INTERGENERATIONAL PROCESSESS IN HOMELESS FAMILIES LINKING PARENT EXECUTIVE FUNCTION, PARENTING QUALITY, AND CHILD EXECUTIVE FUNCTION

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Abstract

Numerous studies support the essential role of executive function (EF) in child development, particularly for children growing up in contexts of risk and adversity. Recent research has begun to elucidate the intergenerational and interpersonal processes that result in individual differences in EF, including the impact of adult EF on parenting quality and parenting quality on child EF. However, studies conducted in high-risk populations suggest that these processes may be disrupted by the stress associated with poverty and other adverse circumstances. The purpose of the present study was to investigate the intergenerational continuity of EF in parents and children living in emergency homeless shelters, as well the processes that might explain or account for this continuity. The study included 105 families with children between the ages of 4 and 6. Parents and children each completed a battery of IQ and both hot and cool EF tasks, as well an observational assessment of harsh and positive parenting. Parents also completed a measure of perceived stress for the past month. Regression-based conditional process analysis revealed a direct statistical effect of parent cool EF on child cool EF, as well as an indirect effect resulting from their shared relationship with harsh parenting. However, this indirect effect was only significant for families of parents reporting high levels of stress. Additional exploratory analyses suggested the presence of an indirect effect of parent hot EF on child hot EF through positive parenting, with no moderating effects for parent stress. Study results support previous theory and research suggesting a critical role for parenting in the development of child EF, as well as the importance of investigating developmental processes in high-risk populations.

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Across the past two decades, interest in executive function (EF) has intensified in child development research. The term "executive function" refers to a set of neurocognitive processes that result in the ability to complete purposeful, goal-directed behaviors, especially in response to novel environments or stimuli (Zelazo, Chandler, & Crone, 2010). An abundance of studies support the critical role of EF in healthy development, including academic success (Blair & Razza, 2007; Clark, Prior, & Kinsella, 2002; McClelland et al., 2007), socialized conduct (Hughes & Ensor, 2010; Riggs, Blair, & Greenberg, 2004), and social competence (Carlson, Mandell, & Williams, 2004; Flynn, 2007; Kochanska, Murray, & Harlan, 2000). Recent longitudinal research confirms that EF skills predict adult adjustment as well, with childhood EF forecasting adult outcomes as varied as completion of college, physical health, criminal behavior, drug and alcohol dependence, and financial stability (McClelland, Acock, Piccinin, Rhea, & Stallings, 2012; Moffitt et al., 2011). The significant relationship between EF and multiple forms of adjustment suggests that supporting the development of EF could have substantial benefits for the wellbeing of children and society as a whole.

Unfortunately, developing EF skills appear to be especially vulnerable to adverse rearing conditions, including poverty and other environmental stressors. For instance, in comparison to other areas of cognitive development (e.g. spatial cognition and memory) development of EF is disproportionately influenced by socioeconomic status (SES; Noble, Norman, & Farah, 2005). This influence appears to have long-term impact, as measures of childhood poverty and chronic stress are still predictive of EF skills in young adulthood (Evans & Schamberg, 2009). Conversely, EF also appears to play a central role in the adaptive processes that allow children to cope with adversity and has been identified as a marker of resilience (Sapienza & Masten, 2011).

The broad scope of adjustment outcomes linked to EF and other forms of self-regulation indicates that these skills are important potential targets for interventions to promote competence and resilience. Thus, there is a critical need for research devoted to elucidating the developmental processes resulting in individual differences in EF, including—and perhaps especially—for children growing up in poverty and other high-risk circumstances. This dissertation focused on interpersonal processes supporting the development of EF for a particularly high-risk population of children living with their families in an emergency homeless shelter.

Risk and Resilience in Homeless Children

Experiencing one or more episodes of homelessness is a relatively common experience for children and families in the U.S., particularly for families of color living below the poverty line. Nationwide, the number of individuals in families experiencing homelessness rose 20 percent from 2007 to 2010, with approximately 1.6 million children experiencing at least one episode per year (National Center on Family Homelessness, 2014). Children are the most common type of resident at homeless shelters, and more than 50 percent of these children are under the age of 6 (U.S. Department of Housing and Urban Development, 2012). This high rate of homelessness experienced by young children has resulted in research focused on how these children and families are impacted by the stress of homelessness and other poverty-related risk factors.

For heuristic purposes, I will be using the term "homeless children/families" throughout this document. However, for most families, periods without housing are temporary, and their status as "homeless" is not the families' defining characteristic (Kuhn & Culhane, 1998). Rather, the fact that a family is seeking emergency shelter is generally an indicator of two conditions: 1) the family is undergoing a time of acute crisis accompanied by high rates of stress and 2) child and adult family members are subject to elevated rates of poverty-related risk factors that preceded and will typically continue following their time in shelter (Kilmer, Cook, Crusto, Strater, & Haber, 2012). For children, these risk factors often include minority status, living with a single parent and/or multiple siblings under the age of 5 (Rog & Buckner, 2007), food insecurity (U.S. Conference of Mayors, 2007), and high rates of residential and school mobility (Institute for Children and Poverty, 2003). These children are also significantly more likely to have experienced adverse life events, including domestic violence, living in unsafe neighborhoods, and time in foster care (Anooshian, 2005; Masten, Miliotis, Graham-Bermann, Ramirez, & Neemann, 1993; Zlotnick, Kronstadt, & Klee, 1998). Unsurprisingly, rates of emotional, behavioral, health, and academic problems are high in this population (Grant et al., 2007; Masten et al., 2014; Rog & Buckner, 2007). However, homeless children are a far from homogenous group and many demonstrate success and competence across multiple domains (Huntington, Buckner, & Bassuk, 2008).

Recent research has begun to explore the processes that allow these children to succeed, including the identification of protective factors. One characteristic that has received a relatively large amount of attention is child EF. In a small sample of homeless children entering kindergarten and first grade, Obradovic (2010) found that a component of EF, effortful control, predicted later teacher report of academic competence, peer competence, and internalizing and externalizing symptoms, even after controlling for child IQ, socio-demographic risk, and parenting quality. A later study by Masten and colleagues (2012) replicated these findings in a larger sample, using more comprehensive measures of both hot and cold EF.

Definition of Executive Function

The term executive function (EF) is generally used as an umbrella construct which includes working memory, inhibition, and set shifting. These basic cognitions combine to result in complex, goal-directed behaviors, including the ability to maintain and shift focus, formulate goals and plans, monitor outcomes, and alter behavior based on these outcomes (Cummings & Miller, 2007). EF provides an evolutionary advantage by allowing humans to move beyond the stimulus-response conditioning typical of other species in favor of novel, planful responses. Because EF is, by definition, effortful, it is not employed in situations where learned or reflexive behaviors are sufficient. Rather, EF occurs in response to complex, novel situations where conscious effort is necessary. An important component of EF is that it typically consists of actions oriented towards future consequences. EF allows humans to inhibit the prepotent tendency to focus on immediate rewards and instead focus on planning for future gains. In other words, EF functions to maximize long-term outcomes. This ability to respond with novel actions and plan for future events plays a critical role in our everyday functioning and, some have argued, is part of what makes humans unique among other species (Barkley, 2004).

Recent characterizations of EF have attempted to delineate between tasks that involve an emotional or motivational component, described as “hot,” and those that are more abstract, described as "cool." The terms "hot EF" and "cool EF" are meant to describe a continuum or relative degree of emotional salience, rather than distinct categories of EF (Zelazo, Qu, Müller, & Schneider, 2005). However, some EF tasks are considered more "hot" than others. Often, these tasks are characterized by the presence of a reward or desirable object (e.g. children are asked to inhibit their response of peaking at a gift (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996)) but may also rely on stimuli designed to instill strong feelings or high arousal as part of an otherwise affectively neutral or "cool" task (e.g. adolescents are asked to complete an inhibitory control task with numbers as stimuli, while arousing and unpleasant images are displayed in the background (Cohen-Gilbert & Thomas, 2013)). Other examples of relatively hot EF tasks include measures of delay of gratification such as the Toy Prohibition Task (Friedman, Miyake, Robinson, & Hewitt, 2011), measures of affective decision making such as the Iowa Gambling Task (Kerr & Zelazo, 2004), and traditional measures of cool EF with emotional stimuli, such as the Emotional Stroop Task (Franken, Gootjes, & van Strien, 2009).

The Development of Individual Differences in Executive Function

The development of individual differences in EF almost certainly involves a transactional relationship between both genetic and environmental factors. While there are some researchers who argue that individual difference in EF are almost entirely genetic in origin (e.g. Friedman et al., 2008), a more nuanced approach considers that heritability coefficients for EF vary across the lifespan (Deater-Deckard, Petrill, Thompson, & DeThorne, 2006) and are lower in children than adults (Mullineaux, Deater-Deckard, Petrill, Thompson, & DeThorne, 2009). In addition, while genetic factors may play a larger role in explaining stable EF in childhood, environmental components are more predictive of change (Deater-Deckard et al., 2006). The protracted nature of post-natal development in the prefrontal cortex also supports the influence of environment on EF, especially in early childhood (Sowell, Trauner, Gamst, & Jernigan, 2002). The primacy of the parent-child relationship in the lives of young children (Sameroff, 2010) suggests that one of the more important sources of environmental influence on EF is the family context. Recent research has shown an increased emphasis on family processes in the development of EF.

One approach to the questions of how EF develops is to investigate the processes that underlie intergenerational transmission of EF skills between parents and children. Research on intergenerational transfer of other characteristics, such as depression (Hammen, Hazel, Brennan, & Najman, 2011), psychopathy (Auty, Farrington, & Coid, 2015), cognitive ability (Byford, Kuh, & Richards, 2012), and adverse life experience (Narayan et al., in review; Wickrama, Conger, & Abraham, 2005) have made important contributions to our understanding of how parent characteristics are transferred to their children outside of passive genetic effects. A consistent theme within study findings is the mediating role of parenting. For instance, Schofield and colleagues (2011) demonstrated that adaptive functioning (such as social competence, emotional stability, and work ethic) in adolescents predicted their later parenting behaviors (including both material and emotional investments in their children) which, in turn, were related to their children's adaptive functioning. A second study by Tung and colleagues (2014) also demonstrated that a facet of parenting behavior (i.e. corporal punishment) mediated the relationship between parent and child symptoms of Attention Deficit/Hyperactivity

Disorder (ADHD). This finding is especially pertinent to the current study, as deficits in EF are a critical component of ADHD (Barkley, 2004).

In terms of intergenerational continuity in EF skills, available studies suggest a moderate correlation (i.e. .34 to .51) between parent and child performance on EF tasks (Cuevas et al., 2013; Jester et al., 2009). However, these studies do not directly address why parent EF would be related to child EF. One potential answer is simply shared genetic variance. However, as previously discussed, there are many reasons to suspect environmental input plays an important role, particularly factors related to parenting. Recently, there has been increasing interest in two likely components of the intergenerational continuity of EF. First, a growing number of studies suggest that parent EF skills impact parenting behavior (see Crandall, Deater-Deckard, & Riley, 2015 for review), while a second group of studies suggest parenting impacts child EF (see Fay-Stammbach, Hawes, & Meredith, 2014 for review). These two components could be part of a larger model of intergenerational transfer, where parent EF is related to child EF through their shared relationship with parenting. Indeed, Cuevas and colleagues (2014) recently presented evidence for this very process, finding that parent performance on a battery of EF tasks was correlated with their child's performance on a similar battery at 48 months *and* confirming that this relationship between parent and child EF was mediated by negative parenting behavior observed at 24 months. This study is a critical step toward our understanding of the role of parents in the development of EF. However, the research was completed in a primarily Caucasian, middle-class sample. Although portions of the model (e.g. the influence of parenting on child EF) have been tested in low-income families, the full model has not. The well-established impacts of poverty and stress on the development of EF (Evans & Schamberg, 2009; Noble et al., 2005) means that this model will need to be tested in higher risk samples.

The purpose of the present study is to investigate the intergenerational continuity of EF in parents and children living in an emergency homeless shelter. The following literature review will address 1) research supporting the impact of parenting on child EF, 2) research supporting the role of parent EF in parenting, and 3) how the acute stress and generally high levels of risk typically experienced by homeless families might impact these important processes.

The Impact of Parenting on Child Executive Function

The impact of parenting on child EF is a fairly new area of study, with Hughes & Ensor referring to it as "terra incognita" as recently as 2009 (p. 36). However, work in this area is expanding rapidly. Much of it has been focused on positive aspects of parenting, particularly in the area of parent scaffolding (often referred to as "autonomy support"). Heavily influenced by Vygotsky (1978) and Luria's (1966) seminal research on children's development of higher order functions within the context of social interactions, the term "scaffolding" refers to parents' deliberate efforts to support their child's problem solving and other goal-directed behavior in a way that allows the child to function on a higher level than they would be able to on their own (Harrist & Waugh, 2002). This behavior is often verbal (e.g. encouragement, probing questions) but may be physical as well (e.g. moving an object so it is just within a child's reach or partially supporting their weight while they climb the monkey bars). Parent scaffolding is thought to impact EF by supporting and augmenting self-directed speech, encouraging persistence in the face of frustration, and fostering confidence by guiding the child towards a successful outcome (Carlson, 2003; Carlson, 2009).

The relationship between parent scaffolding and child EF is supported by multiple studies. Findings include cross-sectional relationship between parent elaborative utterances and child attention-switching (Bibok, Carpendale, & Müller, 2009), autonomy support at 15 months predicting working memory and cognitive flexibility at 3 years (Matte-Gagné & Bernier, 2011), and maternal object stimulation at 6 months predicting child inhibitory control at age 8 (Olson, Bates, Sandy, & Schilling, 2002). Several studies have found that child verbal ability mediates the relationship between scaffolding and child EF (Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012; Landry, Smith, & Swank, 2006), although Matte-Gagné and Bernier (2011) emphasized that this mediating role may only apply for impulse control (hot EF) as opposed to working memory and set-shifting. An important study by Hughes and Ensor (2009) demonstrated that parent verbal scaffolding including praise and elaboration at age 2 supported child EF (working memory and cognitive flexibility) at age 4, even after controlling for child EF at age 2 and child verbal ability at age 4. Finally, Bernier, Carlson and Whipple (2010) measured multiple forms of positive parenting, including scaffolding (autonomy support), sensitivity, and mind-mindedness at age 12-15 months and child EF at 18-26 months and found that scaffolding was the strongest predictor out of the three.

Other studies have used composite variables of positive parenting. As a follow-up to their 2010 study, Bernier and colleagues (2011) combined parent autonomy support, mind-mindedness, and sensitivity into a single measure of positive-interactive behavior as well as a measure of attachment security in children between ages 12 and 24 months.

These caregiving measures were then regressed onto children's performance on measures of two forms of EF skills (conflict EF and delay of gratification) completed between the ages of 2 and 3. Results showed that both caregiving measures had direct links to delay of gratification, but the addition of control variables suggested that these links were due to differences in family SES and child language abilities. Both caregiving measures also predicted conflict-EF even after the addition of controls, with a total of 18% of the variance accounted for by these two variables.

Blair and colleagues (2011) and Rhoades and colleagues (2011) completed analyses on the same dataset (i.e. NICHD's Family Life Project) comprised of rural families with young children, and both used a composite variable of maternal positive engagement comprised of measures collected at age 7 months. Blair and colleagues (2011) regressed this measure of positive caregiving onto salivary cortisol levels at age 15 months and child EF at age 36 months, finding that cortisol levels partially mediated the relationship between parenting and EF. Taking a different approach, Rhoades and colleagues (2011) used person-centered analysis to create family categories based on combinations of risk factors (e.g. poverty-level, race, single versus two-parent family, presence of parent stress and/or mental illness), and then examined relationships between parenting and child EF separately for each group. Study findings suggested that, for white families characterized by poverty, maternal positive engagement predicted child EF and also mediated the relationship between child EF and early risk. The same effect was found for African-American families, but only in families characterized as a single-parent household. Most recently, Blair and colleagues (2014) revisited the same sample, this time at ages 36 months and 60 months. Focusing on parenting sensitivity and responsiveness with measures of both parenting and EF at both time points, the authors applied two analytic approaches (i.e. residualized change analysis and latent change analysis), both of which demonstrated transactional effects: 1) positive parenting predicted change in child EF and 2) child EF predicted change in parenting quality. This important study provided especially robust evidence that changes in child EF can be attributed specifically to changes in parenting behavior, even after controlling for evocative effects of child behavior.

There has been relatively less research on the impact of more negative aspects of parenting behavior on child EF. A study by Gilliom and colleagues (2002) noted that parenting behavior that was harsh or hostile when children were age 18 months predicted children's use of effective regulatory strategies during a frustrating task at age 60 months. Hughes and Ensor (2009) included a measure of inconsistent parenting in addition to the measure of positive parenting described above. However, the relationship between inconsistent parenting and child EF was only marginally significant once it was entered into a model with positive parenting. Blair and colleagues' (2011) study on parenting and cortisol levels found that their measure of negative maternal intrusiveness predicted EF, but this relationship was not mediated by cortisol response. Finally, Rhoades and colleague (2011) used this same measure of intrusiveness and found that this behavior was only related to child EF in White families, while the effect was nonsignificant in African-American families.

Determinants of Parenting

It was 1984 when Belsky first succinctly proposed the question, "Why (do) parents parent the way they do?" (p. 83). While there had been some attention to the topic prior to this point, Belsky was the first to bring it into focus and affirm its importance. Since this time, the study of determinants of parenting behavior has expanded. The second edition of the five-volume *Handbook of Parenting* was released in 2002, and an entire journal, *Parenting: Science and Practice*, is now devoted to the causes and outcomes of parenting. However, as noted by Belsky and Jaffee in their 2006 review, our understanding of the determinants of parenting still lags behind many other fields of study.

In response to his seminal question, Belsky (1984) created a model of parenting that is still very influential today. His model posited that parenting has three main determinants: 1) the parent's developmental history and personal psychological resources, 2) characteristics of the child such as verbal ability and temperament, and 3) contextual sources of stress and support. While all three play a role, Belsky asserted that parent characteristics are especially powerful and a crucial target for research and intervention. In subsequent years, the role of parent characteristics has received moderate attention. A good deal of research has been conducted on the role of parents' personality (e.g. Prinzie, Stams, Deković, Reijntjes, & Belsky, 2009) and mental health (e.g. Zahn-Waxler, Duggal, & Gruber, 2002). Overall however, the field has been fairly limited, particularly in the area of parents' individual cognitive characteristics as predictors of parenting.

Executive Function as a Determinant of Parenting

There are many reasons to suspect that individual differences in EF may influence the ability to parent in multiple ways. For instance, adults who have difficulty staying organized will likely experience challenges creating a structured, stable environment for their children. Poor parental impulse control and low frustration tolerance may result in intense reactions to environmental stimuli, including a child's behavior. Failure to perceive important stimuli due to deficits in attention and difficulties in the areas of verbal fluency and working memory may result in an inability to generate solutions and respond adequately. EF skills may also impact family functioning in an indirect manner by impairing work performance or social skills. These problems outside the home may result in higher levels of stress, less social support, marital disruption, and economic hardship. All of these factors serve to negatively impact parenting capabilities. In addition, good EF skills may facilitate parents in their ability to manage stressful, novel situations, a skill critical for childrearing.

The relationship between adult EF skills and parenting is a very new area of research. Despite some important early theoretical work (Azar, 1986; Milner, 1993; Wahler & Dumas, 1989), until recently, there was very little programmatic research designed to address the topic, and the theories remained largely untested. Early theories linking parenting and aspects of EF (e.g. Azar, 1986; Milner, 1993; Wahler & Dumas, 1989) developed in response to concern that more traditional approaches (focused on attachment, behavioral reinforcement, or instinctual drives) failed to encapsulate the enormous cognitive complexity of parenting behavior. Pointing to early descriptive research on parenting as well as their own personal and clinical experiences, the authors noted that most parents report being faced with constant competing cognitive demands, continuously balancing the needs of their children with their own needs and those of other adults. They concluded that parenting is a highly ambiguous process, which requires constant learning, often through trial and error. While acknowledging the importance of additional determinants of parenting, these early theorists asserted that a complete model of parenting must include a cognitive behavioral component, including the role of self-regulatory processes. Despite providing a good foundation for further study of the role of EF in parenting, empirical support for these theories has been slow to emerge.

With the exception of a few early studies focused on child maltreatment (Nayak & Milner, 1998; Rohrbeck & Twentyman, 1986), the use of neuropsychological measures of EF in the study of determinants of parenting behavior has only occurred in the past five years. In 2010, Deater-Deckard and colleagues conducted a study focused on maternal behavior in relation to working memory, measured using the Digit Span subtest of the Wechsler Adult Intelligence Scale. The authors noted that working memory is especially important to the cognitive process of reappraisal, defined as an individual's ability to choose an action or reaction, as opposed to acting automatically. They proposed that working memory impacts parent behavior by allowing parents to reappraise and consider an event, such as a crying child, before a embarking on a course of action. Using a sibling design, the study examined the relationship between child challenging behavior and maternal negativity (both coded during an observed session), moderated by maternal working memory. Even after controlling for verbal and performance IQ, the authors found that mothers with lower working memory ability were more likely to respond negatively to their children's challenging behaviors. These results suggest that mothers with poor working memory are less able to engage in the cognitive process of reappraisal and are thus less likely to make calm, reasoned decisions in response to their children's actions.

As a follow up to their 2010 research, Deater-Deckard and colleagues completed an additional study on maternal EF and negative reactivity, using a more comprehensive measure of EF in a socioeconomically diverse sample (Deater-Deckard, Wang, Chen, & Bell, 2012). Mothers in the study completed four measures, the Stroop Color Word task, the Wisconsin Card Sort Task, the Tower of Hanoi, and a backward digit span task, which were combined into a composite variable of EF encompassing attention shifting, inhibitory control, and working memory. The study relied on parent-report measures of maternal harsh parenting and child conduct problems. The authors also investigated how the influence of EF on reactive parenting might differ depending on family context, by including a measure of household chaos (Confusion, Hubbub and Order Scale (CHAOS); Matheny, Wachs, Ludwig, & Phillips, 1995) defined as noise, overcrowding, and lack of order in the home. Deater-Deckard and colleagues noted that, while they hypothesized that family chaos would moderate the relationship between parent EF and negative reactivity, they were unsure whether the relationship would be stronger in calmer or more chaotic homes. They theorized that strong EF skills might be especially necessary in an environment lacking structure and predictability, meaning the relationship between EF and parenting would be stronger in high-chaos homes. However, they also considered that this same lack of order might "impair cognitive processes that otherwise operate more automatically when no stressors are present" (Deater-Deckard et al. 2012, pg. 1089), resulting in low EF performance for the majority of parents in high-chaos households, and no relationship between EF and parenting for these families. Study results supported the second assertion: parents with low EF were more likely to respond to their child's conduct problems with harsh or negative parenting, but only in families living in *low-chaos* homes. This finding led the authors to theorize that the relationship between EF and parenting might not be as consequential in high-risk environments.

Despite important findings, both studies by Deater-Deckard and colleagues (2010, 2012) were limited by their cross-sectional design. The research group's most recent work (Cuevas et al., 2014) addressed this issue by measuring parent EF and observed parenting behavior at different time points, making it less likely that results might be influenced by variables specific to one time point (e.g. parent stress level, family illness). Using an EF composite very similar to the one used in the 2012 study and an observational measure of negative parenting during a parent-child interaction, the authors once again demonstrated that maternal EF impacted caregiving behaviors over and above level of maternal education (used as a proxy measure of IQ). It should be noted that this study was completed in a middle class sample, and the moderating effects of home environment were not considered.

Another important piece of research was completed by Gonzalez and colleagues (Gonzalez, Jenkins, Steiner, & Fleming, 2012). An excellent example of translational work, the authors designed their study based on animal models. They especially pulled from a study by Lovic and colleagues (2004) which found that rat pups raised in artificial rearing environments tended to display deficits in EF as adults. Additional research demonstrated that these EF deficits mediated the relationship between type of rearing environment (artificial versus enriched) and maternal behavior, specifically time spent licking pups and in lactating posture (Lovic, Palombo, & Fleming, 2010). These findings suggest that early environmental stressors may impact later parenting behavior through their early impact on the development of EF. Gonzalez and colleagues (2012) endeavored to apply these findings to human mothers. They began by having a low-risk community sample of mothers complete measures of attentional set shifting and spatial working memory, as well as a mother-infant interactions coded for sensitive parenting. They also had the participants complete measures of childhood trauma and HPA functioning. Results showed that early adversity (childhood trauma) was indirectly associated with sensitive parenting through HPA functioning and spatial working memory.

This same group of researchers (led by Alison Fleming at the University of Toronto) also completed a similar study using a sample of adult and teen mothers (Chico, Gonzalez, Ali, Steiner, & Fleming, 2014). Noting that teen mothers tend to display less sensitive parenting than adult mothers (Coll, Hoffman, Van Houten, & Oh, 1987), the authors investigated whether this difference might be due to the teenagers' still-developing pre-frontal cortex and resulting immature EF (Sturman & Moghaddam, 2011). Using a sample of adolescent and adult mothers (4-6 months postpartum), the authors again measured performance on neuropsychological measures of spatial working memory and attentional set-shifting as well as observer ratings of maternal sensitivity. As expected, teen mothers had lower EF skills and showed less maternal sensitivity towards their infants. Performance on the EF measures was negatively correlated with maternal sensitivity for both teen and adults mothers and, as predicted, the relationship was stronger for teen mothers. Finally, a single study has looked at the relationship between a hot EF and parenting. Fontaine and Nolin (2013) had a group of parents complete the Iowa Gambling task as well as the Child Abuse Potential Inventory (Milner, 1994) and found that worse performance was related to higher scores on this self-report measure.

The Role of Parenting and Self-Regulatory Abilities in Homeless Children

As previously noted, several studies have linked child EF skills with resilient functioning in homeless children (Masten et al. 2014; Obradovic, 2012). An additional important predictor of competence in homeless children is parenting, which studies suggest is protective of academic success (Miliotis, Sesma, & Masten, 1999), mental health (Herbers, Cutuli, Monn, Narayan, & Masten, 2014), and peer relationships (Narayan, Sapienza, Monn, Lingras, & Masten, 2014). An important study by Herbers and colleagues (2014) looked at *both* child EF and parenting and found that responsive, supportive parenting predicted teacher-reported academic success later in the year, and this relationship was mediated by child EF. Thus, parents appear to play a critical role in protecting children from the risk associated with homelessness, partially through their impact on child EF. However, as noted in recent review articles (Narayan, 2015; Perlman, Cowan, Gewirtz, Haskett, & Stokes, 2012), parenting well while homeless can be extremely challenging. Thus, characteristics related to resilient functioning in homeless parents is a critical area of research, both for our understanding of promotive processes for competence in general in homeless children as well as our understanding of intergenerational processes that impact child EF.

The Current Study

The overarching aim of the study was to investigate the relationship between parent EF and child EF in a high-risk population, as well as the processes that may explain or account for this relationship. The study was conducted with families living in emergency homeless shelters, as part of a larger study of risk and resilience in homeless families. Families were assessed during the summer and early fall and included children between the ages of 4 and 6 entering kindergarten or first grade. Measures included a battery of hot and cool EF tasks for both the parents and children and ratings of positive and harsh parenting behavior based on observed (video-recorded) parent-child interactions.

The *first aim* of this study was to investigate the model presented by Cuevas and colleagues (2014), where the relationship between a composite measure of parent cool EF was significantly related to a measure of child cool EF, in part through it's relationship with negative parenting behavior. This resulted in two areas of focus: 1) the influence of parent EF on parenting and 2) the influence of parenting on child EF. In terms of the first area of focus, I was cognizant of the findings of Deater-Deckard and colleagues (2012), where the relationship between parent EF and harsh parenting was only found in "calm households" with low levels of family chaos. The effect was nonsignificant in families with high chaos, leading Deater-Deckard (2014) to speculate that "parental regulatory processes may break down in chaotic environments, particularly in the face of multiple socio-economic stressors (pg. 234)". Based on Deater-Deckard et al.'s (2012) findings, it was conceivable for the present study that *no* effect of parent EF on parenting behavior would be found within this high-risk sample. However, research on homeless populations suggests that these families face varying levels of risk exposure and, presumably, stress (Huntington et al., 2008), and many homeless individuals are able to continue to function well in their role as parents (Danseco & Holden, 1998; Narayan, 2015; Perlman et al. 2012). Thus, I hypothesized that the relationship between parent EF and harsh parenting would be moderated by parent perceived stress.[1] In addition, based on research suggesting that household chaos may exacerbate the impact of poor parenting on child behavior (Coldwell, Pike, & Dunn, 2006), I also predicted that parent stress would moderate the relationship between harsh parenting and child cool EF. In the case of the larger model of the relationship between parent EF and child EF mediated by harsh parenting, these potential moderating effects suggest that the overall *indirect or mediating* effect will also be moderated by parent stress.

A conceptual model of these effects is shown in Figure 1. Based on the conditional effects approach recommend by Hayes (2013), confirmation of the model required the establishment of 1) an *a* path between the independent variable and the mediating variable, moderated by an additional variable, 2) a *b* path between the mediator and the outcome variable, moderated by the same additional variable, and 3) an *ab* path (also referred to as an *indirect path)* referring to the relationship between the independent variable and the outcome variable through the mediator variable, dependent on the chosen moderator variable. A *c'* path, referring to the direct effect or unmediated influence of the independent variable on the dependent variable, may also be established but is not necessary for the confirmation of the presence of an indirect effect.

Thus, my specific hypotheses were as follows: 1) parent cool EF would be positively related to child cool EF (i.e. a significant direct effect or *c'* path, *hypothesis 1)*

[1] Footnote: Deater-Deckard, Wang, Chen, & Bell, 2012 was not available when the present study was designed (data collection finished in the fall of 2011), and the measures used in their research, the CHAOS Scale, was not included. However, the present study did include data from the Perceived Stress Scale (PSS), which was created to measure constructs very similar to those measure by the CHAOS Scale, namely the degree to which respondents find their lives to be unpredictable, uncontrollable, and overloaded. Given the obvious challenges of applying a measure of "home chaos" to residents living in a homeless shelter, the PSS was an excellent substitute.

and 2) the relationship between parent and child cool EF would be mediated by harsh parenting, dependent upon parent stress level (i.e. a significant indirect effect or *ab* path; *hypothesis 2)*. Confirming the second hypothesis required establishing the existence of 1) a significant association between parent cool EF and harsh parenting behavior (*a* path) moderated by parent stress (*hypothesis 2a)*, 2) a significant association between harsh parenting and child cool EF (*b* path) moderated by parent stress (*hypothesis 2b), and* 3) harsh parenting's status as a mediator for the indirect effect between parent and child cool EF (*ab* path), dependent upon the moderating effect of parent stress *(hypothesis 2c)*.

My *second aim* was to investigate whether a similar conditional effects model, with the indirect effect of parent EF on child EF mediated by parenting behavior, would apply for measures of (parent and child) *hot EF* and/or for measures of *positive* parenting behavior. This second set of analyses were exploratory in nature. Extant research offers support for several potential individual pathways. For instance, in terms of potential *a* paths, research by Gonzalez and colleagues (2012) and Chico and colleagues (2014) linked measures of parent cool EF with measures of positive parenting. A good deal of research (Bernier, Carlson, & Whipple, 2010; Blair, Raver, Berry, Family Life Project Investigators, 2014; Hughes & Ensor, 2009) also supports the *b* path of positive parenting to child cool EF. However, the lack of full intergenerational models including these variables makes specific hypothesis testing premature. This second set of analyses was completed using a primarily data-driven approach, further described in the results section.

Method

Participants and Procedure

Participants were 105 families including primary caregivers (*M* = 30.53 years, *SD* = 6.35, range = 19-49 years; 63.6% African-American, 12.1% Caucasian, 8.4% Biracial/Multiracial, and 15.9% other) and their 4-6-year-old children (54.3% male; *M* = 5.88, *SD* = .64, range = 4.17-6.99 years; 65.7% African-American, 4.8% Caucasian, 22.9% Biracial/Multiracial, 6.8% other). Primary caregivers were primarily biological mothers (94.5%), but also included biological fathers, grandparents, and other relatives (e.g. stepparent, aunt). Families were recruited during the summer and fall of 2012 from two emergency homeless shelters in a Midwest metropolitan area.

The institutional review board at the University of Minnesota approved all study procedures. Families were considered eligible if parents and children spoke English well enough to understand instructions, and children did not have identified developmental delays that would preclude participation. To allow time for families to adjust to the shelter environment, parents were invited to participate only after the family had been residing at the shelter for at least three consecutive nights. Caregivers provided informed consent for themselves and permission for their children to participate. Caregivers and their children completed the assessments in one two-hour sessions. Parents first completed an interview which included questions about demographic information and perceived-stress level, as well as a battery of assessments designed to measure adult IQ and executive function. At the same time but in a separate room, children also completed multiple tasks measuring IQ and executive function. Once separate sessions were completed, parent and child dyads participated in a video-recorded 20-minute interaction session (further described in the Measures section). As compensation for study participation, caregivers received forty dollars in gift cards, and children received small toys.

Measures:

Parent Stress. As part of the parent interview, caregivers completed the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983). The PSS was designed for community samples and is appropriate for individuals with at least a middle school education. The measure is made up of 10 items designed to assess the respondent's degree of stress, in particular the degree to which they find their lives to be unpredictable, uncontrollable, and overloaded (α = .99). Respondents are asked to recall how often they experienced certain thoughts and feelings in the past month on a scale from 0 – 4, with 0 = "never" and 4 = "very often." Items include "In the last month, how often have you been upset because of something that happened unexpectedly?" "In the last month, how often have you felt nervous or stressed?" and "In the last month, how often have you felt that you were unable to control the important things in your life?". The PSS is a measure of acute stress and is time-limited in nature, with predictive validity expected to fall off in 4 to 6 weeks after completion (Cohen et al. 1983). The measure was normed on a national sample as part of the L. Harris Poll (Cohen & Williamson, 1988). Evidence for the validity of the PSS includes linking high scores to negative affect (van Eck, Berkhof, Nicolson, & Sulon, 1996), increased cortisol response (Pruessner, Hellhammer, & Kirschbaum, 1999; van Eck et al., 1996), deleterious health behaviors (Ng & Jeffery, 2003), immune response (Cohen, Tyrrell, & Smith, 1993), and higher rates of anxiety and depression, even after controlling for negative life events (Pbert, Doerfler, & DeCosimo, 1992). Specifically in relation to parenting, research suggests that parent scores on the PSS are related to lower social support in urban, low-income parents (Green, Furrer, & McAllister, 2007), forceful or uninvolved feeding styles by low-income mothers of infants (Hurley, Black, Papas, & Caufield, 2008), poor parental monitoring among parents of teenagers (Lippold, McHale, Davis, & Ernst Kossek, 2015), child abuse potential in mothers of 6 to 9 year old children (Tucker & Rodriguez, 2014), and child psychosocial morbidity in children with deployed parents (Flake, Davis, Johnson, & Middleton, 2009).

It is important to note that the PSS is a measure of *psychological stress,* as opposed to *environmental stress.* As defined by Cohen, Kessler, and Gordon (1995), environmental stressors are “events or experiences that are normatively (objectively) associated with substantial adaptive demands” (p. 4) and are typically measured by life events questionnaires. In contrast, measures of psychological stress focus on individual perception of stress, allowing for individual differences in “both the interpretation of the meaning of an event and the evaluation of coping resources” (p. 7). For this dissertation, I chose to focus on psychological stress as opposed to environmental stress because I expected it to better differentiate between members of this high-risk sample.

Parenting. The measure of parenting practices was based on observational ratings of parent-child while completing the *Family Interaction Tasks* (FITS; Forgatch & DeGarmo,1999; Weinfield et al.,1995). The FITS consists of a set of tasks desinged to elicit both positive and negative parenting behavior, including a problem-solving task where the dyad is asked to discuss areas of frequent family conflict (identified using the Family Issues Checklist created by Prinz and colleagues (1979)) and a set of teaching tasks, where the parent and child are encouraged to collaborate on a set of puzzles and games. For the present study, FITS required approximately 20 minutes to complete and were video recorded.

FITS were coded by two indepdent raters, using previously validated ratings of key parenting practices (Degarmo, Patterson, & Forgatch, 2004). These included three ratings of "positive parenting" behaviors, specifically positive involvement (ICC = .88, α = .92), rated for qualities of positive affect, affection, empathy, and support towards the child; problem-solving (ICC = .85, α = .87), rated from the two discussions for reasonable, collaborative, and mutually satisfactory conversations and solutions; and skill encouragement (ICC = .77, α = .89), rated from the teaching tasks for qualities such as scaffolding, positive reinforcement, and ability to break task into age-appropriate, clear, and manageable steps. The three variables, which were moderately correlated, were z-scored and composited to form one "positive parenting" variable. The criteria created by Degarmo and colleagues (2004) typically specifies a fourth variable, inept coerrcive discipline, which is meant to capture a range of "negative" parenting behaviors, including actions that are harsh or authoritarian in nature (e.g. yelling, threats of physical punishment) as well as actions that are erratic or permisive (e.g. weak limit-setting, nagging or pleading for compliance, or lack of follow-through). For this study, I chose to focus on harsh parenting behavior for two reasons: 1) previous research has focused specifically on this area (Cuevas et al., 2013; Deater-Deckard et al., 2012), and 2) while both styles of parenting may be problematic, parent characteristics that predict harsh or authoritarian behavior may be quite different from characteristics of parents who are overly permissive. Based on criteria established in previous research with this sample (Narayan et al., in review) the harsh parenting variable consisted of six items with good internal consistency (α = .76). Items included authoritarian, oppressive, hostile, sarcastic, rejecting, or physical parenting behaviors observed across the full 20-minute parent-child interaction. The correlation between positive parenting and harsh parenting was moderate in size ($r = .55$, $p < .001$), indicating that the two variables were related but distinct.

Parent EF and IQ

Intelligence. Measures were chosen to assess both verbal and nonverbal intelligence. The Peabody Picture Vocabulary Test, Fourth Edition (PPVT-IV; Dunn & Dunn, 2007) was included as a measure of receptive vocabulary and verbal comprehension. The measure is a nationally standardized instrument, appropriate for ages 2:6 to 90+ years. Nonverbal intelligence (or performance IQ) was assessed via the Matrix Reasoning subtest of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III; Wechsler, 1997). The two measures were moderately correlated ($r = .31$, $p = .001$).

Executive Function. Measures were chosen to assess four key components of executive function: working memory, planning, inhibitory control, and hot EF (i.e. EF situated in an emotionally salient context). Identifying an appropriate battery of tasks required consideration of several distinct characteristics of the sample and study environment. As part of a larger study conducted on-site at an emergency shelter, tasks needed to be relatively brief and easy to administer. Participant literacy was also a concern. Any written instructions or other text needed to be aimed at a 6^{th} grade reading level, and tasks that were dependent on reading as a “pre-potent response” (e.g. the Stroop Color Word task) were not appropriate. Concerns related to literacy also precluded many of the available hot EF tasks for adults, as they relied on affective words as verbal stimuli, meaning performance could be impacted by reading ability. Finally, given the high rates of trauma exposure and PTSD often seen in homeless samples (Schuster, Park, & Frisman, 2011), we also avoided the use of any tasks with potentially traumatic material, such as emotional go-nogo tasks that include negatively-valenced imagery (e.g. the International Affective Picture System (IAPS); Lang, Bradley, Cuthburt, 2008). These requirements ruled out many of the tasks used in previous studies of parent EF (Cuevas et al., 2013; Deater-Deckard et al., 2012; Jester et al., 2009), mainly due to concerns about length and required reading level. The final set of tasks, chosen to reflect the principle elements of EF, are presented below.

Working memory was measured using the *Digit Span subtest of the WAIS-III* (Wechsler, 1997). For this subtest, participants were read lists of numbers which they were asked to repeat back in the same order. They were then asked to listen to additional lists and repeat them back in reverse order. Scores were based on the maximum number of items participants were able to recall correctly (ranging from 2 to 8), converted to standard scores.

Planning was measured using *The Tower of London task* (TOL; Shallice, 1982). The TOL was computer-administered using the PEBL platform (Psychological Test Battery: http://pebl.sourceforge.net/battery.html). Participants completed 12 trials with stimuli based on the guidelines established by Shallice (1982). The task required the participant to move disks on three “pegs” in order to replicate a target pattern. For each trial, participants were presented with the number of moves required to replicate the target pattern. If the participant exceeded the number of moves before replicating the pattern, the task was reset, and the participant was asked to try again. Participants were allowed three attempts for each pattern, before the program automatically moved on to a new trial. Scores were based on the total number of attempts required across all 12 trials, with a score of 4 assigned to trials where the participant was not able to replicate the pattern after three attempts. Thus, scores could range from 12 to 48.

Inhibitory control was measured using a computer administered *Go-NoGo task* created by Lewis and colleagues (2006). The task included an emotion induction component and was also used to measure a form of hot EF, specifically inhibitory control in an emotionally salient context. The basic instructions of the task were similar to a traditional Go-NoGo task, where participants are asked to press a button each time a letter flashes on the screen (the "go" condition) with the exception of when a letter is repeated, when they are told to refrain from pressing the button (the "nogo" condition). The Go-NoGo task differed from more traditional versions in that it provided error feedback; incorrect responses, omitted responses, and late responses were followed by an unpleasant buzzing sound and a red bar in the middle of the screen. The task also included a running tally of points, which were displayed every 5 – 25 trials in the center of the screen. Prior to beginning the task, participants were told they could win up to five dollars in gift cards based on the number of points they earned (the exact number of points required to "win" was not specified). The task included a short practice block and then three trial blocks (A – C), each consisting of 100 trials including 33 nogo trials presented in a pseudorandom sequence. Block A provided relatively accurate feedback via points, with +50 points awarded for correct responses and -10 points for errors. Block B was designed to induce negative emotions (anxiety and/or anger), and the algorithm for awarding points shifted to approximately +15 points for correct responses and -55 points for errors. Additional adjustments were made so that participants lost all points by the end of the second block. The third block, Block C, was included to mitigate the negative emotions induced by Block B. Scoring reverted to the more generous point algorithm, and participants were told that they had scored high enough to win the full five dollars in gift cards, regardless of their actual performance.

An additional "non-traditional" feature of the program was that it adapted to the participant's ability level, with stimuli duration increasing or decreasing based on performance. The purpose of this adjustment was to provide a similar level of challenge and thus a similar level of negative emotion across participants. In other words, the dynamic adjustment made it more likely that changes in performance across the task were due to the emotion induction component *of the task*, rather than variation in frustration due to participants' individual inhibitory control abilities. Scoring was based on the percentage of correct responses (i.e. the "hit rate" for go trials and the "omission" rate for no-go trials) for Blocks A and B. Despite the adaption of stimuli time based on performance, there was acceptable variability in percentage of correct responses, both for Block A (M = .71, SD = .03, range: .57 - .84) and for Block B (M = .59, SD = .05, range: .43 - .69). Percent accuracy for Block A was used as the measure of inhibitory control, labeled Go-NoGo (GNG); it should be noted that, due to the error feedback and the offer of a reward, the measure had more of emotional or "hot" component than more traditional Go-NoGo tasks. However, Block B provided the more salient emotional context due to the loss of points and was used as a measure of hot EF (labeled Emotional Go-NoGo (EGNG)). In order to account for individual differences in "cool EF" (inhibitory control), GNG scores were entered as a covariate for all analyses that included EGNG performance.

Child EF and IQ

Intelligence. Child IQ was measured using three subtests from the Wechsler Preschool & Primary Scales of Intelligence, Third Edition (WPPSI-III; Wechsler, 2002). Subtests were chosen based on their status as strong indicators of general IQ (Wechsler, 2002), and included two verbal subtests (Information & Receptive Vocabulary) and one nonverbal subtest (Matrix Reasoning). Based on the procedure used in previous studies with a similar sample (e.g. Masten et al., 2014), scaled scores for each subtest were converted to z-scores and then averaged to form a single composite variable (alpha = .66; correlations among subscales ranged from $r = .34$ to $r = .51$).

Executive Function. Child EF was assessed using a battery of seven tasks chosen to capture both hot and cool EF. Measures of cool EF emphasized working memory, set-shifting, and inhibitory control. The first of these tasks, *Forward Backward Word Span* (FBWS; Carlson, Moses, & Breton, 2002), was designed to assess working memory. Children were read lists of words, which they were then asked to repeat back to the experimenter. Similar to the Digit Span Subtest completed by the adults, the first section required the children to repeat the words back in the same order they were read and then, in the second section, to repeat the words back in reverse order. The final scores were based on the maximum number of words they were able to repeat for both the forwards and backwards conditions.

Inhibitory control was measured using the *Peg Tapping* task (Diamond & Taylor, 1996). For this task, children sat across from the experimenter and were given a wooden dowel. The children were asked to watch the experimenter, who also had a dowel, and follow two rules: tap the table with the dowel once when the experimenter tapped twice and tap twice when the experimenter tapped once. Scores were based on percentage of correct responses (e.g. one or two taps).

The battery also included two computerized measures of set-shifting. For the *Pointing Stroop* task (Berger, Jones, Rothbart, & Posner, 2000), children were presented with pictures of two animals and then an animal sound. First, children were asked to point to the animal that made the sound. After 16 trials, the children were asked to "switch rules" and start pointing to the animal that *did not* make the sound. Final scores were based on the percentage of correct responses for this second set of trials (16 total).

The second computerized task was a version of the *Dimensional Change Card Sort* (DCCS; Carlson & Schaefer, 2012; Zelazo, 2006), created as part of the NIH Toolbox Cognitive Battery (Zelazo, Anderson, Richler, Wallner-Allen, Beaumont, & Weintraub, 2013). Similar to the Pointing Stroop, children were asked to switch flexibly between two different sets of rules, this time while sorting pictures. Children were asked to sort shapes based on specific characteristics (e.g. shape). After several trials, the "sorting rule" would change and children would be asked to sort based on a different characteristic (e.g. color). The extension allowed the task to adapt to children's performance, with low-performing children presented with fewer rule changes. This accommodation helps remediate the "floor effect" often found in cognitive testing of high -risk samples.

A single measure of cool EF was created by converting scores from individual measures (i.e. Forward Backward Word Span, Pointing Stroop, DCCS, and Peg Tapping) to z-scores and averaged to form a composite variable (alpha = .64; correlations among subscales ranged from $r = .17$ to $r = .51$).

A second set of tasks were chosen to measure hot EF, with a focus on delay of gratification. For the *Dinky Toys* task (Kochanska et al., 1996), the children were presented with a box of small toys. Prior to opening the box, the experimenter explained that the child could choose one toy, and that they needed to ask for the toy rather than grabbing it. The task was administered three times throughout the session and video-recorded for later scoring. Scoring was based on worst transgression (rated on a 5 point scale), frequency of transgressions, and latency to worst transgression for each of the three trials, and final scores were created by averaging the three composite scores. Scoring was completed by a team of trained raters, with good interrater reliability (K = .84 for worst transgression code; 99.6% agreement for frequency within 1; latency agreement within 2 seconds = 96.6%).

The second measure of hot EF was the *Toy Prohibition* task (Friedman et al., 2011), which began with the experimenter allowing the child to choose between a set of three appealing toys (including a toy guitar, a marble maze, and an expandable ball), and then saying they could "take a break" to play. Once the child chose a toy, the experimenter would place it in front of the child but then ask the child to wait to touch the toy until the experimenter was "ready". The experimenter would then focus on paperwork for a period of 30 seconds, before allowing the child to touch the toy. Child behavior was video-recorded and later coded by a team of trained raters. Final scores were based on a composite of worst transgressions (rated on a 5 point scale), frequency of transgressions, and latency to worst transgression. Once again, inter-rater reliability was good (K = .77 for worst transgression code; 99.4% agreement for frequency within 1; latency agreement within 2 seconds = 97.4%).

The final measure of hot EF was the *Gift Delay* task (Kochanska et al., 1996). Children were told they would be receiving a gift, but it had not been wrapped yet. They were asked to face away from the table while the experimenter noisily wrapped the gift behind them. After 60 seconds, the experimenter made an excuse to leave the room, instructing the child not to "peek" at the gift during their absence. The child was left alone with the gift for two minutes. Children were video-recorded throughout the task. Trained raters scored each section of the task (i.e. the 60 seconds with the experimenter in the room and the 120 seconds with the experimenter outside) based on worst transgression, frequency of transgressions, and latency to worst transgression. Inter-rater agreement was calculated on the basis of 1/3 of the cases which were coded by multiple raters (K = .90 and .92 respectively for Part I and Part II; 98.1% for both Part I and Part II agreement within 1 for frequency; 94.4% and 89.5% agreement within 2 seconds for latency). Final composite scores for child hot EF were based on average z-scores across tasks for worst transgression, frequency, and latency. Scores were truncated to a z-score of + or – 3.0 before compositing.

A single measure of hot EF was created by converting scores from individual measures (i.e. Gift Delay part 1 and 2, Dinky Toys, and Toy Prohibition) to z-scores and averaged to form a composite variable (alpha = .75; correlations among subscales ranged from r = .28 to r = .38).

Missing Data

Complete data were available for parent stress and the child hot EF, cool EF, and IQ composites. Rates of missing data for the remaining values were as follows: 3.8% for parenting variables (positive parenting and harsh parenting), 1.9% for parent Digit Span scores, 7.6% for parent PPVT scores, 6.6% for parent GNG scores, and 27.6% of parent TOL scores. Missing data were managed using a hotdeck imputation procedure, facilitated by an SPSS Macro created by Myers (2011). Appropriate use of hotdeck imputation is dependent upon the percent of missing data in combination with the pattern of missing data (i.e. missing at random - MAR, missing completely at random - MCAR, not missing at random - NMAR). When data conforms to the standard of MCAR, hotdeck imputation is appropriate for rates of missing data as high as 50%. When data is MAR, hotdeck imputation may be used for rates of missing data up to 22%. When data is NMAR, hotdeck imputation is still recommended if missing data is less than 10% (Hawthorne & Elliott, 2005; Roth, 1996). Analysis of missingness suggested that data for all variables at least conformed to the standard of MAR, with the exception of parent PPVT. For PPVT scores, missingness on the measures was found to be related to performance on the measure, indicating MNAR. Based on experimenter observations, this may have been due to certain parents refusing to finish the PPVT because they found it too difficult. Despite the MNAR pattern, hotdeck imputation was determined to be an appropriate approach for the PPVT due to a degree of missing data lower than 10% (i.e. 7.6%). Rates of missingness for all variables were also found to be appropriate for hotdeck imputation (≤ 10%), with the exception of TOL scores. Rates of missing data were high for this measures (27.6%). However, missingness on TOL was found to be independent of any other variables of interest (i.e. parent or child EF variables, parenting variables, stress level) or covariates (e.g. child or parent age, child or parent IQ), suggesting that this variable conformed to the standard of MCAR. Additional review of the missing cases for the TOL suggested that the majority were due to computer error, meaning probability of missingness was equal for all participants and further supporting the standard of MCAR. Thus, despite high rates of missing data, hotdeck imputation was determined to be an appropriate approach for the TOL variable due to its status of MCAR. Data were imputed for 29 families on core analyses. All study findings reported in tables, figures, and text are based on imputed data, unless otherwise noted.

Data Analytic Plan

Data analyses were performed using SPSS. First, descriptive data were examined in order to depict the sample. Bivariate relationships for all measures were tested using Pearson correlation analysis. In addition, partial correlations between primary study variables, controlling for parent and child IQ and demographic variables, were compared with corresponding bivariate correlations. Full and partial correlations between parent EF variables were examined to determine whether the variables would be analyzed separately or as a composite.

Specific hypothesis testing progressed in three steps as recommended by Hayes (2013). First, hierarchical regression analysis was used to assess the impact of cool parent EF on harsh parenting, as well as the extent to which this impact was moderated by parent stress. Second, an additional hierarchical regression analysis was used to assess the impact of parent cool EF and harsh parenting behavior on child cool EF, as well as the moderating effect of parent stress on the relationship between harsh parenting and child cool EF. Finally, a moderated mediation approach was used to estimate the conditional indirect (or mediated) effects of parent cool EF on child cool EF through harsh parenting as a function of parent stress.

Additional analyses were conducted to examine whether a model similar to the moderated-mediation model proposed in my specific hypotheses would apply for measures of (parent and child) *hot* EF and/or for a measure of *positive* parenting behavior. These analyses were exploratory in nature and based on a data-driven approach. They included examining bivariate and partial correlations between variables and using this information to build and test an additional intergenerational model. Analyses are described in detail in the results section.

Results

Descriptive Characteristics of the Sample

The families involved in the study reported many risk factors common to this population. The majority were unemployed (77.6%), and 24.3% had not completed high school. A large percentage (41.1%) had their first child prior to the age of 18 and nearly half (45.8%) had four or more children living with them at the shelter. The majority (67.3%) of the parents reported having experienced at least one previous episode of homelessness as an adult (23.3% also experienced episodes prior to the age of 18), and 40.2% reported that their child had experienced at least one previous episode of homelessness. Parents in this group also reported high levels of stress, with an average score of 19.23 (*SD* = 7.4, range: 2-34), in comparison to a population norm of approximately 14 (*SD* = 6.6; Cohen & Williamson, 1988).

Structure of Parent EF

Bivariate and partial correlations were run to determine whether parent EF variables should be examined separately or as a composite. Although previous research on the relationship between adult EF and parenting has primarily relied on composite measures of parent EF, the nature of the measures chosen for this study as well as the high-risk sample meant that this approach might not be appropriate for the current study.

The bivariate correlations between the four parent EF variables (Digit Span, GNG, TOL, and EGNG) are shown in Table 1. The correlation between GNG and EGNG was significant ($r = .24$, $p = .01$), as expected due to their coming from the same task. However, the small size of this correlation suggests that the two measures are distinct. Relationships between the other parent EF variables included small correlations between Digit Span and EGNG ($r = .20$, $p = .03$) and between GNG and TOL ($r = .21$, $p = .03$). Table 2 presents these same correlations after controlling for demographic and parent IQ variables, with all correlations dropping to non-significant. This change suggests that any shared variance between the parent EF variables is likely due to parent IQ or some other demographic characteristic(s). These results did not support these variables as best-represented by a single composite variable. Thus, the four parent EF variables were examined separately in all analyses.

Bivariate and Partial Correlations Related to Specific Hypotheses

Additional bivariate correlations are also presented in Table 1. Results emphasize the importance of controlling for confounding variables in further analyses. As previously noted, parent WAIS-IV Matrix Reasoning and PPVT performance were significantly correlated with several parent EF variables. The parent IQ measures were also related to positive parenting and child cool EF, while child IQ was related to multiple primary variables, including parent EGNG, positive parenting, and the child cool

EF composite. Among the demographic variables, shelter, child age, and parent education correlated with multiple primary variables. Parent age, child gender, and parent ethnicity each had at least marginally significant relationships with a small number of primary variables. Accordingly, all nine control variables were included in further analyses.

Table 2 presents partial correlations between primary variables after controlling for demographic and IQ variables, with many partial correlations differing from the corresponding bivariate correlation. In terms of my first hypothesis, predicting that parent cool EF would be significantly related to child cool EF, I examined the bivariate relationships between the three parent cool EF variables (Digit Span, TOL, and GNG) and the child cool EF composite. Only the correlation between parent TOL and child cool EF was significant ($r = .24$, $p = .02$) and, as shown in Table 2, this relationship dropped in magnitude and to non-significance after the addition of the control variables ($r = .14$, $p = .20$). This finding did not support my first hypothesis, which predicted that measures of parent cool EF would be significantly correlated with child cool EF, even after controlling for parent and child IQ. However, as specified by Hayes (2013) this the lack of a significant direct effect did not preclude the existence of an indirect effect. For hypothesis 2a, which predicted a significant association between parent cool EF and harsh parenting, a significant negative correlation was found for the combination of harsh parenting and TOL performance ($r = -.28$, $p = .01$), although this also dropped in magnitude and significance after the inclusion of control variables ($r = -.18$, $p = .07$). Finally, as predicted by hypothesis 2b, the relationship between harsh parenting and child cool EF was found to be negative and significant ($r = -.33$, $p = <.01$) and only decreased slightly in magnitude after the addition of control variables ($r = -.26$, $p = .01$). Somewhat surprisingly, parent stress was not related to any of the study variables, with the exception of a negative relationship with parent education (r = -.20, p = .03). However, this did not rule it out as a potential moderator variable.

Regression Model for Harsh Parenting

Establishing the *a* path in Figure 1 required the identification of either 1) a significant main effect between one or more of the parent cool EF variables and harsh parenting or 2) a significant interaction between one or more of parent EF variables and harsh parenting, moderated by parent stress. Thus, in order to address hypothesis 2a, a hierarchical OLS regression for harsh parenting was completed. Step 1 consisted of control variables, including demographic variables and parent and child IQ, as well as parent hot EF and positive parenting. Step 2 included main effects for parent stress and parent cool EF, with order of entry for cool EF variables based on level of cognitive complexity, beginning with working memory (Digit Span), Inhibition (Go-NoGo), and then Planning (TOL). Step 3 was reserved for potential interaction terms. The presence of three cool EF variables meant the possibility of three interaction effects. However, the inclusion of multiple interaction terms in OLS regression increases the risk for multicolinearity and suppressor effects. To reduce this risk, a backwards elimination technique, recommended by Jaccard and Turrisi (2003), was used to systematically eliminate extraneous interaction terms based on p value (i.e. the largest p value associated with the regression coefficient). If the elimination of an interaction term resulted in only a negligible difference in fit, then is was concluded that its inclusion contributed little to the overall model, and the term was dropped. This process began with a "chunk test," where measures of fit were compared for the regression including only main effect variables (Step 2) with the regression containing all possible interaction terms (Step 3). As shown in Table 3, the addition of all possible interaction terms (Model 2) resulted in an increase in R^2 for harsh parenting in comparison to Model 1, which contained no interaction terms (R^2 = .42 and .45, respectively, both with $p < .001$). Of the three interaction terms, only parent TOL by Parent Stress was significant ($\beta = -.19$, $p = .04$). The nonsignificance ΔR^2 for Step 3 in Model 2 suggested the presence of extraneous interaction terms. Individual interaction terms were systematically dropped based on *p*-value in Models 3 (dropped Digit Span) and 4 (dropped Digit Span and GNG), with no changes in R^2, leaving TOL by Parent Stress as the only interaction in Model 4. Thus, Model 4 was deemed the most parsimonious model that still retained an increase in fit in comparison to Model 1. It should be noted that the ΔR^2 for Model 4 was significant, likely due to the removal of unnecessary interaction terms. The full model (including control variables) is presented in Table 4. There were no main effects for parent IQ, parent stress, or any of the three parent EF variables in the final model. However, as noted, the interaction between TOL performance and parent stress was found to contribute significantly to variance in harsh parenting.

To further explore this interaction, simple regression lines were computed for the relationship between TOL performance and harsh parenting at specific values of parent stress (low = 1 *SD* below the mean, score of 11.83; average = at the mean, score of 19.23; high = 1 *SD* above the mean, score of 26.63). As illustrated in Figure 1, the relationship between TOL performance and harsh parenting was non-significant for parents reporting low and average levels of stress ($B = -.01$, $p = .87$ and $B = -.03$, $p = .07$, respectively). For parents reporting high levels of stress, there was a significant negative relationship between the two variables (*B* = -.05, *p* = .01), suggesting that poor performance on TOL predicted a greater degree of harsh parenting *only* in caregivers reporting high levels of stress.

Regression Model for Child Cool EF

In order to address hypothesis 1 and hypothesis 2b by establishing the *b* and *c'* paths in Figure 1, an additional hierarchical regression was completed for the outcome of child cool EF. Once again, Step 1 included control variables, this time controlling for child hot EF as well. Step 2 included the main effect terms for parent stress and the three parent cool EF variables, as well as harsh parenting and positive parenting (positive parenting was included as a control and also to aid in additional analyses). Step 3 included the interaction term for harsh parenting X parent stress. Results are presented in Table 6. The full model accounted for 68% of the variance in child cool EF. The majority of this variance was accounted for by the control variables in Step 1 (R^2= .64, p < .001), and the addition of the main effects in Step 2 did not result in a significant increase in variance (R^2=.66, p<.001, ΔR^2 =.01, p=.176). However, the interaction term for harsh parenting X parent stress included in Step 3 was significant and contributed to a significant change in overall explained variance (β = -.12, p = .03, R^2=.68, p<.001, ΔR^2 =.01, p=.043). Post-hoc analysis of the interaction, illustrated in Figure 3, indicated that the relationship between Harsh Parenting and Child Cool EF was not significant at low levels of stress (β = -.01 p = .91) but was significant and negative for parent's reporting medium and high levels of stress
(β = -.24, p = .03 and β = -.41 p = .01, respectively). This finding suggests that, within this sample, higher rates of harsh parenting was related to lower child cool EF, but only

when parents reported medium or high levels of stress.

Child Cool EF: Moderated Mediation Model

The final step was testing hypothesis 2c, which asserted that the indirect effect of parent cool EF on child cool EF through harsh parenting is dependent upon the moderating effects of stress. Addressing this hypothesis required the use of a moderated mediation approach. Specifically, the PROCESS procedure created by Hayes (2013; Model 58) was used to estimate the indirect effect of TOL on Child Cool EF through harsh parenting at varying levels of parent stress. Utilizing a bootstrapping approach with 10,000 iterations, the procedure produced 95% bias-corrected confidence intervals (CI) for each of the conditional indirect effects. In small samples, Preacher and Hayes (2008) recommend using these CIs for significance testing; a CI that does not include zero provides evidence of a significant effect. Final results of the moderated mediation analysis indicated that the indirect effect of TOL on child cool EF was not significantly different from zero when caregivers reported low (B = .00, 95% CI: -.01 to .01) or average (B = .01, 95% CI: -.01 to .02) levels of stress. However, when caregivers reported high levels of stress, the effect was positive, and bootstrap confidence intervals did not include zero (B = .02*, 95% CI: .01 - .05). This finding suggests that the parents with better planning skills (TOL performance) tended to have children with better EF skills, with the relationship mediated through lower levels of harsh parenting, but *only* when parents reported experiencing high rates of perceived stress.

Additional Analyses

Additional analyses were conducted to address my second aim of investigating whether a similar moderated mediation model, with the indirect effect of parent EF on child EF through parenting behavior moderated by parent stress, would apply for the measure of parent *hot EF* (i.e. EGNG performance), the measure of child hot EF (i.e. the child hot EF composite) and/or for the measure of positive parenting behavior (i.e. the positive parenting composite). These exploratory analyses were conducted using a data-driven approach. Specifically, data were examined in order to identify potential *a* and *b* paths required for the model. I first considered possible *b* paths, which included the relationship between positive parenting and child cool EF as well as the relationship between harsh parenting and child hot EF. I noted that the relationship between positive parenting and cool child EF had already been ruled out, based on the non-significant effect of positive parenting in the regression presented in Table 4 (β = -.07, p = .48). Thus, additional analyses were focused on child hot EF as an outcome variable.

Examination of bivariate correlations in Table 1 revealed that the relationship between parent EGNG performance and the child hot EF composite was not significant, ruling out a direct (but not an indirect) relationship between the two variables. Additional bivariate correlations suggested that both harsh parenting and positive parenting were significantly related to child hot EF (r = .-.25, p= .02; r = .27, p = <.01, respectively), but only the relationship between positive parenting and child hot EF remained significant after the inclusion of control variables (r = .17, p= .04).[2] Thus, the next step was to consider potential *a* paths for positive parenting, including the relationship with parent cool EF and parent hot EF. As shown in Table 1, significant bivariate correlations were present linking positive parenting to Digit Span, TOL, and

[2] Additional analyses using the backward elimination method (Jaccard & Turrisi, 2003) were used to detect any potential interaction effects (e.g. harsh parenting X stress in relation to child hot EF); no significant effects were identified (analyses presented in Appendix A).

EGNG. However, as shown in Table 2, only the relationship between EGNG and positive parenting remained significant with the addition of control variables.[3] Overall, examination of bivariate and partial correlations suggested the presence of one *a* path, parent hot EF (EGNG) -> positive parenting and one *b* path, positive parenting -> child hot EF. Thus, the final model to be tested was a simple mediation model. Using the PROCESS procedure (Hayes, 2013 Model 4) with 10,000 bootstrap samples revealed a significant indirect effect between EGNG on Child Hot EF through positive parenting (point estimate = 1.00, 95% CI = 0.18 to 2.36).

Discussion

The present study investigated the intergenerational continuity of parent and child EF, as well as the mechanisms underlying this relationship, within a sample of families living in emergency homeless shelters. After examining the structure of parent EF in this population, my first aim was to test a mediation model, based on the findings of Cuevas and colleagues (2014), where the relationship between parent and child cool EF was linked by the mediating variable of harsh parenting. In addition, I hypothesized that this mediating effect would be moderated by parent stress (i.e. moderated mediation), resulting in the conceptual model presented in Figure 1. Analyses were also conducted to address my second aim of investigating whether a similar conditional effects model, with the indirect effect of parent EF on child EF mediated through parenting behavior, would apply for measures of (parent and child) *hot* EF and/or for a measure of positive parenting behavior.

The Structure of Parent EF

[3] Additional analyses did not detect interaction effects between parent EF and parent stress in relation to harsh or positive parenting (see Appendix B).

Results examining the relationship between the four parent EF variables did not support the supposition of a single underlying construct of "general EF." Rather, the tasks appear to measure four related but distinct measures of EF, specifically working memory (measured by Digit Span), inhibitory control (measured by GNG), planning ability (measured by TOL), and inhibitory control in the context of strong emotionality (hot EF, measured by EGNG). Although previous research on adult EF and parenting has relied primarily on composite measures, the suitability of this approach for the present study was questionable for several reasons. First, the study design required measures of EF appropriate for a shelter-based population and setting. As a result, many of the tasks used in previous studies of parent EF were ruled out due to concerns about length, potentially stressful content, and required reading level. Second, results from previous research might not be generalizable to this study population of low-income, predominantly minority families experiencing high levels of stress. Third and finally, there is still considerable debate about the underlying structure of adult executive function, with some researchers arguing for a uniform underlying construct (e.g. Friedman et al. 2008) but others asserting that there are several inter-related but discrete dimensions of EF (e.g. Testa, Bennet, & Ponsford, 2012).

The Moderated Mediation Model

Further analyses addressed my specific hypotheses related to the moderated mediation model in Figure 1, which included examining the relationships involved in the *a, b, ab,* and *c'* paths of the model. Results supported my first hypothesis proposing a link between parent and child cool EF, as an element of parent cool EF (planning ability, measured by TOL performance) was significantly related to child cool EF even after controlling for adult and child IQ. This finding is generally consistent with other studies linking measures of parent and child cool EF (i.e. Cuevos et al. 2013; Jester et al. 2009). However, these studies both relied on a composite measure of EF that included a measure of planning in addition to a measure of working memory (Cuevos et al. 2013) or a measure of working memory as well as a measure of inhibitory control (Jester et al., 2009). Thus, it is unclear why the measures of working memory (i.e. Digit Span) and inhibitory control (GNG) used in the present study were not significantly correlated with the composite measure of child cool EF. The finding is especially surprising given that the measures that made up the child cool EF composite included two measures of inhibitory control and one measure of working memory, but no measure of planning ability. One possible explanation for this finding is that planning ability provided a link between parent and child EF *through* its relationship with harsh parenting (which was unrelated to Digit Span and GNG performance).

Indeed, although results generally supported hypotheses 2a, which predicted that parent cool EF would be negatively related to harsh parenting dependent upon parent stress level, only the interaction between TOL and parent stress was significant in the final model. Digit Span and GNG were not related to harsh parenting, even before controlling for IQ, and did not predict harsh parenting as part of an interaction with parent stress. This lack of a significant relationship between harsh parenting and measures of Digit Span and GNG is not entirely consistent with previous studies on parent EF. However, it is somewhat difficult to make comparisons due to differences in the measures of EF. For instance, working memory has been linked to harsh parenting in several other studies. However, it was measured either individually without the inclusion of other EF variables (Deater-Deckard et al. 2010) or as part of a composite variable that also included a measure of planning ability (i.e. Tower of Hanoi; Deater-Deckard et al., 2012; Cuevas et al. 2014). The lack of relationship between harsh parenting and inhibitory control is especially challenging to interpret, given that no study that I am aware of has included a measure of parent inhibitory control, either individually or as part of a composite variable, as a predictor of parenting behavior.

Findings related to the moderating effect of parent stress on the relationship between parent TOL performance and harsh parenting are also somewhat unexpected given previous research. Post-hoc analyses of the interaction effect suggested that TOL only influenced harsh parenting for parents reporting high levels of stress. These results are surprising given Deater-Deckard and colleagues' (2012) finding in a community sample, where the relationship between parent cool EF and negative parenting behavior was found only for families at *low* levels of stress. A potential interpretation is that, in the high risk and high stress sample examined in the present study, parent regulatory processes had largely "broken down," resulting in a primarily non-significant relationship between parent EF and parenting. However, for parents reporting extremely high levels of stress (2 standard deviations above the national norm based on Cohen & Williamson, 1988) the relationship is again significant. This finding is consistent with early theoretical work by Wahler and Dumas (1989) and Azar (1989) proposing that the influence of individual differences in parent cognitive abilities on parenting should be *most* apparent under conditions of extreme stress. The moderating results illustrated in Figure 2 seem to support this theory, at least within this high-risk population. Specifically, TOL performance had virtually no impact on harsh parenting for parents reporting low stress and little impact for parents reporting medium stress levels. But, for parents reporting high stress, poor planning abilities were related to higher rates of harsh parenting. In contrast, *more advanced* planning abilities were related to lower rates of harsh parenting in individuals reporting high rates of stress, even in comparison to parents with higher TOL scores and low or average stress. It is possible that the parents in this high-stress, high planning abilities group were particularly competent individuals, in that they were able to *recognize* their extreme stress level yet continue to display good self-regulatory abilities, and this general competence was reflected in their parenting abilities.

In contrast, the moderated role of stress in the relationship between harsh parenting and child cool EF (as predicted in hypothesis 2b) is much more straight-forward. As expected, the relationship was not significant in families where parents reported low stress. In families with parents reporting average and high rates of stress, harsh parenting predicted substantially lower scores for child cool EF. This finding is consistent with previous research suggesting that parent report of home chaos exacerbates the negative influence of poor parenting on children's behavior problems (Coldwell et al., 2006) and suggests that children living in stressful or chaotic conditions may be especially vulnerable to the impact of harsh parenting.

The final piece of my second hypothesis (part c of hypothesis 2) required confirming harsh parenting's status as a mediator for the indirect effect between parent and child cool EF (*ab* path), dependent upon the moderating effect of parent stress. Results suggested that the indirect effect of parent cool EF on child cool EF through harsh parenting was significant only for parents reporting high rates of stress. Thus, for the majority of the sample, there was no relationship between parent and child cool EF, suggesting that interpersonal processes supporting intergenerational continuity in low-risk samples may not function optimally under conditions of high risk. However, the results also suggest that, at *very* high levels of stress, poor parent cool EF skills (specifically planning ability) are associated with higher rates of harsh parenting behavior in comparison to individuals with poor cool EF skills and *lower* levels of stress. In turn, these higher rates of harsh parenting are associated with especially low child cool EF skills. In contrast, parents who are able to continue to display good self-regulatory abilities under such intensely stressful conditions may be exceptionally skilled at remaining calm under pressure, resulting in a lower degree of harsh parenting behavior. In addition, any harsh parenting they do engage in has less of an impact on their children's cool EF skills, possibly because, overall, their home life is relatively calm.

Additional Analyses

The second aim of the study was to investigate whether a similar moderated mediation model, with the indirect effect of parent EF on child EF through parenting behavior moderated by parent stress, would apply for measures of (parent and child) *hot* EF and/or for measures of *positive* parenting behavior. Although these analyses were exploratory in nature, they produced intriguing results. Initial analyses focused on potential *a* paths, linking parent EF to parenting. The significant positive relationship between parent hot EF (measured by the EGNG) and positive parenting behavior suggests that, while the relationship between parent *cool* EF and parenting behavior may break down in high-risk samples, the influence of hot EF remains significant. As noted in the discussion, only one study that I am aware of has addressed the impact of hot EF on parenting (Fonataine & Nolin, 2012), and it only addressed negative parenting behavior (i.e. child abuse potential). Thus, this is the first study to demonstrate that a component of parent hot EF, specifically inhibitory control performance under emotionally salient conditions, is related to positive parenting behavior in a high or low risk sample.

The findings that parent *hot* EF was not related to *harsh* parenting and parent *cool* EF was not related to *positive* parenting is not consistent with the existing literature. However, differences in measurement and conceptualization of EF and parenting make it very difficult to compare results across studies. For instance, unlike Fontaine and Nolan (2012), I did not find an association between parent hot EF and harsh parenting, but there were substantial differences in measures of hot EF and negative parenting between the two studies. Specifically, Fontaine and Nolin (2012) used the Iowa Gambling task, which may measure multiple constructs such as risk aversion (Buelow & Suhr, 2009), as their measure of hot EF and a self-report measure of child abuse potential as their measure of negative parenting behavior. Ostensibly more surprising was the finding from the present study that the relationships between measures of parent cool EF and positive parenting behavior were also not significant once the covariance attributable to parent and child IQ were controlled. Only two other studies have addressed the relationship between parent cool EF and positive parenting behavior, but both found significant effects in high-risk populations, specifically adolescent mothers (Chico et al., 2014) and mothers with a history of trauma (Gonzalez et al., 2012). However, Gonzalez and colleagues (2012) did not control for IQ when linking maternal working memory with sensitive parenting. When Chico and colleagues included a control measure of maternal IQ, they found that the relationship between maternal cool EF and sensitive parenting only remained significant for their measure of cognitive flexibility, while the relationship between their measure of working memory and positive parenting was no longer significant. Thus, their findings relating maternal working memory to sensitive parenting are actually consistent with the current study, as Digit Span was significantly related to positive parenting *before* controlling for parent IQ.

This second set of analyses also addressed the relationship between parenting and child hot EF (i.e. potential *b* paths). The relationship between harsh parenting and child hot EF was not significant, which corresponds to the results of Rhoades and colleagues (2011), who found that the effects of negative maternal negative control on child delay of gratification skills were significant for Caucasian children, but not children who were African American (the race/ethnicity of the majority of the children in the current study). The significant relationship found between *positive* parenting and child hot EF is generally consistent with findings from studies linking positive parenting with delay of gratification in high-risk samples (Gilliom et al. 2002; Li et al., 2011). The significant relationship between 1) parent hot EF and positive parenting and 2) positive parenting and child hot EF led me to test a simple mediation model. Results supported the interpretation that positive parenting mediated the relationship between parent and child hot EF. Based on my knowledge, this is the first time parent hot EF has been linked with positive parenting and positive parenting has been linked with child hot EF within the same study.

Strengths and Limitations

This was the first study to investigate intergenerational continuity of EF in a low-income, high-risk sample. It was also the first study to consider the role of parent and child hot EF and positive parenting as part of an intergenerational model of EF. Study findings demonstrate the importance of testing theories of interpersonal processes in child development in samples with varying levels of risk and stress. Additional strengths included the use of an observational measure of parenting and neuropsychological measures of parent and child EF. In addition to being considered gold-standard measures of these two concepts, the use of observation and task-performance helps decrease the chance of measurement invariance, a limitation common to intergenerational research.

Despite these strengths, the study also had multiple limitations, the most substantial of which are related to the cross-sectional design in the collection of key parent EF, parenting, and child EF variables. This limitation is especially pertinent for any conclusions based on mediation analysis. The conceptual model presented in Figure 1 could not technically be adequately tested in this sample, because true mediation analysis requires a clear temporal separation of the independent variable, the mediating variable, and the outcome variable. Hypotheses were derived based on previous studies which were longitudinal and identified predictive relationships for parenting and child EF (e.g. Blair et al., 2011), and parent and child EF mediated by parenting (Cuevos et al., 2014). However, the fact that all three measures for the mediational analyses in this study (parent EF, parenting, and child EF) were collected at one time point means that the precise nature of the relationships between measures cannot be determined. For instance, the relationship between harsh parenting and child cool EF might actually be due to evocative effects of the child's dysregulated behavior on parenting. Having all families complete all measures on the same day also made it difficult to rule out confounding variables specific to that time point, such parent stress level or child fatigue. Finally, the correlational nature of the study also precludes conclusions about causality. Longitudinal studies with repeated measures of parent EF, parenting, child EF, and child adjustment would be helpful in providing clues to the direction of effects. Experimental interventions targeting parent EF and/or parenting that result in improved child EF would provide the strongest evidence of causal processes.

Additional limitations include the unusual nature of sample (i.e. primarily African American families living in emergency homeless shelters), which may not generalize to similar families staying in different residential situations or to families of different heritage staying in similar situations. It is important to note that this limitation can also be considered a strength of the study; low-income, minority families, especially ones in crisis, are still largely disenfranchised by child development research (Henrich, Heine, & Norenzayan, 2010). Given the emphasis placed on environmental perturbations as catalysts for change and plasticity in the field of child development (Cicchetti, 2008; Thelen, 1996), it is perhaps just as if not more important to understand developmental processes within families experiencing periods of extreme stress (Yoshikawa & Hsueh, 2001). Nevertheless, current study findings would be easier to interpret in the context of comparison groups varying in residential situation or sociodemographic risk.

A final set of limitations are related to measurement issues. First, the measure of parent hot EF (EGNG) is relatively new and has not previously been used with adults. In addition, most studies that have applied the measure have used it to look at normative developmental changes across age groups, as opposed to individual differences in scores (Lewis et al., 2006). Thus, analyses that included this measure were viewed as exploratory and the results should be treated with considerable caution pending replication. In addition, an ideal study would have included measures of child EF that better paralleled measures of parent EF (e.g. both including developmentally appropriate measures of working memory, inhibitory control, and planning ability). This limitation reflects the overall design of the larger study, which limited some of the measurement choices in order to reduce subject burden or accommodate specific hypotheses unrelated to the present study.

Implications and Conclusions

Study findings have multiple implications for future research. First and foremost, it is extremely important that the findings from this study be retested using a longitudinal design in a racially and socioeconomically diverse sample. Findings from this study add to the existing research supporting the importance of considering the impact of poverty, stress, and other risk factors on interpersonal processes related to the development of EF (e.g. Deater-Decker et al., 2012; Rhoades et al. 2011) and other forms of self-regulation (Raver, 2004). The study findings also present the intriguing possibility that, while some of the interpersonal processes linking parent and child EF may deteriorate under conditions of high stress or chaos (such as raising children in an emergency homeless shelter), others may still be highly salient in the context of extreme stress. More specifically, parent cool EF may be especially important for predicting harsh parenting, and harsh parenting may be especially important for predicting child cool EF in families reporting stress levels one *SD* above the mean for a an already high-risk, high-stress sample and/or two *SD* above the mean for the general population. An ideal test of this hypothesis would use a representative sample, careful to include families experiencing extremely high rates of stress, and apply an advanced procedure for probing interaction effects such as the Johnson-Neyman technique (Preacher, Curran, & Bauer, 2006), allowing for the elucidation of the effects at average, above average, and extreme levels of stress. Additional research might also further explore the hypothesis that people who are able to maintain good EF skills despite reporting high stress levels may be especially competent individuals (both as parents and in other domains).

The findings based on exploratory analysis should also be replicated in additional studies, in both high risk and community populations. Additional questions might include whether the relationships linking parent and child *hot* EF with *positive* parenting are less vulnerable to high-stress environments in comparison to relationships between parent and child *cool* EF and *harsh* parenting. Future studies should also include measures of both hot and cool EF (for both parent and child) as well as positive and negative measures of parenting to help further parse out individual effects. Finally, future research should include measures of multiple components of hot and cool EF, such as working memory, inhibitory control, set-shifting, delay of gratification, and cool EF performance while experiencing intense emotions. Later intergenerational research might also take advantage of new measure of cool EF designed to be used across a variety of age groups (e.g. age 3 - adulthood; Zelazo et al., 2013).

In terms of clinical implications, the present study provides further support for targeting parenting behavior in interventions designed to help children growing up in high-risk environments (e.g. DeGarmo et al., 2004; McCart, Priester, Davies, & Azen, 2006; Miedel & Reynolds, 2000). Intervention efforts should consider tailoring procedures based on parent EF ability and stress level, pulling from previous intervention research on the impact of Adult ADHD and stress reduction on both parenting behavior and treatment response (Crnic & Low, 2002; Johnston, Mash, Miller, & Ninowski, 2012; Kazdin & Whitley, 2003; Sonuga-Barke, Daley, & Thompson, 2002). Findings also encourage the emphasis on both reducing harsh parenting and encouraging positive parenting found in most successful intervention programs (e.g. PMTO, DeGarmo et al. 2004; Parent Child Interaction Therapy (PCIT), Eyberg, Funderburk, Hembree-Kigin, McNeil, Querido, & Hood, 2001).

In conclusion, the present study adds to the research supporting the role of interpersonal processes in the intergenerational continuity of EF, particularly the powerful impact of parenting quality. Findings were consistent with a moderated mediation model for the relationship between parent and child cool EF, including the mediating role of harsh parenting and the moderating role of parent stress. Additional exploratory findings suggest that relationships between parent hot EF, positive parenting, and child hot EF may be more resistant to stress and thus more likely to be found in a high-risk sample. These findings need to be replicated and expanded upon using a longitudinal design in a nationally representative sample, including families experiencing homelessness and other crisis situations.

Table 1
Bivariate Correlations Between All Variables

Primary Variables	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1. Parent Digit Span	-											
2. Parent Go-No-Go	.10	-										
3. Parent Tower of London	.18†	.21*	-									
4. Parent Emotional Go-No-Go	.20*	.24*	.11	-								
5. Parent Stress	.08	.13	.03	-.04	-							
6. Harsh Parenting	-.07	-.11	-.28**	-.18†	-.01	-						
7. Positive Parenting	.24*	.06	.22*	.35**	.02	-.55**	-					
8. Child Cool EF Composite	.11	.01	.23*	.12	.02	-.33**	.25**	-				
9. Child Hot EF Composite	-.04	-.06	.12	-.06	-.13	-.25*	.27**	.53**	-			
Parent and Child IQ												
10. Child IQ Composite	.18†	.07	.17†	.23*	-.02	-.14	.32**	.28**	.27**	-		
11. Parent PPVT	.32**	.12	.38**	.12	.12	-.14	.40**	.32**	.09	.27**	-	
12. Parent Matrix Reasoning	.18†	.06	.19†	.19†	.06	-.12	.23*	.28**	.17†	.29**	.31**	-
Demographic Variables												
Shelter (PSP)	-.09	-.21*	-.15	-.01	.02	.27**	-.22*	-.13	-.25*	-.05	.07	-.02
Parent Age	-.01	.09	.13	.03	.01	-.23*	.17†	.05	.05	.04	.11	.00
Parent Education (HS Diploma)	-.20*	.22*	-.12	-.01	-.20*	-.09	-.03	-.06	-.01	.01	-.29**	-.13
Child Age	.02	-.13	.08	-.04	.02	-.14	-.03	.48**	.27**	.06	-.01	.04
Child Sex (Male)	-.01	.03	-.09	.01	-.04	.19†	-.14	-.18†	-.13	-.05	-.01	-.10
Parent Ethnicity (nonwhite)	-.08	.09	-.06	-.05	.00	.11	-.06	.04	-.06	-.16	-.15	-.22*
Descriptive Statistics												
Mean	7.93	.71	26.84	.59	19.2	0.72	0.59	-.01	-.01	-0.01	82.95	7.85
SD	2.41	.03	3.86	.05	7.40	0.03	0.05	0.83	0.74	.78	10.26	2.86

Sample Range	3-13	.57-.84	19 - 34	.43-.69	2-34	.66-.76	.43-.69	-2.0-1.1	-1.9-1.1	-2.4-1.9	60-105	3-15

† $p < .10$, * $p < .05$, ** $p < .0$

Table 2
Partial Correlations for Primary Variables, Controlling for Parent and Child Demographics and IQ

	1	2	3	4	5	6	7	8
1. Parent Digit Span	-							
2. Parent GNG	.07	-						
3. Parent TOL	.04	.17	-					
4. Parent EGNG	.17	.20†	.06	-				
5. Parent Stress	.03	.19†	-.02	-.05	-			
6. Harsh Parenting	.00	-.04	-.18†	-.17†	-.01	-		
7. Positive Parenting	.10	-.11	-.01	.31**	-.01	-.50**	-	
8. Child Cool EF	-.01	.07	.13	.05	.02	-.26*	.10	-
9. Child Hot EF	-.15	-.13	.00	-.16	-.16	-.11	.17†	.39**

Note: Control variables: Shelter, parent age, child age, parent ethnicity, parent education level, parent PPVT, parent WAIS-IV Matrix Reasoning, child IQ composite. Correlations including parent EGNG also controlled for parent GNG.
† $p < .10$, * $p < .05$, ** $p < .01$

Table 3
Regression Model Comparison for Harsh Parenting

	Harsh Parenting			
	Model 1	Model 2	Model 3	Model 4
Step 1 *Control variables*				
R^2	.39	.39	.39	.39
Step 2				
Parent Stress	-.03	.00	.00	.00
Parent Digit Span	.03	.02	.02	.02
Parent GNG	.04	.04	.04	.04
Parent TOL	-.17	-.18†	-.18†	-.17†
ΔR^2 **Step 2**	.03	.03	.03	.03
Step 3				
Digit Span X Stress		.03		
GNG X Stress		.13	.13	
TOL X Stress		-.24*	-.24*	-.23*
R^2	.24**	.29**	.29**	.29**
ΔR^2 **Step 3**	NA	.05	.05*	.05*

† $p < .10$, * $p < .05$, ** $p < .01$

Table 4
Hierarchical Regression Analysis for Harsh Parenting

	B	*SD*	*β*
Step 1:			
(Constant)	4.90	.93	
Shelter	.17	.11	.13
Parent Age	-.01	.01	-.10
Child Age	-.17	.08	-.18*
Child Gender	.12	.10	.10
Parent Education Level	-.12	.11	-.10
Parent PPVT (Verbal Ability)	.00	.01	.03
Parent WAIS-IV MR (Nonverbal Ability)	.00	.02	-.02
Child IQ Composite	.05	.07	.06
Positive Parenting	-.83	.16	-.52**
Parent Emotional Go-No-Go (Hot EF)	-.46	1.15	-.04
R^2= .39**			
Step 2:			
Constant	5.59	1.35	
Shelter	.12	.11	.10
Parent Age	-.01	.01	-.09
Child Age	-.16	.08	-.17*
Child Gender	.11	.10	.09
Parent Education Level	-.11	.11	-.09
Parent PPVT (Verbal Ability)	.01	.01	.09
Parent WAIS-IV MR (Nonverbal Ability)	.00	.02	-.01
Child IQ Composite	.05	.07	.06
Positive Parenting	-.86	.16	-.53**
Parent Emotional Go-No-Go (Hot EF)	-.25	1.20	-.02
Parent Perceived Stress	.00	.01	-.02
Parent WAIS-IV Digit Span (Working Memory)	.01	.02	.06
Parent Go-No-Go (Inhibitory Control)	-.68	1.65	-.04
Parent Tower of London (Planning Ability)	-.03	.01	-.17†
ΔR^2 = .03 p = .37			
Step 3			
Constant	5.62	1.33	
Shelter	.12	.11	.10
Parent Age	-.01	.01	-.12
Child Age	-.16	.08	-.17*
Child Gender	.13	.10	.10
Parent Education Level	-.08	.11	-.06
Parent PPVT (Verbal Ability)	.00	.01	.07
Parent WAIS-IV MR (Nonverbal Ability)	.00	.02	-.01
Child IQ Composite	.06	.07	.08
Positive Parenting	-.83	.16	-.52
Parent Emotional Go-No-Go (Hot EF)	-.11	1.18	-.01

Parent Perceived Stress	.00	.01	.01
Parent WAIS-IV Digit Span (Working Memory)	.01	.02	.05
Parent Go-No-Go (Inhibitory Control)	-.71	1.63	-.04
Parent Tower of London (Planning Ability)	-.03	.01	-.17†
Parent TOL X Parent Stress	.00	.00	-.17*
$\Delta R^2 = .03$ $p = .04$			

Table 5
Hierarchical Regression Analysis for Child Cool EF

	B	*SD*	*β*
Step 1			
(Constant)	-3.31	.97	
Shelter	-.04	.11	-.02
Parent Age	.00	.01	.00
Child Age	.50	.08	.39**
Child Gender	-.25	.11	-.15*
Parent Education Level	-.10	.11	-.06
Parent PPVT (Verbal Ability)	.00	.01	-.01
Parent WAIS-IV MR (Nonverbal Ability)	-.03	.02	-.09
Child IQ Composite	.49	.07	.46**
Parent Emotional Go-No-Go (Hot EF)	1.50	1.16	.09
Child Hot EF Composite	.34	.08	.30**
R^2= .64, $p < .001$			
Step 2			
Constant	-3.27	1.48	
Shelter	.04	.12	.02
Parent Age	.00	.01	-.02
Child Age	.46	.09	.36**
Child Gender	-.21	.11	-.13*
Parent Education Level	-.12	.12	-.07
Parent PPVT (Verbal Ability)	.00	.01	-.05
Parent WAIS-IV MR (Nonverbal Ability)	-.03	.02	-.10
Child IQ Composite	.50	.08	.47**
Parent Emotional Go-No-Go (Hot EF)	1.07	1.26	.06
Child Hot EF Composite	.35	.08	.31**
Parent Perceived Stress	.01	.01	.05
Parent WAIS-IV Digit Span (Working Memory)	.01	.02	.03
Parent Go-No-Go (Inhibitory Control)	.96	1.72	.04
Parent Tower of London (Planning Ability)	.01	.02	.06
Positive Parenting	-.15	.20	-.07
Harsh Parenting	-.21	.11	-.15†
R^2= .66 $p < .001$, $\Delta R^2 = .01$ $p = .176$			
Step 3			
Constant	-3.60	1.47	
Shelter	.04	.12	.02
Parent Age	.00	.01	-.02
Child Age	.47	.09	.37**
Child Gender	-.23	.11	-.14*
Parent Education Level	-.13	.12	-.08
Parent PPVT (Verbal Ability)	.00	.01	-.05
Parent WAIS-IV MR (Nonverbal Ability)	-.03	.02	-.09
Child IQ Composite	.52	.07	.49**

Parent Emotional Go-No-Go (Hot EF)	1.14	1.25	.07
Child Hot EF Composite	.33	.08	.30**
Parent Perceived Stress	.00	.01	.04
Parent WAIS-IV Digit Span (Working Memory)	.01	.02	.03
Parent Go-No-Go (Inhibitory Control)	1.51	1.72	.06
Parent Tower of London (Planning Ability)	.00	.02	.02
Positive Parenting	-.15	.19	-.07
Harsh Parenting	-.21	.11	-.15†
Harsh Parenting X Parent Stress	-.02	.01	-.12*
R^2= .68 p < .001, ΔR^2 = .01 p = .043			

Figure 1
Conceptual Model

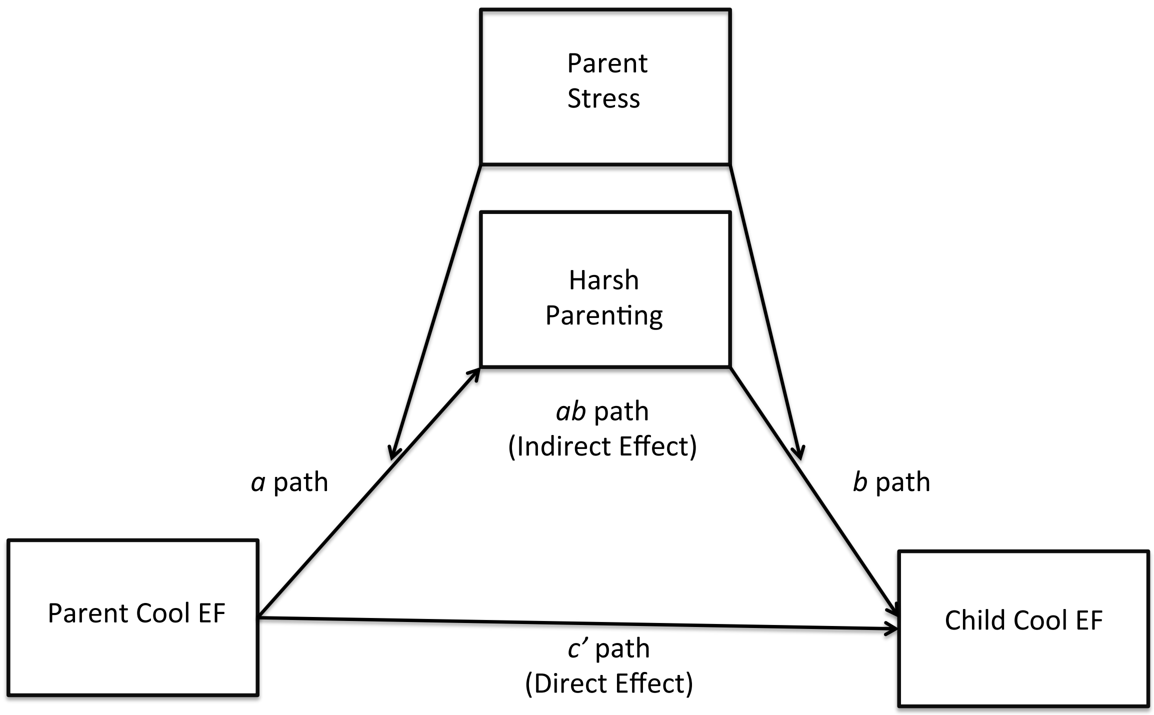


Figure 2

Parent stress moderates the relationship between parent planning abilities (TOL performance) and harsh parenting

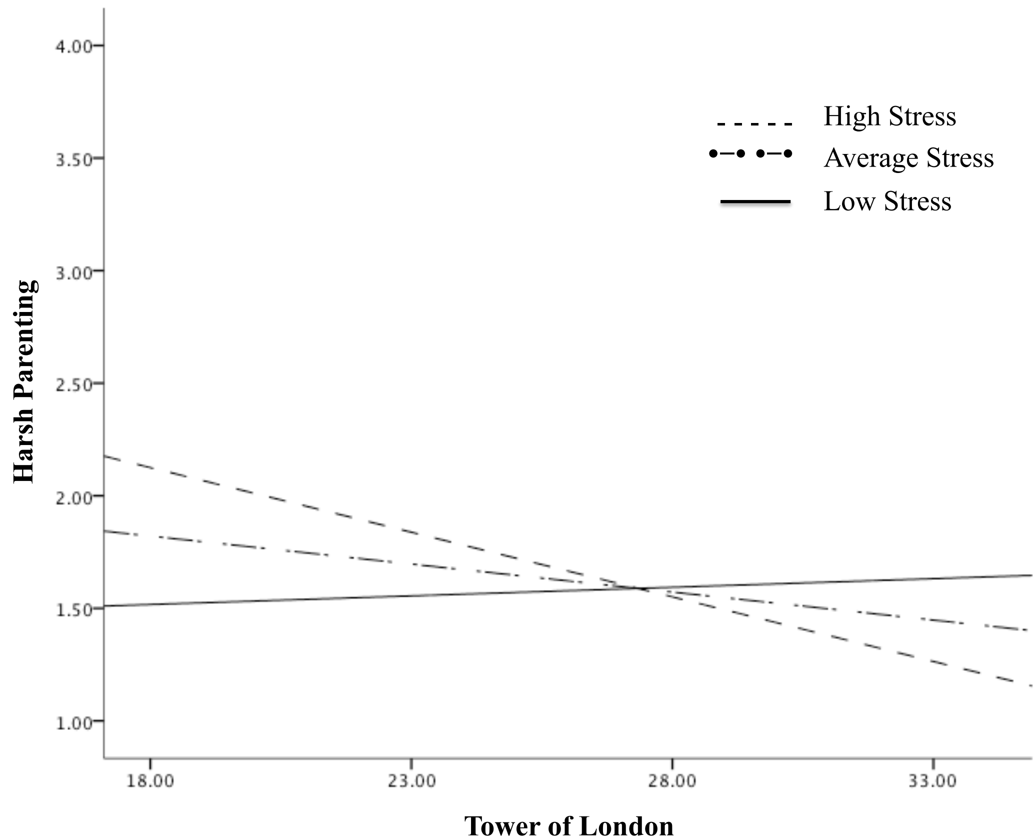
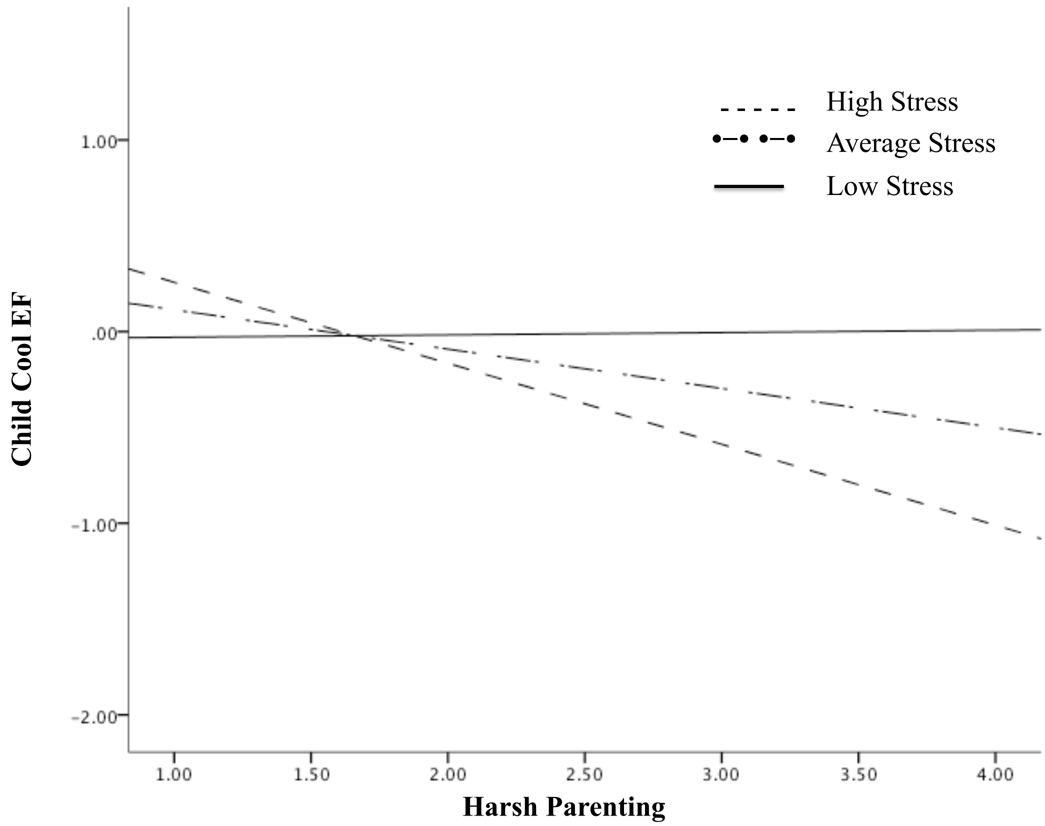


Figure 3
Parent stress moderates the relationship between harsh parenting and child cool EF



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Appendix A
Regression Model Comparison for Child EF Outcomes

	Child Cool EF			Child Hot EF	
	Model 1	Model 2	Model 3	Model 4	Model 5
Step 1 *Control variables*					
R^2 = .63**				R^2 = .35**	
Step 2 *Main effects*					
Parent Stress	.04	.03	.04	-.14†	-.14†
Parent Digit	.03	.04	.03	-.11	-.11
Parent GNG	.04	.07	.06	-.04	-.04
Parent TOL	.06	.02	.02	-.01	-.01
Parent EGNG	.06	.07	.07	-.18	-.18
Harsh Par.	-.15†	-.15†	-.15†	.06	.06
Pos Par.	-.07	-.07	-.07	.23*	.23*
ΔR^2 = .03				ΔR^2 = .06	
Step 3 *Parenting X Parent Stress*					
Positive X Stress		-.09	-.12*		.00
Harsh X Stress		.07			-.01
$\boldsymbol{R^2}$	.66**	.68**	.68**	.42**	.42**
$\boldsymbol{\Delta R^2}$ **Step 3**	*NA*	.02	.02*	*NA*	.00

The backwards elimination approach described on page 40 (also see Jaccard & Turris, 2003) was used to rule out extraneous interaction terms in predicting child EF outcomes, with Step 1 including control variables, Step 2 including main effect variables, and Step 3 including interaction terms for positive and harsh parenting by parent stress. For Child Cool EF, there was an increase in R^2 for the regression containing all possible interaction terms (Model 2) in comparison with the regression with no interaction terms (Model 1; $R^2 = .66$, $p < .01$ versus $R^2 = .69$, $p < .01$). The p value for Positive Parenting X Parent Stress was lower than the value for Harsh Parenting X Parent Stress ($p = .31$ versus $p = .21$), and the interaction for positive parenting was dropped from Model 3. Total R^2 did not change from Model 2 to Model 3, and both ΔR^2 and the single interaction term (Harsh Parenting X Parent Stress) were significant (ΔR^2 = .02, p = .04; β = -.12, p = .04). Thus, Model 3 was retained, resulting in the same model used in the main analyses (see Table 5). For child hot EF, there was no change in R^2 between the model that contained no interaction terms (Model 4) and the model that included all interaction terms (Model 5; R^2 = .42, p < .001 for both models). The ΔR^2 for Model 5 was also small and non-significant (ΔR^2 = .00, p = .92). Model 4 was identified as the most appropriate model, so no further comparisons were needed.

Appendix B
Regression Model Comparison for Parenting Outcomes

	Harsh Parenting					Positive Parenting	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Step 1 *Control variables*							
R^2 = .39**						R^2 = .46**	
Step 2 *Main effects*							
Parent Stress	-.02	.00	.00	.00	.01	.01	.01
Parent Digit Span	.06	.05	.05	.05	.05	.07	.07
Parent GNG	.04	-.04	-.04	-.04	-.04	-.13	-.13
Parent TOL	-.17†	-.17†	-.17†	-.17†	-.17†	-.08	-.07
Parent EGNG	-.02	.01	.01	.00	-.01	.20*	.18*
ΔR^2 = .03						ΔR^2 = .05	
Step 3 *Parent EF X Parent Stress*							
DS X Stress		.03	.03				.02
GNG X Stress		.05	.05	.05			-.09
TOL X Stress		-.19*	-.19*	-.18*	-.17*		.00
EGNG X Stress		-.01					.01
$\boldsymbol{R^2}$	.42**	.45**	.45**	.45**	.45**	.52**	.52**
$\Delta \boldsymbol{R^2}$ **Step 3**	NA	.03	.03	.03	.03*	NA	.01

The backwards elimination approach was also used to rule out extraneous interactions terms for regressions onto harsh parenting and positive parenting. The procedure for harsh parenting was exactly as described on page 40, with the addition of a main effect term and interaction term for EGNG. The main effect did not predict harsh parenting, and the interaction term was dropped in Model 3 with no impact on model fit. For positive parenting, there was no change in R^2 between the model that contained no interaction terms (Model 6) and the model that included all interaction terms (Model 7; $R^2 = .52$, $p < .001$ for both models). The ΔR^2 for Model 7 was also small and non-significant ($\Delta R^2 = .01$, $p = .87$). It was concluded that the model without any interaction terms (Model 6) was appropriate, so no further comparisons were needed.