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Effects of socioeconomic status and executive function on school readiness across levels of household chaos

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Abstract

Isolating child attributes and familial characteristics that support school readiness in children on the upper half of the socioeconomic spectrum can complement existing research on lower-socioeconomic status (SES) children and facilitate a more complete understanding of how children's performance varies across the full SES spectrum. This study examined if relations between SES, two components of executive function (EF; set-shifting and inhibitory control), and school readiness vary as a function of household chaos in 564 four-year-old children, primarily from middle-to upper-middle class families in the Northeast Region of the United States. Structural equation modeling of direct and indirect effects revealed three major findings: 1) higher levels of EF were related to better school readiness regardless of level of household chaos; 2) SES had an indirect effect on school readiness through set-shifting; and 3) household chaos was negatively associated with school readiness.

Keywords

school readiness; executive function; household chaos; socioeconomic status; preschool; early experience

Introduction

School readiness refers to the behavioral, socioemotional, and academic preparedness of young children to learn in school and forecasts later academic success, employment, and health (Duncan et al., 2007; Quirk, Grimm, Furlong, Nylund-Gibson, & Swami, 2016). Individual differences in children's skills emerge early in development and research

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indicates that this variability may be due to complex interactions between children and their surroundings (e.g., Bronfenbrenner & Morris, 2006). Therefore, identifying child attributes and familial characteristics that support school readiness may help to recognize which children may benefit from additional support prior to formal school entry and can serve to isolate targeted avenues for that support. Due to their theoretical relevance to and observed associations with school readiness, socioeconomic status (SES), household chaos, and executive function have emerged as potential targets for interventions aimed at promoting school readiness (Blair, 2002; Evans, 2006; Lee & Burkham, 2002).

Households are key contexts in which children's executive function and school readiness develop, but it remains unknown if the well-documented associations between SES, executive function, and school readiness (Blair & Raver, 2015; Sarsour et al., 2011; Sirin, 2005) are the same for all children, or if the relations differ as a function of level of chaos in the home (i.e., if household chaos moderates these associations). This is an important question, as findings may shed light on potentially differing mechanisms that propel associations between SES and school readiness (NICHD Early Child Care Research Network, 2003) for children living in homes with varying levels of household chaos. If a differential pattern of effects emerges for children living in chaotic homes, interventions may address household chaos prior to interventions focused on executive function.

Socioeconomic Status and School Readiness

Research points to links between familial socioeconomic standing and child outcomes. For example, children from families with low SES lag behind higher-SES peers in school readiness (Browne, Wade, Prime, & Jenkins, 2018; Larson, Russ, Nelson, Olson, & Halfon, 2015; Palermo, Ispa, Carlo, & Streit, 2018; Solano & Weyer, 2017; Walker, Greenwood, Hart, & Carta, 1994) an effect that is amplified as children progress through school (The Family Life Project Key Investigators, 2018). A meta-analysis revealed a medium effect size for the relation between SES and academic achievement (Sirin, 2005), indicating that social and economic contexts appear to be key in understanding why some children do not succeed academically.

SES-related achievement gaps are also evident prior to formal schooling (Lee & Burkham, 2002), underscoring the need for examinations of SES-related achievement gaps before school entry. Further, although the links between SES and child outcomes are often examined in children living at or near the poverty line, SES effects have been demonstrated for academic achievement across the full SES spectrum (Lawson & Farah, 2015). There is a widening achievement gap across the top 50% of the socioeconomic spectrum, such that the gap between families with incomes in the 90th percentile and families with incomes in the 50th percentile is greater than the gap between the 50th and 10th percentiles (Reardon, 2011). Therefore, it is important to examine how SES is related to individual differences in school readiness in middle-to upper-socio economic strata to better understand school readiness across the full SES spectrum. The current study advances this effort.

SES and Executive Function

Accumulating evidence indicates that SES indirectly influences child academic outcomes through executive functions (Dilworth-Bart, 2012). Executive function is the capacity to plan, organize, and monitor the execution of behaviors that are strategically directed in a goal-oriented manner (Zelazo et al., 2013). Two foundational and commonly indexed components of executive function include: (1) set-shifting, the ability to flexibly switch among multiple tasks to meet changing environmental demands; and (2) inhibitory control, the suppression or delay of a prepotent, salient response for one that is less dominant to achieve a goal (Miyake et al., 2000; Wiebe et al., 2011). Attention also plays a critical role in executive function, as it allows children to control the internal and external information that they process (see Posner & Rothbart, 2013 for a discussion of attention development in self-regulation, a broader construct that is subserved by executive function; Hofmann, Schmeichel, & Baddeley, 2012).

Substantial development in executive function occurs across the preschool period (Carlson, 2005). Therefore, it is particularly vulnerable to early environmental impacts, such as SES (Blair, 2010; Hackman, Farah, & Meaney, 2010). Lower SES children tend to perform more poorly on executive function tasks across development (see Hackman, Gallop, Evans, & Farah, 2015 for a discussion). Behavioral evidence of SES-related differences in executive function is bolstered by brain-based assessments that reveal differences in brain function and structure associated with executive function abilities across high and low SES children (Blair, 2010; Kishiyama, Boyce, Jimenez, Perry, & Knight, 2008; Noble, Houston, Kan, & Sowell, 2012). For example, low SES children show reduced extrastriate and novelty-related event related potential responses, indicating altered prefrontal function (Kishiyama et al., 2008). However, as has been demonstrated for academic achievement (Lawson & Farah, 2015), SES effects on executive function have emerged across the full SES spectrum (Noble, McCandliss, & Farah, 2007; Sarsour et al., 2011). Again, this highlights the need for examinations of the links between SES, executive function, and school readiness in children on the upper half of the SES spectrum to complement existing research on lower-SES children and facilitate a more complete understanding of how children's performance varies across the full SES spectrum.

Executive Function and School Readiness

The importance of executive function to academic competence is indisputable; better executive function skills are associated with better school readiness level and improvement in academic success (see Blair, 2002 for a review). Advanced executive function skills place children at an advantage at school entry that is maintained throughout early schooling (Bull, Espy, & Wiebe, 2008). Executive function accounts for significant variance in preschool math scores (Espy et al., 2004; Fitzpatrick, McKinnon, Blair, & Willoughby, 2014; Nesbitt, Baker-Ward, & Willoughby, 2013), grade 1 math and literacy achievement (Nesbitt et al., 2013) and longitudinally predicts mathematics and reading achievement in middle childhood (Bull et al., 2008; Clark, Pritchard, & Woodward, 2010).

A meta-analysis of 75 studies with samples of children in preschool and kindergarten across a wide range of SES reported a mean effect size (indexed by bivariate correlations) of .27

between one aspect of executive function, inhibitory control, and academic performance, with stronger relations emerging with behavioral measures as compared to parent-report (Allan, Hume, Allan, Farrington, & Lonigan, 2014). The association between executive function and academic achievement is so robust that the relation withstands control for cognitive abilities (Espy et al., 2004), baseline academic capacities (McClelland et al., 2007) and maternal education (Espy et al., 2004). In fact, good executive function is so essential for academic achievement that research indicates that executive function is often a better predictor of academic achievement than IQ (Blair & Raver, 2015) and executive function interventions improve academic outcomes (Bierman, Nix, Greenberg, Blair, & Domitrovich, 2008). Examining how individual differences in executive function skills are related to school readiness may inform interventions aimed at improving children's school readiness through improving executive function.

Indirect Effects of SES on School Readiness through Executive Function

Accumulating evidence points to executive functions as pathways by which SES can influence academic outcomes (Dilworth-Bart, 2012; Nesbitt et al., 2013; The Family Life Project Key Investigators, 2018). Higher SES is associated with better executive function, which, in turn, is associated with better academic outcomes (Bierman et al., 2008; Brody & Flor, 1997; Crook & Evans, 2013; Dilworth-Bart, 2012; Fitzpatrick et al., 2014; Nesbitt et al., 2013; NICHD Early Child Care Research Network, 2003). One potential mechanism for this effect is that children living in higher-SES homes who are exposed to age-appropriate resources and learning opportunities may have more advanced executive function development, which may support school readiness (Dilworth-Bart, 2012). These findings indicate that executive function represents a potential proximal target for interventions aimed at mitigating the adverse effects of SES on academic outcomes. The present study seeks to examine if this effect is paralleled in a relatively economically advantaged sample.

The Role of Household Chaos

Despite several studies demonstrating links between SES, executive function and academic outcomes (e.g., Bierman et al., 2008), to our knowledge no studies examine if these relations change as a function of household chaos. Although not directly related to academic instruction within the home, households "set the conditions for learning" (Johnson et al., 2008, p. 447). Children living in chaotic households, environments that are characterized by increased levels of background noise, crowding, disorganization and lack of routine (Matheny, Wachs, Ludwig, & Phillips, 1995) exhibit less adaptive behavioral, socioemotional, self-regulatory, and academic functioning (see Evans, 2006 for a review). For example, children living in homes with high levels of household chaos have poorer language and regulatory processes (Hardaway, Wilson, Shaw, & Dishion, 2011; Hughes & Ensor, 2009), attentional focusing (Dumas et al., 2005), and school readiness (Hanscombe, Haworth, Davis, Jaffee, & Plomin, 2011).

Although household chaos has been shown to occur more frequently in low SES homes, household chaos is also present in higher SES homes (Vernon-Feagans, Willoughby, Garrett-Peters, & The Family Life Project Key, 2016). Further, given that household chaos has been shown to impact cognitive functioning and other developmentally significant outcomes independently of SES (Hart, Petrill, Deater Deckard, & Thompson, 2007), converging evidence underscores the utility of evaluating the impact of household chaos on the relation between SES and school readiness across the SES spectrum. For example, higher household chaos in middle childhood predicted lower growth in self-control trajectories across middle-to-late childhood, above and beyond SES (Brieant, Holmes, Deater-Deckard, King-Casas, & Kim-Spoon, 2017).

There is evidence that household chaos is one of the most salient proximal environmental factors through which other aspects of the environment exert their influence on child outcomes (Wang, Deater-Deckard, Petrill, & Thompson, 2012). Consequently, it is plausible that household chaos may moderate the relation between SES and school readiness. That is, household chaos is a proximal mechanism in the home that may help to explain how SES exerts its influence on child outcomes (Vernon-Feagans et al., 2016; Wang, Deater-Deckard, & Bell, 2013); the relation between SES and school readiness may depend on the level of chaos in the home. In other words, household chaos may: 1) moderate the direct link between SES and school readiness, such that high household chaos amplifies the adverse effects of low SES on school readiness; 2) moderate the indirect link of SES on school readiness through executive function (i.e., high chaos may amplify the negative effects of SES and low chaos may mitigate adverse effects of SES); or 3) directly impact school readiness, such that high chaos is associated with lower school readiness independent of SES and executive function

Present Study

This study extends existing research aiming to identify individual characteristics and qualities of the home environment that contribute to less adaptive developmental outcomes in young children by exploring pathways that may explain the developmental impacts of the environment (Evans, 2006). This study also differs from previous research due to our focus on middle-to upper-middle class families. In doing so, we investigate if the associations between SES, executive functioning and school readiness are present and vary as a function of household chaos within relatively economically advantaged families.

Based on literature and theory indicating the importance of familial characteristics and executive function to school readiness, the hypotheses were as follows: 1) SES is a predictor of school readiness (i.e., higher SES is associated with better school readiness); 2) higher scores on set-shifting and inhibitory control tasks are associated with more advanced school readiness; 3) SES influences school readiness through set-shifting and inhibitory control (i.e., higher SES is related to increased executive function and, in turn, better executive function is related to more advanced school readiness); and 4) household chaos moderates the direct effect of SES on school readiness and/or the indirect effects of SES on school readiness through set-shifting and inhibitory control. That is, we tested if the magnitudes of the direct and/or indirect effects of SES on school readiness through set-shifting and inhibitory control remain constant across different levels of chaos. The current approach allows novel insights to be drawn from results that may be used to tailor intervention programs that may differ for families living in homes with different levels of chaos.

Methods

Participants

Participants included 574 four-year-old children (51% female) who were recruited from the Massachusetts Registry of Vital Records into the Boston University Twin Project (BUTP). The sample comprised monozygotic and dizygotic twin pairs, primarily from middle-to upper-middle class families (see Measures and Results for more detailed information about SES of the sample). Children were excluded if they were below 1750 grams' birth weight, had a gestational age less than 34 weeks, or presented with possible developmental issues (e.g., chromosomal abnormalities) that might affect their task performance. Race and ethnicity of the analytic sample (see below) was generally representative of the state of Massachusetts (90.04% Caucasian, 1.42% Black, 2.14% Asian, 6.40% Mixed; 6.38% Hispanic or Latino). A total of 468 children were in child care (i.e., cared for anyone other than their parent[s]). Of these, 116 children attended center-based child care.

Measures

Procedure

Children completed one two-hour visit at the BUTP laboratory within approximately one month of their fourth birthdays. The study protocol included scheduled breaks and additional breaks were permitted if requested by parents or children. In addition, testers were trained to identify signs of tiredness and gave children additional breaks as needed throughout the session. Different testers individually assessed each member of the twin pair on a computerized assessment of executive function and a standardized assessment of school readiness (described below). Prior to visiting the laboratory, parents completed a questionnaire about the home environment. All procedures were approved by the Boston University Institutional Review Board. Informed consent was obtained from all parents of participants included in the study.

Household Chaos

Household chaos was assessed with the *Confusion, Hubbub, and Order Scale* (CHAOS; Matheny et al., 1995). Parents responded on 15 items in a true/false format (e.g., "we almost always seem to be rushed"). Seven items were reverse scored (e.g., "there is very little commotion in our home"). Total scores were derived by summing individual item responses. Higher scores represent more disorganized, chaotic, and hurried homes. Internal consistency for the CHAOS in the present study as demonstrated by Cronbach's alpha was .81. CHAOS demonstrates satisfactory reliability and validity (Matheny et al., 1995).

Socioeconomic Status

Family SES was computed using the *Hollingshead Four-Factor Index of Social Status* (Hollingshead, 1975). The Hollingshead index comprises a composite of maternal and paternal education and occupation status. Level of education is assigned a score of 1–7 with 7 representing the highest level. Occupation scores range from 1–9, with 9 representing the highest level. The final SES index is obtained by multiplying each parent's education rank by 3 and occupational rank by 5, then summing the resultant scores and diving by 2. The possible SES range on the Hollingshead is 8–66, with a cutoff of 30 for ‘low SES’ (Cirino et al., 2005).

Eighty-two percent of parents completed college or graduate school. Sixty-six percent of parents had occupation ratings of 7 (i.e., smaller business owners, farm owners, managers, minor professionals) or higher. Eighteen children lived with a parent who was divorced, separated, or widowed. For these children, SES calculations were based on the education and occupation status of the reporting parent. Two children lived with the reporting parent, who was living with a partner other than the child’s other parent. For these children, the co-inhabitant’s information contributed to the calculation of SES. There was no significant difference in SES for the two-parent vs. one-parent households (t [18.65] = 1.27; $p = .22$). The Hollingshead is one of the most frequently used measures of SES and yields substantial agreement (i.e., reliability) with more recently developed measures (Cirino et al., 2002).

Executive Function

Two measures of executive function, inhibitory control and set-shifting, were assessed using the NIH Toolbox: Early Childhood Cognitive Battery (NIH Toolbox; Zelazo et al., 2013; Weintraub et al., 2013). The NIH Toolbox is a computerized battery of multidimensional measures normed for administration from ages 3–85 years. Both measures demonstrate excellent reliability and validity (Weintraub et al., 2013).

Inhibitory Control.—The *Flanker Inhibitory Control and Attention Test* (Flanker) was used to assess inhibitory control and attention by testing the child’s ability to attend to one visual stimulus while inhibiting attention to distractor stimuli flanking the target. In the traditional Flanker task, participants are asked to indicate the orientation of a central arrow while inhibiting attention to either congruent or incongruent arrows that flank it. In the NIH Toolbox version, the stimuli for ages 3–8 years are fish. For each trial, a fixation point was presented, followed by auditory and visual cues, ‘middle’, encouraging attention to the screen, followed by the presentation of the Flanker stimuli. Children were required to attend to the target stimulus (i.e., the middle fish) and ignore the flanking fish, which were pointed either congruently or incongruently with the middle fish. Performance on incongruent trials provided a measure of inhibitory control in the context of visual selective attention (Zelazo, 2006).

NIH Toolbox-generated computed scores combine accuracy and reaction time on the Flanker task (Slotkin et al., 2012a). If accuracy levels were less than 80%, the computed score was equal to the accuracy score. In cases where accuracy levels reached or exceeded 80%, the reaction time and accuracy scores were combined to create the computed score. The computed scores were converted to unadjusted scale scores that compare the performance of the individual to the entire NIH Toolbox normative sample regardless of age or any other variable, providing a measure of overall performance (Slotkin et al., 2012c). Higher unadjusted scale scores indicate better executive function.

Set-Shifting.—Set-shifting was assessed with a modified version of the *Dimensional Change Card Sort* (DCCS; Zelazo, 2006). The DCCS included four blocks: practice, pre-switch, post-switch, and mixed trials. In the practice block, participants were presented with pictorial stimuli on a computer monitor and were instructed to match a test stimulus (e.g., a blue ball) to one of two target stimuli (e.g., a yellow ball or a blue truck). Participants were required to match either by shape or color by pointing to the target stimulus that matches the test stimulus on the relevant dimension. Following fixation cues to attend to the screen, the test stimulus appeared on the screen and children responded by pointing to one of two of the test stimuli. In the practice block, children received feedback on their responses. Children needed to correctly answer 3 out of 4 practice trials. If they failed, four practice trials were repeated up to three times. Once they successfully completed 3 out of 4 of the practice trials, children proceeded to practice trials for the other dimension. Children who met criterion on this dimension proceeded to test trials that were similar in structure but involved different stimuli.

Test trials began with a pre-switch block that consists of five trials in which children sorted by the last dimension used in the practice block. No feedback was provided during test trials. Children needed to correctly match on 4 out of 5 trials to proceed to the next block, which consisted of five trials in which children were instructed to sort by the other dimension. The transition between blocks was noted explicitly by instructions from the experimenter to switch (i.e., "Now we are going to play the color game. In the color game, we choose the picture on the bottom that is the same color as the picture in the middle. If it [experimenter points to middle picture] is blue, we choose this picture [experimenter points to target stimulus], because they are both blue, they are the same color"). Children who correctly matched on at least four trials in the post-switch block proceeded to the mixed block. The mixed block consists of 30 trials of mixed shape and color matches. Scoring for the DCCS task was identical to the Flanker task. Again, higher unadjusted scale scores on the DCCS are indicative of better performance.

School Readiness

School readiness was assessed with the *Bracken School Readiness Assessment-III* (BSRA; Panter & Bracken, 2009), a standardized test of basic skills that demonstrates adequate reliability and validity (Bracken, 2007). The BSRA includes 88 items across five subtests (i.e., colors, letters, numbers/counting, sizes/comparisons, shapes). Testers labeled a target item and the child selected one answer from four to ten alternatives (e.g., "Look at all of the pictures, show me which animal is big"). A subtest was discontinued following three consecutive incorrect responses. Raw scores (i.e., total number correct) were converted into standard scores based on age (i.e., with a mean of 100 and a standard deviation of 15). The standard scores were used for all analyses. To evaluate inter-rater reliability, a second rater completed BSRA ratings for 20% of the sample. The intraclass correlation between raters was high (.99; p<.01).

Data Analysis Plan

First, a structural equation model was fit to the data in MPlus version 8 (Muthén & Muthén, 1998–2015) to examine if there were direct effects of SES, chaos, set-shifting, and inhibitory control on school readiness and indirect effects of SES on school readiness independently through two measures of executive function, set-shifting and inhibitory control (i.e., Model 1; Preacher, Rucker, & Hayes, 2007). Sex was entered as a covariate on set-shifting and inhibitory control to account for potential sex differences in executive function. Next, because the interaction of household chaos and SES could influence the indirect paths through executive function, the direct effect of SES on school readiness, or all of these paths, chaos was entered as a moderator for any relationship that was observed to be significant in Model 1 (i.e., Model 2).

Although these data were drawn from a larger twin sample, we did not conduct genetically-informed analyses. To account for non-independence in the data arising from the fact that twin pairs are nested in families, robust maximum likelihood estimation was used with type=complex. Because MPlus does not allow bias-corrected bootstrap in combination with the type=complex option, the estimates presented herein account for the non-independence of the data but were not bootstrapped. We re-ran the most parsimonious model (presented in supplementary materials) without accounting for non-independence but with bias-corrected bootstrap using 1000 draws. The pattern of findings is consistent with those presented here. After each step, models were refined based on the pattern of significant parameters (i.e., nonsignificant paths fixed to zero) and nested model comparisons using the Satorra-Bentler scaled difference test (Satorra & Bentler, 2010) were conducted to determine the best fitting, most parsimonious model.

The original sample included 574 individuals. Ten children were missing on all outcome variables and were excluded from analyses. Therefore, the final sample size for analyses was 564. Within the sample of 564, one child was missing a school readiness score due to experimenter error. Forty-three children were missing on inhibitory control and 21 children were missing on set-shifting. Models were fit to raw data using full information maximum likelihood (FIML) estimation to allow for the use of all available data. Little's MCAR test (Little, 1988), implemented in R (R Core Team, 2013), indicated that the data were missing completely at random ($p = .08$; chi-square [χ^2] = 40.03; $df = 29$), supporting this important assumption of FIML.

Results

Table 1 lists the descriptive statistics and correlations among study variables. The sample was primarily middle-to upper-middle class (Hollingshead SES mean [*M*] = 52.82; standard deviation [*SD*] = 8.77), but ranged from low (i.e., 28.5) to high SES (i.e., 66). The range for household chaos was modestly restricted (i.e., sample response range = 0–13, possible range 0–15; *M* = 5.00; *SD* = 3.41) and the overall sample mean was slightly lower than those observed in other studies of low income families (e.g., chaos *M* = 5.29 in Hardaway et al., 2011). The household chaos variable had a slight positive skew (0.364), but was well within the rule of thumb of a departure from normality with a skew value >2 (West, Finch, & Curran, 1995). The mean scores for set-shifting and inhibitory control in the present sample were comparable to those from NIH Toolbox nationally representative sample (nationally representative sample *M* = 77.83, *SD* = 4.15 for set-shifting, *M* = 77.28, *SD* = 3.93 for inhibitory control; Slotkin et al., 2012a; 2012b). The sample mean for school readiness was slightly above the standardized mean (standardized *M* = 100, sample *M* = 108), but within one *SD* (*SD* = 15).

In Model 1, the association between SES and school readiness through set-shifting and inhibitory control was tested. Table 2 presents the unstandardized parameter estimates and model fit statistics; Figure 1 presents the standardized path estimates. Overall, the model provided an adequate fit to the data. Effect sizes were small. Better set-shifting and inhibitory control were independently associated with more advanced school readiness. Higher SES was associated with better set-shifting. The relation between SES and inhibitory control was not significant. Consequently, evidence for the indirect effect of SES on school readiness was supported for set-shifting, but not inhibitory control. Chaos was significantly negatively related to school readiness.

Based on the findings from Model 1, we fit a reduced model by fixing non-significant paths to zero such that inhibitory control was a direct predictor of school readiness (i.e., effect from SES to inhibitory control fixed to zero) and chaos was a direct predictor of school readiness (i.e., effect from chaos to inhibitory control and set-shifting fixed to zero). Satorra-Bentler Scaled χ^2 difference test (Satorra & Bentler, 2010) revealed that constraining these parameters to zero did not significantly reduce model fit (χ^2 difference (4) = 5.48, $p = 0.24$). See Table 3 for unstandardized parameter estimates for reduced Model 1 and see Supplementary Table 1 for bootstrapped estimates for reduced Model 1.

In Model 2, chaos was entered into the reduced Model 1 as a moderator of the direct effect of SES on school readiness. Because there was no association between chaos and set-shifting in the reduced Model 1, chaos was not entered as a potential moderator of the indirect effect of SES on school readiness through set-shifting. Although this model provided an adequate fit to the data, χ^2 (7, N = 564) = 8.164, $p = 0.318$; *RMSEA* = 0.017 (90% CI = 0.000, 0.056); *CFI* = .989; *SRMR* = 0.029, the overall interaction term was not significant. Consequently, we fit a reduced Model 2 (see Figure 2 for standardized path estimates) that removed the interaction term from the model to determine whether this term significantly impacted model fit. The Satorra-Bentler Scaled χ^2 difference test (Satorra & Bentler, 2010) revealed that constraining these parameters did not significantly reduce model fit (χ^2 difference (1) = 1.62, $p = 0.20$). Therefore, the best fitting, most parsimonious model was a model in which SES directly and indirectly (i.e., through set-shifting) influenced school readiness and chaos directly influenced school readiness. When the interaction between SES and chaos is fixed to 0, reduced Models 1 and 2 both converge to the same parameter estimates. See supplementary materials for unstandardized parameter estimates and model fit for Model 2 and reduced Model 2.

Discussion

The present study contributes novel findings as, to our knowledge, it is the first to examine if the relations between SES, executive function, and school readiness vary as a function of household chaos. The results revealed that children with higher SES had better set-shifting, and in turn, better set-shifting was associated with more advanced school readiness. Further, increased SES was associated with more advanced school readiness, whereas higher levels of chaos were associated with lower school readiness.

The findings are consistent with the literature (e.g., Dilworth-Bart, 2012); set-shifting accounts for some, but not all, of the association between SES and school readiness. There are three plausible mechanisms that could explain the links between SES and set-shifting and SES and school readiness in the present sample. First, it could be the case that SES is linked with set-shifting and school readiness because something that is inherent to the SES measure is also inherent to the set-shifting and school readiness measures (e.g., parental education). That is, parents who have higher education and presumably better academic skills may also have better set-shifting and parental education may drive the observed SES effect. Second, a third variable that co-occurs with SES, set-shifting and school readiness may explain the links among these constructs (e.g., intellectual climate, parental scaffolding). Alternatively, it may be some combination of the two. Finally, it may be the case that SES directly impacts brain function and structure associated with set-shifting abilities (e.g., Blair, 2010; Kishiyama et al., 2008; Noble et al., 2012). Therefore, we do not know precisely what aspects of SES (or its correlates) are responsible for the effects of SES; it is possible that SES is related to set-shifting and school readiness in the present sample through processes that were not measured, such as parental behaviors (Dilworth-Bart, Poehlmann, Hilgendorf, Miller, & Lambert, 2010). Nonetheless, because there were direct effects of set-shifting on school readiness, these findings may inform future intervention work aiming to improve school readiness.

Existing studies find indirect effects of SES on academic outcomes through global executive function factors (Dilworth-Bart, 2012; Nesbitt et al., 2013). The present study provides specificity to this work; when two executive function factors are investigated separately, there are indirect effects of SES on school readiness through set-shifting, but not inhibitory control. Inhibitory control and set-shifting are not entirely overlapping constructs. Indeed, in our sample, the two domains were only modestly correlated. Thus, it is reasonable to expect that SES may differentially impact distinct components of executive function.

Evidence for dissociation of SES effects on executive functions observed in other studies (Noble et al., 2007) may shed light on the present findings. SES has been associated with some (e.g., cognitive control) but not all (e.g., reward processing) outcomes, and the factors that statistically mediated links between SES and executive function outcomes differed. For example, the association between SES and a third commonly indexed component of executive function, working memory, was mediated by home and school variables (e.g., literacy environment, daycare/preschool attendance) whereas language abilities (e.g., receptive vocabulary) accounted for the association between SES and cognitive control. In considering potential explanations for the different patterns of effects observed for set-shifting and inhibitory control, one explanation may be that set-shifting is inherently a more complex process than inhibitory control (e.g., Garon, Bryson, & Smith, 2008). There may be more opportunities for SES to synergistically interact with other aspects of the environment to impact set-shifting, whereas for inhibitory control, a less complex, earlier emerging ability, other means of compensation may be possible and in place by age 4. Therefore, the interplay between SES and neurocognitive development is complex and precludes generalization of the mechanisms of the effects of SES across different neurocognitive outcomes, even different aspects of executive function (Noble et al., 2007). These findings argue for examinations of indirect effects of SES on school readiness through separate executive function components rather than global executive function measures.

The overall interaction between chaos and SES was not significant, though both factors significantly influenced school readiness. Household chaos is a proximal contextual influence that can differentially impact children's preparedness to enter formal schooling. Although there is demonstrated efficacy of tailored interventions to enhance characteristics of the environment (e.g., mealtime; Flattum et al., 2015), less is known about interventions to reduce household chaos. However, there is preliminary evidence to suggest that household chaos is responsive to intervention. For example, one promising potential pathway for intervention in families living with high levels of chaos is familial routine. Evidence indicates that the presence of familial routines contributes to better child outcomes (Brody & Flor, 1997; Martin, Razza, & Brooks-Gunn, 2012). Familial routines may promote more positive developmental outcomes through the illustration of lawfulness and lessons that events are predictable (Martin et al., 2012), lessons that are particularly relevant to school readiness.

The current findings underscore the need for research attention focused on examining the mechanisms through which household chaos influences child outcomes as a step toward identifying concrete avenues toward adaptive familial functioning (Coldwell, Pike, & Dunn, 2006) that can be targeted to mitigate the adverse effects of household chaos. A consideration for generalization is that household chaos represents only one of many aspects of the home environment. Parent reports of household chaos are only modestly correlated with other parental and household characteristics, such as more crowded living conditions (Dumas et al., 2005). As such, reports of household chaos are not entirely overlapping with other household and family environment factors and appear to represent a distinct aspect of the household environment (Deater-Deckard et al., 2009) that is not simply a proxy for other adverse factors (Coldwell et al., 2006). Future research should continue to explore how other aspects of the home environment impact child outcomes.

There is consensus between parent and observer ratings of household chaos (Matheny et al., 1995), so it is to be expected that observer ratings of chaos would yield a similar pattern of results. However, future research may consider testing this empirically. Nonetheless, parent reports of household chaos are uniquely informative (e.g., Deater-Deckard et al., 2009) and provide valuable information about the home environment that is reliable, valid, and related to child behavior (Matheny, 1995).

The present study also extends our developmental understanding of the links between SES, executive function, and academic outcomes to the upper end of the SES spectrum in three important areas. First, prior research finding indirect effects of SES on academic achievement through executive function has not examined school readiness prior to entry to formal schooling. School readiness reflects preparedness for formal schooling, and although school readiness predicts later achievement (e.g., Blair, 2001), the constructs are not interchangeable. Identifying young children who may benefit from support at an early age may allow for additional time to foster the development of these skills and better prepare them to learn in a formal school environment (Schmitt, McClelland, Tominey, & Acock, 2015; Ursache, Blair, & Raver, 2011). A second related consideration is that the children in the present study were all assessed within approximately one month of their fourth birthdays, whereas the children in prior studies were older. As previously noted, substantial growth in executive function occurs across childhood, particularly during the preschool period (e.g., Carlson, 2005). Therefore, the present findings extend the accumulating evidence for indirect effects of SES on academic outcomes through one component of executive function, set-shifting, to younger ages. Finally, most of the existing studies are of children living at or near the poverty line. The children in the present sample are primarily from middle-to upper-middle class families. These findings extend existing literature by providing novel evidence for indirect effects of SES on school readiness through set-shifting and direct effects of SES and chaos on school readiness in a relatively low risk sample.

It is important to consider how these findings may generalize across early childhood. As previously noted, there is substantial growth in executive functions during this period. However, there is rank order stability in executive functions across toddlerhood (Carlson, Mandell, & Williams, 2004) and impairments in attention and executive functions are also stable across early childhood (Wåhlstedt, Thorell, & Bohlin, 2008). Given this stability, we would expect that our findings would generalize to other ages within early childhood. In considering how and when to intervene on these skills, it is reasonable to expect that there may be periods within early childhood in which children’s developing competences, such as executive functions and school readiness, are most sensitive to the effects of both household chaos and interventions. The developmental sensitivity of executive functions to the environment across this period is an in important topic that has garnered increased research attention of late, but remains an area deserving of further inquiry.

Limitations

Despite the unique contributions of the present study, these findings should be interpreted in light of the following limitations. First, the population was primarily Caucasian and findings may not to extend to more racially diverse ethnic groups. Second, although the present study benefitted from the assessment of two facets of executive function, generalization of findings to the third aspect of executive function, working memory, which was not assessed in this study, and across other measures of executive function cannot be made. The components of executive function are differentially predictive of and associated with various aspects of school readiness and academic achievement (e.g., Blair & Razza, 2007) and different measures of executive function, even of the same construct, yield modest agreement (Toplak, West, & Stanovich, 2012). Because there is evidence that SES and chaos predict working memory (Evans & Schamberg, 2009) and that working memory is a robust predictor of academic success (Alloway & Alloway, 2010), it is possible that working memory would parallel the findings for set-shifting observed here. Future studies should strive to use more diverse executive function measures to permit examination of potential differential effects across components and measures of executive function.

Third, despite a clear theoretical and well-documented empirical framework for testing indirect effects, it is possible that the present estimates are biased by the cross-sectional nature of the data. Therefore, replication in longitudinal samples is needed to confirm the robustness of the present findings. Fourth, these analyses did not consider child care experiences and it is plausible that these experiences may impact the constructs assessed herein and the associations among them. Future studies may consider addressing this possibility empirically.

Additionally, although SES remains a topic that is of great interest to developmental scientists, as discussed earlier, there is no complete consensus on precisely what SES represents (McLoyd, 1998). One of the most encompassing conceptualizations of SES is one that reflects access to capital (Coleman, 1988); material (financial) capital, nonmaterial (human) capital (e.g., education), and capital garnered through social connections. Therefore, SES in the present study reflects both financial capital (i.e., occupational status) and human capital (i.e., education). This combined approach is a better indicator of SES than either alone (Bradley & Corwyn, 2002). Different indicators of SES may be tapping different underlying phenomena (Bradley & Corwyn, 2002) and the meaning of SES may not be universal across cultural groups (Bradley, 1994). Therefore, generalization of these findings to other measures of SES and to other cultural groups may be limited. Finally, because SES is associated with parental stress, behaviors, and mental health (e.g., Dumas et al., 2005), we cannot identify precisely what drives the SES effect.

Conclusion

Taken together, these findings with an economically advantaged sample mirror those observed in lower-SES samples. Coupled with findings from studies including lower-SES samples, these results indicate that increased SES is associated with better set-shifting and school readiness across the SES spectrum. This study also demonstrates that household chaos is negatively associated with school readiness. However, the effect sizes are modest and these results require replication and should be considered preliminary. Future research investigating mechanisms of the effects of child attributes and familial influences on school readiness is essential for identifying targets for prevention and intervention. The ultimate goal of this work is to identify ways to bolster school readiness prior to formal school entry. Doing so would enable children to enter formal schooling prepared to learn, and perhaps, foster better long-term outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Higher levels of executive function were related to better school readiness
- Increased socioeconomic status was associated with better school readiness
- Socioeconomic status indirectly impacted school readiness through set-shifting
- Household chaos was negatively associated with school readiness

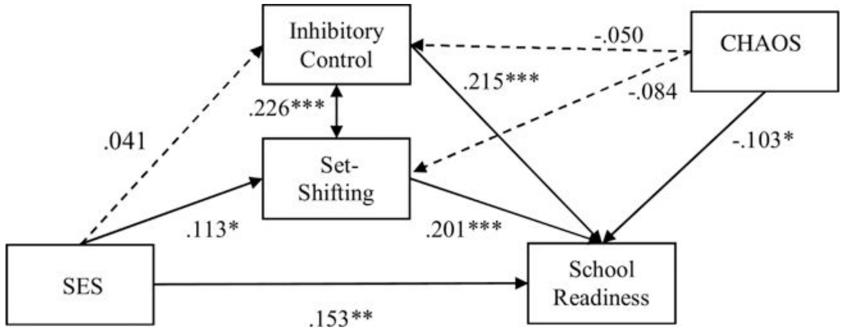

Figure 1.

Standardized path estimates from Model 1. Dashed paths were not significant. ***p<.001; **p<.01; *p<.05. Model fit statistics χ^2 (1, N=564) = 0.356, p=0.551; RMSEA= 0.000 (90% CI=0.000, 0.093); CFI=1.0; SRMR=0.005. Sex was included as a covariate to account for potential sex differences in executive function, $b_{sex,\ set\text{-}shifting} = -.133$, $SE_{b\text{-}sex,\ set\text{-}shifting} = .045$ $b_{sex,\ inhibitory\ control} = -.060$, $SE_{b\text{-}inhibitory\ control} = .049$.

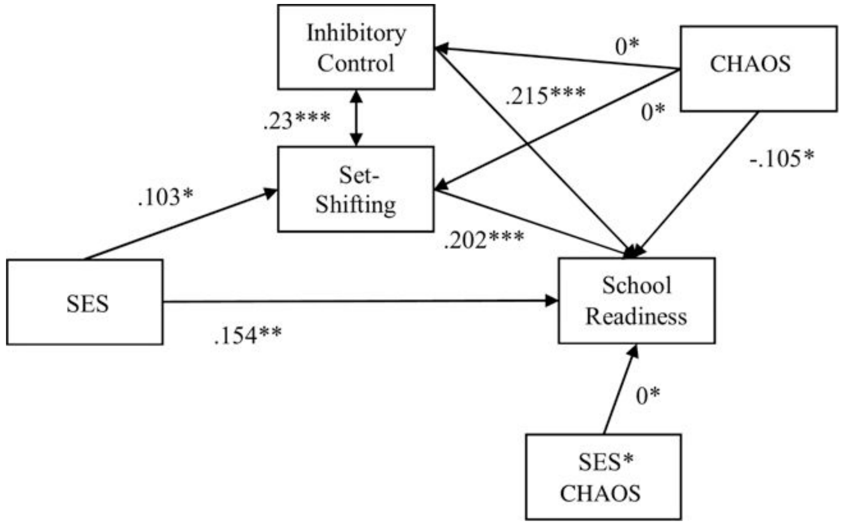

Figure 2.
Standardized path estimates for reduced Model 2. SES = socioeconomic status. SES*Chaos = interaction between socioeconomic status and household chaos. 0* indicates that path was fixed to 0. Model fit statistics χ^2 (8, N=564) = 11.478, p=0.318; RMSEA= 0.028 (90% CI=0.000, 0.061); CFI=.967; SRMR=0.030. Sex was included as a covariate to account for potential sex differences in executive function, $b_{sex,\ set\text{-}shifting}$ =−.128, $SE_{b\text{-}sex,\ set\text{-}shifting}$ = .043, $b_{sex,\ inhibitory\ control}$ =0*, $SE_{b\text{-}inhibitory\ control}$ =N/A

Table 1.

Correlation coefficients (standard errors) and descriptive statistics

.											
Correlations Among Study Variables							**Mean (*SD*)**		**Min.**		**Max.**
	School Readiness	**Inhibitory Control**	**Set-Shifting**	**SES**	**Chaos**						
School Readiness	1.0						107.31 (14.38)		67		137
Inhibitory Control	.28 (.04)	1.0					74.64 (5.29)		53.55		87.38
Set-Shifting	.28 (.04)	.24 (.04)	1.0				76.40 (7.21)		49.52		92.31
SES	.19 (.06)	.05 (.04)	.12 (.05)	1.0			52.82 (8.77)		28.5		66
Chaos	−.13 (.05)	−.05 (.05)	−.10 (.05)	−.01 (06)	1.0		5.00 (3.41)		0		13

Note: SES=socioeconomic status; SD=standard deviation; Min=minimum; Max=Maximum.

Table 2.

Parameter estimates and model fit for Model 1.

Path	Parameter Estimate		
	b	**SE**	***p***
Direct Effects			
SES→Set-Shifting	.093	.039	.018
SES→Inhibitory Control	.024	.025	.328
SES→School Readiness	.251	.089	.005
Set-Shifting→School Readiness	.400	.083	<.001
Inhibitory Control→School Readiness	.583	.123	<.001
Chaos→Set-Shifting	−.178	.095	.061
Chaos→Inhibitory Control	−.078	.079	.324
Chaos→School Readiness	−.434	.211	.040
Set-Shifting ↔Inhibitory Control	8.427	1.673	.000
Indirect Effects			
SES→Set-Shifting→School Readiness	.037	.018	.035
SES→Inhibitory Control→School Readiness	.014	.015	.326
Total Effects			
SES→Set-Shifting→School Readiness	.288	.090	.001
SES→Inhibitory Control→School Readiness	.265	.090	.003

SES= socioeconomic status; *b*=unstandardized regression coefficient; *SE*= standard error. Model fit statistics χ^2 (1, *N*=564) = 0.356, *p*=0.551; RMSEA= 0.000 (90% CI=0.000, 0.093); CFI=1.0; SRMR=0.005. Sex was included as a covariate to account for potential sex differences in executive function, $bsex, set\text{-}shifting = -1.920$, $SE_{b\text{-}sex,\ set\text{-}shifting} = .666$ $b_{sex,\ inhibitory\ control} = -.639$, $SE_{b\text{-}inhibitory\ control} = .514$.

Table 3.

Parameter estimates and model fit for Reduced Model 1.

Path	Parameter Estimate		
	b	**SE**	***p***
Direct Effects			
SES→Set-Shifting	.084	.039	.029
SES→Inhibitory Control	0*	—	—
SES→School Readiness	.252	.089	.005
Set-Shifting→School Readiness	.402	.083	<.001
Inhibitory Control→School Readiness	.581	.123	<.001
Chaos→Set-Shifting	0*	—	—
Chaos→Inhibitory Control	0*	—	—
Chaos→School Readiness	−.440	.210	.036
Set-Shifting ↔Inhibitory Control	8.647	1.692	<.001
Indirect Effects			
SES→Set-Shifting→School Readiness	.034	.017	.048
Total Effects			
SES→Set-Shifting→School Readiness	.286	.089	.001

Note:

*Note: indicates that the parameter was fixed to 0. SES= socioeconomic status; *b*=unstandardized regression coefficient; *SE*= standard error. Model fit statistics χ^2 (5, *N*=564) = 6.751, *p*=0.240; RMSEA= 0.025 (90% CI=0.000, 0.067); CFI=.983; SRMR=0.028. Sex was included as a covariate to account for potential sex differences in executive function, $b_{sex,\ set\text{-}shifting} = -1.844$, $SE_{b\text{-}sex,\ set\text{-}shifting} = .642$, $b_{sex,\ inhibitory\ control} =$ 0*, $SE_{b\text{-}inhibitory\ control}$ = N/A.