with exposure to emotional challenges. Corroborating the notion of a "stealing effect," mild-to-moderate parental emotional challenges were related to better EFs in a community sample.

1. Introduction

Striking socioeconomic disparities in children's developmental outcomes have been documented before children enter school in the United States (Reardon & Portilla, 2016). Socioeconomic challenges, typically indexed by lower levels of family income, parental education, and social status, affect the quality of children's early environments and their access to resources (Bradley & Corwyn, 2002; Duncan, Magnuson, & Votruba-Drzal, 2014). In addition to the well-established risks of living in or near poverty (Bradley & Corwyn, 2002; Evans & English, 2002; Raver, Blair, & Willoughby, 2013), significant economic disparities in developmental outcomes have been documented between middle- and high-income children (Reardon, 2011). Separately, parental emotional challenges, such as marital conflict, lack of social support, and parental distress have also been shown to impact children's early development by undermining parents' capacities to provide sensitive and responsive care (Choe, Olson, & Sameroff, 2013; Heberle, Krill, Briggs-Gowan, & Carter, 2015) or by exposing children to more chaotic and distressing family dynamics (McCoy, Cummings, & Davies, 2009). Although high levels of financial stress can increase the likelihood of parental emotional challenges, highly educated and affluent adults also experience stress, parental role overload, and mental health challenges (Luthar & Ciciolla, 2015; West, Reed, & Gildengorin, 1998) and can be perceived by their children to be emotionally unavailable (Luthar & Latendresse, 2005). Both socioeconomic and emotional aspects of the early family environment play a

critical role in the development of children's executive functions (EFs), higher-order cognitive skills that support self-regulation of attention and behavior. However, less is known about the unique effects of both socioeconomic and emotional challenges on EFs, especially in community samples with a wide distribution of incomes and educational attainment, where the two types of challenges may not co-occur. Furthermore, extant research has largely focused on identifying linear relations between children's family experiences and EFs, obscuring our understanding of whether exposure to mild to moderate challenges in the early years may be promotive of EF development. The current study uses a community sample to examine how socioeconomic and emotional challenges linearly and non-linearly relate to kindergarteners' EFs.

1.1. Socioeconomic disparities and executive functions

Socioeconomic status, a composite measure of family income, parental education, and sometimes occupational prestige, has been consistently correlated with children's EFs (Hackman & Farah, 2009; Noble, McCandliss, & Farah, 2007). Some studies report independent effects of maternal education and family income on children's EFs (Hackman, Gallop, Evans, & Farah, 2015; Raver et al., 2013), whereas others highlight the importance of family financial resources (Piotrowski, Lapierre, & Linebarger, 2013). Positive linear associations between family socioeconomic status, as indexed by parental income and education, and EFs have been reported in both low- and high-risk samples

* Corresponding author.

E-mail address: jenna.e.finch@stanford.edu (J.E. Finch).

(Choe et al., 2013; Lengua et al., 2015; Obradović, Portilla, & Ballard, 2015; Raver et al., 2013). Significant gaps between low-, middle-, and high-income parents' investments in cognitively-stimulating materials and learning activities in and out of the home (Bassok, Finch, Lee, Reardon, & Waldfogel, 2016; Espinosa, Laffey, Whittaker, & Sheng, 2006; Hackman et al., 2015) may account for socioeconomic disparities in young children's EFs. There are also well-documented socioeconomic differences in access to high-quality and center-based preschool programs, which are known to benefit children's cognitive development (Bassok & Galdo, 2016; Loeb, Bridges, Bassok, Fuller, & Rumberger, 2007; Magnuson & Waldfogel, 2005).

Subjective perceptions of financial stress and social status have been linked to children's socio-emotional and cognitive development, including measures of EFs (Leininger & Kalil, 2014; Ponnet, 2014; Ursache, Noble, & Blair, 2015). These subjective measures have been shown to predict children's EFs over and above objective measures of socioeconomic status in a sample representing a wide distribution of parental income and education (Ursache et al., 2015). Using measures of financial stress and subjective socioeconomic status in conjunction with traditional measures of objective socioeconomic status may also address the fact that indices of parental income and education can be restricted or skewed in community samples. Averaging subjective and objective measures of socioeconomic status creates a more comprehensive measure of the socioeconomic challenges that parents face.

1.2. Emotional challenges and executive functions

Since the quality of parental caregiving is implicated in EF development (Blair & Raver, 2012), it is important to examine how related parental emotional challenges, such as marital conflict, parental burnout, and distress, are related to developing EFs. Most research has focused on how more severe measures of emotional adversity, such as maternal depression, parental maltreatment, and institutional deprivation, relate to EF development using at-risk samples (Colvert et al., 2008; Hughes, Roman, Hart, & Ensor, 2013). There has been a limited amount of research on community samples linking normative experiences of various parental emotional challenges to children's EFs. In middle- to high-income families, Choe et al. (2013) have linked a composite measure of maternal internalizing symptoms, interpersonal sensitivity, and hostility, to children's EFs at age three. Similarly, in a longitudinal community sample, maternal depressive symptoms during the preschool years have been uniquely associated with poorer EFs in early childhood (Hughes et al., 2013). Further, in socio-demographically diverse samples, mothers with higher levels of social support have been shown to report lower levels of depressive and anxiety symptoms (Kingsbury et al., 2015; Skipstein, Janson, Kjeldsen, Nilsen, & Mathiesen, 2012), along with more positive parenting practices (Heberle et al., 2015) and higher cognitive skills in children (Slykerman et al., 2005). Since parents at all socioeconomic levels report experiencing emotional challenges (Choe et al., 2013; Luthar & Cicciolla, 2015), we need more research on how emotional challenges are uniquely related to developing EFs in community samples.

Parental emotional challenges tend to capture proximal and dynamic experiences compared to the more distal measures of income and parent education (Obradović, Shaffer, & Masten, 2012), and as such, they may impact development of children's EF capacities in different ways. For example, witnessing emotional discord at home may directly challenge children's abilities to regulate their emotions and behavior, whereas socioeconomic resources may affect children's access to stimulating experiences. Sektnan, McClelland, Acock, and Morrison (2010) found that socioeconomic and emotional challenges, such as maternal depression, family income, and parental education, independently contributed to parent-rated self-regulation skills in a diverse sample of young children. However, since parents reported on both the challenge predictors and the children's outcomes, the

generalizability of this study's findings is limited. It is important to extend to this research by employing more objective, task-based measures of children's regulatory skills that eliminate the same-informant bias.

1.3. Non-linear effects of challenges on children's development

Researchers have theorized that not all levels of risk exposure are deleterious to children's development and that there are non-linear effects such that limited challenging experiences may be beneficial for children (Dienstbier, 1989; Rutter, 2006). For example, Rutter suggested that moderate levels of stress exposure might help build individual's resilience to future stressors (Rutter, 2006). This so-called "steeling" or "inoculation" effect implies that some challenging experiences may strengthen later resistance to stress by providing opportunities to successfully overcome limited adversity. In a nationally-representative sample of adults, Seery, Holman, and Silver (2010) corroborated this idea; they found curvilinear relations between lifetime adversity and well-being. Moderate levels of adversity, as indexed by three to four self-reported negative lifetime events (e.g. illness or injury, violence, family member's death, financial difficulties, relationship stress), were associated with the lowest levels of distress, functional impairment, and posttraumatic stress disorder symptoms and the highest amounts of life satisfaction when compared to low or high levels of lifetime adversity. However, most extant studies of adversity effects in early childhood employ linear models, where chronicity or severity of challenges predict a higher probability of negative outcomes (Evans, Li, & Whipple, 2013; Trentacosta et al., 2008), limiting our understanding of when and how non-linear effects emerge (Obradović, 2016).

Limited exposure to emotional challenges in the home may provide children with opportunities to practice self-regulation on a daily basis that could enhance their EFs over time. For example, children of parents who report mild parenting stress, marital conflict, or difficulties with their own emotions, may have more chances to learn how to cope with these limited challenges through regulating their own emotions and behavior compared to children of parents who report no discord at home. This idea is consistent with the finding that mid-range levels of parent-infant synchrony, which allow for mismatched emotional states and unpredictability, can be more promotive of maternal sensitivity (Bornstein & Manian, 2013) and attachment security (Jaffe et al., 2001) than high levels of coordination. However, complete asynchrony contributes to insecure attachment and low maternal sensitivity, as mothers become withdrawn and unresponsive. Similarly, higher levels of emotional challenges would most likely overwhelm children's capacities for self-regulation and undermine development of these skills over time.

1.4. Hot and cool executive functions during early childhood

Researchers often distinguish between "cool" EFs which reflect cognitive control in emotionally-neutral contexts, and "hot" EFs which reflect cognitive control in response to motivationally- and emotionally-significant demands (Prencipe et al., 2011; Zelazo & Carlson, 2012). Cool EFs are assessed in relatively abstract contexts, whereas hot EFs are assessed in contexts which involve rewards, such as gambling or waiting for a treat. A growing body of research suggests that contextual factors, such as the reliability of the experimenter in providing promised materials, can influence participants' performance on EF tasks in laboratory settings (Kidd, Palmeri, & Aslin, 2013; Mittal, Griskevicius, Simpson, Sung, & Young, 2015). Children's perceptions of the laboratory environment could affect the emotional valence of cool EF tasks, making the distinction between expression of hot and cool EFs less clear. Although both are considered "top-down" processes, hot and cool EFs have different neural correlates and developmental trajectories (Prencipe et al., 2011; Zelazo & Carlson, 2012). Lesion studies have

provided evidence that hot and cool EFs are independent because impairments in hot EFs can occur in the absence of impairments of cool EFs (Bechara, 2004). Finally, studies show that cool and hot EFs have divergent predictive validity. Cool EFs are more robustly linked to academic achievement, whereas hot EFs are more strongly correlated with behavior problems (Kim, Nordling, Yoon, Boldt, & Kochanska, 2013; Willoughby, Kupersmidt, Voegler-Lee, & Bryant, 2011). They also are differentially linked to children's stress physiology, such that children's cool EFs were linked to physiological response during engagement with a sociocognitive laboratory task and hot EF skills were associated with greater physiological recovery following the task (Obradović & Finch, 2016).

Given noted differences in developmental trajectories and correlates of hot and cool EFs, it is also feasible that environmental factors differentially contribute to their development. Only a few studies, to our knowledge, have explored how different aspects of children's environments are differentially linked to hot and cool EFs. In a low-income sample of preschoolers, Li-Grining (2007) found that sociodemographic and residential risks are associated with deficits in children's cool EFs, but not hot EFs. In contrast, parent-child connectedness predicted higher hot EFs, but was unrelated to the development of children's cool EFs. A recent study of a community sample revealed that a cumulative measure of negative life events, maternal depression, residential instability, and family structure transitions, negatively predicted preschooler's initial levels and growth of hot EFs, but was not related to their cool EFs (Lengua et al., 2015). In contrast, family income was linked to initial levels of both hot and cool EFs. These studies suggest that hot EFs may be more sensitive to proximal, emotional experiences in the home, whereas cool EFs may be more affected by socioeconomic factors, even in samples spanning the full income distribution.

1.5. Current study

This study examined how different levels of parental socioeconomic and emotional challenges in early childhood uniquely relate to direct measures of children's EFs (working memory, inhibitory control, and delay of gratification), as well as assessor-rated EFs. Our measures of family context captured comprehensive experiences of two types of challenges. Socioeconomic challenges were indexed by a composite of family's income, financial stress, parental education, and subjective social status, whereas emotional challenges were indexed by a composite of caregiver depressive symptoms, marital stress, lack of social resources, emotional regulation difficulties, and parental distress. We hypothesized that both types of early challenges would be linked to EFs, in an additive manner. Consistent with prior research, we expected socioeconomic challenges to show a negative association with EFs, especially for cool EFs. We also examined quadratic relations between early challenges and children's EFs. We were interested in exploring whether moderate levels of challenges, particularly emotional challenges, may promote hot and cool EFs in a community sample of young children. Moreover, we examined whether these relations varied

according to the affective nature of the task. To control for omitted variable bias, we included children's age, sex, minority status, and receptive vocabulary skills as covariates. Finally, we used a multi-method and multi-informant design, to avoid the same-informant biases introduced when parents both report on challenges and children's outcomes.

2. Method

2.1. Participants and procedure

The sample comprised 102 kindergarten children (*M* age = 5.61 years; *SD* = 0.56; range = 4.42–6.87; 51.96% females) who participated in a laboratory study along with their primary caregivers, hereafter referred to as parents (*M* age = 38.9 years; *SD* = 6.8; range = 24–60; 93.1% females). Families were recruited from advertisements at community centers, preschools, elementary schools, and libraries. Families were eligible if they had a child entering kindergarten or first grade. The recruitment protocol required that children complete all tasks in English, but parents were interviewed in either English or Spanish, depending on their preferences.

The sample was highly diverse with parents reporting the children as 36% White, 26% Hispanic/Latino, 20% Asian, 4% Black, and 14% as Multiracial/Other. Ninety-three percent of participating caregivers were female and 17% were single parents, which is representative of the study area. Seventeen percent reported educational attainment at a high school diploma or less while 42% had earned a graduate or professional degree. Consistent with this, 23% of the families reported a total household income as less than \$50,000 while 36% reported a household income greater than \$200,000, which reflects the higher cost of living in the San Francisco Bay Area.

Parents and their children visited a university laboratory to complete a protocol that lasted three hours in length. Parents completed an in-depth, in-person survey with a trained interviewer, which assessed demographic information, family functioning, parenting strategies, and child functioning. While parents were being interviewed, children completed a battery of EF tasks in a separate room with a trained child assessor. Parents received compensation and children received small toys and stickers throughout the assessment, plus a final prize at the end of the visit.

3. Measures

3.1. Challenges

Parents reported on all indicators of their challenges. Means, standard deviations, ranges, and skew for all components of the challenges measures are presented in Table 1.

3.1.1. Socioeconomic challenges

The socioeconomic challenges composite was the average

Table 1
Descriptive statistics for early challenges outcome measures.

Variable	# Items	M	(SD)	Skewness	Possible Range	Actual Range	n	α
Socioeconomic challenges	4	0.00	(0.83)			– 1.20–1.98	102	0.84
Total family income	–	\$125,041	(\$72,701)	– 0.31	\$2500 – \$200,000	\$2500 – \$200,000	97	–
PC highest education	–	15.75	(2.83)	– 0.86	0–21 years	8–21 years	102	–
Social status in USA	–	6.64	(2.26)	– 0.45	1–10	2–10	101	–
Financial stress	4	2.45	(1.20)	0.66	1–5	1–5	101	0.87
Emotional challenges	5	0.02	(0.76)			– 1.22–2.65	98	0.79
Depressive symptoms	20	27.60	(7.94)	1.77	20–80	20–61	98	0.89
Marital conflict	10	1.81	(0.46)	1.03	1–5	1.10–3.50	87	0.79
Lack of social resources	15	1.94	(0.71)	1.48	1–7	1–5	97	0.89
Emotion regulation difficulties	41	1.82	(0.40)	0.28	1–5	1.14–2.94	98	0.90
Parenting distress	12	2.04	(0.67)	0.39	1–5	1.00–4.17	97	0.85

standardized score on four indicators: (1) total family income, (2) parents' education, (3) subjective social status, and (4) financial stress ($\alpha = 0.84$). Parents reported on *total family income* and their highest *level of education*. *Subjective social status* was measured using the MacArthur Scale of Subjective Social Status (Adler, Epel, Castellazzo, & Ickovics, 2000), which consisted of a 10-rung ladder on which parents ranked themselves in terms of typical socioeconomic indicators (income, education, and occupational status), relative to others in the United States. This measure has been validated in a sample of American adults and showed support for convergent and discriminant validity (Cundiff, Smith, Uchino, & Berg, 2013). *Financial Stress* was measured with four items assessing parents' thoughts about money problems, difficulty paying bills, and limited opportunities due to lack of finances ($\alpha = 0.87$; Essex, Klein, Cho, & Kraemer, 2003). In our sample, financial stress was significantly correlated with income ($r = -0.60, p < 0.001$), education ($r = -0.50, p < 0.001$), and subjective social status ($r = -0.50, p < 0.001$), as well as measures of parental depression ($r = 0.45, p < 0.001$) and parental distress ($r = 0.22, p = 0.02$), suggesting construct validity.

3.1.2. Emotional challenges

The *emotional challenges* composite was the average standardized score on five indicators: (1) parents' depressive symptoms, (2) marital conflict, (3) lack of social resources, (4) emotion regulation difficulties, and (5) distress in their role as parents ($\alpha = 0.79$). *Parents' depressive symptoms* were measured with the 20-item Center for Epidemiological Studies Depression Scale ($\alpha = 0.89$; CES-D; Radloff, 1977). The CES-D utilized a four-point Likert scale, ranging from "rarely or none of the time (less than 1 day/week)" to "most or all of the time (5-7 days/week)" on items such as "I felt like I could not shake off the blues" and "I felt that people dislike me." The CES-D can accurately discriminate between psychiatric and general population samples, and is significantly correlated with other self-report measures of depression (Radloff, 1977). *Marital conflict* was assessed using the 10-item O'Leary – Porter Overt Hostility Scale, which measures how often parents openly argue, display physical and verbal hostility and criticize each other in the presence of their children ($\alpha = 0.79$; Porter & O'Leary, 1980). This measure was rated on a five-point Likert scale ranging from "never" to "very often" on items such as "How often do arguments between you and your partner take place in front of this child?" and "How often does your partner complain to you about your personal habits in front of this child?" The O'Leary – Porter scale has been correlated with other measures of marital quality, providing evidence for construct validity (Cummings, Goeke-morey, & Papp, 2003; Essex et al., 2003). *Lack of social resources* were assessed using the Personal Resources Questionnaire ($\alpha = 0.89$; PRQ; Brandt & Weinert, 1981). The PRQ includes 15 dichotomous items that measure perceived support from friends and relatives (e.g., "There is someone I feel close to who makes me feel secure", "I have relatives or friends who will help me out, even if I can't pay them back"). The PRQ has been associated with other measures of social support and interpersonal conflict (Weinert & Tilden, 1990), indicating construct validity. *Emotion regulation difficulties* were assessed with the Difficulties in Emotion Regulation Scale ($\alpha = 0.90$; DERS; Gratz & Roemer, 2004). DERS includes 41 items on a 5-point Likert scale ranging from "almost never" to "almost always", and measures difficulties in understanding or accepting emotions, refraining from impulsive behavior when upset, and lack of emotion regulation strategies (e.g. "When I am upset, I lose control over my behaviors"). Scores on the DERS are highly correlated with other measures of emotional regulation and predictive of self-harm behavior (Gratz & Roemer, 2004). *Parental distress* was measured using a subscale from the Parenting Stress Index ($\alpha = 0.85$; PSI; Abidin, 1995). The subscale includes 12 items on a five-point Likert scale ranging from "strongly disagree" to "strongly agree" and measures the distress a caregiver experiences due to an impaired sense of parenting competence, stresses associated with the restrictions placed on other life roles,

conflict with significant other, lack of social support, and presence of depression (e.g. "I find myself giving up more of my life to meet my child's needs than I ever expected"). The parental distress subscale is positively correlated with measures of parent psychopathology, parental perceptions of children's behavior problems, and self-report of harsh physical discipline, providing evidence for construct validity (Haskett, Ahern, Ward, & Allaire, 2006).

3.2. Working memory skills

The Backward Digit Span, drawn from the Wechsler Intelligence Scale for Children-IV (BDS; Flanagan & Kaufman, 2009), is a commonly used measure of cool *working memory* skills in young children (Carlson, 2005; Carlson, White, & Davis-Unger, 2014; Weiland, Barata, & Yoshikawa, 2014). Children's performance on the BDS correlates highly with other measures of working memory and complex cognition both concurrently and longitudinally (Conway et al., 2005), providing evidence for the convergent, discriminant, and predictive validity of the BDS. Children were verbally presented with strings of digits that increased in length and were asked to repeat the series in reverse. Each item consisted of two trials of equal length. If the child correctly answered at least one of the trials, the assessor administered a more difficult item that increased the digit series by one number. The task continued until the child failed both trials within an item. The BDS total score was a sum of all correct trials.

3.3. Inhibitory control skills

Inhibitory control was assessed using a computerized version of the Flanker task from the NIH toolbox (Zelazo et al., 2013), which requires focusing on a given stimulus while inhibiting attention to stimuli flanking it. The Flanker task has been widely used to assess cool inhibitory control skills in early childhood (Traverso, Viterbori, & Usai, 2015; Zelazo & Carlson, 2012). The Flanker task shows evidence for both convergent and discriminant validity in early childhood (Zelazo et al., 2013). The total score was comprised of a two-vector scoring method using both accuracy and reaction times. For any given child, accuracy was considered first. If accuracy levels for the child were < 80%, the final total score was equal to the accuracy score. If accuracy levels for the child reached 80% or more, the reaction time score and accuracy score were combined to calculate the total score, following Zelazo et al. (2013). Data for two children (1.96%) were excluded from analyses because they failed the practice blocks and therefore did not advance to the test trials.

3.4. Delay of gratification skills

Children's hot EFs were measured using a standard *delay of gratification* task. The Gift Wrap task (Kochanska, Murray, Jacques, Koenig, & Vandegest, 1996) was administered at the end of the session before the final prize was given to the child. The child was told to sit facing away from a table where the assessor noisily wrapped a gift for 60 s, and the child was instructed to refrain from peeking. After the wrapping was done, the assessor told the child she needed to find a bow in another room to make the gift extra special, reminded the child to not peek, and left the child alone with the gift for three minutes. Children's performance during the first part of the task (when the assessor is still in the room) is related to children's obedience and behavioral inhibition, whereas the second part of the task (when the assessor leaves the room) is a common measure of hot EFs (Kim et al., 2013; Li-Grining, 2007; Peterson & Welsh, 2014). Children's performance on the Gift Wrap task is highly correlated with other delay of gratification tasks, providing evidence for construct validity (Kim et al., 2013). The task was video recorded and independent coders coded the child's peeking behavior during the *second part* of the task. The child's worst transgression was used as an outcome variable in which a lower score

indicated the worst transgression (0 = turns body to peek; 1 = turns head to peek; 2 = no transgression). A composite *delay of gratification* (DG) measure was created by averaging the standardized values of the (1) worst transgression, (2) total number of transgressions (reversed), and (3) latency to the first transgression on the Gift Wrap task ($\alpha = 0.89$). Children who did not transgress were given a latency value equivalent to the full task length (180 s). Thirty-two percent of cases were double coded with excellent reliability (κ : 1.00; IC-Cs = 0.94–0.97).

3.5. Assessor-rated EF skills

The original 28-item Preschool Self-Regulation Assessment (PSRA; Smith-Donald, Raver, Hayes, & Richardson, 2007) is an assessor report designed to provide a global picture of children's emotions, attention, and behavior as observed across the duration of a proscribed assessor-child interaction. Items were coded by the child assessor after the completion of the session, using a four-point scale. A composite variable including 13 items was created to capture children's self-regulation ($\alpha = 0.96$). Items described children's attention focusing ("sustains concentration", "pays attention during instructions"), inhibitory control ("refrains from indiscriminately touching materials"), and emotion regulation ("modulates and regulates arousal level") during the laboratory assessment. The PSRA reports have been associated with children's performance on hot and cool EF tasks and correlated with teacher report of children's behavior problems and social competence (Smith-Donald et al., 2007). Given that the *assessor-rated EFs* capture both behavioral and emotional regulation skills, we believe it measures a mix of hot and cool EFs such that it lies in the middle of the hot-cool EF continuum.

3.6. Covariates

To reduce the likelihood that any observed association between parental challenges and children's EFs was explained by other factors that are correlated with children's early experiences, we included covariates that are empirically linked to children's early experiences, EFs, or both. Child age, sex, and minority status were reported by the parent as part of the demographic questionnaire completed during the laboratory visit. *Receptive vocabulary* was measured using the Peabody Picture Vocabulary Test IV to assess children's English language ability (Dunn & Dunn, 2007).

4. Analytic plan

Grubbs's (1969) test was used in the statistical evaluation of the data to identify outliers on all study variables. There was only one outlier on the emotional challenges variable detected at the 95% significance level, which we truncated to the next highest value on the emotional challenges composite that was not deemed to be an outlier. The percentage of missing data was small, ranging from 0.0% to 4.90%, except for the marital conflict measure (14.71%) due to the portion of single parents in our sample for whom this did not apply. Missing data was addressed using multiple imputations with chained equations (MI). We estimated 20 datasets based on all variables presented in Table 2, as well as a robust set of variables measuring children's negative life experiences, parental report of discipline in the home, children's social-emotional skills and parental stress, and other indicators of disadvantage such as family structure, using Stata version 13 (StataCorp, 2013). We did not include marital conflict values when creating the composite measure of emotional challenges for children with single parents.

For each EF outcome, a hierarchical regression model was conducted to explore associations between parental challenges in early childhood and children's EFs. Step 1 included only associations between covariates and children's EFs. Steps 2 and 3 added linear and quadratic

terms for socioeconomic challenges, respectively. Steps 4 and 5 added linear and quadratic terms for emotional challenges, respectively, to assess the unique links between socioeconomic and emotional challenges and children's EFs. Socioeconomic and emotional challenges were standardized and quadratic terms created by squaring the respective linear terms.

5. Results

5.1. Bivariate correlations

Table 2 presents correlations among all analysis variables. As anticipated, significant positive correlations were found among all measures of children's EFs. Further, socioeconomic challenges were negatively associated with all measures of children's EFs. Emotional challenges were negatively correlated with measures of cool EFs (working memory and inhibitory control), and not significantly associated with children's assessor-rated EFs or hot EFs (delay of gratification skills). On average, older children performed better on all measures of children's EFs. Receptive vocabulary scores were negatively correlated with both measures of parental challenges and child minority status, and positively correlated with all measures of children's EFs. Minority children experienced higher socioeconomic challenges, and had significantly lower levels of working memory, delay of gratification, and assessor-rated EFs.

5.2. Regression analyses

The hierarchical regression models are presented in Table 3. Given that the addition of the emotional challenges terms explained a significant portion of the variance in all four measures of children's EFs, results for the final step are interpreted below. All models accounted for a significant proportion of the variance in children's EFs (R^2 : 0.23–0.44). Figs. 1–2 show all significant associations between challenges and children's EFs.

5.2.1. Socioeconomic challenges

As shown in Fig. 1, socioeconomic challenges had a linear negative association with children's EFs, such that higher exposure to socioeconomic challenges was linked to lower cool EFs (working memory: $\beta = -0.369$, $p = 0.001$; inhibitory control: $\beta = -0.250$, $p = 0.019$) and children's assessor-rated EFs ($\beta = -0.239$, $p = 0.035$). Socioeconomic challenges were not significantly associated with children's hot EFs (i.e. delay of gratification). All associations between the quadratic socioeconomic challenges term and children's EFs were non-significant.

5.2.2. Emotional challenges

Linear associations between emotional challenges and children's cool EFs were not significant. There were, however, significant negative quadratic associations between emotional challenges and children's cool EFs (working memory: $\beta = -0.105$, $p = 0.042$; inhibitory control: $\beta = -0.111$, $p = 0.036$). As shown in Fig. 2a and b, mild levels of composite emotional challenges, around zero standard deviation units, were linked with the highest levels of cool EFs, relative to both low and high levels of emotional challenges. Further, significant linear and quadratic associations emerged in final models for children's assessor-rated EFs. Specifically, we found a positive linear and a negative quadratic association between emotional challenges and assessor-rated EFs ($\beta = 0.311$, $p = 0.004$; $\beta = -0.135$, $p = 0.016$, respectively). Moderate levels of composite emotional challenges, around one standard deviation above the mean, were associated with the highest levels of assessor-rated EFs, relative to both low and high levels of emotional challenges (see Fig. 2c). Finally, we found a positive linear association between emotional challenges and children's hot EFs (delay of gratification: $\beta = 0.358$, $p = 0.003$; see Fig. 2d). Together these findings

Table 2
Zero-order correlations between predictor and outcome variables.

	M	SD	1	2	3	4	5	6	7	8	9
1. Socioeconomic challenges	0.002	(0.825)	—								
2. Emotional challenges	0.016	(0.744)	0.34***	—							
3. Working memory	3.892	(2.273)	-0.52***	-0.31**	—						
4. Inhibitory control	5.631	(1.730)	-0.25*	-0.28*	0.46***	—					
5. Delay of gratification	0.011	(0.919)	-0.18	0.18	0.34***	0.27**	—				
6. Assessor-rated EFs	3.324	(0.690)	-0.33***	0.03	0.55***	0.44***	0.43***	—			
7. Child gender (female)	52%		0.03	0.00	0.02	-0.06	-0.02	0.05	—		
8. Child age	5.610	(0.562)	-0.13	-0.11	0.36***	0.52***	0.23*	0.36***	-0.08	—	
9. Child PPVT vocab	108.703	(25.556)	-0.48***	-0.28**	0.48***	0.42***	0.37***	0.44***	-0.05	0.47***	—
10. Child minority status	0.637	(0.483)	0.44***	0.17	-0.31**	-0.08	-0.23*	-0.17	-0.03	-0.02	-0.5-9**

* $p < 0.05$.
** $p < 0.01$.

describe inverted U-shaped associations between exposure to emotional challenges and children's cool and assessor-rated EFs, and a positive association between exposure to emotional challenges and children's hot EFs.

To interpret the inverted U-shaped relations, we investigated what mild and moderate levels of emotional challenges represented in our sample. Below, we describe the five emotional challenge indicators in standard deviation units using the original Likert scale response options

Table 3
Regression analyses predicting children's EFs from socioeconomic and emotional challenges.

	Working Memory		Inhibitory Control		Delay of Gratification		Assessor-rated EFs	
	β	(SE)	β	(SE)	β	(SE)	β	(SE)
Step 1	$\Delta R^2 = 0.266^{***}$		$\Delta R^2 = 0.351^{***}$		$\Delta R^2 = 0.133^{***}$		$\Delta R^2 = 0.242^{***}$	
Child female	0.093	(0.174)	-0.065	(0.169)	-0.013	(0.192)	0.183	(0.178)
Child age	0.371	(0.192)	0.716	(0.182)***	0.162	(0.212)	0.304	(0.200)
PPVT vocab	0.013	(0.005)*	0.012	(0.005)*	0.011	(0.006)	0.016	(0.006)**
Child minority	-0.228	(0.244)	0.135	(0.231)	-0.074	(0.273)	0.183	(0.255)
Step 2	$\Delta R^2 = 0.121^{***}$		$\Delta R^2 = 0.038^*$		$\Delta R^2 = 0.002$		$\Delta R^2 = 0.029$	
Child female	0.105	(0.161)	-0.058	(0.165)	-0.013	(0.194)	0.189	(0.175)
Child age	0.417	(0.175)*	0.742	(0.177)***	0.159	(0.213)	0.327	(0.196)
PPVT vocab	0.006	(0.005)	0.009	(0.005)	0.012	(0.006)	0.013	(0.006)*
Child minority	-0.052	(0.227)	0.237	(0.229)	-0.088	(0.275)	0.271	(0.251)
Linear SES	-0.401	(0.094)***	-0.232	(0.098)*	0.030	(0.118)	-0.200	(0.103)
Step 3	$\Delta R^2 = 0.000$		$\Delta R^2 = 0.009$		$\Delta R^2 = 0.001$		$\Delta R^2 = 0.000$	
Child female	0.108	(0.177)	-0.094	(0.169)	-0.026	(0.198)	0.187	(0.179)
Child age	0.418	(0.177)*	0.727	(0.178)***	0.154	(0.215)	0.325	(0.198)
PPVT vocab	0.006	(0.005)	0.010	(0.005)	0.012	(0.007)	0.013	(0.006)*
Child minority	-0.054	(0.229)	0.266	(0.230)	-0.080	(0.279)	0.273	(0.255)
Linear SES	-0.396	(0.105)***	-0.281	(0.105)**	0.013	(0.128)	-0.203	(0.115)
Quadratic SES	-0.008	(0.080)	0.087	(0.086)	-0.030	(0.097)	0.006	(0.088)
Step 4	$\Delta R^2 = 0.009$		$\Delta R^2 = 0.012$		$\Delta R^2 = 0.067^*$		$\Delta R^2 = 0.034^*$	
Child female	0.111	(0.165)	-0.091	(0.168)	-0.033	(0.191)	0.182	(0.176)
Child age	0.423	(0.177)*	0.733	(0.177)***	0.149	(0.207)	0.315	(0.195)
PPVT vocab	0.006	(0.005)	0.009	(0.005)	0.014	(0.006)	0.014	(0.006)*
Child minority	-0.066	(0.230)	0.252	(0.230)	-0.047	(0.269)	0.296	(0.251)
Linear SES	-0.375	(0.106)**	-0.255	(0.107)*	-0.048	(0.127)	-0.246	(0.114)*
Quadratic SES	-0.008	(0.081)	0.086	(0.086)	0.032	(0.094)	0.007	(0.087)
Linear emo	-0.096	(0.086)	-0.116	(0.087)	0.272	(0.102)**	0.193	(0.093)*
Step 5	$\Delta R^2 = 0.028^*$		$\Delta R^2 = 0.031^*$		$\Delta R^2 = 0.025$		$\Delta R^2 = 0.047^*$	
Child female	0.124	(0.162)	-0.076	(0.166)	-0.021	(0.191)	0.199	(0.173)
Child age	0.470	(0.176)**	0.782	(0.175)***	0.184	(0.206)	0.375	(0.193)
PPVT vocab	0.004	(0.005)	0.007	(0.005)	0.012	(0.006)	0.013	(0.006)*
Child minority	-0.085	(0.226)	0.233	(0.225)	-0.064	(0.267)	0.271	(0.247)
Linear SES	-0.369	(0.104)**	-0.250	(0.105)*	-0.042	(0.127)	-0.239	(0.111)*
Quadratic SES	-0.016	(0.079)	0.078	(0.084)	0.026	(0.094)	-0.002	(0.086)
Linear emo	-0.004	(0.096)	-0.020	(0.098)	0.358	(0.117)**	0.311	(0.104)**
Quadratic emo	-0.105	(0.051)*	-0.111	(0.052)*	-0.098	(0.060)	-0.135	(0.055)*
Total R^2	0.421		0.441		0.228		0.352	

SES = socioeconomic parental challenges, emo = emotional parental challenges.

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

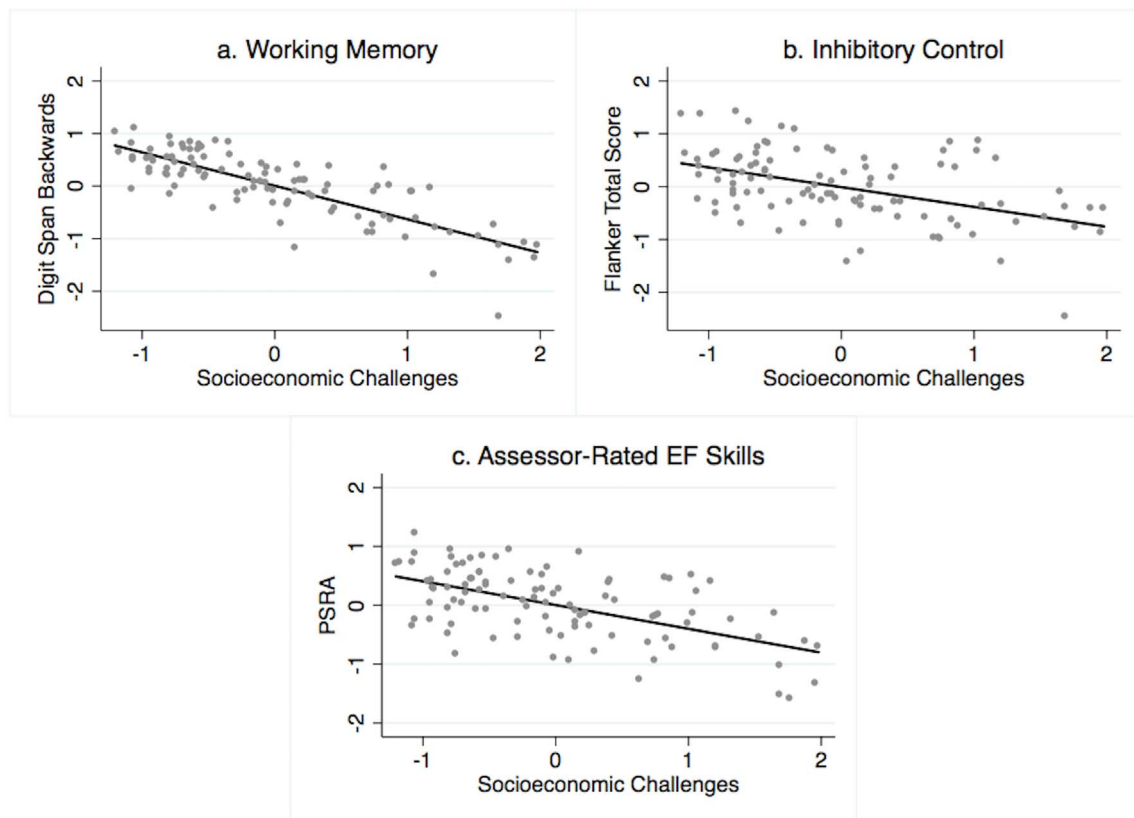


Fig. 1. Linear associations between socioeconomic challenges and children's EFs. Digit Span Backwards, Flanker, PSRA, and socioeconomic challenges scores are standardized within our sample, and thus can be interpreted as effect sizes. The socioeconomic challenges composite is the standardized mean of the standardized scores on total family income, parents' education, social status, and financial stress.

(see Table 4). Mild levels of emotional challenges in our sample (zero standard deviation units) were represented by (1) an experience of depressive symptoms on average 1 day per week; (2) rare marital conflict; (3) a presence of social resources; (4) an experience of emotion regulation difficulties on average 1 day per week; and (5) little parenting distress. Moderate levels of emotional challenges (one standard deviation unit above the mean) were represented by (1) an experience of depressive symptoms on average 1–2 days per week; (2) some marital conflict; (3) some, but not strong, presence of social resources; (4) an experience of emotion regulation difficulties on average 2 days per week; and (5) average levels of parenting distress.

5.3. Sensitivity analyses

Several sensitivity analyses were conducted to test the robustness of our results. Results remain unchanged with the exclusion of PPVT vocabulary as a covariate. Results were identical when we removed children at the floor level on the Backward Digit Span task from the sample. No floor effects were found for the Flanker task, and the other two measures of EFs cannot have floor effects, by design. Finally, results were substantially the same when we specified race ethnicity as four separate dummy variables (Asian, Black, Hispanic/Latino, and multi-racial/other) with White/Caucasian as a reference group. Given that these sensitivity analyses showed that our results were robust to different specifications, we reported the more parsimonious models as our final models.

6. Discussion

The present study represents a novel investigation of linear and nonlinear associations between two unique types of parental challenges and different indices of EFs in early childhood. As hypothesized, both

emotional and socioeconomic challenges were independently linked to children's EF development. Exposure to socioeconomic challenges was associated with lower levels of children's cool EFs (working memory and inhibitory control) and assessor-rated EF skills in a linear fashion. In contrast, emotional challenges were linked to EFs in a nonlinear fashion that varied with the affective nature of the EFs. Consistent with our expectations, inverted U-shaped associations revealed that mild levels of emotional challenges (around zero standard deviation units) were associated with the highest performance on cool EF tasks. Moderate levels of emotional challenges (around one standard deviation unit above the mean) were associated with the highest level of assessor-rated EFs. Surprisingly, performance on a hot EF task linearly increased with exposure to emotional challenges in this relatively-advantaged community sample.

6.1. Socioeconomic challenges

Corroborating previous studies (Hackman et al., 2015; Noble et al., 2007), we found robust, negative associations between socioeconomic challenges and children's performance on traditional cool EF tasks that assessed inhibitory control and working memory skills. Likewise, socioeconomic challenges were associated with lower levels of assessor-rated EFs. These socioeconomic disparities may be due to differential access to opportunities that promote the development of EFs. Access to materials and experiences that support early cognitive development differ along socioeconomic gradients (Bradley & Corwyn, 2002). Caregivers in both low- and middle- SES homes may not afford to provide children with stimulating learning materials, send children to high quality child care settings, or involve children in enriching out-of-home educational activities.

Although our sample was economically diverse, both objective and subjective measures of socioeconomic challenges suggested that very



Fig. 2. Quadratic associations between emotional challenges and children's (a) working memory, (b) inhibitory control, and (c) assessor-rated EFs. Linear associations between emotional challenges and children's (d) delay of gratification skills. EFs and emotional challenges scores are standardized within our sample, and thus can be interpreted as effect sizes. The emotional challenges composite is the standardized mean of the standardized scores on the parent's depressive symptoms, marital conflict, lack of social resources, emotion regulation difficulties, and distress in their role as parents.

Table 4

	- 1 SD on indicator	0 SD on indicator	+ 1 SD on indicator	+ 2 SD on indicator	+ 3 SD on indicator
Depressive symptoms 20 items 4-point: Rarely – Most/ all of the time	1.00	1.40	1.80	2.20	2.56
	“Rarely or none of the time” (less than 1 day/ week)	“Rarely or none of the time” – “Some or a little of the time”	“Some or a little of the time” (1–2 days/week)	“Some or a little of the time” (1–2 days/week)	“Some or a little of the time” – “Occasionally or a more moderate amount of the time” (3–4 days/week)
Marital conflict 10 items 5-point: Never – Very often	1.35	1.82	2.30	2.75	3.2
	“Never”	“Rarely”	Between “rarely” and “occasionally”	Between “rarely” and “occasionally”	“Occasionally”
Lack of social resources 15 items 7-point: Strongly agree – Strongly disagree	6.80	6.05	5.33	4.60	3.95
	“Strongly disagree”	“Disagree”	“Somewhat disagree”	“Somewhat disagree”	“Neutral”
Emotion regulation difficulties 41 items 5-point: Almost never – Almost always	1.42	1.83	2.22	2.63	N/A
	Between “almost never” (0–10% of the time) and “sometimes”	“Sometimes” (11–35% of the time)	Between “sometimes” and “about half of the time”	“About half of the time” (36–65% of the time)	
Parenting distress 12 items 5-point: Strongly disagree – Strongly agree	1.35	2.05	2.70	3.37	4.04
	“Strongly disagree”	“Disagree”	“Not Sure”	Between “not sure” and “agree”	“Agree”

few children in our sample were living in poverty. The median parental education level was a bachelor's degree and mean family income of the sample was \$125,041, which is commensurate with the high costs of living in the San Francisco Bay Area. Compared to a nationally-representative sample of kindergarteners (Mulligan, Hastedt, & McCarroll, 2012), the parents in our sample also completed more years of education. Nationally, 29% of parents attained a high school diploma or less, whereas 17% of our sample attained a high school diploma or less. Our sample had significantly more children whose parents earned a graduate or professional degree (42% of parents in our sample compared to 18% nationally). The distribution of parental subjective social status in our sample was comparable to findings in studies of middle-class adults (Cundiff et al., 2013). Given the wide distribution of income in our sample, we leveraged measures of financial stress and subjective social status to yield a more comprehensive measure of socioeconomic challenges in more advantaged families. Our findings suggest that socioeconomic disparities in young children EFs can be detected across the range of socioeconomic status.

In contrast, we found that socioeconomic challenges were not related to children's delay of gratification skills, an aspect of hot EFs. These findings corroborate work by Li-Grining (2007) who reported that socioeconomic-type adversities are negatively associated with preschooler's cool EFs but not their hot EFs. Since others have found that children who experience a higher number of both socioeconomic and emotional risk factors (e.g. single parent, housing problems, income-to-needs ratio, violence) demonstrate poorer delay of gratification in middle childhood (Evans, 2003; Evans & English, 2002), it is important to further examine the unique effect of socioeconomic challenges on EFs across different developmental periods.

6.2. Emotional challenges

The current study revealed that mild to moderate levels of emotional challenges were positively associated with EFs in early childhood, after controlling for socioeconomic challenges. Although the socioeconomic challenges explained a greater amount of variance in children's cool and assessor-rated EFs, emotional challenges uniquely explained additional variability in all measures of children's EFs. Inverted U-shaped associations were found between emotional challenges and measures of cool and assessor-rated EFs, whereas a positive, linear association was found for children's delay of gratification skills, a component of hot EFs.

In our relatively socioeconomically advantaged community sample, the “optimal” levels of emotional challenge exposure differed depending on the affective nature of the EF measure: (1) performance on working memory and inhibitory control tasks was highest around zero standard deviation units or mild levels of emotional challenges experienced; (2) assessor-rated EFs peaked around one standard deviation unit or moderate levels of emotional challenges; and (3) performance on a delay of gratification task linearly improved with the exposure to emotional challenges. It is interesting that the optimal level of challenges for assessor-rated EFs fell between that for cool and hot EFs given that our measure of assessor-rated EFs captured both behavioral regulation skills (e.g., being careful, planning) and emotional regulation skills (e.g., refraining from touching materials, regulating arousal level).

When we anchored the standard deviation units in children's real-life experiences, we showed that the amount of emotional challenges associated with the highest EF skills represented generally mild to moderate levels of stressors in young children's homes. It is important to note that the parents in our sample reported slightly fewer depressive symptoms compared to a nationally-representative study of young children (Yan, Benner, Tucker-Drob, & Harden, 2016). The frequency of all indicators of emotional challenges, including depressive symptoms, was very similar to those found in other community samples in the United States (Booth, Rose-Krasnor, McKinnon, & Rubin, 1994; Chacko, Fabiano, Doctoroff, & Fortson, 2017; Havighurst, Wilson, Harley,

Prior, & Kehoe, 2010; Kouros, Papp, Goeke-Morey, & Cummings, 2014). This suggests that our findings may be generalizable to other relatively-advantaged community samples.

Theoretically, limited exposure to emotional challenges in the home may allow children opportunities to engage and practice hot EFs. Children whose parents report mild to moderate levels of parental distress or marital conflict in the home may have more opportunities to witness their parents' emotion regulation or practice effective self-regulation strategies that can be implemented in other emotional situations. The nonlinear associations corroborate the notion of a “steeling” effect, where experiences of stress may promote resilience to later stressful experiences (Rutter, 2006). Further, these results echo the research on “helicopter parenting”, which shows that over-involved and intrusively protective parenting is linked to psychological distress and poor coping in young children (Bayer, Sanson, & Hemphill, 2006). The quadratic relations between emotional challenges and EF skills parallel the findings that moderate levels of mother-child asynchrony, which allowed for more ambiguity, were associated with the highest levels of infant's initiative and flexibility when compared to highly coordinated dyads (Jaffe et al., 2001). Our study is also a developmental extension of work showing that adults who experienced moderate levels of lifetime adversity reported the highest levels of wellbeing, compared to adults who experienced low or high levels of lifetime adversity (Seery et al., 2010).

6.3. Strengths, limitations, and future directions

This study presents a unique attempt to examine how different types of parental challenges are related to children's EFs, however several limitations should be noted. The correlational and cross-sectional design of the study does not support causal inferences. While the children were ethnically diverse and representative of the surrounding community, our sample size was small. Although similar analyses should be examined in a larger, nationally-representative group of children, it is important to note that sensitivity analyses suggest that our findings are robust to various model specifications. Further, our findings of a nonlinear association between assessor-rated EFs and emotional challenges were not driven by outliers. In fact, if our more extreme values at the higher-end of the emotional challenges spectrum were removed, it appears that a positive linear association would emerge between emotional challenges and assessor-rated EFs, similar to our hot EF result. Analogously, it is possible that a quadratic pattern would have emerged for hot EFs if slightly higher levels of emotional challenges were present in the sample.

The measures of parental challenges were standardized based on the experiences of our sample which limits generalizability of what constitutes low, mild, or moderate challenges. Future research should also address the need for standardization of risk and adversity levels in nationally-representative samples that would enable us to understand how these effects vary across different contexts and populations (Obradović et al., 2012). We recommend that researchers use subjective measures of socioeconomic status when studying samples that include participants with high levels of income and education. Future work should extend parental reports to those of secondary caregivers and other members of the household to get more comprehensive measures of children's home experiences. Home observations and child report could also help researchers better understand how children perceive and experience these challenges.

The sole use of the Gift Wrap task does not allow us to make conclusions about children's hot EFs overall. Expanding this work to include other measures of preschoolers' hot EFs would help researchers to understand whether these differences are task-specific or applicable to the whole domain of “hot EFs.” In our sample, the correlation between the cool EF tasks and the correlations between the cool EF tasks and the hot EF task were not significantly different. We relied on previous work demonstrating that the tasks used in our study capture cool and hot EFs

when using these labels. It would be valuable to further examine the distinctions in how contextual experiences shape development of cool and hot EFs, especially in older children whose cool and hot EFs may be more differentiated.

Future studies need to identify the family and parenting practices that may mediate the effect of various parental challenges on children's EFs. Theoretical and empirical research support the notion that parenting behaviors act as important mediators of the link between socioeconomic status and children's EF development (Blair & Raver, 2012; Hackman et al., 2015; Lengua et al., 2014). Some emotional challenges also impact child development through changes in parenting quality, including discipline practices, and sensitive and responsive caregiving (Buehler & Gerard, 2002; Choe et al., 2013; Kiernan & Huerta, 2008). Researchers should investigate whether mild to moderate levels of emotional challenges in the home are linked to specific parenting practices or family dynamics that promote the development of EFs. We also hope that researchers explore interactions between family structure and parental challenges, as we hypothesize that measures of both socioeconomic and emotional challenges may be more salient for children from single-parent homes.

6.4. Conclusion

In summary, our findings suggest that experiences in early childhood may be differentially associated with children's EFs depending on the type of parental challenges and EF skill assessed. The current study raises the question of whether it is beneficial to protect children from witnessing or experiencing any negative events, or if circumscribed exposure to mildly challenging situations may be beneficial for some aspects of their development. Given the positive link between constructive resolution of marital conflict and children's emotional security and prosocial skills (McCoy et al., 2009), future research should investigate how the different ways in which parents resolve emotional challenges link to EF development. These could serve as potential mediators or moderators of association between exposure to parental emotional challenges and child EFs.

Further examination of the curvilinear relation between exposure to life challenges and EFs may shed a new light on why moderate levels of physiological stress reactivity have been associated with the highest levels of EFs (Blair, Granger, & Razza, 2005; Davis, Bruce, & Gunnar, 2002). Future studies should examine the dynamic interplay between different types of parental challenges and children's physiology related to their emotion regulation and EFs (Obradović, 2016). Since EFs are important for adaptive classroom behaviors and academic success (Blair & Razza, 2007; Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009), it is critical that we identify specific emotional challenges and related family dynamics in early childhood that may offer opportunities to practice and develop hot EFs and emotion regulation across the wide distribution of socioeconomic resources. Such work would help us improve home-based interventions designed to support the development of children's early self-regulation skills.

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