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# Predictors of Behavioral Regulation in Kindergarten: Household Chaos, Parenting, and Early Executive Functions

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Behavioral regulation is an important school readiness skill that has been linked to early executive function (EF) and later success in learning and school achievement. Although poverty and related risks, as well as negative parenting, have been associated with poorer EF and behavioral regulation, chaotic home environments may also play a role in understanding both early EF and later behavioral regulation at school age. To explore these relationships, a unique longitudinal and representative sample was used of 1,292 children born to mothers who lived in low-wealth rural America who were followed from birth into early elementary school. This study examined whether household chaos, which was measured across the first 3 years of life, predicted behavioral regulation in kindergarten above and beyond poverty-related variables. In addition, this study tested whether parent responsivity and acceptance behaviors, measured during the first 3 years of life, as well as EF skills, which were measured when children were 3 to 5 years of age, mediated the relationship between early household chaos and kindergarten behavioral regulation. Results suggested that household chaos disorganization indirectly predicted kindergarten behavioral regulation through intermediate impacts on parenting behaviors and children's early EF skills. These findings suggest the importance of early household chaos disorganization, the parenting environment, and early EF skills in understanding behavioral regulation above and beyond poverty-related risks.

*Keywords:* chaos, behavioral regulation, executive functions, poverty, school readiness

Research has suggested that children's early regulatory behaviors are foundational skills that promote better learning in school (Blair & Raver, 2015; McClelland, Acock, & Morrison, 2006; Rimm-Kaufman, Curby, Grimm, Nathanson, & Brock, 2009). These early regulatory behaviors are likely part of the development of executive function (EF) skills (working memory, inhibition, and attention skills) that emerge from the interplay between early brain development and environmental experiences. These skills have been hypothesized to be precursors or antecedent skills that facilitate later complex behavioral regulation as children make the transition to formal schooling (Blair & Raver, 2015; Garon, Bryson, & Smith, 2008; Willoughby, Kupersmidt, & Voegler-Lee, 2012). At school age, the coordination of regulatory and EF-like skills have been found to predict both better behavioral adjustment in school and better academic achievement (N. Eisenberg et al., 2000; Ponitz, McClelland, Matthews, & Morrison, 2009). In one study, children who scored higher on a child behavioral regulation task received higher ratings by both parents and teachers on behavioral regulation measures. Moreover, individual differences in changes in behavioral regulation are predictive of gains in early academic skills, even after controlling for initial achievement and child demographics (McClelland et al., 2007) or controlling for

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time-invariant confounds (McClelland et al., 2014). Aspects of regulation also predict long-term school achievement, even after controlling for child previous achievement/IQ and demographics (Blair & Razza, 2007; McClelland et al., 2006).

On the other hand, children who struggle with regulating their behavior in the classroom have more difficulty in school (Calkins & Howse, 2004). Regulatory deficits have been found to be the core characteristics related to manifestations of attention-deficit hyperactivity disorder (ADHD; Barkley, 1997), with the most persistent deficits in response inhibition, attention, working memory, and planning (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005), all of which can lead to regulatory problems in the classroom (N. Eisenberg et al., 2000). These children with regulatory problems often come from homes with lower income and have parents with less education and fewer resources (Blair & Raver, 2015; Raver, Blair, Willoughby, & The Family Life Project Key Investigators, 2013). From a psychobiological perspective, these early poverty-related factors may be related to heightened stress hormone levels, which negatively influence the neural underpinnings of cognitive processes like regulatory behaviors (Blair & Raver, 2015). Given the importance of these regulatory processes in early schooling for children at risk, it is critical to better understand what early childhood environmental factors might lead to poorer or better regulation at school entry.

The purpose of the current study is to build on previous research on the development of early EF and regulatory skills that has shown that early childhood environmental factors might be important in both early and later regulatory abilities. Specifically, this study uses longitudinal data from a large representative sample of rural children living in low-wealth rural communities to test whether and how household poverty and chaos predict behavioral regulation in kindergarten through intermediate effects on parental caregiving behaviors and children's EF abilities across early childhood.

## Household Chaos and Poverty as Predictors of Child Regulatory Skills

### Household Chaos Definition

One aspect of the home environment that has been negatively associated with children's early cognitive and regulatory processes is household chaos. Most research has used the CHAOS parent-report scale (Matheny, Wachs, Ludwig, & Phillips, 1995) that assesses a variety of chaos indicators, including confusion, clutter, and ambient noise in the home. The CHAOS scale has been linked to poorer outcomes in children, including poorer language and regulatory processes (Hardaway, Wilson, Shaw, & Dishion, 2012; Hughes & Ensor, 2009; Wachs & Corapci, 2003). Some studies have used a specific aspect of chaos, such as ambient noise (neighborhood noise, TV noise, as well as fast-paced TV, etc.), linking this chaos indicator to poorer attention and regulatory behaviors (Blankson, O'Brien, Leerkes, Calkins, & Marcovitch, 2015; Lillard, Drell, Richey, Boguszewski, & Smith, 2015). These aspects of chaos, generally named *household disorganization* chaos, are usually experienced daily by family members and children. Thus, it has been this dimension or key aspects of this dimension that most research has examined in relation to negative child outcomes (M. E. Eisenberg, Olson, Neumark-Sztainer, Story, & Bearinger, 2004; Evans, Lepore, Shejwal, & Palsane, 1998).

Other chaos research has used a broader definition of chaos that has included chaos disorganization as well as a second dimension of chaos called *household instability*. Household instability refers to frequent changes in the household composition and home resident environment, including frequent moving of an entire household to a new residence, changes in the mother or father figure in the family, and general changes in the people who live in the household. Instability has been used as a separate indicator of chaos or has been coupled with disorganization in a number of studies (Ackerman, Kogos, Youngstrom, Schoff, & Izard, 1999; Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005; Vernon-Feagans, Garrett-Peters, Willoughby, Mills-Koonce, & The Family Life Project Key Investigators, 2012). Instability is likely not experienced daily by children, although repeated instances of instability even a few times a year have been related to poorer child outcomes, especially for school-age children (Tiesler et al., 2013; Tucker, Marx, & Long, 1998).

A recent synthesis of studies of chaos (Evans & Wachs, 2010) across childhood identified disorganization and instability as critical dimensions of household chaos in understanding the negative effects of chaos on children's development (Evans & Wachs, 2010; Sameroff, 2010). The current study examines both of these dimensions of household chaos longitudinally from infancy through kindergarten, unlike most other studies. In addition, this study also uses longitudinal and multi-informant measures of disorganization and instability instead of relying on a parent questionnaire.

Although household chaos has been consistently related to poverty (Evans et al., 2005; Evans, Eckenrode, & Marcynyszyn, 2010; Lichter & Wethington, 2010), it is not coincident with poverty. Poverty is likely a marker variable that stands for processes in the home and elsewhere that may be the more proximal causal mechanisms that can explain the negative child outcomes associated with poverty (Bronfenbrenner & Evans, 2000; Vernon-Feagans, Garrett-Peters, Willoughby, et al., 2012). Household chaos is one of those possible proximal mechanisms in the home that might help to explain how poverty exerts its influence on parenting and child behavioral and academic outcomes. Although chaos is found in nonpoverty homes, it occurs more often and with greater severity in poor homes, because it has been found that such poverty-related factors such as nonstandard work hours, single parenthood, and fewer home resources are related to chaotic households (Valiente, Lemery-Chalfant, & Reiser, 2007; Vernon-Feagans, Garrett-Peters, De Marco, & Bratsch-Hines, 2012).

### Two Possible Pathways From Household Chaos to Regulatory Skills

Household chaos has been shown to be one plausible explanation to account for children's behavioral regulation difficulties (Evans et al., 2005; Evans & Wachs, 2010). Two possible pathways have been proposed to help explain why household chaos can impact children's development that will be evaluated in the current study. The first pathway postulates a more direct relationship between chaos and children's regulatory skills. The second pathway model proposes that chaos leads to poor regulatory skills through its impact on parenting processes. The

current study will examine the viability of both of these possible pathways in understanding early EF and behavioral regulation in kindergarten.

**Direct pathway of chaos to children's EF and regulatory skills.** It has been hypothesized that household disorganization and instability chaos create the context of an overstimulating and unpredictable home environment. This chaotic environment can directly result in children blocking out and withdrawing from the overwhelming stimulation and unpredictability in the home. Children, especially young children, may withdraw from a chaotic home environment, and thus might not be able to benefit from the scaffolding and other input by parents that can promote early regulatory and other cognitive processes related to later EF and school readiness behaviors. Further, young children can easily be distracted by overwhelming and changing external stimuli in the home because they have not yet developed the attentional and regulatory capacities to screen out irrelevant stimuli (Lillard et al., 2015; Wachs & Evans, 2010). Most of the early studies of household chaos examined the direct relationship between household chaos and child regulatory behaviors. One major study (Evans et al., 2005) examined the relations among poverty, household chaos, and later behavioral regulation. The study found that household chaos, as measured by questionnaires that tapped both disorganization and instability, completely mediated the relationship between poverty and behavioral regulation in a group of rural adolescents who were mostly from low-income families. Other studies have also found direct relationships between disorganized chaotic home life (noisy homes, less organized and structured daily lives, and lack of routines) and children's early regulatory skills (Coldwell, Pike, & Dunn, 2006; Evans, Kliewer, & Martin, 1991; Evans et al., 1998; Martin, Razza, & Brooks-Gunn, 2012).

There is also growing evidence that chaos instability may also be important in understanding early regulatory behaviors in children. Studies have found that residential mobility was related to increased inattention and externalizing problems for children from low-income families as well as poorer performance on inhibitory control measures (Schmitt, Finders, & McClelland, 2015; Ziol-Guest & McKenna, 2014). In a year-long study of children attending a Head Start program (Brown, Ackerman, & Moore, 2013), home disorganization chaos and family instability were combined to form an "adversity index." Findings suggested that the adversity index, but not the income/needs ratios or verbal ability, contributed to poorer EF inhibitory control over the course of the preschool year.

**Indirect pathway of chaos to EF and regulatory skills through parenting.** The second pathway postulates an indirect relationship between chaos and regulatory skills through parenting. Chaotic home environments may create the context for less contingent responding by parents because of the unpredictability and disorganization in the home (Hughes, Roman, & Ensor, 2014; Wachs & Evans, 2010). It may also interrupt important scaffolding and responsivity that parents provide, especially in helping children regulate their behavior. Parenting in turn may be the more proximal causal variable or the mediator between chaos and children's poorer regulatory behaviors (Hughes & Ensor, 2011; Hughes et al., 2014; Valiente et al., 2007). Among young children, household disorganization chaos has been shown to be associated with parents who use more negative parenting strategies, such as physical punishment and inconsistent discipline (Dumas et al., 2005; Wachs & Corapci, 2003; Whitesell, Teti, Crosby, & Kim, 2015). In a recent study that examined parenting in a high-risk sample of preschool children (Hardaway et al., 2012), results suggested observed positive parental support in the home at 3 years of age fostered 4-year-old self-regulatory skills, whereas household chaos at 3 years of age impeded the development of self- regulation over time, which in turn predicted 5-year-old rated behavior problems. In this study, chaos and parenting were separate additive predictors of self-regulation without a test of parenting as a mediator.

A study by Hughes and Ensor (2009) has the most relevance for the current study because of their focus on chaos, parenting, and change in EF as a predictor of children's later behavioral regulation. Although many studies have used the intercept of child skill as a predictor, using change over time helps make a stronger case for causal relationships. Hughes and Ensor examined disorganization chaos from the CHAOS questionnaire, parenting (maternal scaffolding, maternal mean length of utterance [MLU], and inconsistent parenting), and change in child EFs at Age 4 by controlling for EF at Age 2. They found significant prediction to 4-year-old EF from only three of their measures (maternal planning, maternal scaffolding, and family chaos), but they did not find support for the influence of socioeconomic status (SES), inconsistent parenting, or maternal MLU. Thus, both positive parenting and chaos were related to change in EF, even after controlling for SES and other covariates. They did not test whether chaos might indirectly impact EF change through parenting, which will be examined in the current study.

There is much less research on the relationship between instability and poorer parenting and child outcomes. In one of the few large studies, residential mobility was found to be directly associated with negative internalizing behaviors in adolescence but indirect associations between residential mobility and children's externalizing behaviors through poorer parenting in early childhood (Anderson, Leventhal, & Dupéré, 2014).

## The Goal of the Current Study

The aim of this study was to provide a test of whether the experience of cumulative chaos (instability and/or disorganization) across the first 3 years of life was prospectively related to early EF and/or teacher-rated and child performance-based measures of behavioral regulation in kindergarten, controlling for maternal education and poverty (income/needs). In addition, we tested whether the effects of cumulative chaos was directly related to behavioral regulation in kindergarten or indirectly through the quality of parenting and/or EF in early childhood (36 to 60 months of age). We predicted that chaos disorganization would be a stronger predictor than chaos instability in predicting kindergarten behavioral regulation. We also postulated that parenting might be a partial mediator of the relationship between household chaos and regulatory behaviors in kindergarten, as well as a partial mediator between chaos and initial EF skills at 36 months of age, as well as the growth in EF skills from 36 to 60 months, as others have suggested (Hammond, Müller, Carpendale, Bibok, & Liebermann-Finestone, 2012; Hughes & Ensor, 2009, 2011).

## Method

### Participants

The Family Life Project (FLP) is a prospective longitudinal study of families residing in six low-wealth counties in Eastern North Carolina and Central Pennsylvania (three counties per state) that were selected to be indicative of the Black South and Appalachia, respectively. Complex sampling procedures were employed to recruit a representative sample of 1,292 children whose families resided in one of the six counties at the time of the child's birth. Low-income families were oversampled in both states and African American families were oversampled in North Carolina; however, sampling weights were used to allow inferences back to the representative sample. Full details of the sampling plan and study design appear elsewhere (Vernon-Feagans, Cox, & The Family Life Project Key Investigators, 2013). The current study included 1,145 children who had outcome (i.e., EF) data from the Age 36-, 48-, or 58-month home visits and/or who had teacher-rated or performance-based indicators of regulatory competence from the kindergarten school visit. Families and children used in this study ($N = 1{,}145$) did not differ from participants who were enrolled in the larger study ($N = 1{,}292$) with respect to state of residence (40% vs. 39% residing in Pennsylvania, $p = .71$), living in a household that was recruited into the low-income stratum (78% vs. 76% poor, $p = .53$), mother educational status at study enrollment (80% vs. 78% with a high school degree/GED or beyond, $p = .53$), or child gender (50% vs. 56% male, $p = .20$). However, there were proportionally more African American children who participated in the current study compared with those in the larger sample (43% vs. 35%, $p = .04$).

### Procedures

Children and their families participated in home visits during infancy and early childhood at five points in time: 2 months, 6 months, 15 months, 24 months, and 36 months. During the home visits, the research assistants conducted interviews with the primary caregiver (who was the mother in 95% of the sample) and administered questionnaires including questions that helped create the chaos variables. Home visitors made ratings of the home environment after the home visit that were also used to create the chaos variables. At 36, 48, and 60 months, home visitors conducted child assessments, including an EF battery. In kindergarten, trained research assistants took children from their classroom to a quiet room in the school, where the behavioral regulation assessments were administered.

### Measures

**Covariates.** Two covariates were used to control for poverty/risk: Mother education and household income. Mother education (mother's number of years of education) was reported at the 2-month home visit. Regarding household income, the FLP adopted the approach taken by Hanson, McLanahan, and Thomson (1997), and based household income on anyone who resides in the household, not simply those people related by blood, marriage, or adoption. Individuals were considered to be coresidents if they spent three or more nights per week in the child's household. Using this information, the total annual household income was divided by the federal poverty threshold for a family of that size and composition (thresholds vary based on number of adults and children) to create the income/needs ratio. The average of this income/needs ratio was calculated across the five time points from the 2-month home visit to the 36-month home visit.

**Household chaos.** Ten cumulative indicators of household chaos were derived from data collected at home visits when target children were approximately 2, 6, 15, 24, and 36 months old. Six indicators were based on data that were collected at all five possible home visit periods (i.e., at 2-, 6-, 15-, 24-, and 36-month visits). Thus, from the data at each time point, we were able to construct changes from one time point to the next for each of these variables. They included (a) the total number of times the child moved physically to another residence, (b) the total number of changes in the mother figure in the home, (c) the total number of changes in the father figure, (d) the total number of different people living in the household, (e) the total number of times household members moved into or out of the household, and (f) report of the average number of hours that the TV was on each day, an index of ambient background noise in the home (this was a simple average of the number of hours the TV was reported to be on at each separate visit). A seventh indicator, average household density, was created using data that were collected at four home visits (i.e., 2, 6, 24, and 36 months). At each visit, the number of rooms in the home was divided by the number of people residing in the home to create a time-specific household density score. This item reflected the average density across these three time points. The eighth, ninth, and tenth indicators were consensus ratings by the two research assistants who completed the initial home visit at each time point. These indicators and the consensus procedure were selected from the Post-Visit Inventory used in the Fast Track Intervention Study (Dodge, Pettit, & Bates, 1994) at the 2-, 6-, 24-, and 36-month home visits that captured the chaos indicators in the household. These included the following three items: (a) home visit preparation by the household (0 = cannot rate, 1 = surprise/difficulty, 2 = aware, but unprepared, 3 = aware/ready, 4 = good hosts), (b) the cleanliness of the household (0 = cannot rate, 1 = very dirty, 2 = slightly dirty, 3 = messy, 4 = clean), and (c) the neighborhood noise level around the home (0 = cannot rate, 1 = very quiet, 2 = average, 3 = noisy, 4 = very noisy). Scores of "0" on these indicators were treated as missing in the analyses.

The structure of the 10 chaos indicators over the first 3 years of the children's lives was examined using a combination of principle components analysis (PCA) and exploratory factor analysis (EFA). PCA indicated that two eigenvalues optimally represented the covariation in these 10 items. Following best practices, scree plots and parallel analyses were evaluated to determine the optimal number of factors to retain (Dinno, 2009; Floyd & Widaman, 1995). A follow-up EFA model was examined, which forced extraction of two correlated factors (see Vernon-Feagans et al., 2012, for details). We labeled the first factor Household Instability, which included five variables: (a) the number of people moving in and out of the household, (b) the total number of people in the household, (c) the number of actual household moves, (d) the number of changes in the mother figure in the home, and (e) the number of changes in the father figure/grandmother in the home. We labeled the second factor Household Disorganization, and it also included five variables: (a) household density, (b) background noise as indexed by

the reported number of hours the TV is on per day, (c) the family's overall rated preparation for home visits, (d) the rated cleanliness of the home, and (e) the rated neighborhood ambient noise.

PCA and EFA results were consistent across weighted and unweighted analyses. These 10 indicators were standardized ($M = 0$, $SD = 1$) and averaged to create two composite scores. The Household Instability and Household Disorganization composites had reasonable internal consistency (Cronbach's alphas of .76 and .67, respectively) and were positively correlated with each other, $r = .38$, $p < .0001$, as well as with maternal education ($r$ instability $= -0.34$; $r$ disorganization $= -0.56$; $ps < .0001$) and household income ($r$ instability $= -0.32$; $r$ disorganization $= -0.58$; $ps < .0001$).

**Parental responsiveness and acceptance of the child.** The HOME Inventory was designed to measure the overall quality of parenting in the home environment during infancy and toddlerhood (Bradley, Caldwell, & Rock, 1988). The FLP used two of the subscales of the HOME that captured the quality of parenting for the child's age. These included (a) Responsivity, which measured the mother's sensitivity and warmth as well as the mother's scaffolding through appropriate positive verbal interactions; and (b) Acceptance of the Child, which measured general punitive and harsh parenting (items reversed scored).

Home visitors were initially trained by Bob Bradley on the correct administration of the HOME in order to measure the quality and quantity of stimulation and support available to each child in the home environment. Information used to score the items was obtained during the course of the home visit by means of observation and a semistructured interview conducted by our two home visitors. The infant HOME contains six subscales, but only three were administered to FLP families: Parent Responsivity, Parent Acceptance of the Child, and Home Resources for the Child. Because we were interested in parenting and not the resources in the home, we only included the Parent Responsivity and Acceptance subscales of the HOME. In infancy, these two subscales contain 19 items. The toddler/preschool version of the HOME used at 36 months included 11 items. Each of these items (e.g., "Caregiver's voice conveys positive feelings toward the child") was scored by trained research assistants in a yes–no fashion. The internal consistency estimate from the FLP sample was 0.78.

**EF.** A common battery of EF tasks was administered at the 36-, 48-, and 60-month home visits. The task administration procedures, psychometric properties of individual tasks and the overall battery score, retest reliability, and criterion validity of these tasks have been elaborated elsewhere (Willoughby & Blair, 2011; Willoughby, Blair, Wirth, Greenberg, & The Family Life Project Key Investigators, 2012; Willoughby, Wirth, Blair, & The Family Life Project Key Investigators, 2012). These 7 tasks included Working Memory Span (WMS), Pick the Picture Game (PTP), Silly Sounds Stroop, Spatial Conflict, Spatial Conflict Arrows, Animal Go No-Go, and Something's the Same Game.

As previously elaborated (Willoughby, Blair, et al., 2012), individual EF tasks exhibited longitudinal measurement invariance. EF task scoring was facilitated by drawing a calibration sample of children—all of whom were deemed to have high-quality data (e.g., data collectors did not report interruptions, children completed multiple tasks)—from across the 36-, 48-, and 60-month assessments (no child contributed data from more than one assessment). Graded response models were used to score the two tasks with polytomous item response formats (i.e., PTP, WMS), whereas two-parameter logistic models were used to score the remaining tasks (all of which involved dichotomous-item response formats) in the calibration sample. The set of item parameters that was obtained from the calibration sample was applied to *all* children's EF data across *all* assessments, resulting in a set of item-response-theory-based (i.e., expected a posteriori) scores for each task that were on a common developmental scale. Children's mean performance across all of their completed tasks at a given assessment served as their overall battery score.

**Teacher-rated behavioral regulation.** Kindergarten teachers rated children's ADHD symptoms, which were drawn from the Disruptive Behavior Disorders Scale (Pelham, Evans, Gnagy, & Greenslade, 1992). Each symptom was rated on a 4-point Likert rating scale (from 0 = *never or rarely* to 3 = *very often*) and referred to behaviors that had occurred over the last 6 months. Exemplar items included "fails to give close attention to details" or "blurts out answers before questions have been completed."

Teachers also completed the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997), which is a 25-item screening questionnaire for use with children 3 to 16 years old. Items were rated on a 3-point Likert scale (0 = *not true*, 1 = *somewhat true*, 2 = *certainly true*). The SDQ has five subscales (Emotional Symptoms, Conduct Problems, Prosocial Behavior, Peer Relationship Problems, and Hyperactivity/Inattention), but the current study only used the Hyperactivity/Inattention scale (e.g., easily distracted, concentration wanders), which had adequate internal consistency ($\alpha = .89$).

**Performance-based child behavioral regulation.** Direct assessments of children's behavioral regulation were conducted at the children's schools when they were in kindergarten using the Puzzle Box Task (Feagans & Farran, 1981; Feagans & Short, 1986) and the Head-Toes-Knees-Shoulders Task (Ponitz et al., 2008). The Puzzle Box Task was designed to mimic the kinds of working memory and attention that are required by young children as they enter formal schooling. The task requires children to follow a series of three complicated verbal steps that, if followed correctly and in the right sequence, will result in being able to open an attractive puzzle box that contains a piece of candy. The box was designed so that at each step there were distractors that could lead the child to push the wrong lever on the box or slide the lever in the wrong direction. Thus, the child was required to listen carefully and to hold in working memory complex information that needed to be enacted in the correct temporal sequence. After making sure the child understood the meaning of each word in the task, the research assistant told the child that if they followed the directions, they would be able to open the box and get a piece of candy. The directions were repeated up to 3 times if needed for the child to do the task correctly. If the child failed on the final trial, the research assistant aided the child in completing the task, so all children received the candy inside the box. The verbal directions were as follows.

1. *Take the key on the blue side of the box and turn it toward the heart.* (There is a distractor key on the red side of the box and the key can be turned toward the heart or toward a distractor star.)

2. *Then, take the stick on the yellow side of the box and pull it out.* (There is a distractor stick on the red side of the box and the stick can be pushed or pulled.)

3. *Then, you can open the little red door on the top of the box and you'll find the candy.* (There is a blue distractor box on the top of the box).

Children received a perfect score if they completed all steps on the first reading of the directions. Children received partial credit for completing one or two of the parts of the direction on each of the trials needed.

The Head-Toes-Knees-Shoulders Task integrates working memory, attention, and inhibitory control in one game-like task involving four paired verbal rules: "Touch your head" and "Touch your toes"; "Touch your shoulders" and "Touch your knees." Children first responded to the verbal commands as spoken and then were instructed to switch and respond in an "opposite" way (such as touching their head when told to touch their toes). To succeed, children must master and apply three cognitive skills to gross motor movements: (a) focusing on instructions and commands, (b) using working memory to remember and execute new rules while processing commands, and (c) inhibiting the automatic response while responding correctly. The task taps behavioral regulation by requiring children to pay attention to the verbal directions, use working memory to remember the verbal instructions while responding, and demonstrate inhibitory control by inhibiting an initial prepotent response and initiating the correct response. Interrater reliability, scoring agreement, and test–retest reliability have been reported as high, with alphas of .93 over a 3-month period (Ponitz et al., 2008, 2009).

# Results

## Analytic Strategy

All study questions were addressed using structural equation models (SEMs). All SEMs utilized a robust full information maximum likelihood estimator and took into account the complex sampling design (stratification and individual probability weights). Model fit was evaluated using the likelihood ratio chi-square test, as well as the comparative fit index (CFI) and the root mean squared error of approximation (RMSEA) fit indices, in which values of CFI $>=$ .95 and RMSEA $<$ .05 were indicative of good fit (Hu & Bentler, 1999). All models were estimated using Version 7.1 of Mplus software (Muthén & Muthén, 1998–2013).

## Preliminary Analyses

**Descriptive statistics.** Correlations among all of the measured variables that were used in this study appear in Table 1. Four points were noteworthy. First, cumulative indices of household chaos (disorganization, instability) and socioeconomic status indicators (household income to needs ratio, mother education) were all moderately intercorrelated ($|r|$s = .34 to .60). Disorganization was more strongly associated with mother education and household income ($|r|$s = −.58 and −.60, respectively) than was instability ($|r|$s = −.38 and −.34, respectively). Second, cumulative chaos and socioeconomic status indicators were all moderately intercorrelated with time-specific indicators of the home environment ($|r|$s = .13 to .45). Notably, chaos disorganization was equally (or more) strongly associated with time-specific indices of parenting behaviors, as were the socioeconomic status indicators. Third, the chaos composites, socioeconomic status indicators, and time-specific indicators of home quality were all moderately correlated with EF composite scores at Ages 3, 4, and 5 years ($|r|$s = .12 to .32), as well as with teacher-rated and performance-based indicators of behavioral regulation in kindergarten ($|r|$s = .06 to .28). Fourth, the time-specific indicators of EF (at Ages 36 to 60 months) were moderately correlated with teacher-rated and performance-based indicators of regulation in kindergarten ($|r|$s = .10 to .48). This overall pattern of correlations was broadly consistent with study hypotheses. Structural equation models were estimated to facilitate data reduction and to provide direct tests of study hypotheses.

Table 1
*Bivariate Correlations Among all Study Variables*

| Variable name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Mother education (years) | — | | | | | | | | | | | | | | |
| 2. Income needs ratio | .60 | — | | | | | | | | | | | | | |
| 3. Chaos-Disorganization | −.58 | −.60 | — | | | | | | | | | | | | |
| 4. Chaos-Instability | −.38 | −.34 | .40 | — | | | | | | | | | | | |
| 5. Parenting (6 months) | .37 | .33 | −.45 | −.27 | — | | | | | | | | | | |
| 6. Parenting (15 months) | .38 | .32 | −.44 | −.21 | .39 | — | | | | | | | | | |
| 7. Parenting (24 months) | .34 | .32 | −.45 | −.22 | .30 | .40 | — | | | | | | | | |
| 8. Parenting (36 months) | .27 | .21 | −.35 | −.13 | .18 | .30 | .30 | — | | | | | | | |
| 9. EF (36 months) | .25 | .23 | −.25 | −.12 | .19 | .17 | .21 | .10 | — | | | | | | |
| 10. EF (48 months) | .31 | .25 | −.32 | −.20 | .27 | .27 | .19 | .21 | .39 | — | | | | | |
| 11. EF (60 months) | .30 | .25 | −.30 | −.21 | .26 | .29 | .25 | .22 | .36 | .61 | — | | | | |
| 12. HTKS | .22 | .21 | −.28 | −.13 | .20 | .23 | .22 | .21 | .25 | .46 | .48 | — | | | |
| 13. Puzzle box | .11 | .08 | −.06 | −.11 | .07 | .07 | .11 | .07 | .10 | .22 | .23 | .29 | — | | |
| 14. ADHD behaviors | −.17 | −.16 | .22 | .13 | −.16 | −.21 | −.21 | −.17 | −.19 | −.33 | −.37 | −.30 | −.14 | — | |
| 15. SDQ hyperactivity | −.25 | −.19 | .28 | .13 | −.19 | −.28 | −.25 | −.21 | −.19 | −.36 | −.41 | −.34 | −.16 | .87 | — |
| Mean | 13.07 | 2.21 | −.11 | −.09 | .85 | .86 | .85 | .88 | −.48 | −.04 | .36 | 27.87 | .75 | .63 | .70 |

*Note.* $N = 1{,}145$; all $|r|$s $> .05$, $p < .05$. EF = executive function composite; HTKS = Head Toes Knees Shoulders task; ADHD = attention-deficit hyperactivity disorder; SDQ = Strengths and Difficulties Questionnaire.

**Growth and measurement models.** A series of models were estimated to facilitate data reduction. First, a latent growth curve (LGC) model was estimated to characterize individual differences in both level and rate of change in EF across time. With only three assessments, a linear model was estimated. Time was coded such that the intercept referred to EF at 36 months. We used two fit indices. We used Steiger-Lind root mean square error of approximation (RMSEA; Steiger, 1990) with its 90% confidence interval and Bentler comparative fit index (CFI; Bentler, 1990). This model fit the data well, $\chi^2_N = 1{,}121$ (1) = 1.2, $p = .28$, CFI = 1.0, RMSEA (90% confidence interval [CI]) = .01 (.00–.08). There were significant individual differences in both initial level ($\mu_{\text{Intercept}} = -.47$, $\varphi^2_{\text{Intercept}} = .12$, $ps < .001$) and rate of change ($\mu_{\text{Slope}} = .41$, $\varphi^2_{\text{Slope}} = .04$, $ps < .001$) in EF. The intercept and slope parameters were significantly negatively correlated, $\varphi = -.27$; children who started with the lowest levels of EF at 36 months exhibited faster linear increases in EF from Age 36 months to 60 months. The linear model accounted for 42%, 47%, and 93% of the observed variation in EF scores at Ages 36, 48, and 60 months, respectively.

Next, the LGC model was extended to include three additional latent variables—parent responsive and accepting behaviors across the first 3 years of life (via the HOME at 6, 15, 24, and 36 months), teacher-rated regulation in kindergarten (overall ADHD behaviors, SDQ Hyperactivity scale), performance-based regulation in kindergarten (HTKS, Puzzle Box Task), as well as four manifest variables—the two cumulative chaos indicators (disorganization, instability) and the two socioeconomic status indicators (household income to needs ratio, mother education). The model was parameterized such that all of the latent and manifest variables were freely intercorrelated. This model fit the data well, $\chi^2_N = 1145$ (61) = 106.1, $p = .0003$, CFI = .99, RMSEA (90% CI) = .03 (.02–.03).

All of the estimated factor loadings were statistically significant and in the expected directions. Moreover, the variances for all of the manifest and latent variables were statistically significant. As summarized in Table 2, with the exception of the linear slope term for the EF composite scores, all of the study constructs were moderately to strongly intercorrelated. Although the overall pattern of correlations among the latent constructs was similar to that described earlier (see Table 1), the magnitude of the correlations was stronger because of the use of latent variables, which accounted for measurement in time-specific indicators.

## Structural Equations Model

**Direct effects.** The previous measurement model established moderate-sized bivariate associations between all study constructs. In the SEM model, directional associations were tested. Specifically, the teacher-rated and performance-based regulation constructs were regressed on the EF intercept and slope, the parental responsivity and acceptance latent construct, and the four chaos and socioeconomic manifest variables. The EF intercept and slope were regressed on the parental responsivity and acceptance latent construct and the four chaos and socioeconomic manifest variables. Finally, the parental responsivity and acceptance latent construct was regressed on the four chaos and socioeconomic manifest variables. Correlations were freely estimated between the chaos variables and socioeconomic status indicators, between the EF intercept and slope, and between the teacher-rated and child performance-based regulation outcomes. Model fit for this final SEM model was identical to that described in the previous measurement model (i.e., these models were chi-square equivalent; the current model differed only from the previous model in that previously nondirectional [correlational] associations were now parameterized as directional [regression]).

The standardized coefficients for all of the direct effects that were statistically significant are depicted in Figure 1. Here, we report all standardized coefficients (including those that were not statistically significant) and exact *p* values. In terms of teacher-rated behavioral regulation in kindergarten, parenting behaviors ($\beta = -.26$, $p = .003$), EF intercepts ($\beta = -.29$, $p < .001$), and EF slopes ($\beta = -.25$, $p < .001$) each exerted significant and unique direct effects. Children who were the recipients of more responsive and accepting caregiving, and/or who exhibited higher levels of EF at Age 36 months, and/or who exhibited faster rates of improvement in EF from Age 3 to 5 exhibited lower levels of teacher-rated ADHD behaviors in kindergarten. None of the variables of maternal education ($\beta = -.01$, $p = .82$), family income ($\beta = .04$, $p = .39$), chaos disorganization ($\beta = -.00$, $p = .97$), or chaos instability ($\beta = -.04$, $p = .30$) were uniquely associated with teacher-rated behavioral regulation. Collectively, the set of predictors explained approximately one quarter of the variation in the latent construct of teacher-rated behavioral regulation ($R^2 = .26$).

A similar pattern of results was evident for performance-based behavioral regulation in kindergarten. Specifically, EF intercepts

Table 2
*Correlations Among Study Constructs*

| Construct Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| 1. Mother education (years) | — | | | | | | | | |
| 2. Income needs ratio | .60*** | — | | | | | | | |
| 3. Chaos-Disorganization | −.58*** | −.60*** | — | | | | | | |
| 4. Chaos-Instability | −.38*** | −.34*** | .40*** | — | | | | | |
| 5. Parenting (responsivity/acceptance) | .60*** | .52*** | −.75*** | −.37*** | — | | | | |
| 6. Executive function: Intercept | .45*** | .39*** | −.43*** | −.23*** | .53*** | — | | | |
| 7. Executive function: Slope | −.04 | −.06 | .01 | −.07 | .11 | −.14 | — | | |
| 8. Kindergarten regulation (Rated) | −.25*** | −.19*** | .28*** | .13*** | −.41*** | −.37*** | −.24** | — | |
| 9. Kindergarten regulation (Perform) | .28*** | .25*** | −.33*** | −.17*** | .46*** | .63*** | .26* | −.41*** | — |

*Note.* $N = 1{,}145$. $\chi^2 = 106.13$, $df = 61$, $p = .0003$, RMSEA = .025 (.017–.033, $p = 1.0$), CFI = .99.
* $p < .05$. ** $p < .01$. *** $p < .001$.

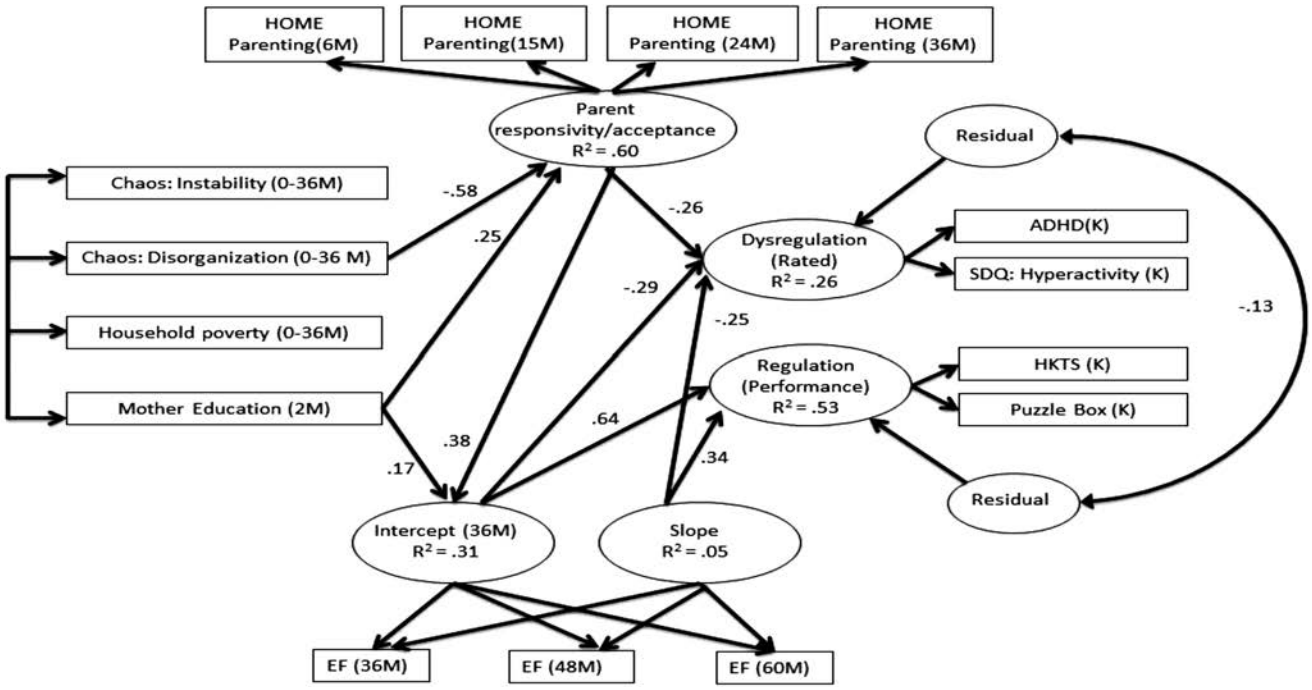


*Figure 1.* Results of full structural equation model. "Parenting" refers to the responsivity and acceptance subscales of the HOME. EF = executive function; SDQ = Strength and Difficulties Questionnaire; ADHD = attention-deficit hyperactivity disorder; HTKS = Head Toes Knees Shoulders task; M = months; K = kindergarten.

($\beta$ = .64, $p < .001$) and slopes ($\beta$ = .34, $p$ = .002) each exerted significant and unique direct effects. Children who exhibited higher levels of EF at Age 36 months and who exhibited faster rates of improvement in EF from Age 3 to 5 years demonstrated significantly better on performance-based measures of behavioral regulation in kindergarten. None of the variables of parenting behaviors ($\beta$ = .13, $p$ = .29), maternal education ($\beta$ = −.06, $p$ = .19), family income ($\beta$ = .00, $p$ = .98), chaos disorganization ($\beta$ = −.01, $p$ = .91), or chaos instability ($\beta$ = .02, $p$ = .65) were uniquely associated with performance-based behavioral regulation. The set of predictors explained over one half of the variation in the latent construct of performance-based behavioral regulation ($R^2$ = .53).

In terms of EF intercepts, both parenting behaviors ($\beta$ = .38, $p$ = .001) and mother education ($\beta$ = .17, $p$ = .03) exerted unique direct effects; children who were the recipients of more responsive and accepting parenting behaviors and whose parent was more highly educated had higher scores on the EF composite at Age 3. In contrast, none of the variables of family income ($\beta$ = .09, $p$ = .24), chaos disorganization ($\beta$ = −.00, $p$ = .99), or chaos instability ($\beta$ = .01, $p$ = .87) were uniquely associated with EF intercepts at Age 3 years. Moreover, none of the variables of mother education ($\beta$ = −.12, $p$ = .22), family income ($\beta$ = −.09, $p$ = .32), chaos disorganization ($\beta$ = .16, $p$ = .25), or chaos instability ($\beta$ = −.10, $p$ = .22) were uniquely associated with EF slopes. There was, however, a trend for more responsive and accepting caregiving behaviors to be associated with faster rates of improvement in EF abilities from Age 3 to 5 years of age ($\beta$ = .32, $p$ = .08). The set of predictors explained nearly one third of the variation in EF intercepts ($R^2$ = .31) and a negligible amount of the variation in EF slopes ($R^2$ = .05).

In terms of parenting behaviors, chaos disorganization ($\beta$ = −.58, $p < .001$) and mother education ($\beta$ = .25, $p < .001$) each exerted unique direct effects. In contrast, neither family income ($\beta$ = .01, $p$ = .73) nor chaos instability ($\beta$ = −.04, $p$ = .32) were uniquely associated with parenting behaviors. Collectively, this set of predictors explained over one half of the variation in the latent construct of home quality ($R^2$ = .60).

**Indirect effects.** The previous results indicated that chaos disorganization was uniquely associated with parenting behaviors, which were uniquely associated with EF intercepts (and possibly slopes, $p$ = .08), both of which were uniquely associated with kindergarten outcomes. These results were suggestive of a possible indirect path through which chaos disorganization was associated with child outcomes. In order to systematically investigate this possibility, we considered five indirect effects for two aspects of chaos (disorganization, instability) and the two kindergarten outcomes (teacher-rated and performance-based measures of behavioral regulation). The five indirect effects that were considered took the form (a) chaos → parenting → K outcome, (b) chaos → EF intercept → K outcome, (c) chaos → EF slope → K outcome, (d) chaos → parenting → EF intercept → K outcome, and (e) chaos → parenting → EF slope → K outcome.

With respect to the teacher-rated behavioral regulation, two of the five possible indirect effects that involved chaos disorganization were statistically significant. Chaos disorganization was indirectly associated with teacher-rated behavioral regulation through intermediate effects on parenting behaviors ($\beta_{\text{Disorg} \rightarrow \text{Parenting} \rightarrow \text{Teacher-Rated Regulation}}$ =

.15, $p = .004$) and their resulting effects on EFs at Age 3 ($\beta_{\text{Disorg} \rightarrow \text{Parenting} \rightarrow \text{EF intercept} \rightarrow \text{Teacher-Rated Regulation}} = .06$, $p = .008$). None of the remaining indirect effects involving chaos disorganization or chaos instability were statistically significant.

With respect to child performance-based behavioral regulation, only one of the five possible indirect effects that involved chaos disorganization was statistically significant. Chaos disorganization was indirectly associated with performance-based behavioral regulation through combined effects on parenting behaviors and their resulting effects on EFs at Age 3 ($\beta_{\text{Disorg} \rightarrow \text{Parenting} \rightarrow \text{EF intercept} \rightarrow \text{Performance-Based Regulation}} = -.14$, $p = .005$). None of the remaining indirect effects involving chaos disorganization or chaos instability were statistically significant.

## Discussion

The major contribution of this study was to help clarify whether early household chaos disorganization and/or instability might have a direct influence on EF and behavioral regulation, or, as suggested by a number of authors (Brown et al., 2013; Evans et al., 2005; Hughes et al., 2014), whether household chaos may impact EF and behavioral regulation indirectly through early parenting. The findings in the current study found no direct relationship between household chaos measures and early EF or kindergarten regulation. Instead, we found that only household disorganization chaos over time in early childhood appeared to be negatively related to parental responsiveness and acceptance of the child. In turn, the parenting measure predicted EF at 36 months and EF growth from 36 to 60 months in predicting behavioral regulation at the end of kindergarten. This study stresses the importance of a more developmental and longitudinal approach to understanding these constructs and points to parenting as the possible mechanism through which household disorganization had its most immediate negative impact. Because we were able to examine both the direct and indirect impacts of household chaos, we lend support to the indirect path, such that household disorganization may have its greatest negative impact not directly but indirectly through parenting.

Specifically, household chaos disorganization, but not household instability, over the child's first 3 years only had an effect on the quality of parenting, which in turn had an effect on early EF at 3 years of age as well as change in EF from 3 to 5 years of age. These paths were significant even when controlling for family poverty and maternal education. Like some previous studies, household disorganization in this study had a unique effect beyond poverty (Brown et al., 2013; Hart, Petrill, Deckard, & Thompson, 2007; Razza, Martin, & Brooks-Gunn, 2012; Vernon-Feagans, Garrett-Peters, Willoughby, et al., 2012). Thus, chaos disorganization may be the more proximal process in the home that captures some of the poverty-related adversity that leads to poorer parenting. Furthermore, it has been argued that even though many studies have controlled for poverty in examining chaos effects on children's development, most of these previous studies did not include large enough samples of low-income children to truly understand whether chaos was a unique contributor to development (Evans et al., 2010). The current study had a large proportion of low-income children in a representative sample of children who lived in low-wealth rural communities. Thus, this study lends specific evidence for the unique effects of chaos disorganization in predicting parenting behaviors and later child EF and regulation.

Unlike most other studies that used the CHAOS parent report measure or individual indicators of chaos, our findings seem particularly important because our study measured both household instability and disorganization in a multifaceted and multi-informant way (10 indicators) while tracking these indicators of chaos longitudinally over the child's first 3 years of life. Thus, it would seem that our measure would be a more stable indicator of chaos and would contribute to an objective measure beyond parent report. In addition, it has been argued theoretically that the chronic experience of chaos over time should produce the most detrimental effects on children's development (Lichter & Wethington, 2010), again suggesting that the measurement of chaos in this article is a contribution and extension of previous research (Evans & Wachs, 2010), while supporting previous work on the importance of chaos beyond demographic characteristics like poverty. In future studies, it would be important to use both the CHAOS questionnaire as well as more objective measures like ours to understand the unique effects of both chaos measures on children's development.

We believed that chaos disorganization would be the most disruptive aspect of chaos for children's regulatory behaviors because it is experienced on a daily basis in everyday living, whereas chaos instability is experienced less often. Although young preschool children are just beginning to develop brain processes that allow for the cognitive/behavioral capacities to both attend to and screen out irrelevant stimuli, chaos disorganization and instability in the home did not appear to be directly related to either early EF skills or later behavioral regulation. As others have argued (Evans et al., 2010; Matheny et al., 1995; Wachs & Corapci, 2003), the disorganized chaotic household appears in this study to disrupt positive parenting, such that parents may not be able to scaffold children's early EF and regulatory skills.

Chaos instability has been found in other studies to be related to both parenting and regulatory behaviors (Ackerman et al., 1999; Brown et al., 2013; Schmitt et al., 2015), yet in the current study, instability was not an important predictor of behavioral regulation or EF. Our lack of findings with respect to instability may be a result of a variety of factors. First, our measurement of instability was very early in life when the child has less exposure to the outside world of neighborhood and schools. It might be that instability has its largest impact later when children are in school. There is some evidence for this in other samples. In a large sample of children, it was found that instability had its greatest impact on problem behaviors when the moves were at school age rather than in the preschool period (Tiesler et al., 2013). This might be especially true because residential moves include a different neighborhood with different peers, and likely a different school that would impact both older children's peers and teachers, but would not be as likely to impact preschool children. Another study (Tucker et al., 1998) found that residential instability in elementary schoolchildren was not related to poorer academic/behavioral outcomes for children in two-biological-parent families but did relate to poorer outcomes for all other family constellations, suggesting that children from risky backgrounds might be more affected by school-age residential mobility.

Second, our instability measure did not measure whether the changes in the residence or changes in the people in the home were positive or negative. Some residential changes may be good, as when young families advance by buying a home, or when a young family moves out of their family of origin, this could also be a

positive move. A recent study investigated residential moves of poor children in relationship to children's behavioral and cognitive dysregulation in fifth grade (Roy, McCoy, & Raver, 2014). Stable residential locations and moves to low-poverty neighborhoods were advantageous for regulatory abilities, but moves into poverty neighborhoods were detrimental to teacher-rated child regulatory abilities. Thus, future studies may need to differentiate the reasons for residential moves and moves of people in and out of the household to better understand the impact of instability.

An important finding from this study was that EFs predicted both teacher ratings of behavioral regulation and performance-based measures of behavioral regulation. Using multimethod measurement, including teacher-rated and child performance-based measures of behavioral regulation, strengthens findings when different measurements are in the same direction (Holmbeck et al., 2002). Teacher ratings and child performance on tasks have not always been found to correlate highly with each other, but each may tap different but important aspects of behavioral regulation. For instance, a recent study relating teacher ratings of hyperactivity/inattention were related to child performance on EF tasks, with correlations between −.18 and −.22 (Lakes, 2013); but there was clearly significant unique variance contributed by each, which is in line with the current study. Thus, the finding that EF related to both outcomes more strongly supports the importance of EF in understanding behavioral regulation as rated by the teachers and on child performance measures.

The results from this study come from a representative sample of children who lived in low-wealth rural counties in North Carolina and Pennsylvania. The findings are more generalizable to other rural low-wealth areas because of the representative sample, but may be different from more urban/suburban populations. Given the greater risk factors in many low-wealth rural communities with respect to geographic isolation, fewer good jobs, and poorer educational settings (Vernon-Feagans, 2008), the findings here may be stronger than for other children and families.

In summary, this study was a strong test of the relationship between early childhood household chaos and later behavioral regulation in kindergarten, beyond poverty-related aspects of the home (Raver et al., 2013). This study adds to the literature on the importance of processes in the home environment in early childhood that may be linked to later school readiness skills. Chaos, specifically household disorganization, appeared to be an important source of variation in homes—beyond poverty and maternal education—that was linked to important parenting processes in the home. Parenting responsiveness and acceptance were linked to better 3-year EF and changes in EF from 3 to 5 years of age, and, in turn, both the EF intercept and slope were predictive of later rated and observed behavioral regulation in kindergarten. Although this is a descriptive study that cannot claim causation, these longitudinal findings suggest that household disorganization and its negative relationship to parenting and EF may be particularly important precursors to behavioral regulation processes that lay the foundation for children's learning in school.

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