EFFORTFUL CONTROL DEVELOPMENT IN THE FACE OF
HARSHNESS AND UNPREDICTABILITY

by

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Abstract

Through the life history theory perspective, this paper seeks to demonstrate how early adversity shapes the development of effortful control in ways that aim to best match the individual to the proximal environment toward ultimate goals despite trade-offs related to social, academic, and later health outcomes. Investigation linking early life harshness (i.e., cues of extrinsic morbidity-mortality; Ellis et al., 2009) and unpredictability (i.e., stochastic changes in environmental conditions; Ellis et al., 2009) to the development of self-regulation could facilitate a more nuanced understanding of early environmental effects on development. The current study investigates early environmental harshness and unpredictability as unique predictors for a self-regulation construct, effortful control. It was hypothesized that early life harshness and unpredictability would uniquely and negatively predict effortful control among preschoolers. While there was no evidence that cues of unpredictability predicted effortful control, cues of harshness, specifically neighborhood harshness, did statistically significantly predict effortful control in the direction expected. This appears to be the first study to explicitly investigate effortful control development in early childhood within the harshness and unpredictability framework.

Key words: effortful control, life history theory, early childhood, harshness, unpredictability

Introduction

Evolutionary perspectives on development provide important insights about the impact of early environmental experiences on developmental outcomes (Belsky, Steinberg, & Draper, 1991; Blair & Raver, 2012; Bjorklund & Ellis, 2014; Bjorklund & Pellegrini, 2000; Brumbach, Figueredo, & Ellis, 2009; Del Giudice, Ellis, & Shirtcliff, 2011; Ellis, & Del Giudice, 2014; Ellis, Figueredo, Brumbach, & Schlomer, 2009; Frankhuis & de Weerth, 2013; Mittal, Griskevicius, Simpson, Sung, & Young, 2015; Wenner, Bianchi, Figueredo, Rushton, & Jacobs, 2013). Considering evolutionary perspectives on development may reframe the abundant research that draws a causal arrow between adverse early childhood experiences and suboptimal or impaired development (Bjorklund & Ellis, 2014; Ellis & Del Giudice, 2014; Frankhuis & de Weerth, 2013). From an evolutionary theoretical perspective, survival and successful reproduction are the ultimate goals of an individual. Given biological and environmental constraints, energetic resources are allocated at important decision nodes during development to aspects of growth that serve to best optimize the individual's ability to survive and successfully reproduce within a specific environment. This allocation involves necessary trade-offs, as not all aspects of development can be maximized by an individual at any one time. As an example, in adverse early environments with increased morbidity-mortality rates, allocating resources towards strategies that accelerate growth, development, and mating may be more effective than allowing for slower growth and delayed mating when time is of the essence (Ellis et al., 2009). The payoff (i.e., successful reproduction) outweighs the trade-offs (e.g., psychopathology and later health conditions) if it better prepares an individual to be successful (i.e., successfully reproduce) in the local harsh environment. When re-examined through the lens of evolutionary theory, and when considering ultimate purposes of human development, early adversity may

actually be shown to *shape*, rather than impair development (Belsky et al., 1991; Bjorklund & Ellis, 2014; Blair & Raver, 2012; Ellis et al., 2009; Frankenhuis & de Weerth, 2013; Mittal et al., 2015).

This paper investigates how life history theory, as an evolutionary theory on development, may provide important reframing on how early experiences shape development towards successfully meeting ultimate goals. Specifically, using the Building Strong Families national longitudinal data set (Wood, Moore, Clarkwest, Killewald, & Monahan, 2012), early experiences with environmental harshness and unpredictability are explored as unique predictors of a self-regulation construct, effortful control. Effortful control is well established in developmental research as an important aspect of early development that is tied to an individual's social and academic success (Rothbart & Bates, 2006; Rothbart & Rueda, 2005; Zhou, Chen, & Main, 2012), with early adverse experiences being linked to impaired or suboptimal effortful control (Lengua, 2012). Through the life history theory perspective, this paper seeks to demonstrate how early adversity shapes the development of effortful control in ways that aim to best match the individual to the proximal environment toward ultimate goals despite trade-offs related to social, academic, and later health outcomes.

Effortful Control

Effortful control, defined as the ability to inhibit a dominant response in favor of a subdominant response, involves both inhibitory control and executive attention (Rothbart & Rueda, 2005). Rothbart, Ahadi, Hershey, and Fisher's (2001) factor analysis of effortful control based on the Children's Behavior Questionnaire revealed the following aspects: attentional shifting, attentional focusing, inhibitory control, and perceptual sensitivity. Effortful control, when considered in conjunction with temperament, emerges as distinct from surgency (Rothbart

et al., 2001). An individual's success in employing effortful control in any specific instance is dependent on the interaction between one's motivational impulses and one's efforts to overcome those (Rothbart & Rueda, 2005).

Effortful control is used as an indicator of later social and academic success. Higher effortful control has been associated with a host of positive developmental outcomes including increased prosocial behaviors and social competence, conscience and moral development, as well as academic outcomes, including increased math and language competencies, grade point average, and overall school competence (Diamond, 2006; Rothbart & Bates, 2006; Rothbart & Rueda, 2005; for review see Zhou et al., 2012). Conversely, individuals lower in effortful control have shown increased internalizing and externalizing behaviors across multiple studies (for review see Diamond, 2006, Rothbart & Bates, 2006 and Zhou et al., 2012). Thus, effortful control is an important focus in research with implications across developmental domains. While effortful control has been a topic of child development research for decades, new insights continue to emerge as research accumulates across fields.

Effortful control and executive functions. Effortful control as a specific construct primarily emerged from temperament research and has recently been identified by Zhou, Chen, and Main (2012) as potentially being synonymous with aspects of executive functions, which have traditionally been a focus of cognitive psychology. Zhou and colleagues call for an integration of effortful control and executive functions research based on their identification of two core commonalities: inhibition as a key component, and executive attention as a key underlying process. The outcomes previously discussed for effortful control mirror those associated with executive functions (Bridgett, Oddi, Laake, Murdock & Bachmann, 2013; Zhou et al., 2012). The differences between the two constructs, as identified by Zhou and colleagues,

seem to be limited to the tradition of effortful control research focusing on emotion-laden contexts, while executive functions research focuses on emotionally neutral cognitive contexts. This is likely reflective of their originating fields of study (i.e., temperament and cognitive psychology, respectively). The overlap of effortful control and executive functions is supported by similar analyses revealing considerable similarities between effortful control and executive functions (Diamond, 2013; Rothbart & Rueda, 2005). This support includes an empirical investigation across three studies by Bridgett, Oddi, Laake, Murdock, and Bachmann (2013) who echo the call for theoretical integration of effortful control and executive functions constructs.

In this thesis, the term effortful control will be used under the assumption that effortful control and executive functions are overlapping, but with independent histories of research, measurement, and terminology (Diamond, 2006). As such, the literature reviewed in this thesis will span across fields with the aim of an integrated approach to informing the proposed study. As this thesis will focus specifically on attention assessed using a behavioral measure developed in the tradition of temperament and effortful control research (discussed in Methods), the consistent use of the term effortful control is considered most appropriate.

Future-oriented self-regulation. Effortful control is a future-oriented self-regulation construct specific to humans. Self-regulation, treated as an overarching construct within social-emotional development in children, refers to the processes that allow an individual to manage goal-directed behaviors over time and across changing contexts (Karoly, 1993). Under this umbrella, effortful control is also conceptualized as future-oriented and integral to managing thoughts, actions, and emotions in order to reach one's goals (Diamond, 2006). This complex aspect of development involves processes in the brain that serve as an executive control system. This system has the aim to align attention and behavior toward a desired, hypothetical future in

the face of competing internal and external demands and stimuli (Barkley, 2001; Del Giudice, 2015; Karoly, 1993). Effortful control involves a shift from behavior regulation based on the immediate, temporal now toward self-regulation of behavior based on internal representations of a projected, hypothetical future (Barkley, 2001). These projections are based on repeated cause-and-effect experiences, which may be experienced either directly or vicariously (Barkley, 2001). Thus, individuals high in effortful control will be more successful in future-oriented behavior strategies.

Effortful control is considered an asset in cooperative social interactions. Rothbart, Ahadi, and Hershey (1994) found that 6 and 7 year olds high in effortful control were also high in empathy as well as guilt/shame, and low in aggressiveness. Individuals who inhibit antisocial responses in complex social interactions likely are considering future impacts of their behavior. Thus, individuals high in effortful control likely propagate cooperative, nonhostile social interactions, particularly if those interactions are considered advantageous towards future needs and goals.

Inhibitory control. The central component of effortful control is the ability to inhibit a dominant response in favor of a subdominant response, termed inhibitory control (Rothbart & Bates, 2006). This type of control over thoughts, actions, and emotions affords the developing individual the opportunity to both restrict responses that may preclude reaching a desired goal and enact specific, effortful responses that serve to reach a desired goal. For example, in a disagreement between young children, a dominant response based on the immediate, temporal now may be to strike out physically and hit the perceived offender. However, if the child's goal is to avoid punishment or other negative repercussions or foster friendship (as projected via internal representations of an undesired hypothetical future), the subdominant yet preferred

response may be to refrain from hitting, and instead use words to express the anger (e.g., aim towards a desired hypothetical future).

Effective inhibitory control may also depend on a separate aspect of temperament, surgency. Surgency is reflected in factors such as activity level, extroversion, positive anticipation, high intensity pleasure/sensation seeking, impulsivity, smiling/laughter and lack of shyness (Rothbart & Rueda, 2005). Based on their longitudinal study of children from infancy through age 7, Rothbart and Derryberry (2002) liken the relationship between surgency and effortful control as the “accelerator” and the “brakes,” suggesting an inverse relationship of opposing functions. Thus, individuals high in surgency and extroversion would be expected to be lower in effortful control and vice versa. This negative relationship was found specifically with both effortful control factors of inhibitory control and attentional control (i.e., executive attention). This suggests that children high in surgency may be less likely to control a dominant behavioral response as well as attention.

Executive attention. Effortful control has been described as the efficiency of executive attention (Rothbart & Bates, 2006). Executive attention involves the management of both sustaining and shifting attention as context appropriate (Rothbart & Derryberry, 2002). While executing control over attention, individuals may better inhibit a dominant response by shifting their attention away from goal hindering motivations and/or sustaining attention on goal promoting motivations (Rothbart & Bates, 2006; Rothbart & Derryberry, 2002), thus filtering out undesired distractions. The ability to filter undesired or goal-inhibiting distractions is linked to social-emotional outcomes.

Children demonstrating flexibility in attention and the ability to exhibit control in the face of competing demands have been characterized as “well-adjusted” and more likely to achieve

positive developmental outcomes and prosocial behaviors (Diamond, 2006; Rothbart & Bates, 2006). Eisenberg, Fabes, Nyman, Bernzweig, and Pinulas (1994) found that boys high in attentional control (measured as both attention shifting and attention focusing) at ages 4 to 6 exhibited more constructive anger reactions (e.g., nonhostile verbal reactions versus overt aggressive responses). Interestingly, within animal research, Rhesus monkeys that were put through attention training anecdotally also showed increased social ability and decreases in aggression (Rumbaugh & Washburn, 1996). Thus, individuals higher in executive attention would likely be more successful in inhibiting aggressive responses and responding prosocially during conflict.

Influences on Development: A Life History Theory Perspective

Research on the processes underlying effortful control, as well as correlational studies of effortful control and other related behavioral and neurological aspects of development, has yielded insights into how effortful control as a construct is connected to social-emotional and cognitive outcomes (Rothbart & Bates, 2006). Less clear, however, are what environmental factors influence phenotypic development of specific effortful control developmental trajectories. This is a question that evolutionary perspectives on development may help unfold (Del Giudice, 2015).

According to life history theory, early experiences influence the development of a coordinated suite of traits that lie along a slow to fast continuum (Belsky et al., 1991; Ellis et al., 2009). This suite of traits instantiate strategies aimed to best match the developing individual to the anticipated environment (i.e., environment expected in adulthood) for the ultimate purpose of increased fitness (i.e., successful survival and reproduction; Wenner et al., 2013). Humans as a species are on the slower end of the continuum, as opposed to rabbits for example (see k-factor

in Figueredo, Vasquez, Brumbach, & Schneider, 2004). However, this slow to fast continuum represents variations within populations of the same species as well (Ellis et al., 2009). While there is evidence life history strategies may be passed genetically over generations based on adaptations to a population's environment over time (e.g., genetic polymorphisms), phenotypic plasticity may also provide for conditional adaptation during early development (Belsky, Schlomer, & Ellis, 2012; Boyce & Ellis, 2005; Ellis et al., 2009). Natural selection for phenotypic plasticity during human development would allow individuals to flexibly adapt their behavior to environmental conditions, thus potentially increasing fitness in varied ecological conditions (Blair & Raver, 2012). This conditional adaptation allows for the development of strategies specific to one's proximal ecological conditions (Belsky et al., 2012; Blair & Raver, 2012; Boyce & Ellis, 2005; Del Giudice et al., 2011; Ellis et al., 2009).

It is theorized that variability in life history strategies along the slow to fast continuum has been selected for based on its effectiveness at increasing successful reproduction given repeated exposures to a range of anticipated ecological conditions (Ellis et al., 2009). Slower life history strategies are typified by slower growth and development, later reproduction with fewer mates, and more investment in quality over quantity of offspring. Slower life history strategies have the advantages of longer periods of growth resulting in increased somatic and neurological maturity (Wenner et al., 2013), as well as more time for accumulating skills and resources prior to reproduction. Delaying reproduction is a strategy seen in many Western societies where individuals invest more time in accumulating status and resources (e.g., education, career aspirations, and financial capital) prior to coupling and conceiving children (Ellis et al., 2009). This strategy has the benefit of potentially increasing the life chances of one's offspring (Ellis et al., 2009). Slower life history strategies are often associated with those developmental traits and

outcomes that are considered in child development research to be optimal. Traits associated with slow life history strategies that may be advantageous in environments low in harshness include higher inhibitory control, a cooperative interpersonal style, and increased delay of gratification (Belsky et al., 1991). Thus, the suite of traits that characterize slow life history strategies are also future-oriented strategies developed in anticipation of a longer life based on low levels of local morbidity-mortality. However, with the ultimate goals of successful survival and reproduction, slow life history strategies and their associated traits may not be advantageous in environments of high morbidity-mortality, as there may not be excess time or resources to pursue a slow course of development and delayed reproduction.

On the opposite end of the continuum lie fast life history strategies. These strategies are typified by faster growth and development, earlier and higher rates of reproduction with a greater number of mates, and therefore more investment in a quantity versus quality approach to mating and rearing (i.e., present-oriented strategies; Belsky et al., 1991). While less valued by most modern Western societal ideals, these strategies are particularly advantageous among many species who encounter higher rates of external morbidity-mortality (Ellis et al., 2009). In humans, populations who also experience relatively higher morbidity-mortality rates may experience better fitness outcomes by employing fast life history strategies, hence making “the best of a bad situation” (Ellis & Del Giudice, 2014, p.1) despite trade-offs (e.g., less time for somatic and neurological growth and maturity, poor health outcomes later in life). After all, employing increased delay of gratification by exchanging immediate rewards for future rewards (i.e., future-orientation; Ross & Hill, 2002) may prove fruitless in an environment where the morbidity-mortality risks are high or unpredictable. In these environments, one is less likely to live long enough to reach those future rewards; hence, time is of the essence. In fact, extant

research shows a correlation between low-SES Western populations and earlier sexual debut as well as mating and rearing strategies consistent with fast life history strategies (Ellis et al., 2009). In addition, traits associated with fast life history strategies that may be advantageous in environments high in harshness include aggression, noncompliance, opportunistic behaviors, and a preference for immediate gratification (Belsky et al., 1991).

Effortful control from a life history theory perspective. Under life history theory, no one suite of traits along the continuum is universally superior over the other (Wenner et al., 2013). Instead, a specific suite of traits can only be more or less effective in survival and reproductive efforts, depending on its match to the given context. When there exists a match between the developed life history strategies and the adult environment, an individual's fitness is optimized given biological and environmental constraints. Effortful control, as a goal-oriented aspect of self-regulation integral to managing thoughts, actions, and emotions, may have a key role in directing and implementing these adaptive strategies (Wenner et al., 2013). As there is a continuum of life history strategies, one could also construct a continuum of effortful control. Importantly, these continua seem to align and the suite of traits that instantiate life history strategies have profound implications for behavior (Del Giudice, 2015) which is regulated through effortful control. As an example, impulsivity (i.e., behavioral disinhibition and lack of future orientation; Ross & Hill, 2002) which would be on the end of the continuum of lower effortful control, systematically correlates with fast life history strategies (Del Giudice, 2015). Highly impulsive individuals, and thus those lower in effortful control, may more effectively maximize survival and reproduction in environments with high threat of morbidity-mortality. A present-orientation (also at the end of the continuum corresponding to fast life history strategies) favoring short versus long-term gains in environments of harshness and scarcity may be one way

to maximize survival and reproduction efforts (Del Giudice, 2015). Conversely, individuals who have developed slower life history strategies based on an anticipated environment with low morbidity-mortality, and thus whose behaviors are more future-oriented, are expected to be higher in effortful control. These individuals are likely to favor larger future gains over smaller immediate gains, and therefore are more likely to inhibit goal-hindering behaviors and maintain focus and attention on future goals. Thus, natural selection for effortful control malleability and development in response to one's proximal environment could contribute to fitness outcomes (Blair & Raver, 2012).

It is well established across developmental science that early experiences affect development and later outcomes. From an evolutionary perspective, early environmental experiences serve as cues to the levels of morbidity-mortality in the anticipated environment that will host both opportunity and constraint (e.g., availability/scarcity of resources, and levels of selection and competition for mates) on future survival and reproduction. The developing individual theoretically tracks these cues through an evolved physiological mechanism that then adjusts the individual's developmental trajectory to best match him/her to the anticipated environment (Ellis et al., 2009). Life history strategies have been selected for over evolutionary time based on species-typical adaptations to a range of past ecological and developmental environments (Ellis et al., 2009). Nature selects species-specific strategies that maximize fitness given anticipated morbidity-mortality rates, and may be independent of modern ideals and social desirability. Hence, life history strategies and associated traits are selected for as functional responses to specific environmental conditions or problems (Ellis et al., 2009). For example, fast life history traits such as high competitiveness characterized by physical aggression and risky behaviors may serve males well in an environment where there is high competition for female

mates despite these behaviors being socially undesirable in many modern cultures. Thus, from an evolutionary perspective, early experiences shape development to best match the individual to one's anticipated environment despite possible trade-offs in socially desirable traits and behaviors.

Influences on Development: Harsh and Unpredictable Environments

Two environmental characteristics that have emerged in research as distinct and unique predictors of development are those that serve as cues of environmental harshness and unpredictability (Ellis et al., 2009; Belsky et al., 2012). These proximal cues are important in that they provide information to the developing individual regarding the levels of morbidity-mortality in his/her expected future environment (Ellis et al., 2009). Cues of environmental harshness and unpredictability are integral in the calibration of the stress response system (Del Giudice et al., 2011; Ellis & Del Giudice, 2014) which likewise plays a role in the canalization of self-regulation (e.g., effortful control; Blair & Raver, 2012). Thus, environmental harshness and unpredictability are potential predictors of life history strategies and development, and have implications for the development of effortful control. Yet, there appear to be no studies to date that explicitly investigate the link between environmental harshness and unpredictability and effortful control development in early childhood.

As harshness and unpredictability often go hand-in-hand, it can be difficult to tease out how each may specifically and uniquely influence development and life history strategies (Brumbach et al., 2009). In Western societies, socioeconomic status (SES) is often used as a proxy for harsh and unpredictable environments across many disciplines of developmental science. Children experiencing environments with high levels of harshness are often also experiencing unpredictable or chaotic environments (Ellis et al., 2009). Given that Western

societies generally do not have severe bioenergetic deprivation (the baseline of hierarchical effects on life history strategies which is beyond the scope of this paper; Ellis et al., 2009), lower income environments have consistently been shown in research to correlate with the fast life history strategies, the associated suite of traits, and outcomes (e.g., adolescent pregnancy, multipartner fertility, etc.) mentioned earlier. While environments both of harshness and unpredictability predict life history strategies towards the same side of the continuum (and this makes sense since unpredictability represents stochastic changes in levels of morbidity-mortality; Ellis et al., 2009), recent research suggests that harshness and unpredictability are unique predictors of development (Belsky et al., 2012; Blair & Raver, 2012; Brumbach et al., 2009; Ellis et al., 2009). Thus, using SES as an indicator of both cues of harshness and unpredictability may be conflating the effects.

The unique contribution of harshness and unpredictability on development is supported by a study by Brumbach, Figueredo, and Ellis (2009). This study investigated the impact of harshness (self-reported exposure to violence) and unpredictability (self-reported frequent or ongoing childhood environmental inconsistency) on life history strategies measured in adolescence. In their analyses, Brumbach and colleagues compared structural equation models with and without a harshness-by-unpredictability interaction term. The analysis revealed that the interaction term did not further explain the variance in the model, and instead supported the position that harshness and unpredictability, as measured in their study, were independent predictors and thus additive in their effects. As such, cues of harshness and unpredictability might best be measured independently as they are in the current study. This allows for further testing of harshness and unpredictability as having concurrent effects on development.

Cues of environmental harshness. Harshness is conceptualized as the level of extrinsic morbidity-mortality (i.e., threat of disease, disability, and death; Ellis et al., 2009).

Environments high in harshness impose a probable decreased life expectancy on the developing individual (due to increased exposure to premature disability and death; Mittal & Griskevicius, 2014) and therefore may require a unique set of life history strategies to optimize development specific to this harsh context. Effortful control then, as an internal executive system of behavior control, may play a role in implementing such strategies (Wenner et al., 2013).

When faced with an environment high in extrinsic morbidity-mortality, accelerating growth and development and enacting behaviors that instantiate a fast life history strategy may be advantageous. In the face of harshness, delaying reproduction in order to approach growth and development at a slower pace may result in disability or death that ultimately prevents successful reproduction. Thus, present- versus future-orientation (i.e., associated with lower effortful control) may be advantageous. In harsh environments, delay of gratification toward future goals may result in missed opportunities. In this context, lower inhibitory control and the inclination towards impulsivity (e.g., a reactive versus reflective approach to self-regulation; Blair & Raver, 2012) may actually increase one's ability to be more competitive, resourceful, and opportunistic and, consequently, better secure available resources (Wenner et al., 2013). In addition, higher surgency and extroversion, seen as the "accelerator" compared to effortful control's "brakes" (Rothbart & Derryberry, 2002), may also facilitate an individual's ability to explore and approach a competitive harsh environment more opportunistically (Del Giudice, 2015). Therefore, accelerated life history strategies, a present-orientation, and increased impulsivity and surgency (i.e., lower effortful control) may actually be adaptive (i.e., optimal development) given the opportunities and constraints of a harsh environment.

Economic harshness. As discussed earlier, SES has been used as an indicator of early experiences with both harshness and unpredictability across disciplines. However, in the few recent studies exploring early environmental harshness and unpredictability in the context of life history theory, economic status is most often used uniquely as an indicator of environmental harshness (e.g., SES, income-to-needs ratio; Belsky et al., 2012; Mittal et al., 2015; with the exception of a study by Mittal & Griskevicius [2014] which uses SES as a measure of unpredictability). Use of economic status aligns with previous conclusions that even beyond a lack of resources (i.e., harsh survival conditions), economic harshness also seems to undermine the functionality and coping capabilities of the family, and is thus often correlated with harsh family interactions and violence (Belsky et al., 1991; Belsky et al., 2012; Ellis et al., 2009).

Harsh parenting. Beyond economic status, there are other aspects of early environmental experiences that are theorized to serve as cues of environmental harshness. One of the most salient is the parent-child relationship. The developmental impact of harsh and neglectful parenting in early childhood is well documented across disciplines (e.g., parent-child interactions, abuse and neglect, attachment). From an evolutionary perspective, harsh and neglectful parenting may reflect low levels of parental investment in offspring (Belsky et al., 1991). Low parental investment, which aligns with a quantity versus quality approach to mating and rearing, is characterized by a lack of supportive, sensitive parenting. This fast life history strategy is theorized to in turn influence the development of offspring life history strategies. Life history theorists posit that children are particularly sensitive to parental investment efforts that serve to forecast the level of harshness (or supportiveness) of the local environment and direct life history strategies accordingly (Belsky et al., 1991; Del Giudice et al., 2011; Ellis et al., 2009). This moves beyond the view that harsh environments simply undermine parenting and

development. Instead, an evolutionary perspective also views harsh early experiences as facilitative in shaping development in purposeful ways aimed to best maximize fitness in anticipated harsh environments.

Neighborhood harshness. Based on life history theory, there are other early cues of environmental harshness that might be considered. In addition to proximal experiences with harsh or neglectful parenting, harshness cues are also theorized to come from neighborhood harshness including observed high levels of local morbidity-mortality and exposure to violence (Brumbach et al., 2009; Ellis et al., 2009).

Cues of environmental unpredictability. Unpredictability is conceptualized as stochastic changes in the level of extrinsic morbidity-mortality over space and time (Ellis et al., 2009). Environments high in unpredictability impose a sense of uncertainty on the developing individual, which interferes with one's ability to solve the adaptive problem of avoiding risk (Brumbach et al., 2009) and may be an overlooked predictor of development (Ross & Hill, 2002). A unique challenge is imposed on the development of life history strategies that best optimize development specific to context, when the context itself is unpredictable (Ellis et al., 2009). In fact, some researchers theorize that contexts of unpredictability have led to the evolution of bet-hedging strategies where offspring in contexts high in unpredictability are produced with diversified strategies and traits (Ellis et al., 2009). This bet-hedging theory is based on the logic that one single phenotype cannot be optimal in all potential environments, and therefore producing offspring of varied strategies may result in at least some of them surviving (Ellis et al., 2009). It has also be theorized that early cues of unpredictability contribute to the development of an unpredictability schema that orients the developing individual to the "here and now" (Ross & Hill, 2002). Therefore, cues of environmental unpredictability may have

unique impacts on the early development of effortful control which are additive to those of environmental harshness.

As in environments of high morbidity-mortality, when faced with an environment high in unpredictability, accelerating growth and development and enacting behaviors representing a fast life history strategy may be advantageous. This may be one way that some individuals embrace unpredictability rather than try to control it (Del Giudice et al., 2011). In fact, it is theorized that individuals with a higher unpredictability schema also have a lower sense of control (Ross & Hill, 2002). Empirically, individuals with early experiences higher in unpredictability responded to uncertain situations more impulsively, expressed a lower sense of control, and exhibited a lower rate of persistence as compared to individuals with more predictable early experiences (Mittal & Griskevicius, 2014). Delay of gratification and persistence are related and mediated by sense of control (Mittal & Griskevicius, 2014) and both are also self-regulatory aspects associated with effortful control (Rothbart & Bates, 2006). In the face of unpredictability, delaying reproduction, maintaining a present- versus future-orientation where impulsivity over delay of gratification and inhibitory control is favored (e.g., a reactive versus reflective approach to self-regulation; Blair & Raver, 2012) may increase one's fitness (Wenner et al., 2013). This would include more risk-taking behaviors since future opportunities and rewards cannot be counted on, and therefore risks that may lead to immediate reward may be more appealing (Ross & Hill, 2002). In childhood, parent reports of children's behavioral, emotional, and attention problems are associated with increased family unpredictability (Ross & Hill, 2002). More "accelerator" versus "brakes" (i.e., surgency versus effortful control) may also contribute to an individual's success in mating, foraging, and exploration given an unpredictable context (Del Giudice et al., 2015). Therefore, accelerated life history strategies, a present-orientation, and

increased impulsivity and surgency (i.e., lower effortful control) may also be adaptive given the opportunities and constraints of an unpredictable environment.

Financial instability. As discussed earlier, SES has been used as an indicator of both harshness and unpredictability across disciplines. However, Ross and Hill (2002) propose that beyond the (un)availability of resources, it is the (un)predictability of resources that may be most salient. Blair and Raver (2012) posits that early experiences in fluctuations or changes in economic status over time may have implications for development of their own. In this view, actual economic status and levels of financial instability may have separate, unique impacts on development. In support of this conjecture is a study by Belsky, Schlomer, and Ellis (2012) investigating harshness and unpredictability as determinants of parenting and early life history strategy. Income-to-needs ratios in the first 5 years of life were used as indicators of environmental harshness, whereas parental job changes in the same timeframe were used as one of three indicators of unpredictability (other unpredictability variables were residential changes and paternal transitions). Parental job changes were defined by changes in employment status between consecutive time points. In an unpredictability latent construct, parental job changes had a loading of .42 (compared to .64 and .66 for paternal transitions and residential changes, respectively). In the final analysis by Belsky and colleagues, the unpredictability construct uniquely predicted early life history strategies beyond harshness as measured by income-to-needs ratios. To continue investigation of financial instability as a cue of environmental unpredictability, two indicators of financial instability will be used in the proposed study: changes in parental employment (hence, fluctuations in family routines and income), and instances of financial hardship (i.e., instability of resources).

Parental instability. Beyond financial instability, there are other aspects of early environmental experiences that are theorized to serve as cues to environmental unpredictability. As in harshness, one of the most salient cues of unpredictability is regarding parent-child relationships, specifically parental transitions and inconsistencies in rearing (Ellis et al., 2009). Parental transitions early in life may be prompted by separation/divorce, death, remarriage/cohabitation, reconciliation, adoption, or removal of the child from the home (Ellis et al., 2009). Parental instability, considered here as parental coresidence transitions of mothers, fathers, and new partners, may contribute to a child's development of an unpredictability schema in which the individual believes people and the world are unpredictable or chaotic (Ross & Hill, 2002). Along with parental transitions, inconsistencies in rearing and attending to a child's needs is also shown to contribute to the development of an unpredictability schema (Ross & Hill, 2002). Unpredictability schema is associated with the behaviors that represent fast life history strategies (Mittal & Griskevicius, 2014). Accordingly, parental transitions and inconsistent rearing routines will be included as independent variables in the proposed study.

In sum, the current study investigates variables representing cues of harshness (i.e., income-to-poverty ratio, harsh discipline, and neighborhood harshness) and variables representing cues of unpredictability (i.e., unpredictable employment, unpredictable finances, parental unpredictability, and unpredictable daily routines) during the first 3 years of life as unique predictors of effortful control at 36 months. Specifically, it is hypothesized that early cues of harshness and early cues of unpredictability will uniquely and negatively predict effortful control at 36 months. Investigating the impact of early cues of harshness and unpredictability on the development of effortful control may provide important information about the connection between this early developing aspect of self-regulation and life history strategies.

Methods

The Building Strong Families Project (BSF; Wood et al., 2012) recruited couples from eight U.S. communities: Atlanta, Georgia; Baltimore, Maryland; Baton Rouge, Louisiana; Houston, Texas; Oklahoma City, Oklahoma; San Angelo, Texas; and counties in Florida and Indiana. Eligibility requirements for participation included: (1) both partners agreed to participate, (2) couples were romantically involved at time of enrollment, (3) couples were either expecting a baby together or had just had a baby born within the past 3 months, (4) couples were unmarried at conception, and (5) partners were 18 years or older. Couples with a history with intimate partner violence were excluded and referred to other services. A total of 5,102 eligible couples were randomly assigned to the treatment or control group, where the treatment aimed to increase couples' relationship skills. For a full description of recruitment, assignment, and treatment procedures see Building Strong Families Project Data Collection, 2005-2008 (information on this restricted-use public data set can be found at <http://icpsr.umich.edu/>).

Information was collected from mothers and fathers at three time points: baseline (T0) and 15 months (T1), and 36 months (T2) post-intervention. Direct assessments of parenting and child development were also conducted with mothers and fathers separately at 36 months (T2) in 6 of the original 8 sites. Response rates for each data collection wave was as follows: at T1 87% of couples had one or both partners respond to the survey; at T2 85% of couples had one or both partners respond to the survey; at T2 about 56% of 3,547 couples had one or both partners participate in the direct observation.

Proposed study sample

The proposed study will use data from the 1,969 couples for whom at least one partner participated in direct observations (T2). These couples came from all sample locations

previously listed with the exception of Florida counties and San Angelo, Texas. Of these couples, 985 were randomly assigned to treatment and 984 were assigned to the control group. Consistent research findings indicate that the intervention did not affect individual or family functioning (Wood et al., 2012), and thus in the present study, the intervention and control groups will be combined with intervention status used as a control variable.

In terms of demographic characteristics, 65% of fathers and 62% of mothers identified as Black/African American, and 21% of fathers and 26% of mothers identified as White, while 16% of both mothers and fathers identified as Latina/o or Hispanic. Regarding education level, 59% of fathers and 61% of mothers reported having earned a high school diploma or equivalent certificate. While there was no income level requirement for participating in BSF, the aim of the program was to improve relationship skills of low income, unmarried couples (Wood et al., 2012). Thus, the majority of the participants in the proposed study sample were low income. Median income for fathers reported at T0 was \$10,000 – \$14,999, whereas for mothers median income reported at T0 was \$1,000 - \$4,999. Low income level for mothers at T0 was explained by a high rate of unemployment which was reported as 64% at T0, likely explained by maternity leave or unemployment at the birth of their child. See also Table 1 for study variable descriptive statistics.

Treatment of missing data

As with most longitudinal studies, not all participants completed all information at all time points. Across the 12 study variables used in the analyses, the missing data proportions ranged between 11 and 57%. Based on missing data analyses, data were missing by race/ethnicity and parent gender. Therefore, data were determined to be missing at random (MAR). In order to preserve all couples' data and statistical power, missing data were treated

with multiple imputation using a chained equation method using the Mice package in R Version 3.3.2 (Enders, 2010).

Multiple imputation using chained equations is an iterative process that uses regression to estimate missing data (Enders, 2010). Methodologists currently regard multiple imputation as “state of the art” in handling missing data because it not only preserves all data, but also improves the power and accuracy of the analyses compared to other missing data techniques (Schafer & Graham, 2002; Enders, 2010). Baseline covariates, survey responses from the other partner’s data collection along with the individual’s nonmissing related variables were used to calculate a predictor matrix within the imputation model to produce estimates. Predicted values plus random disturbance terms were used to impute values for missing data so that all cases were complete. To address convergence issues in the multiple imputation process, a ridge prior distribution was applied to the covariance matrix in the imputation model. A ridge prior distribution conceptually adds a small number of imaginary cases to the data from a hypothetical population in which the model variables are uncorrelated (Enders, 2010). The benefit to using a ridge prior distribution is that it stabilizes estimation without requiring the removal of study variables in the imputation model (Enders, 2010). The trade-off with using this method to address convergence issues is that it introduces a slight bias to the imputed values. Thus, minimizing this bias is essential when assigning a ridge prior value. In the current study, a ridge prior distribution was specified at a value of $1e-04$, which is within the range of recommended values. Twenty plausible replacement values were imputed for each missing value as recommended by Enders (2010), and then analyses were conducted on all 20 plausible data sets. Final estimates for study analyses were then obtained by pooling the results from the 20 analyses using Rubin’s (1987) formulas.

For data that includes categorical variables such as in the current study, a decision must be made on how to handle imputed categorical values that have decimals. While there are both complex categorical data imputation models as well as post-imputation rounding approaches to addressing this, recent research argues that these may not necessarily produce more accurate or less biased estimates (Enders, 2010). Therefore, in the current study, decimal values for categorical variables were carried forward in the analyses.

Note that an additional situation of missingness arose in the analyses in which some children in the sample had harshness and unpredictability measures included for mother's partner and father's partner while others did not (i.e., some children's mothers and fathers do not have partners). This causes unbalanced data (e.g., 82% of mothers and 88% of fathers report not having partners at T2, while the remaining mothers and fathers report on partner harsh discipline at T2). To address this issue, dummy variable adjustment was used such that two additional dummy variables were created indicating whether or not the case includes mother's partner data and father's partner data. This method is used to address missingness (and unbalanced data) in analyses for values that do not exist (Allison, 2002).

Measures

Harshness. Cues of harshness measures include aspects of economic harshness, harsh discipline, and neighborhood harshness.

Income-to-poverty ratio. An income-to-poverty ratio (i.e., the ratio of household income to poverty threshold determined by total number of household dependents) was calculated using monthly income data collected from mothers and fathers at T1 and T2 for the child's primary household. If mothers and fathers report living together all or most of the time, monthly income was combined. Monthly income calculations were consistent with the U.S. Census Bureau

(2013) definitions of income in the supplemental poverty measure: (1) residential parent's income, (2) coresidential partner's income, if applicable, (3) child support, (4) cash welfare, and (5) unemployment insurance and disability benefits. Monthly income was then divided by the poverty guidelines for the years of data collection and for the appropriate family size to create this ratio (U.S. Department of Health and Human Services, 2008).

Harsh discipline. To create harsh discipline scores, 7 items from T2 was used from the Conflict Tactic Scale: Parent Child Version (Straus, Hamby, Finkelhor, Moore, & Runyan, 1998) to create a total score (range 0–7) for each parent. The 7 items correspond to seven yes/no questions asked regarding harsh discipline tactics used within the past month (e.g., child was hit on the bottom with a bottle, brush, or stick; child was sworn or cursed at; child was slapped on face, head, or ears) by the mother, father, and each parent's partner, when applicable. Self-reports were used for mothers' and fathers' harsh discipline behaviors, and partners' harsh discipline behaviors were reported by the corresponding parent (e.g., mothers reported on mothers' partners' harsh discipline behaviors).

Neighborhood harshness. As a measure of cues of neighborhood harshness, 8 interview-rated items were summed to create a total neighborhood harshness score. These items were independently rated by the interviewer following the direct assessment home visit at T2 along a continuum. Sample items and scaled responses include: How would you rate the general condition of most of the housing units or other buildings in the face-block? (1-Well kept, good repair, 2-Fair condition, 3-Poor condition, 4-Badly deteriorated); Are there drug-related paraphernalia, condoms, beer or liquor containers or packaging, cigarette butts or discarded cigarette packages in the street or on the sidewalk? (1-None, or almost none, 2-Yes, but not a lot, 3-Yes, quite a bit, 4-Yes, just about everywhere); How did you feel parking, walking or waiting

at the door in the face-block? (1-Very comfortable, 2-Comfortable: it seems to be a safe friendly place, 3-Fairly safe and comfortable, 4-Uncomfortable, 5-I felt afraid for my personal safety).

Given the 8 items were not reported on equivalent scales, items were standardized prior to total score calculation. To arrive at a total neighborhood harshness score, answers across all 8 items were summed ($\alpha = .82$).

Unpredictability. Cues of unpredictability measures in the current study include aspects of financial unpredictability, parental unpredictability, and unpredictable daily routines.

Financial unpredictability. There are two measures used for financial unpredictability: employment unpredictability (i.e., inconsistency in parental employment across 12 months) and financial unpredictability (i.e., instances of financial hardship).

Unpredictable employment was scored for mothers and fathers separately based on their individual responses to the question, “How many months have you worked for pay in the past 12 months?” asked at T1 and T2. Answers for each time point indicating that the individual had consistent employment status across all 12 months (i.e., answers of 12 or 0) were scored as “0” and all other answers were scored as “1”. To create a total score, scores for mothers and fathers were summed across all time points where potential total unpredictable employment scores range from 0 – 4.

Instances of financial hardship includes (1) inability to pay full rent/mortgage, (2) instances of utility shutoff due to inability to pay bill, and (3) eviction due to inability to pay rent/mortgage. Mother reports about experiences with each of these within the last 12 months at T1 and T2 were used to represent experiences in the child’s primary household. A total financial hardship score was calculated by summing the total number of yes/no responses for a possible total instances of financial hardship score ranging from 0 – 6.

Parental unpredictability. Parental instability is measured in the proposed study as parental coresidential transitions into and out of the home. Parental figures include mothers, fathers, and new partners of both mothers and fathers. The number of parental coresidential transitions was based on coresidence information collected from mothers and fathers at T0, T1, and T2 regarding their current coresidence with one another and with a new partner, when applicable. For questions regarding mother and father coresidence with one another, mother reports were used. Possible responses to questions regarding coresidence (e.g., Do you currently live in the same household as mother/father?) were on a 4-point scale which consisted of *all of the time*, *most of the time*, *some of the time*, or *never/none of the time*. Parental instability for mothers/fathers, mothers/partners, and fathers/partners at each time point were created as a binary variable where 0 represents no change in response between consecutive time points, and 1 represents a change in response between time points. These scores were then summed across mothers/fathers, mothers/partners, and fathers/partners across time points with possible scores ranging from 0 to 6.

Unpredictable daily routines. In order to capture how inconsistent rearing routines may serve as proximal cues of environmental unpredictability, three available measures regarding daily routines were used. Mothers responded to daily routine questions by reporting the number of days in a typical week the child experienced the following: (1) eats evening meal with mother/father, (2) goes to bed at regular bedtime, and (3) experiences regular bedtime routine. Scores for each question were reverse-scored to represent level of unpredictability. Scores were first standardized as questions were not reported using the same scale (i.e., out of 5 days a week/out of 7 days a week), and then summed for a total unpredictable daily routine score.

Effortful control. The dependent variable, effortful control, was calculated as a composite score of 4 interviewer-rated items measured during the direct observation portion of data collection at T2: task persistence, attention span, body movement, and attention to directions. Interviewers were instructed upon completing the direct observation visit to rate the child's behavior and attitude overall during the Peabody Picture Vocabulary Test (a language assessment not included in the present study) and Walk the Line portions of the child assessment for each item. (Walk the Line is a behavioral assessment within a multitask battery that is used to assess effortful control; Zhou et al., 2012.) Each item was scored on a 4-point scale specific to the item. For example, possible ratings for attention span were: 1-easily distracted, 2-some distraction with noise or movement of others, 3-attends with assessor direction, 4-focuses attention voluntarily. To create a composite score, all 4 items were averaged for a total score range of 0 – 4 ($\alpha = .86$).

Analyses

Table 1 presents the descriptive data for all measures included in the current study. Bivariate correlations were also calculated in order to identify significant correlations between the independent variables and the dependent variable, as well as correlations between predictors (see Table 2).

To test the current study hypothesis (i.e., early cues of harshness as well as unpredictability will uniquely and negatively predict effortful control at 36 months), hierarchical regression models predicting effortful control were estimated. The first step of the model included the control variables (i.e., child's sex, parents' race, intervention site, and intervention status). The second step of the model introduced the harshness variables (i.e., income-to-needs ratios, harsh discipline, and neighborhood harshness). The final step of the model added the

unpredictability variables (i.e., unpredictable employment, unpredictable finances, parental unpredictability, and unpredictable daily routines). The inclusion of harshness and unpredictability measures in separate steps is congruent with the study hypothesis (i.e., harshness and unpredictability will uniquely predict effortful control, thus additive in their effects).

In hierarchical regression, there is an assumption of normality for the dependent variable or, more accurately, the standardized residuals. The dependent variable, effortful control was slightly negatively skewed post-imputation. Based on the Shapiro-Wilk test for normality, the effortful control data do not appear to come from a normally distributed population ($W = 0.89, p = .00$). A quantile-quantile plot was used to further investigate if the assumption of normality was violated in the analyses (see Figure 1). The plot suggests that while the residuals are slightly negatively skewed (indicated by the arched curve from below, towards, and slightly above the line), the assumption of normality may not be unreasonable (i.e., the overall appearance of the plot approximates a straight line).

Results

Bivariate correlations are presented in Table 2. Among the selected predictors, effortful control showed a small but statistically significant correlation in the expected (i.e., negative) direction only with neighborhood harshness ($r = -.12, p = .00$). This preliminary analysis gives the indication that a significant negative relationship exists between this independent variable (i.e., neighborhood harshness) and the outcome variable (i.e., effortful control), making neighborhood harshness a good predictor candidate. The majority of harshness variables were statistically significantly correlated with one another. In particular, mother's harsh discipline and father's harsh discipline were positively correlated ($r = .29, p = .00$). Interestingly, mother's and father's harsh discipline were both negatively correlated with neighborhood harshness ($r = -.08,$

$p = .00$ and $r = -.06$, $p = .01$, respectively), indicating that parents in harsher neighborhoods used less harsh discipline strategies. Among the unpredictability variables, only unpredictable employment and unpredictable finances were statistically significantly correlated in the expected direction ($r = .10$, $p = .00$). In addition, all unpredictability variables had statistically significant correlational relationships with one or more harshness variables, though not always in the same direction (e.g., parental unpredictability had a statistically significant negative correlation with fathers' harsh discipline [$r = -.13$, $p = .00$] which had a statistically significant positive correlation with unpredictable finances [$r = .06$, $p = .02$]).

The summary of the hierarchical regression analyses is shown in Table 3. Each step of the hierarchical regression model was first analyzed for total variance of the dependent variable (i.e., effortful control) explained by the model, and then individual predictors were examined.

Step 1 of the hierarchical regression model examined the control variables (i.e., child's sex, parents' race, intervention site, and intervention status) as predictors of effortful control at 36 months. In Step 1, 60% of the variation in effortful control was explained by the variation in the control variables ($R^2 = .06$). Consistent with preliminary correlational analyses, child's sex was a statistically significant predictor of effortful control at 36 months. As child's sex was coded as boys = 0 and girls = 1, this indicates that girls had a higher baseline score for effortful control than boys in the same age group. Individual intervention sites also statistically significantly predicted effortful control. As intervention site in this study represents one of six different cities/counties across the U.S., this likely indicates differences in sample demographics across these geographical locations.

Step 2 of the hierarchical regression model examined harshness variables (i.e., income-to-poverty ratios, harsh discipline, and neighborhood harshness) as predictors of effortful control at

36 months, controlling for all variables from Step 1. Step 2 of the analyses indicated that an additional 1% of the variation in effortful control was explained by the variation in the harshness variables ($\Delta R^2 = .01$). Step 2 better predicted effortful control compared to Step 1 ($F = 3.46, p = .00$) meaning that collectively, variables of harshness explained a statistically significant greater portion of variance in effortful control, even when controlling for variables in Step 1.

Specifically, neighborhood harshness negatively predicted a statistically significant portion of effortful control ($\beta = -0.01, p = .00$) such that children in neighborhoods one standardized unit higher in harshness exhibited a 0.01 unit decrease in effortful control at 36 months. (Note that the dummy variable for mother's partner also shows as a statistically significant predictor in the model, however as this variable is only indicating unbalanced data for individual cases, this is not an interpretable result [Allison, 2002].)

As a final step in the hierarchical regression model, Step 3 examined unpredictability measures (i.e., unpredictable employment, unpredictable finances, parental unpredictability, and unpredictable daily routines) as predictors for effortful control at 36 months beyond measures of harshness. However, this step of the model did not result in any change in variance of effortful control explained ($\Delta R^2 = .00$), and therefore the addition of the unpredictability measures did not improve the model ($F = 0.95, p = .44$).

Post-hoc Exploratory Factor Analysis

An exploratory factor analysis was run as a post-hoc analysis to better understand the underlying structure, if any, of the independent variables. Given the results of the main analyses did not provide the expected support for a harshness and unpredictability framework, it may be enlightening to statistically investigate if there is an alternate underlying structure. Using an

exploratory factor analysis may be helpful in better understanding how the study variables covary and, therefore, identifying the latent variables among them.

To run the exploratory factor analysis, the number of potential factors must first be identified which can be determined by using a scree plot. Figure 2 shows the scree plot for the harshness (i.e., income-to-poverty ratio, harsh parenting, and harsh neighborhood) and unpredictability (i.e., unpredictable employment, unpredictable finances, parental unpredictability, and unpredictable daily routines) variables. As indicated in Figure 1, Kaiser-Guttman's rule, the parallel analysis, and the optimal coordinates analysis all suggest that 4 factors of the data will be sufficient. This is contradicted, however, by the acceleration factor analysis (which also is visually indicated by the lack of abrupt change in slope of the graphed eigenvalues) which suggests that the data cannot be sufficiently explained by multiple factors. This may explain why expected harshness and unpredictability relationships were not evident in the study analyses.

Using the guidance from the scree plot, the harshness and unpredictability variables were entered into the analysis first using a varimax rotation, extracting 4 factors. A varimax rotation is an orthogonal rotation that assumes that the factors are uncorrelated. Given the study hypothesis and previous research that suggests that early cues of harshness are unique from early cues of unpredictability, using an orthogonal rotation is a good place to start. Results from this analysis can be seen in Table 4. Ultimately, the analysis determined that 4 factors were not sufficient in explaining the relationships of the data, $\chi^2(17) = 892.21, p = 9.77e-179$. (Note that attempting to extract 1, 3, or 5 factors also did not produce any statistically significant results.)

Next, the exploratory analysis was attempted using a promax rotation, again extracting 4 factors. A promax rotation is an oblique rotation and thus assumes that the factors are correlated.

Given individuals experiencing harshness are often also experiencing unpredictability and these can be difficult to tease out, using an oblique rotation may be more appropriate. However, using a promax rotation did not yield successful results. (Note that attempting to extract 1, 3, or 5 factors also did not produce any statistically significant results.)

These post-hoc analyses suggest that an underlying structure may not be present among the predictors, and alternatively, the potential for each of the variables to predict effortful control may be best investigated in isolation. In other words, the independent variables in the current study do not appear to correspond to the hypothesized early harshness and unpredictability framework.

Discussion

Phenotypic plasticity may provide for variations in effortful control, allowing individuals to use strategies (i.e., along the slow to fast continuum) that aim to best match the individual to the environment. From a life history theory perspective, early cues of environmental harshness and unpredictability may shape individuals along a continuum of higher to lower effortful control (i.e., higher impulsivity) depending on what is more adaptive. This study investigated the hypothesis that early cues of harshness and unpredictability uniquely and negatively predict effortful control at 36 months. While there was no evidence that cues of unpredictability predicted effortful control, cues of harshness, specifically neighborhood harshness, did statistically significantly predict effortful control in the direction expected. This appears to be the first study to explicitly investigate effortful control development in early childhood within the harshness and unpredictability framework. Neighborhood harshness as a predictor of effortful control, and possible reasons for the lack of support for unpredictability variables as predictors are discussed next.

Neighborhood Harshness Predicts Effortful Control

Aspects of neighborhood harshness may serve as important cues early in development that aim to direct developmental trajectories in ways that best match the individual to the environment through a process of conditional adaptation (Belsky et al., 1991; Ellis et al., 2009). In the current study, neighborhood harshness (e.g., condition of the housing block, evident drug-related litter, overall feeling of safety) surfaced as a statistically significant predictor of effortful control at 36 months. This supports the possibility that neighborhood harshness, as measured in the current study, has a significant impact on the developmental trajectory for self-regulation in young children, though the mechanisms through which this occurs is still unclear (Ellis et al., 2009). From a life history theoretical perspective, these cues provide information to the developing individual about the levels of local morbidity-mortality. In tandem, harsh neighborhoods may also direct lower levels of parental investment (i.e., a quantity over quality approach to mating; Nettle, 2010), also serving as a cue to the developing individual about the expected environment in adulthood (e.g., levels of harshness versus levels of support). In harsh and unsupportive environments, impulsivity versus higher effortful control may be more adaptive (Del Giudice, 2015). Thus, theoretically, these cues of neighborhood harshness may, both directly and indirectly, take part in shaping individual trajectories towards higher impulsivity and, therefore, lower effortful control.

In the current study, neighborhood harshness did indeed show statistically significant correlations with both mothers' and fathers' harsh discipline, but in the opposite direction (e.g., negative correlations). This suggests that children in harsher neighborhoods experienced less harsh discipline from mothers and fathers. Though one may anticipate neighborhood harshness and harshness from parents to be positively correlated (i.e., receiving consistent cues of

harshness from one's environment), decreased parental investment can also present as less involved parenting (i.e., neglectful parents; Ellis et al., 2009) which may be reflected in the decreased use of discipline and overall lack of responsiveness. Both harsh and neglectful parenting are consistently associated in the literature with faster life history strategies (Ellis et al., 2009), however whether there are nuances in the types of cues provided by each (i.e., harshness versus neglect/unresponsiveness) is still unclear. In environments where child morbidity-mortality is uncontrollable (e.g., in highly unpredictable and harsh environments) lower parental investment may be more adaptive for parents' own fitness.

While studies explicitly investigating harshness and unpredictability in relation to outcomes in early childhood have yet to emerge, there is abundant extant research examining the impact of cumulative risk on early childhood development using models of allostatic load (for review see Lengua, 2012). The notion that environments of lower socioeconomic status are associated with lower levels of self-regulation (e.g., effortful control) in children is well documented. What is interesting in the results of the current study is that out of the group of harshness variables (i.e., financial harshness, harsh discipline, and neighborhood harshness) it was neighborhood harshness alone that emerged as a significant predictor of effortful control. That financial harshness (i.e., income-to-needs ratio) and aspects of harsh parenting do not emerge as significant predictors of effortful control is contrary to the existing literature (for review see Lengua, 2012). Given the current sample is somewhat homogeneous in income levels (Wood et al., 2010), it is possible there was not enough variation to detect a significant relationship with effortful control. One additional important detail that needs to be acknowledged is that both effortful control and neighborhood harshness were interviewer-rated measures that both took place at the T2 direct observation visit. This raises the concern of

common method variance where the variance is actually attributable to the measurement itself (here, interviewer ratings of both the independent and dependent variables). All other independent variables included in the current study came from parent-reported items. Further, given there is no formal documentation available from the depository regarding interviewer training or reliability, one cannot discount the possibility that the ratings on effortful control and neighborhood harshness are biased. Importantly, there were significant negative correlations between income-to-poverty as reported by parents and interviewer-rated neighborhood harshness (i.e., higher income-to-poverty ratios correlated with lower neighborhood harshness).

The final yet nontrivial point to discuss is the fact that though neighborhood harshness was a significant predictor in the current study, it only weakly predicted effortful control. Given the study hypothesis is rooted in the concept of phenotypic development, one must consider the genetic components of effortful control. Friedman and colleagues (2008) argued that these processes (specified as executive functions in their study) were highly heritable. In fact, the results of their multivariate twin study indicated that they were 99% heritable. This raises an important concern: How much of the predictive power of neighborhood harshness was actually attributable to the proximal environment and how much of the covariation is confounded by genetic predisposition? Correlation between one's life history strategies and one's environment is not only explainable by phenotypic development (i.e., conditional adaptation), but also by niche selection in which individuals seek out environments that match their genotype (Ellis et al., 2009). Further, neighborhoods themselves reflect the families that live within them and this relationship may contribute to biological embedding of environmental experiences (Hertzman, 2012). In other words, not only does the neighborhood impact upon the individual, but the individual impacts upon the neighborhood (i.e., bidirectional effects). It is possible that in the

current study, had genetic inheritability been included, the predictive power of neighborhood harshness would not have emerged. This is an important consideration and thus is mentioned also in Limitations and Future Directions.

Early Unpredictability and Effortful Control

Emerging research suggests that cues from unpredictable environments may be distinct from cues of harshness, and may uniquely impact phenotypic development of life history strategies and associated traits (Ellis et al., 2009; Belsky et al., 2012). The measurements of unpredictability in the current study, conceptualized as financial unpredictability, parental unpredictability, and unpredictable daily routines, did not emerge in the analyses as statistically significant predictors of effortful control. The post-hoc exploratory factor analyses failed to identify any significant underlying latent structure for the unpredictability data (or for harshness for that matter). The previously mentioned study by Belsky, Schlomer, and Ellis (2012) investigated early unpredictability using similar measurements that successfully loaded onto an unpredictability factor in their analyses. However, unpredictability data were collected across 3 month intervals from 1 months to 60 months of age. This demonstrates the benefit of using frequent intervals of data collection for measures of unpredictability which future studies should consider.

Another potential explanation for the lack predictive power of unpredictability on effortful control in the current study may be related to the measurement of effortful control itself. As mentioned, effortful control was interviewer-rated based on overall observations after the Peabody Picture Vocabulary Test and the Walk the Line portions of the child assessment. A recent study by Sturge-Apple, Davies, Cicchetti, Hentges, and Coe (2016), only just released at the end of this thesis project, found statistically significant associations between family

instability (i.e., caregiver changes, residential changes, caregiver intimate relationship changes, job/income loss, and family member deaths) and effortful control at ages 4 and 6. However, these associations were only found with hot effortful control (e.g., delay of gratification) and not with cool effortful control (e.g., inhibitory control). Sturge-Apple and colleagues interpret these results as indicating that early environments characterized by unpredictability are more salient to hot effortful control. These results reinforce the importance of present- versus future-orientation such that impulsivity, as opposed to effortful control, might be more adaptive in an environment where future reward opportunities are not reliable. In the current study, no distinctions were made between these types of effortful control processes during rating. Delineating between hot and cool effortful control, in addition to an objective measure of the construct, may yield different results.

Limitations and Future Directions

There are some limitations to the current study that should be acknowledged and that serve as recommendations for future studies investigating similar early developmental processes. As mentioned briefly, the current study sample was somewhat homogenous in income (Wood et al., 2012), with the majority of families experiencing financial harshness at the U.S. Census poverty level. This limited variation in financial harshness may have contributed to the lack of significant results in the analyses. Similarly, a more representative sample may also provide for more variation in child's effortful control. Future studies would benefit from having a more representative sample with a greater variation in financial harshness and effortful control to better investigate aspects of early harshness as predictors of effortful control. Harsh parenting within a harshness and unpredictability framework is currently underexplored, though broader research within developmental science linking parenting quality and child developmental

outcomes is more plentiful. Maternal sensitivity, support of autonomy, and intrusiveness are typically examined parenting variables related to effortful control (Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Cuevas et al., 2014) as opposed to harsh discipline as used in the current study. Based on results, parental disciplinary strategies may be less relevant to the development of effortful control and therefore may have limited the current investigation on early harshness and effortful control. In this sense, considering alternate harsh parenting constructs may be beneficial, or even considering lack of supportiveness as an indicator of low parental investment may provide important insight. Future studies should aim to tease out the mechanisms through which early cues of harshness are communicated through parenting within a harshness and unpredictability framework.

Relatedly, there were limitations in the measurement of early cues of unpredictability. The measurements used in the current study (i.e., unpredictable finances, parental unpredictability, and unpredictable daily routines) were guided by the work of the few existing studies investigating early cues of unpredictability (e.g., Belsky et al., 2012). In previous studies showing statistically significant predictive power of unpredictability on life history strategies (though not examined in early childhood), more frequent and shorter time intervals were used (e.g., Belsky et al., 2012). Though the current study used a longitudinal data set, there were only 2-3 time points across 3 years with which to construct the unpredictability measures. This does not allow for the capturing of more frequently experienced changes (e.g., in employment, financial hardship, and changes in parental co-residence), which cannot be captured using one year intervals. Using more frequent data collection over shorter time intervals (e.g., months versus years) would improve the methodology and increase the potential for detecting a relationship between unpredictability and the development of effortful control. Additionally,

including caregiver changes in the unpredictability measurements (as used in other studies) would be beneficial as these changes likely impact the child's daily proximal experiences.

Additional limitations of the current study relate to the dependent variable, effortful control. Effortful control in the current study was slightly negatively skewed post-imputation and therefore normality assumptions were questioned for the hierarchical regression analyses. Also, effortful control was potentially biased in its measurement given it was interview-rated based on overall observations at T2. Further, delineating between hot and cold effortful control (i.e., delay of gratification and inhibitory control) may be important when investigating early unpredictability (Sturge-Apple et al., 2016). Using objective assessment of both hot and cold effortful control processes would improve the methodological rigor in future studies. There was also not any measurement of heritability of effortful control included in the current study. To truly capture how early cues of harshness and unpredictability are predictive of effortful control, one must also consider to what degree the outcome is genetic. There are many ways that this could be done that range in complexity and rigor (e.g., measuring parents' effortful control, using more sophisticated modeling, conducting twin studies). Future studies investigating environmental cues and development will benefit from considering the role of environment and genetics in phenotypic development, providing more explanatory potential.

Conclusion

Using a life history theory perspective, this study sought to demonstrate how early harshness and unpredictability shape the development of effortful control to best match the individual to the environment. Though support for the overall hypothesis was not found, neighborhood harshness specifically emerged as a statistically significant negative predictor of effortful control. Based on life history theory, characteristics of the local environment (e.g.,

neighborhood) in early childhood may provide information to the developing individual regarding local levels of morbidity-mortality. These cues then have an impact on development, including cognitive development, which may be malleable and subject to conditional adaptation (Belsky et al., 1991). While existing empirical studies using an evolutionary framework show correlations between cues of neighborhood harshness (e.g., neighborhood hazards) and outcomes in adolescence as well as in adulthood (for review see Ellis et al., 2009), no identified studies to date investigate the impact of cues of neighborhood harshness specifically on outcomes in early childhood. The current study makes a contribution to the literature by suggesting cues of neighborhood harshness (e.g., condition of housing/buildings, existence of drug-related litter, overall feeling of safety) may be a potential predictor of life history related traits (i.e., effortful control/impulsivity) even in early childhood. Future studies should aim to further investigate the specific mechanisms of early cues of harshness and unpredictability during early childhood to continue to probe at effortful control development within a harshness and unpredictability framework.

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Table 1. Descriptive Statistics of Study Variables (post-imputation).

Variables	<i>M</i>	<i>SD</i>
Income:poverty (T1)	0.97	1.93
Income:poverty (T2)	0.79	0.92
Harsh discipline, mother	1.52	1.57
Harsh discipline, father	1.35	1.50
Harsh discipline, mother's partner	0.04	0.26
Harsh discipline, father's partner	0.00	0.40
Neighborhood harshness ^a	0.01	1.84
Unpredictable employment	0.01	1.01
Unpredictable finances	1.06	1.27
Parental unpredictability	0.00	0.98
Unpredictable daily routines ^a	2.05	1.29
Effortful control (DV)	2.86	0.77

Notes. Multiple imputation of study variables may result in out of range values. T1 = 15 months, T2 = 36 months, DV = dependent variable. ^aStandardized values are displayed.

Table 2. Bivariate Correlation Matrix.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Child's sex												
2. Income:poverty, T1	.02											
3. Income:poverty, T2	-.01	.23***										
4. Harsh discipline, mother	-.04	.05*	.08**									
5. Harsh discipline, father	-.10***	.07**	.08**	.29***								
6. Harsh discipline, mother's partner	-.03	.00	.08***	.14***	.01							
7. Harsh discipline, father's partner	-.04	.09***	.12***	.09	.19***	.10**						
8. Harsh neighborhood	.01	-.08**	-.15***	-.08***	-.06*	.00	.01					
9. Unpredictable employment	.01	.01	-.06*	.02	.05*	-.03	-.02	.11***				
10. Unpredictable finances	.00	-.02	-.03	.11***	.06*	.07**	.09**	.03	.10***			
11. Parental unpredictability	-.03	-.09***	-.10***	.01	-.13***	.19***	.01	.04	-.04	.03		
12. Unpredictable daily routines	.00	.01	-.02	.06*	.01	-.02	-.06*	.01	-.01	-.02	.00	
13. Effortful control (DV)	.22***	-.01	.03	.00	-.02	.01	.00	-.12***	.01	.02	.04	-.04

Notes. T1 = 15 months, T2 = 36 months, DV = dependent variable. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3. Summary of Hierarchical Regression Results.

Predictor	Step 1			Step 2			Step 3		
	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
Constant	2.17	0.07	-	2.59	0.12	-	2.61	0.14	-
Controls									
Child's sex	0.35	0.04	0.23***	0.35	0.04	0.23***	0.35	0.04	0.90***
Race, white (M)	-0.10	0.08	-0.06	-0.10	0.08	-0.06	-0.11	0.08	-0.07
Race, white (F)	0.03	0.08	0.02	0.02	0.08	0.01	0.02	0.08	0.01
Race, other (M)	-0.03	0.10	-0.01	-0.03	0.10	-0.01	-0.04	0.10	-0.01
Race, other (F)	-0.08	0.10	-0.02	-0.08	0.10	-0.02	-0.07	0.10	-0.02
Site 2	0.27	0.07	0.12***	0.22	0.07	0.10**	0.21	0.07	0.10**
Site 3	0.22	0.06	0.12***	0.18	0.06	0.10**	0.18	0.06	0.10**
Site 4	0.03	0.09	0.01	0.03	0.09	0.01	0.03	0.09	0.01
Site 5	0.10	0.07	0.04	0.07	0.07	0.03	0.07	0.07	0.03
Site 6	0.27	0.07	0.16***	0.24	0.07	0.14***	0.24	0.07	0.14***
Intervention	0.01	0.03	0.01	0.01	0.03	0.01	0.01	0.03	0.01
Harshness									
Income:poverty (T1)				-0.01	0.01	-0.02	-0.01	0.01	-0.02
Income:poverty (T2)				0.01	0.02	0.01	0.01	0.02	0.01
Harsh discipline (M)				-0.00	0.01	-0.01	-0.00	0.01	-0.00
Harsh discipline (F)				-0.00	0.01	-0.00	-0.00	0.01	-0.00
Harsh discipline (M partner)				-0.02	0.07	-0.01	-0.02	0.07	-0.01
Harsh discipline (F partner)				0.02	0.05	0.01	0.02	0.06	0.01
Dummy variable (M partner)				-0.14	0.05	-0.07**	-0.13	0.06	-0.07*
Dummy variable (F partner)				0.05	0.06	0.02	0.05	0.06	0.02
Neighborhood harshness				-0.05	0.01	-0.11***	-0.05	0.01	-0.12***
Unpredictability									
Unpredictable employment							0.02	0.02	0.02
Unpredictable finances							0.01	0.01	0.01
Parental unpredictability							0.00	0.02	0.00
Unpredictable daily routines							-0.02	0.01	-0.04
$R^2(\Delta R^2)$	.06			.08(.01)			.08(.00)		

Notes. African American is the reference category for race. Site 1 is the reference category for site. M = mother, F = father, T1 = 15 months, T2 = 36 months. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 4. Exploratory Factor Analysis with Verimax Rotation.

	Factors			
	1	2	3	4
Income:poverty (T1)		.33		
Income:poverty (T2)		.63		.13
Harsh discipline (M)	.62	.17	.19	-.36
Harsh discipline (F)	.50	.12	-.15	
Harsh discipline (M partner)	.12		.44	
Harsh discipline (F partner)	.33			.41
Neighborhood harshness		-.27		
Unpredictable employment	.10	-.13		
Unpredictable finances	.21			
Parental unpredictability		-.16	.48	
Unpredictable daily routines				-.14
Eigenvalues	.82	.69	.51	.36
Variance explained (%)	.08	.06	.05	.03

Notes. $\chi^2(17) = 892.21$, $p = 9.77e-179$. M = mother, F = father, T1 = 15 months, T2 = 36 months.

Figure 1. Normal Quantile-Quantile Plot.

Figure 2. Scree Plot for Exploratory Factor Analyses.