THE INFLUENCE OF CHILD ATTACHMENT SECURITY, DIETARY CONSUMPTION, AND HOUSEHOLD CHAOS ON EXECUTIVE FUNCTION

BY

SAMANTHA JEAN IWINSKI

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Human Development and Family Studies
in the Graduate College of the
University of Illinois Urbana-Champaign, 2021

Urbana, Illinois

Master's Committee:

Professor Kelly Bost, Chair
Associate Professor Aaron Ebata

Abstract

Executive function (EF) encompasses an array of higher-order cognitive skills that have been associated with optimal functioning (Garon et al., 2008). Children's EF unfolds over time and may be influenced by multiple factors, including caregiver-child relationships, household environments, and dietary consumption. Children with more secure attachment representations (Menon et al., 2020) and who eat more healthy foods instead of snack foods or processed meats have been found to have more optimal EF abilities (Cohen et al., 2016; Isaacs & Oates, 2008). Literature has also shown that higher household chaos is associated with lower EF skills (Dumas et al., 2005; Pike et al., 2006) and may indirectly predict behavioral regulation for children and impact parenting behaviors (Vernon-Feagans et al., 2016). In this study, we tested two models examining influences on children's EF: one that examined the relationship between observed child attachment security and child EF, and the other that examined parent-reported dietary consumption and child EF. A third aim was to determine if household chaos moderated these relationships.

The sample consisted of 275 families participating in a more extensive birth cohort study of nutrition and child health. Home observations were conducted when children were 18-24 months (52% females) to assess child attachment security (van IJzendoorn et al., 2004). Caregivers completed the Food Frequency Questionnaire (FFQ; Nutrition Quest, 2014) to evaluate children's dietary consumption. PCA analyses were used to determine child dietary consumption through food groupings. The Confusion, Hubbub, and Order Scale (CHAOS; Matheny et al., 1995) assessed household chaos, and the Behavior Rating Inventory of Executive Function®-Preschool Version (BRIEF-P; Gioia et al., 1996) was used to measure children's EF. The following subscales of the BRIEF-P were used in all analyses: Inhibitory Self-Control (ISCI), Flexibility (FI), and Emergent Metacognition (EM). Multiple regressions were used to test study hypotheses.

Child attachment security ($\beta = -0.24$, $p = 0.03$), and household chaos ($\beta = 0.41$, $p \leq 0.001$) were both independent and significant predictors of ISCI scores (see Table 5). For the EMI subscale, only household chaos ($\beta = 0.40$, $p = 0.002$) was a significant predictor (see Table 6). Additionally, child attachment security ($\beta = -0.23$, $p = 0.03$) and household chaos ($\beta = 0.31$, $p = 0.003$) were found to be significant predictors of EF FI scores (see Table 7). For the second model, all analyses examining associations between dietary consumption, household chaos, and child EF subscales revealed significant effects for household chaos only with betas ranging from -0.02-0.38 (see Tables 8-12).

These findings suggest that child attachment security, child dietary consumption, and household chaos may independently and uniquely impact children's EF during early childhood. Future longitudinal studies that include multi-method approaches are needed to shed light on these associations over time.

Table of Contents

Chapter 1: Introduction and Literature Review

Executive function (EF) encompasses an array of higher-order cognitive skills that have been associated with optimal functioning (Garon et al., 2008). EF abilities involve a set of processes that regulate thoughts and behaviors, affecting how children react to situations and relationships across various contexts. EF consists of general-purpose control mechanisms that are often linked to the brain's prefrontal cortex (PFC), and this function helps regulate an individual's thoughts and behaviors (Miyake & Friedman, 2012). Children's EF unfolds over time with PFC development and is influenced by a myriad of multi-level factors. In addition to genetic contributions (Barnes et al., 2011; Diamond, 2013; Gilbert & Burgess, 2008; Greene et al., 2008), parenting quality, dietary intake, and household environment factors have been shown to impact children's EF. For example, children with more secure attachment representations have been shown to have higher EF capacities (Menon et al., 2020), and the overall caregiving environment is thought to be critical in promoting the development of children's EF (Bernier et al., 2015; Bernier et al., 2012; Diamond et al., 2007; Fay-Stammbach et al., 2014). In addition, research has shown that young children who eat more healthy foods and fewer snack foods or processed meats tend to have more optimal EF abilities (Cohen et al., 2016; Isaacs & Oates, 2008). With respect to household environments, research findings suggest that higher household chaos (settings high in noise and crowding) is associated with lower executive functioning skills, such as limited ability to focus (Dumas et al., 2005; Pike et al., 2006), and may indirectly predict behavioral regulation for children and impact parenting behaviors (Vernon-Feagans et al., 2016)

Although these modifiable aspects of a child's environment may impact EF development, much less is known about the interplay among parenting quality, dietary consumption, and household environment factors as influences on children's EF. To address this gap in the literature, we tested two models of the impact of these factors on children's EF. The first model examined the relations between observed child attachment security and child EF abilities. The second model examined parent-reported dietary consumption and child EF. In both models, household chaos was tested as a moderator.

Executive Function

EF consists of general-purpose control mechanisms that are often linked to the brain's PFC. The literature shows that EF may regulate and impact the dynamics of cognition, actions, and create meaning for all ages (Garon et al., 2008; Miyake & Friedman, 2012). These processes develop throughout childhood and adolescence and may play a role in a child's social, emotional, and physical interactions (Anderson, 2002; Isquith et al., 2005). The frontal lobes, specifically the PFC, send and receive information from major sensory and motor control regions. The PFC is an essential brain structure that controls and oversees neural systems located in cortical and subcortical areas. The PFC continually monitors activities in the cortical and sub-cortical regions while simultaneously sending signals to all of these structures to control and perform certain behaviors (Funahashi & Andreau, 2013). Thus, these signals help assist with an individual's executive function abilities and behaviors.

Within the literature, there is a general consensus regarding three core factors or dimensions of EF. These include Inhibitory Control, Working Memory, and Cognitive Flexibility or set-shifting. These processes govern goal-directed actions and responses to complex or significant situations (Hughes & Devine, 2019; Hughes & Ensor, 2009). They may consist of reasoning, problem-solving, and planning within a child's life (Collins & Koechlin, 2012; Lehto et al., 2003; Lunt et al., 2012; Miyake & Friedman, 2012). These EF abilities and skills are crucial for success in school, cognitive and social development, and physical and mental health (Diamond, 2013).

The ability to inhibit behavioral responses, shift attention when needed, control emotions, plan/organize, and use one's working memory all fall within EF's definition. Inhibitory control encompasses the ability to control one's emotions, attention, behaviors, and thoughts while doing what may be appropriate or needed in a given situation (Diamond, 2013). Shift refers to the ability to move freely from one situation or aspect of a problem to another. Emotional control refers to difficulties of emotional expression, and a child's ability to control one's emotions. Planning/organizing involves the child's ability to manage current or future tasks in an array of situations. Lastly, working memory taps into the capacity to hold information in memory for goals or plans. Collectively, these aspects constitute the broader construct of EF. These concepts can also be combined to create other forms of EF, which may include combining inhibition and emotional control, shifting and emotional control, and working memory and planning/organizing. These combinations will be used in the present study to illustrate further different components of EF (Ezpeleta et al., 2015; Gioia et al., 1996). Additionally, many of these components of EF may work within separate parts of the brain, including the frontal lobe, temporal lobe, parietal lobe, and sensory cortex (Aron, 2008; Blakemore & Choudhury, 2006; Gilbert & Burgess, 2008).

Child Attachment Security/Parenting Quality and Children's EF

The early caregiving environment is widely studied using assessments of parent-child attachment security. A secure attachment is thought to provide the child with a haven of safety and a sense of being worthy of care and protection (Posada et al., 2013; van IJzendoorn et al., 1992). According to Bowlby (1979), all infants are born with a behavioral attachment system that, when activated in times of distress or need, leads infants to seek proximity to adult caregivers (Bretherton, 1985). The nature and quality of the attachment relationship are determined by caregiving responses to a child's bids for proximity, support, or help in times of distress. As such, the attachment relationship has important implications for biobehavioral stress regulation, including a child's ability to develop capacities to regulate emotion, behavior, and attention – all essential aspects of EF. Early life attachment disruptions may negatively impact EF, including behavioral inhibition and emotion regulation (Blair et al., 2018). Researchers have also proposed that the affective bond that characterizes secure attachment relationships may provide children with a safe relational context. This may then help children gradually learn to self-regulate actions defined by EF (Bernier et al., 2015; Kochanska & Aksan, 1995; Lewis & Carpendale, 2009).

Previous studies suggest that children who are more securely attached to their mothers show better performance on EF tasks (Bernier et al., 2015; Meuwissen & Englund, 2016). Parent-child relationships may directly affect a child's working memory, emotion regulation, and cognitive flexibility. Bernier et al.'s (2010, 2012, 2015) results suggested that scores of child attachment and parenting behaviors (18-26 months and 15 months to 3 years old) were related to child performance on working memory and cognitive flexibility tasks. If the parent-child relationship was strong, there was an increased likelihood of the child having better working memory or cognitive flexibility abilities (Bernier et al., 2015; Bernier et al., 2010).

Additionally, parent-child relationships and parenting have often been proposed to impact children's prefrontal brain structure, affecting various levels of EF (Bernier et al., 2015). Many researchers express the importance of EF and parenting on later outcomes, including school readiness, emotional control within schools, and verbal ability (Diamond & Lee, 2011). Furthermore, parenting quality and EF may have a bidirectional relationship (Blair et al., 2014). While longitudinally examining children (aged 36 to 60 months), researchers found that parenting sensitivity and responsiveness predicted higher positive changes in EF, and EF may bidirectionally predict a shift in parenting quality. This link provides insight into the importance of caregiving relationships at a young age and the transactional relations between early experiences and EF.

In addition to child attachment security, others have examined parent-child relationships using assessments of maternal sensitivity and parenting styles. Bernier et al. (2010) assessed this relationship using maternal sensitivity during interactions, maternal mindfulness, and maternal autonomy support. The researchers found that all three parenting dimensions (maternal sensitivity, mind-mindedness, and autonomy support) were positively related to the child's EF scores (Bernier et al., 2010). In addition, researchers have found that parental behaviors show patterns of associations with children's EF abilities, highlighting how positive and negative interactions within the parent-child relationship may influence children's cognitive abilities (Hughes & Devine, 2019). In a recent meta-analysis, researchers found associations between parental behaviors and EF with a significant moderation of child age, with younger children showing a more substantial effect size. Additionally, positive (warmth, responsiveness, sensitivity) and negative (control, detachment, intrusiveness) parental behaviors had a stable association with EF across various age groups (0-8 years) (Valcan et al., 2018). Researchers found small effect sizes when examining environmental and genetic effects but indicated that cognitive abilities and genetic effects tend to increase with age (Plomin et al., 1997; Valcan et al., 2018).

The research surrounding EF and attachment focuses on the healthy development of a child. This research allows us to understand from past literature and theory that early relationships and the quality of those relationships are essential for children's developing cognitive abilities. Given the importance of EF and child attachment security, it is crucial to analyze multiple dimensions of EF and at different age groups. Children are building a bond with an adult or caregiver at a young age, and this relationship may shape how their PFC and cognitive abilities structure themselves. Since there is an established relationship between child attachment security and EF, it is novel to analyze different facets of EF through various subscales and avenues.

Dietary Consumption and Children's EF

In addition to sensitive and responsive caregiving, nutrition plays an important role in healthy development, including EF capacities. Researchers have found a relationship that may create a bidirectional link between EF and dietary consumption. Riggs et al. (2010) found that in fourth-grade students (M = 9.4), EF proficiency was negatively related to snack food intake. They discussed how youth with enhanced cognitive abilities and emotional control skills might be better at inhibiting cognitive and emotional rewards that may come with snack food. They also explain that youth with stronger working memory skills may have more goals to eat healthier foods (Riggs et al., 2010). This study illustrates that cognition may impact dietary consumption on multiple levels. Literature also shows that creative thinking and working memory may be impacted by added sugar and dietary fiber. For example, in preadolescent children, researchers have found that added sugar intake was negatively associated with tests of creative thinking, and that dietary fiber was positively associated with overall creative thinking (Hassevoort et al., 2020). Additionally, researchers found that executive cognition-function in fourth-grade children was negatively associated with high-calorie snack food intake and positively associated with fruit and vegetable intake (Riggs et al., 2012).

Through a recent systematic review exploring young and old adolescents and older children, researchers examined various studies that found a positive association between healthy food consumption and EF, including whole grains, fish, fruits, and vegetables. In addition, less nutritious food, including snack foods, sugar-sweetened beverages, and processed meats, were inversely related to EF (Cohen et al., 2016). The studies contained various forms of executive function, including inhibition, working memory, and attention and planning. When specifically examining inhibition in adolescents, researchers found a positive association between inhibitory problems, poor decision-making, and sweet drink and snack food intake (Ames et al., 2014). Researchers have also examined cognition in older children and young adolescents and found that intake of mixed grains is beneficial for cognitive performance (Chung et al., 2012), and poorer diet quality may be associated with worse cognition (Haapala et al., 2015). In addition, researchers have found that increased fish intake, using a cluster-randomized cross-over trial, explained increases in reading and inattention performance in third and fourth-grade children (age 8-11 years) (Sorensen et al., 2015). Timing of meals and the type of food may also influence performance throughout the day. For example, a typical breakfast that is rich in carbohydrates has been found to help mental performance, including attention and memory, through the morning and day (Wesnes et al., 2003).

Overall, study findings suggest positive associations between healthy food consumption and children's EF abilities, and negative associations between snack, processed, or more unhealthy food consumption and children's EF abilities. However, most of the studies were conducted with older children and adolescent samples and focus on school-related executive function tasks. The current study focuses on a younger population (18-24 months), which can help researchers and community members understand the effect of dietary consumption on children's EF at a younger age.

Household Chaos

Household chaos describes an environment that is high in noise and crowding and low in regularity and routines (Vernon-Feagans et al., 2016). Researchers have found that household chaos is associated with less effective parental discipline, behavior problems, limited attentional focusing, reduced ability to understand and act in social situations, and reduced accuracy and efficiency in cooperative parent-child tasks (Dumas et al., 2005). This high level of noise and chaos may result in lower caregiver attentiveness, responsivity, and verbal stimulation (Wachs, 1993; Wachs & Camli, 1991). Additionally, researchers have found a direct association between elevated levels of household chaos and poor performances on tasks that are related to core components of executive functioning such as inhibitory control, cognitive flexibility, working memory, attention, and effortful control (Andrews et al., 2020; Brown et al., 2010; Chen et al., 2014; Hughes & Ensor, 2009; Hur et al., 2015). Higher levels of household chaos may also interfere with a child's competency levels, creating a lack of control within their environment (Evans & Stecker, 2004). Furthermore, researchers have found that household disorganization may also negatively influence working memory, attention shifting, and other forms of inhibitory control (Berry et al., 2016). Additionally, a lack of routines has often been linked to poor performance on EF tasks within kindergartners (Martin et al., 2012). Lastly, a recent meta-analysis examining 35 articles found evidence that household chaos is significantly and negatively associated with child executive functioning, including completed questionnaires and direct assessments. When examining the moderator analysis, the only significant moderator with a strong association between household chaos and EF was found in studies that used informant completed questionnaires (Andrews et al., 2020). Therefore, the form of measurement and assessment may impact the relationship between household chaos and EF.

Regarding household environment and parenting behaviors, researchers also found that household chaos may indirectly predict behavior regulation through parenting and parental responsiveness (Vernon-

Feagans et al., 2016). Household chaos and home atmosphere have predicted children's behavioral regulation and parenting behaviors (Vernon-Feagans et al., 2016).

Additionally, positive home environments (low family conflict, high family cohesion, and low household chaos) have been associated with healthier food-related behaviors. More negative home environments (high family conflict, low family cohesion, and high household chaos) have been associated with more unhealthy food-related behaviors (Anderson & Keim, 2016; Berge et al., 2014; Cyril et al., 2016; Halliday et al., 2014; Martin-Biggers et al., 2018; Renzaho et al., 2014; Renzaho et al., 2011; Smith et al., 2015). Household environment increasing affects diet quality in children because the caregivers are supplying the nutrients. This interaction may in turn affect the parent-child relationship. Therefore, household chaos may influence the association between child attachment security, dietary consumption, and child EF. In high household chaos conditions, an insecure or weak parent-child relationship may have a great influence on the child's EF abilities. The clear relationships between these concepts indicate the importance of analyzing household chaos in the form of a moderator instead of a predictor or outcome.

Present Study

This study aimed to examine the association between child attachment security and EF abilities in children 18-24 months of age using caregiver reports and naturalistic observations of child attachment security. It also aimed to explore the relationships between children's dietary consumption and their EF abilities. A final aim was to examine whether household chaos moderates these associations. First, we investigated the association between child attachment security and three EF subscales, using caregiver reports of their children's EF, and home observational data for the assessment of child attachment security. Second, we examined the association between six dietary consumption patterns and children's EF. We hypothesized that children with higher attachment security and more healthy dietary consumption would have higher EF scores. Third, we determined whether household chaos moderated the association between child attachment security and EF subscales, as well as dietary consumption and EF subscales. We hypothesized that lower household chaos would buffer children from the effects of less healthy dietary consumption and lower attachment security on EF.

Chapter 2: Methods

Participants

The data in this analysis are from families participating in a longitudinal birth cohort study in the Midwestern United States. It is designed to examine multi-level predictors of weight trajectories and dietary habits over the first seven years of life (Fiese et al., 2019). As part of the more extensive study, caregivers completed questionnaires regarding their household chaos, child EF behaviors, child dietary consumption, and demographics on the parent and child. They also indicated if they would be willing to participate in a home observation component of the study when children were 18 and-24 months of age. Those parents who indicated a willingness to be contacted were recruited for the home observation and videotaped attachment and mealtime study. Caregivers were compensated $80 for their participation in the home visit. This study was approved by the University Institutional Review Board. Participant characteristics can be found in Table 1.

Table 1
Descriptive Statistics for Model Variables

	N	%	M	SD	Range
Child gender					
Male	53	48.2			
Female	57	51.8			
Monthly income					
$3,000 and under	30	27.3			
$3,001-$5,000	31	28.2			
$5,001 and above	39	35.5			
Parent race/ethnicity					
White	81	73.6			
Black	6	5.5			
Asian	7	6.4			
Biracial	5	4.5			
American Indian/Alaska Native	1	0.9			
Child age at time of home visit (months)	110		21	2.7	17.8 - 34.9
Parent age at childbirth (years)	108		30.9	4.5	19.1 - 45.2
Home visit mealtime length (minutes)	109		17.44	3.48	7.14 - 20.0
Child attachment security	108		0.29	0.24	-0.37 – 0.77
Household chaos	391		26.75	7.11	13 - 48
ISCI score	321		38.66	8.21	26 - 66
FI score	340		29.45	5.89	20 - 45
EMI score	316		39.00	8.75	27 - 63
Assorted snacks and processed foods	342		11.92	2.65	5.14 – 28.57
Assorted vegetables, fruit, and fish	342		14.50	3.38	5.60 – 32.40
Fruit juice and sweet items	342		9.16	3.23	4.00 – 23.00
Assorted proteins	342		5.29	1.81	1.67 – 13.33
Grains and nuts	342		8.86	2.77	2.50 – 15.50
Assorted dairy and water	342		10.65	1.80	4.33 – 14.33

Home Visit Procedures

Caregivers were invited to participate in a 2-hour home observation using a script with detailed information about the visit, and all participating families provided written informed consent. Researchers instructed caregivers to plan their dinnertime meal as they typically would. The trained researchers would arrive 30-45 minutes before the parent-arranged dinnertime to build rapport and set up video equipment. When families were ready to begin dinner, the researchers turned on the video equipment and then left the home to prevent bias and avoid influencing behavior during the meal. Once the mealtime ended, the researchers returned to complete observations of parent-child interactions to assess attachment security.

Measures

Child Attachment Security. Child attachment behavior was assessed with the Attachment Behavior Q-Set version 3.0 (AQS; van IJzendoorn et al., 2004; Waters, 1995). The AQS uses Q-methodology to describe a child's organization of secure base behavior and interactions around a caregiver in naturalistic settings. Trained observers sorted 90 behavioral items based on how descriptive they were of the child's behavior according to their detailed observations *after* the family mealtime. During the home visit, the observer took notes and asked the caregivers a series of questions regarding the behaviors outside of mealtime. After the visit, the observer sorted AQS items into three separate piles: most, moderately, and least like the child. Eventually, nine piles were created with ten items. The observer then used a rating scale from 1 (least like the child) to 9 (most like the child). Higher scores represented more secure attachment in the child-caregiver relationship. Scale items from the AQS have been shown to have adequate internal consistency and are associated with maternal adult attachment classifications (Kazui et al., 2000; Posado et al., 2008). The AQS has been shown to have ecological, discriminant, predictive, and convergent validity, and findings are consistent across cultural contexts (van IJzendoorn et al., 2004). In this study, q-correlations for 18 of the 108 double-sorted visits (calculated from the agreement between the q-descriptions of child behavior) ranged from 0.375 to 0.857 (M = 0.673).

Household Chaos. Household chaos and environmental levels were assessed using the Confusion, Hubbub, and Order Scale (CHAOS; Matheny et al., 1995). The questionnaire consists of 15 statements surrounding their household environment, and each question is on a 4-point Likert scale, ranging from very much like your home to not at all like your own home. Example questions include, "It's a real zoo in our home," "Our home is a good place to relax," and "First thing in the day, we have a regular routine at home." CHAOS measures two facets of household chaos. The first facet is routines and organization, and the second is disorganization, confusion, and noise. A single score is obtained by summing the items, with a highest possible score of 60. A higher score indicates a higher level of chaos within the home. Adequate internal reliability was demonstrated for household chaos (Cronbach's α=0.86).

Dietary Consumption. Child dietary consumption was assessed using a child block of the Food Frequency Questionnaire (FFQ) developed by Nutrition Quest (Nutrition Quest, 2014). The FFQ is a measure of the consumption of fruits, vegetables, fats, proteins, and dairy in children 2 to 7 years of age (Fiese et al., 2019). Parents complete the 90-item questionnaire in response to their child's "usual eating habits in the past six months." Example items include banana, broccoli, beef, and butter. Questions are rated on an 8-point Likert scale. The scale consists of never, once per month, 2-3 times per month, once per week, twice per week, 3-4 times per week, 5-6 times per week, and every day. The food list was developed from NHANES III dietary recall data, and USDA Nutrient Database for Standard Reference was also used for nutrient assessment. Based on previous literature, food groups were created to combine related food types (Berding et al., 2018; Leong et al., 2018). There were 23 food groups, and a principal component analysis was then conducted to reduce the dietary consumption data. The results revealed 6 components from the 23 food groups (see description below and Table 2).

Table 2

Dietary Consumption: Principal Component Analysis

Description	Loading
Assorted Snacks and Processed Foods	
Savory snacks	0.69
Refined carbohydrates	0.69
Fried foods	0.62
Processed meats	0.54
Mixed foods	0.54
Condiments	0.51
Butter/Margarine	0.49
Assorted Vegetables, Fruit, and Fish	
Vegetables	0.81
Starchy foods	0.68
Legumes	0.65
Fruit	0.60
Fish/Seafood	0.50
Fruit Juice and Sweet Items	
100% Fruit juice	0.76
Sweet beverages	0.65
Sweet foods	0.55
Assorted Proteins	
Poultry	0.68
Red meats	0.67
Eggs	0.57
Grains and Nuts	
Grains	0.69
Peanuts/Nuts	0.67
Assorted Dairy and Water	
Yogurt	0.80
Dairy	0.59
Water	0.47

Note. Cutoffs of 0.4 were used for analyses

Executive Function. EF was assessed using the Behavior Rating Inventory of Executive Function- Preschool Version (BRIEF-P; Isquith et al., 2005). This survey assesses multiple components of EF, including inhibition, shifting, emotional control, working memory, and planning/organizing. Parents are asked to complete this questionnaire based on how often each behavior has been a problem in their child's life during the last six months. These items are ranged from 1 (never) to 3 (often). Example questions include: "is easily overwhelmed or overstimulated by typical daily activities," "gets out of control more than playmates," and "talks or play too loudly." Five subscales (listed above), three broad index scores (Inhibitory Self-Control, Flexibility, and Emergent Metacognition), and one global composition score are also derived from the BRIEF-P. Two validity scales (Inconsistency and Negativity) are can also be derived. The Inhibitory Self-Control Index (ISCI) index combines the ability to inhibit and emotionally control subscales, the Flexibility Index (FI) combines the shift and emotional control subscales, and the Emergent Metacognition Index (EMI) combines the working memory and plan/organize subscales. The global composition score (GEC) combines all subscales to receive a total score. Higher scores on the BRIEF-P indicate worse performance on EF abilities. For this study, the ISCI, FI, and EMI subscales will be used for analyses. Adequate internal reliability was demonstrated for the ISCI (Cronbach's α=0.92), FI (Cronbach's α=0.88), and EMI subscales (Cronbach's α=0.93).

Data Analysis. The Statistical Package for the Social Sciences (SPSS) version 27.0 was used for data analysis. Statistical significance was set at $p \leq 0.05$. A PCA was conducted to examine food groups further and create dietary consumption model variables. To test associations among all study variables, bivariate parametric correlations were conducted. Then, multiple regressions with both models and all EF subscales were examined.

Chapter 3: Results

Preliminary Analyses

Preliminary analyses were conducted to determine whether demographic variables were associated with outcome variables. Child gender and parent race/ethnicity were not found to be associated with any EF outcome variables (all p's > .05). Family income was significantly correlated with ISCI subscale r (79) = -0.24, p = 0.04 and the EMI subscale r (75) = -0.26, p = 0.02. Child age was significantly associated with the EMI subscale r (82) = 0.23, p = 0.04. Descriptive statistics for all study variables are reported in Table 1.

FFQ Analyses

To create dietary consumption food groups, a principal components analysis was conducted. A PCA with varimax rotation was performed using responses to the food groups formed from the FFQ. Six components with Eigenvalues >1.00 collectively accounted for 57.365% of the variance. A factor loading of .4 was used, which was consistent with previous studies (Korkalo et al., 2019; Niedzwiedzka et al., 2019; Northstone et al., 2008; Northstone & Emmett, 2008). All food groups loaded on a factor using this cutoff. Components can be found in Table 2.

Component 1, Assorted Snacks and Processed Foods, explained 13.93% of the variance and included Savory Snacks, Refined Carbohydrates, Fried Foods, Processed Meats, Mixed Foods, Condiments, and Butter/Margarine. Component 2, Assorted Vegetables, Fruit, and Fish, explained 11.53% of the variance and included Vegetables, Starchy Foods, Legumes, Fruit, and Fish/Seafood. Component 3, Fruit Juice and Sweet Items, contain 100% fruit juice, Sweet Beverages, and Sweet Foods. This explained 8.98% of the variance. Component 4, Assorted Proteins, includes Poultry, Red Meats, and Eggs, and it explained 8.76% of the variance. Component 5, Grains and Nuts, explained 7.80% of the variance, contains items directly related to Grains and Peanut/Nuts. Lastly, Component 6, Assorted Dairy and Water, included Yogurt, Dairy, and Water and explained 6.37% of the variance. Adequate internal reliability was demonstrated for Component 1 (Cronbach's α=0.76), as well as Component 2 (Cronbach's α=0.65), Component 3 (Cronbach's α=0.55), and Component 4 (Cronbach's α=0.51). Two factors contained poor internal reliability: Component 5 (Cronbach's α=0.47) and Component 6 (Cronbach's α=0.26). Due to poor reliability, these two factors were not used in the final analyses.

Bivariate Correlations

Observed Attachment Security and Child EF (Model One). Bivariate associations between all model variables are depicted in Table 3. Child attachment security was negatively and significantly associated with the ISCI r (86) = -0.23, p = 0.04 and FI subscales r (91) = -0.21, p = 0.04. No significant correlation was found between child attachment security and the EMI subscale. Household chaos was positively and significantly associated with each EF subscale (all p's < 0.05).

Dietary Consumption and Child EF (Model Two). Bivariate associations between all model variables are depicted in Table 3. Assorted Snacks and Processed Foods was positively and significantly associated with household chaos and each EF subscale (all p's < 0.05). Consumption of Assorted Vegetables, Fruit, and Fish was negatively and significantly associated with household chaos $r(331) = -0.12$, $p = 0.03$, and no EF subscales. Fruit Juice and Sweet Items were positively and significantly associated with household chaos and EMI EF subscale (all p's < 0.05). Assorted Proteins was positively and significantly associated with the EMI subscale $r(270) = 0.13$, $p = 0.04$. Assorted Snacks and Processed Foods and Fruit Juice and Sweet Items were the only subscales used in final analyses.

Table 3

Pairwise Bivariate Correlations Among all Model Variables

		1	2	3	4	5	6	7	8	9
1	Child AQS	---								
2	Assorted snacks and processed foods	-0.04	----							
3	Assorted vegetables, fruit, and fish	**0.21***	**0.32*****	----						
4	Fruit juice and sweet items	-0.17	**0.56*****	0.09	----					
5	Assorted proteins	0.07	**0.49*****	**0.41*****	**0.29*****	----				
6	Household chaos	0.06	**0.17*****	**-0.12***	0.03	0.03	----			
7	ISCI subscale	**-0.23***	**0.20*****	-0.10	0.08	0.08	**0.38*****	----		
8	FI subscale	**-0.21***	**0.16****	-0.04	0.08	0.08	**0.25*****	**0.86*****	----	
9	EMI subscale	-0.02	**0.19*****	-0.05	**0.13***	**0.13***	**0.38*****	**0.82*****	**0.67*****	----

Note. Statistically significant correlations are bolded (p ≤ .05*, p ≤ .01**, p ≤ .001***).

Regression Analysis

Observed Attachment Security and Child EF (Model One). In the first analysis, child attachment security, household chaos, and the interaction term were entered as predictor variables, and each subscale of EF were separate dependent variables. Control variables were added to block one if they correlated with the outcome variables. Results revealed that the full model accounted for 26% of the variance in the ISCI subscale (Adjusted R^2 = 0.22). Child attachment security (β = -0.24, p = 0.03), and household chaos (β = 0.41, p ≤ 0.001) were both independent and significant predictors of ISCI scores. The interaction score and income were not found to be significant (see Table 4). Additionally, with the EMI subscale, results revealed that the full model accounted for 21% of the variance (Adjusted R^2 = 0.15). For the EMI subscale, only household chaos (β = 0.40, p = 0.002) was a significant predictor (see Table 5). Lastly, the FI subscale results revealed that the full model accounted for 14% of the variance (Adjusted R^2 = 0.11). Child attachment security (β = -0.23, p = 0.03), household chaos (β = 0.31, p = 0.003) were found to be significant predictors of EF FI scores, but not the interaction term (see Table 6).

Regression Analysis

Dietary Consumption and Child EF (Model Two). In the second analysis, dietary consumption, household chaos, and the interaction term were entered as predictor variables, and each subscale of EF were separate dependent variables. Control variables were added to block one if they correlated with the predictor variables. Regarding the Assorted Snacks and Processed Foods subscale, results revealed that the whole model accounted for 24% of the variance (Adjusted R^2 = 0.20).

For the EF ISCI subscale, only household chaos (β = 0.38, p = 0.002) was a significant predictor and not income, the Assorted Snacks and Processed Foods subscale, or the interaction score (see Table 7). Similar results were found for subscales EMI and FI (Table 8 and Table 9). Regarding the Fruit Juice and Sweet Items subscale, results revealed that the full model accounted for 25% of the variance (Adjusted R^2 = 0.20). For the EF ISCI subscale, only household chaos (β = 0.38, p = 0.002) was a significant predictor of EF abilities (see Table 10). Similar results were found for subscales EMI and FI (Table 11 and Table 12).

Table 4

Multiple Regression Analyzing Associations Between Income, Child Attachment Security, Household Chaos, and Inhibition and Emotional Control (ISCI)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Income	-0.57 (0.27)	**-0.24 (0.04)**	-0.59 (0.26)	**-0.25 (0.03)**	-0.28 (0.25)	-0.12 (0.27)	-0.28 (0.26)	-0.12 (0.27)
Child attachment security (AQS)			-7.54 (3.74)	**-0.22(0.05)**	-7.85 (3.43)	**-0.23 (0.03)**	-7.98 (3.56)	**-0.24 (0.03)**
Household chaos					0.47 (0.12)	**0.41 (0.00)**	0.47 (0.13)	**0.41 (0.00)**
AQS x household chaos							-0.09 (0.57)	-0.02 (0.88)
R^2	0.06		0.11		0.26		0.26	
ΔR^2	0.05		0.08		0.23		0.22	
ΔF	**4.58**		**4.07**		**14.74**		0.02	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=76

Table 5

Multiple Regression Analyzing Associations Between Income, Child Age, Child Attachment Security, Household Chaos, and Working Memory and Planning/Organizing (EMI)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Income	-0.53 (0.27)	-0.23 (0.06)	-.052 (0.28)	-0.22 (0.07)	-0.22 (0.28)	-0.10 (0.43)	-0.21 (0.28)	-0.09 (0.46)
Child age	0.39 (0.36)	0.13 (0.28)	0.39 (0.36)	0.13 (0.28)	0.21 (0.34)	0.07 (0.55)	0.18 (0.35)	0.06 (0.61)
Child attachment security (AQS)			-0.79 (3.91)	-0.02 (0.84)	-2.27 (3.70)	-0.07 (0.54)	-1.26 (3.98)	-0.04 (0.75)
Household chaos					0.44 (0.14)	**0.38 (0.002)**	0.46 (0.14)	**0.40 (0.002)**
AQS x household chaos							0.42 (0.60)	0.08 (0.49)
R^2	0.08		0.08		0.20		0.21	
ΔR^2	0.08		0.001		0.12		0.01	
ΔF	**3.11**		0.04		**10.51**		0.49	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=74

Table 6
Multiple Regression Analyzing Associations Between Child Attachment Security, Household Chaos, and Shifting and Emotional Control (FI)

	Model 1		Model 2		Model 3	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Child attachment security (AQS)	-4.78 (2.36)	**-0.21 (0.04)**	-5.25 (2.24)	**-0.23 (0.02)**	-5.18 (2.31)	**-0.23 (0.03)**
Household chaos			0.24 (0.08)	**0.31 (0.003)**	0.24 (0.08)	**0.31 (0.003)**
AQS x household chaos					0.05 (0.34)	0.01 (0.90)
R^2	0.05		0.14		0.14	
ΔR^2	0.03		0.12		0.11	
ΔF	**4.18**		**9.42**		0.02	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=91

Table 7
Multiple Regression Analyzing Associations Between Income, Assorted Snacks and Processed Foods, Household Chaos, and Inhibition and Emotional Control (ISCI)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Income	-0.52(0.26)	**-0.23 (0.05)**	-0.40 (0.26)	-0.17 (0.13)	-0.17 (0.25)	-0.07 (0.50)	-0.17 (0.26)	-0.08 (0.50)
Assorted snacks and processed foods			0.83 (0.34)	**0.28 (0.02)**	0.48 (0.33)	0.16 (0.15)	0.49 (0.34)	0.17 (0.15)
Household chaos					0.43 (0.13)	**0.38 (0.001)**	0.43 (0.13)	**0.38 (0.002)**
Assorted snacks and processed foods x household chaos							-0.01(0.05)	-0.02 (0.88)
R^2	0.05		0.13		0.24		0.24	
ΔR^2	0.04		0.10		0.21		0.20	
ΔF	**3.93**		**6.10**		**10.92**		0.02	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=75; Assorted snacks and processed foods component includes Savory Snacks, Refined Carbohydrates, Fried Foods, Processed Meats, Mixed Foods, Condiments, and Butter/Margarine

Table 8

Multiple Regression Analyzing Associations Between Income, Child Age, Assorted Snacks and Processed Foods, Household Chaos, and Working Memory and Planning/Organizing (EMI)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Income	-0.56 (0.28)	-0.24 (0.05)	-0.52 (0.28)	-0.22 (0.07)	-0.31 (0.28)	-0.13 (0.27)	-0.33 (0.29)	-0.14 (0.26)
Child age	0.45 (0.37)	0.15 (0.22)	0.45 (0.37)	0.14 (0.23)	0.24 (0.36)	0.08 (0.50)	0.24 (0.36)	0.08 (0.51)
Assorted snacks and processed foods			0.41 (0.36)	0.13 (0.26)	0.07 (0.37)	0.02 (0.85)	0.09 (0.38)	0.03 (0.81)
Household chaos					0.40 (0.15)	**0.35 (0.01)**	0.40 (0.15)	**0.35 (0.01)**
Assorted snacks and processed foods x household chaos							-0.01 (0.05)	-0.03 (0.80)
R^2	0.09		0.11		0.20		0.20	
ΔR^2	0.07		0.07		0.15		0.14	
ΔF	**3.47**		1.31		**7.45**		0.06	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=71; Assorted snacks and processed foods component includes Savory Snacks, Refined Carbohydrates, Fried Foods, Processed Meats, Mixed Foods, Condiments, and Butter/Margarine

Table 9

Multiple Regression Analyzing Associations Between Assorted Snacks and Processed Foods, Household Chaos, and Shifting and Emotional Control (FI)

	Model 1		Model 2		Model 3	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Assorted snacks and processed foods	0.36 (0.13)	**0.16 (0.01)**	0.24 (0.13)	0.11 (0.06)	0.24 (0.13)	0.11 (0.06)
Household chaos			0.23 (0.05)	**0.28 (0.000)**	0.23 (0.05)	**0.29 (0.000)**
Assorted snacks and processed foods x household chaos					0.02 (0.02)	0.07 (0.25)
R^2	0.02		0.10		0.11	
ΔR^2	0.02		0.10		0.10	
ΔF	**7.24**		**25.00**		1.35	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=294; Assorted snacks and processed foods component includes Savory Snacks, Refined Carbohydrates, Fried Foods, Processed Meats, Mixed Foods, Condiments, and Butter/Margarine

Table 10
Multiple Regression Analyzing Associations Between Income, Fruit Juice and Sweet Items, Household Chaos, and Inhibition and Emotional Control (ISCI)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Income	-0.52 (0.26)	**-0.23 (0.05)**	-0.37 (0.26)	-0.16 (0.16)	-0.15 (0.25)	-0.07 (0.55)	-0.15 (0.26)	-0.06 (0.56)
Fruit juice and sweet items			0.70 (0.27)	**0.29 (0.01)**	0.41 (0.27)	0.17 (0.13)	0.42 (0.27)	0.17 (0.13)
Household chaos					0.42 (0.13)	**0.28 (0.002)**	0.43 (0.13)	**0.38 (0.002)**
Fruit juice and sweet items x household chaos							-0.02 (0.04)	-0.06 (0.60)
R^2	0.05		0.13		0.24		0.25	
ΔR^2	0.04		0.11		0.21		0.20	
ΔF	**3.93**		**6.47**		**10.75**		0.28	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=75; Fruit juice and sweet items component contains 100% Fruit Juice, Sweet Beverages, and Sweet Foods

Table 11
Multiple Regression Analyzing Associations Between Income, Child Age, Fruit Juice and Sweet Items, Household Chaos, and Working Memory and Planning/Organizing (EMI)

	Model 1		Model 2		Model 3		Model 4	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Income	-0.56 (0.28)	**-0.24 (0.05)**	-0.44 (0.29)	-0.19 (0.13)	-0.27 (0.28)	-0.11 (0.35)	-0.26 (0.28)	-0.11 (0.36)
Child age	0.45 (0.37)	0.15 (0.22)	0.45 (0.36)	0.14 (0.22)	0.26 (0.35)	0.08 (0.47)	0.25 (0.36)	0.08 (0.49)
Fruit juice and sweet items			0.47 (0.28)	0.20 (0.10)	0.28 (0.28)	0.12 (0.31)	0.27 (0.28)	0.12 (0.33)
Household chaos					0.37 (0.14)	**0.32 (0.01)**	0.38 (0.14)	**0.33 (0.01)**
Fruit juice and sweet items x household chaos							-0.01 (0.04)	-0.04 (0.71)
R^2	0.09		0.13		0.21		0.21	
ΔR^2	0.07		0.09		0.16		0.15	
ΔF	**3.47**		2.87		**6.89**		0.14	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=71; Fruit juice and sweet items component contains 100% Fruit Juice, Sweet Beverages, and Sweet Foods

Table 12
Multiple Regression Analyzing Associations Between Fruit Juice and Sweet Items, Household Chaos, and Shifting and Emotional Control (FI)

	Model 1		Model 2		Model 3	
	B (SE)	β (p)	B (SE)	β (p)	B (SE)	β (p)
Fruit juice and sweet items	0.23 (0.11)	**0.13 (0.03)**	0.11 (0.11)	0.06 (0.30)	0.12 (0.11)	0.07 (0.26)
Household chaos			0.23 (0.05)	**0.29 (0.000)**	0.28 (0.05)	**0.28 (0.000)**
Fruit juice and sweet items x household chaos					0.02 (0.02)	0.07 (0.24)
R^2	0.02		0.09		0.10	
ΔR^2	0.01		0.09		0.09	
ΔF	**4.77**		**24.98**		1.40	

Note. Bolded lines indicate statistically significant findings ($p \leq .05$); N=294; Fruit juice and sweet items component contains 100% Fruit Juice, Sweet Beverages, and Sweet Foods

Chapter 4: Discussion

This study examined associations between child attachment security, dietary consumption, household chaos, and EF in children 18-24 months of age. Within the first model and consistent with previous literature (Bernier et al., 2015; Blair et al., 2018; Fay-Stammbach et al., 2014; Meuwissen & Englund, 2016), the findings revealed that higher child attachment security was related to lower EF problems for two of the three EF subscales. In the second model's final analyses, we see no significant associations between dietary consumption and EF - besides a trend for the Assorted Snacks and Processed Foods component, with higher consumption related to lower shift and emotional control abilities. Contrary to our hypotheses, results also indicated that household chaos does not modify attachment – EF and dietary consumption – EF associations, but rather has an independent effect on EF. Indeed, household chaos was significantly associated with all three BRIEF-P subscales in the regression models. The association between household chaos and poorer EF is consistent with previous literature (Dumas et al., 2005; Wachs, 1993; Wachs & Camli, 1991). Since household chaos describes an environment that is high in noise and crowding and low in regularity and routines (Vernon-Feagans et al., 2016), this environment may distract, limit, or alter a child's EF abilities.

The current findings surrounding household chaos can contribute to the literature in multiple ways. First, since we found independent relationships with child EF, this illustrates how even at a young age (18-24 months), household chaos and environment might influence children's EF abilities. They may understand the cues around them, and the lack of routine and regularity might influence their cognitive abilities. Second, these findings can help researchers, policymakers, and families understand how household chaos can influence their child's relationships with others, dietary consumption, and EF abilities. Informing other individuals about this phenomenon can help assist with families' ability and motivation to change their current environment if needed. Lastly, these results can help future researchers examine how household chaos may impact other dimensions of EF through various methodologies and samples.

The findings also highlight the unique effect of child attachment security on EF. These findings are consistent with those of an array of different studies (Bernier et al., 2015; Blair et al., 2018; Kochanska & Aksan, 1995; Lewis & Carpendale, 2009; Meuwissen & Englund, 2016). Children with secure attachments have a history of experiences with trusting caregivers who provide sensitive and responsive care in response to their distress and needs. Regulatory capacities that develop through these experiences may impact developing EF capabilities. Interestingly, the findings from this study show that attachment security was not significantly associated with the EMI subscale (Planning/Organizing and Working Memory) in the multiple regression analysis. This might suggest that attachment-related experiences have more impact on inhibitory/emotional control and capacities to shift attention than organization and memory. Future research should examine the relative influence of attachment security on different dimensions of EF, using multiple methodologies, to determine whether these findings are replicated across EF components.

When examining dietary consumption, we found that our hypotheses were not supported in the final analyses; however, we saw a correlational association between assorted snacks and processed foods and worse performance on all EF subscales. We also saw this relationship with fruit juice and sweet items and the EMI subscale. This indicates that various types of food may impact a child's performance on EF-related tasks. Consistent with previous research (Ames et al., 2014; Cohen et al., 2016; Haapala et al., 2015; Riggs et al., 2012, Riggs et al., 2010), the diet quality may influence a child's or adolescent's performance on EF related tasks, and this may further influence their cognitive abilities. This warrants further investigation to understand how younger children may be affected by diet quality and consumption and how that can influence a child's EF abilities. Throughout a child's life, they are experiencing different milestones, trajectories, and environments; therefore, it is essential to examine other age groups and how they may be affected differently.

There are several notable strengths of this study, which include various measures, including self-report and observational methodologies, and data analysis, including multiple regressions and PCA analyses. Dietary consumption was measured using a PCA analysis to ensure proper food categories. Also, child attachment security was observed in a naturalistic setting, allowing for a range of caregiver-child behaviors during the home visit. To date, virtually no studies have examined household chaos as a moderator of attachment-EF and dietary consumption-EF associations. However, researchers have found connections between all model variables and household chaos (Anderson & Keim, 2016; Beier et al., 2019; Dumas et al., 2005; Vernon-Feagans et al., 2016; Wachs & Camli, 1991). Therefore, this study provides new knowledge and information that can inform future studies examining the impact of household environment and chaos on children's development.

There are also limitations to this study. For model 1, the analysis sample was small, and both models were not diverse with respect to race/ethnicity and income. Therefore, the findings are not generalizable, and diverse family contexts should be examined in the future. Based on the correlational design, no causal inferences can be made regarding the found associations, highlighting the need for longitudinal and experimental techniques. Future research should include multiple measures of child attachment security, dietary consumption, EF, and household chaos to understand these results further. Finally, it should be noted that this study was not pre-registered according to open science approaches, which is a limitation.

Despite these limitations, the current findings are novel and contribute to the larger literature on EF in children aged 18 to 24 months. For example, they further support the notion that early caregiver-child relationships and the nature of the household environment can impact young children’s developing EF capacities. As such, preventions focused on increasing the quality of the parent-child interactions, as well as surrounding lowering household chaos, might help mitigate EF problems. Furthermore, the data suggest that children’s unhealthful dietary consumption may also be related to the household environment, and associations with EF warrant more attention. These factors can influence a child and family on multiple levels; therefore, it is essential to explore further and examine these factors at various age groups, over time, and in diverse family contexts.

References

Ames, S. L., Kisbu-Sakarya, Y., Reynolds, K. D., Boyle, S., Cappelli, C., Cox, M. G., Dust, M., Grenard, J. L., Mackinnon, D. P., Stacy, A. W. (2014). Inhibitory control effects in adolescent binge eating and consumption of sugar-sweetened beverages and snacks. *Appetite, 81*, 180–192. https://doi.org/10.1016/j.appet.2014.06.013

Anderson, P. (2002). Assessment and development of executive function (EF) during childhood. *Child Neuropsychology*, *8*(2), 71–82. https://doi.org/10.1076/chin.8.2.71.8724

Anderson, S. E., & Keim, S. A. (2016). Parent-child interaction, self-regulation, and obesity prevention in early childhood. *Current Obesity Reports*, *5*(2), 192–200. https://doi.org/10.1007/s13679-016-0208-9

Andrews, K., Atkinson, L., Harris, M., & Gonzalez, A. (2020). Examining the effects of household chaos on child executive functions: A meta-analysis. *Psychological Bulletin*. *147*(1), 16. https://doi.org/10.1037/bul0000311

Aron, A. R. (2008). Progress in executive-function research. *Current Directions in Psychological Science*, *17*(2), 124–129. https://doi.org/10.1111/j.1467-8721.2008.00561.x

Barnes, J. J., Dean, A. J., Nandam, L. S., O'Connell, R. G., & Bellgrove, M. A. (2011). The molecular genetics of executive function: Role of monoamine system genes. *Biological Psychiatry*, *69*(12), e127-e143. https://doi.org/10.1016/j.biopsych.2010.12.040

Beier, J. S., Gross, J. T., Brett, B. E., Stern, J. A., Martin, D. R., & Cassidy, J. (2019). Helping, sharing, and comforting in young children: Links to individual differences in attachment. *Child Development*, *90*(2), e273–e289. https://doi.org/10.1111/cdev.13100

Berding, K., Holscher, H. D., Arthur, A. E., & Donovan, S. M. (2018). Fecal microbiome composition and stability in 4- to 8-year-old children is associated with dietary patterns and nutrient intake. *Journal of Nutritional Biochemistry*, *56*, 165–174. https://doi.org/10.1016/j.jnutbio.2018.01.002

Berge, J. M., Wall, M., Larson, N., Forsyth, A., Bauer, K. W., & Neumark-Sztainer, D. (2014). Youth dietary intake and weight status: Healthful neighborhood food environments enhance the protective role of supportive family home environments. *Health and Place*, *26*, 69–77. https://doi.org/10.1016/j.healthplace.2013.11.007

Bernier, A., Beauchamp, M. H., Carlson, S. M., & Lalonde, G. (2015). A secure base from which to regulate: Attachment security in toddlerhood as a predictor of executive functioning at school entry. *Developmental Psychology*, *51*(9), 1177–1189. https://doi.org/10.1037/dev0000032

Bernier, A., Carlson, S. M., Deschênes, M., & Matte-Gagné, C. (2012). Social factors in the development of early executive functioning: A closer look at the caregiving environment. *Developmental Science*, *15*(1), 12–24. https://doi.org/10.1111/j.1467-7687.2011.01093.x

Bernier, A., Carlson, S. M., & Whipple, N. (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development*, *81*(1), 326–339. https://doi.org/10.1111/j.1467-8624.2009.01397.x

Berry, D., Blair, C., Willoughby, M., Garrett-Peters, P., Vernon-Feagans, L., Mills-Koonce, W. R., & Family Life Project Key Investigators. (2016). Household chaos and children's cognitive and socio-emotional development in early childhood: Does childcare play a buffering role? *Early Childhood Research Quarterly*, *34*, 115–127. https://doi.org/10.1016/j.ecresq.2015.09.003

Blair, C., Raver, C. C., & Berry, D. J. (2014). Two approaches to estimating the effect of parenting on the development of executive function in early childhood. *Developmental Psychology*, *50*(2), 554. https://doi.org/10.1037/a0033647

Blair, M. A., Nitzburg, G., DeRosse, P., & Karlsgodt, K. H. (2018). Relationship between executive function, attachment style, and psychotic like experiences in typically developing youth. *Schizophrenia Research*, *197*, 428–433. https://doi.org/10.1016/j.schres.2018.02.026

Blakemore, S. J., & Choudhury, S. (2006). Development of the adolescent brain: Implications for executive function and social cognition. *Journal of Child Psychology and Psychiatry*, *47*(3–4), 296–312. https://doi.org/10.1111/j.1469-7610.2006.01611.x

Bowlby, J. (1979). Psychoanalysis as art and science. *International Review of Psycho-Analysis*, *6*, 3-14.

Bretherton, I. (1985). Attachment theory: Retrospect and prospect. *Monographs of the Society for Research in Child Development*, *50*(1/2), 3. https://doi.org/10.2307/3333824

Brown, D. D., Weatherholt, T. N., & Burns, B. M. (2010). Understanding parent reports of children's attention behaviors: Role of children's attention skills, temperament, and home environment. *Journal of Early Childhood & Infant Psychology*, (6).

Chen, N., Deater-Deckard, K., & Bell, M. A. (2014). The role of temperament by family environment interactions in child maladjustment. *Journal of Abnormal Child Psychology*, *42*(8), 1251–1262. https://doi.org/10.1007/s10802-014-9872-y

Chung, Y. C., Park, C. H., Kwon, H. K., Park, Y. M., Kim, Y. S., Doo, J. K., Shin, D. H., Jung, E. S., Oh, M. R., Chae, S. W. (2012). Improved cognitive performance following supplementation with a mixed-grain diet in high school students: A randomized controlled trial. *Nutrition*, *28*(2), 165–172. https://doi.org/10.1016/j.nut.2011.05.017

Cohen, J. F. W., Gorski, M. T., Gruber, S. A., Kurdziel, L. B. F., & Rimm, E. B. (2016). The effect of healthy dietary consumption on executive cognitive functioning in children and adolescents: A systematic review. *British Journal of Nutrition*, *116*(6), 989-1000. https://doi.org/10.1017/S0007114516002877

Collins, A., & Koechlin, E. (2012). Reasoning, learning, and creativity: Frontal lobe function and human decision-making. *PLoS Biology*, *10*(3), e1001293. https://doi.org/10.1371/journal.pbio.1001293

Cyril, S., Halliday, J., Green, J., & Renzaho, A. M. N. (2016). Relationship between body mass index and family functioning, family communication, family type and parenting style among African migrant parents and children in Victoria, Australia: A parent-child dyad study. *BMC Public Health*, *16*(1), 1-10. https://doi.org/10.1186/s12889-016-3394-1

Diamond, A. (2013). Executive functions. *Annual Review of Psychology*, *64*, 135-168. https://doi.org/10.1146/ANNUREV-PSYCH-113011-143750

Diamond, A. B., Barnett, S. W., Thomas, J., Munro, S. (2007). Preschool program improves cognitive control. *Science*, *318*(5855), 1387-1388. https://doi.org/10.1126/science.1151148

Diamond, A. (86). Lee. K. (2011) Interventions shown to aid executive function development in children 4-12 year old. *Science*, *333*, 958-964. https://doi.org/10.1126/science.1204529

Dumas, J. E., Nissley, J., Nordstrom, A., Smith, E. P., Prinz, R. J., & Levine, D. W. (2005). Home chaos: Sociodemographic, parenting, interactional, and child correlates. *Journal of Clinical Child and Adolescent Psychology*, *34*(1), 93–104. https://doi.org/10.1207/s15374424jccp3401_9

Evans, G. W., & Stecker, R. (2004). Motivational consequences of environmental stress. *Journal of Environmental Psychology*, *24*(2), 143–165. https://doi.org/10.1016/S0272-4944(03)00076-8

Ezpeleta, L., Granero, R., Penelo, E., de la Osa, N., & Domènech, J. M. (2015). Behavior Rating Inventory of Executive Functioning–Preschool (BRIEF-P) applied to teachers: Psychometric properties and usefulness for disruptive disorders in 3-year-old preschoolers. *Journal of Attention Disorders*, *19*(6), 476–488. https://doi.org/10.1177/1087054712466439

Fay-Stammbach, T., Hawes, D. J., & Meredith, P. (2014). Parenting influences on executive function in early childhood: A review. *Child Development Perspectives*, *8*(4), 258–264. https://doi.org/10.1111/cdep.12095

Fiese, B. H., Musaad, S., Bost, K. K., McBride, B. A., Lee, S. Y., Teran-Garcia, M., & Donovan, S. M. (2019). The Strong Kids 2 birth cohort study: A cell-to-society approach to dietary habits and weight trajectories across the first 5 years of life. *Current Developments in Nutrition*, *3*(3), nzz007. https://doi.org/10.1093/CDN/NZZ007

Funahashi, S., & Andreau, J. M. (2013). Prefrontal cortex and neural mechanisms of executive function. *Journal of Physiology Paris*, *107*(6), 471–482. https://doi.org/10.1016/j.jphysparis.2013.05.001

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin*, *134*(1), 31–60. https://doi.org/10.1037/0033-2909.134.1.31

Gilbert, S. J., & Burgess, P. W. (2008). Executive function. *Current Biology*, *18*(3), R110-R114. https://doi.org/10.1016/j.cub.2007.12.014

Gioia, G. A., Andrwes, K., & Isquith, P. K. (1996). *Behavior Rating Inventory of Executive Function-Preschool Version (BRIEF-P)*. Odessa, FL: Psychological Assessment Resources.

Greene, C. M., Braet, W., Johnson, K. A., & Bellgrove, M. A. (2008). Imaging the genetics of executive function. *Biological Psychology*, *79*(1), 30–42. https://doi.org/10.1016/j.biopsycho.2007.11.009

Haapala, E. A., Eloranta, A. M., Venäläinen, T., Schwab, U., Lindi, V., & Lakka, T. A. (2015). Associations of diet quality with cognition in children-the physical activity and nutrition in children study. *British Journal of Nutrition*, *114*(7), 1080–1087. https://doi.org/10.1017/S0007114515001634

Halliday, J. A., Palma, C. L., Mellor, D., Green, J., & Renzaho, A. M. N. (2014). The relationship between family functioning and child and adolescent overweight and obesity: A systematic review. *International Journal of Obesity*, *38*(4), 480-493. https://doi.org/10.1038/ijo.2013.213

Hassevoort, K. M., Lin, A. S., Khan, N. A., Hillman, C. H., & Cohen, N. J. (2020). Added sugar and dietary fiber consumption are associated with creativity in preadolescent children. *Nutritional Neuroscience*, *23*(10), 791-802. https://doi.org/10.1080/1028415X.2018.1558003

Hughes, C., & Devine, R. T. (2019). For better or for worse? Positive and negative parental influences on young children's executive function. *Child Development*, *90*(2), 593–609. https://doi.org/10.1111/cdev.12915

Hughes, C., & Ensor, R. (2009). How do families help or hinder the development of executive function? *New Directions in Child and Adolescent Psychiatry*, *123*, 35-50. https://doi.org/10.1002/cd.234

Hur, E., Buettner, C. K., & Jeon, L. (2015). Parental depressive symptoms and children's school-readiness: The indirect effect of household chaos. *Journal of Child and Family Studies*, *24*(11), 3462–3473. https://doi.org/10.1007/s10826-015-0147-1

Isaacs, E., & Oates, J. (2008). Nutrition and cognition: assessing cognitive abilities in children and young people. *European Journal of Nutrition*, *47*(3), 4-24. https://doi.org/10.1007/s00394-008-3002-y

Isquith, P. K., Crawford, J. S., Espy, K. A., & Gioia, G. A. (2005). Assessment of executive function in preschool-aged children. *Mental Retardation and Developmental Disabilities Research Reviews*, *11*(3), 209–215. https://doi.org/10.1002/mrdd.20075

Kazui, M., Endo, T., Tanaka, A., Sakagami, H., & Suganuma, M. (2000). Intergenerational transmission of attachment: Japanese mother–child dyads. *Japanese Journal of Educational Psychology*. *48*(3), 323–332. https://doi.org/10.5926/jjep1953.48.3_323

Kochanska, G., & Aksan, N. (1995). Mother-child mutually positive affect, the quality of child compliance to requests and prohibitions, and maternal control as correlates of early internalization. *Child Development*, *66*(1), 236. https://doi.org/10.2307/1131203

Korkalo, L., Vepsäläinen, H., Ray, C., Skaffari, E., Lehto, R., Hauta-alus, H., Nissinen, K., Meinilä, J., Roos, E., Erkkola, M. (2019). Parents' reports of preschoolers' diets: Relative validity of a food frequency questionnaire and dietary patterns. *Nutrients*, *11*(1), 159. https://doi.org/10.3390/nu11010159

Lehto, J. E., Juujärvi, P., Kooistra, L., & Pulkkinen, L. (2003). Dimensions of executive functioning: Evidence from children. *British Journal of Developmental Psychology*, *21*(1), 59–80. https://doi.org/10.1348/026151003321164627

Leong, C., Taylor, R. W., Haszard, J. J., Fleming, E. A., Tannock, G. W., Szymlek-Gay, E. A., Cameron, S. L., Yu, R., Carter, H., Chee, K. L., Kennedy, L., Moore, R., Heath, A. L. M. (2018). Relative validity and reproducibility of a food frequency questionnaire to assess nutrients and food groups of relevance to the gut microbiota in young children. *Nutrients*, *10*(11), 1627. https://doi.org/10.3390/nu10111627

Lewis, C., & Carpendale, J. I. M. (2009). Introduction: Links between social interaction and executive function. *New Directions for Child and Adolescent Development*, *2009*(123), 1–15. https://doi.org/10.1002/cd.232

Lunt, L., Bramham, J., Morris, R. G., Bullock, P. R., Selway, R. P., Xenitidis, K., & David, A. S. (2012). Prefrontal cortex dysfunction and 'Jumping to Conclusions': Bias or deficit? *Journal of Neuropsychology*, *6*(1), 65–78. https://doi.org/10.1111/j.1748-6653.2011.02005.x

Martin-Biggers, J., Quick, V., Zhang, M., Jin, Y., & Byrd-Bredbenner, C. (2018). Relationships of family conflict, cohesion, and chaos in the home environment on maternal and child food-related behaviours. *Maternal and Child Nutrition*, *14*(2), e12540. https://doi.org/10.1111/mcn.12540

Martin, A., Razza, R. A., & Brooks-Gunn, J. (2012). Specifying the links between household chaos and preschool children's development. *Early Child Development and Care*, *182*(10), 1247–1263. https://doi.org/10.1080/03004430.2011.605522

Matheny, A. P., Wachs, T. D., Ludwig, J. L., & Phillips, K. (1995). Bringing order out of chaos: Psychometric characteristics of the Confusion, Hubbub, and Order Scale. *Journal of Applied Developmental Psychology*, *16*(3), 429–444. https://doi.org/10.1016/0193-3973(95)90028-4

Menon, M., Katz, R. C., & Easterbrooks, M. A. (2020). Linking attachment and executive function systems: Exploring associations in a sample of children of young mothers. *Journal of Child and Family Studies*, *29*(8), 2314–2329. https://doi.org/10.1007/s10826-020-01759-5

Meuwissen, A. S., & Englund, M. M. (2016). Executive function in at-risk children: Importance of father-figure support and mother parenting. *Journal of Applied Developmental Psychology*, *44*, 72–80. https://doi.org/10.1016/j.appdev.2016.04.002

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science*, *21*(1), 8–14. https://doi.org/10.1177/0963721411429458

Niedzwiedzka, E., Wadolowska, L., & Kowalkowska, J. (2019). Reproducibility of a non-quantitative food frequency questionnaire (62-item ffq-6) and pca-driven dietary pattern identification in 13–21-year-old females. *Nutrients*, *11*(9), 2183. https://doi.org/10.3390/nu11092183

Northstone, K., Ness, A. R., Emmett, P. M., & Rogers, I. S. (2008). Adjusting for energy intake in dietary pattern investigations using principal components analysis. *European Journal of Clinical Nutrition*, *62*(7), 931–938. https://doi.org/10.1038/sj.ejcn.1602789

Northstone, Kate, & Emmett, P. M. (2008). Are dietary patterns stable throughout early and mid-childhood? A birth cohort study. *British Journal of Nutrition*, *100*(5), 1069–1076. https://doi.org/10.1017/S0007114508968264

Nutrition Quest. (2014). Block questionnaire for ages 2-7—kids 2-7 FFQ. Retrieved from http://www.nutritionquest.com/assessment/list-of-questionnaires-and-screeners/

Pike, A., Iervolino, A. C., Eley, T. C., Price, T. S., & Plomin, R. (2006). Environmental risk and young children’s cognitive and behavioral development. *International Journal of Behavioral Development*, *30*(1), 55–66. https://doi.org/10.1177/0165025406062124

Plomin, R., Fulker, D. W., Corley, R., & DeFries, J. C. (1997). Nature, nurture, and cognitive development from 1 to 16 years: A parent-offspring adoption study. *Psychological Science*, *8*(6), 442–447. https://doi.org/10.1111/j.1467-9280.1997.tb00458.x

Posada, G., Lu, T., Trumbell, J., Kaloustian, G., Trudel, M., Plata, S. J., Peña, P. P., Perez, J., Tereno, S., Dugravier, R., Coppola, G., Constantini, A., Cassibba, R., Kondo-Ikemura, K., Nóblega, M., Haya, I. M., Pedraglio, C., Verissimo, M., Santos, A. J., Monteiro, L., Lay, K. L. (2013). Is the secure base phenomenon evident here, there, and anywhere? A cross-cultural study of child behavior and experts’ definitions. *Child Development*, *84*(6), 1896–1905. https://doi.org/10.1111/cdev.12084

Renzaho, A. M.N., Kumanyika, S., & Tucker, K. L. (2011). Family functioning, parental psychological distress, child behavioural problems, socio-economic disadvantage and fruit and vegetable consumption among 412 year-old Victorians, Australia. *Health Promotion International*, *26*(3), 263–275. https://doi.org/10.1093/heapro/daq054

Renzaho, A. M.N., Dau, A., Cyril, S., & Ayala, G. X. (2014). The influence of family functioning on the consumption of unhealthy foods and beverages among 1- to 12-y-old children in Victoria, Australia. *Nutrition*, *30*(9), 1028–1033. https://doi.org/10.1016/j.nut.2014.02.006

Riggs, N. R., Spruijt-Metz, D., Chou, C. P., & Pentz, M. A. (2012). Relationships between executive cognitive function and lifetime substance use and obesity-related behaviors in fourth grade youth. *Child Neuropsychology*, *18*(1), 1–11. https://doi.org/10.1080/09297049.2011.555759

Riggs, N. R., Spruijt-Metz, D., Sakuma, K. L., Chou, C. P., & Pentz, M. A. (2010). Executive cognitive function and food intake in children. *Journal of Nutrition Education and Behavior*, *42*(6), 398–403. https://doi.org/10.1016/j.jneb.2009.11.003

Smith, J. D., Montaño, Z., Dishion, T. J., Shaw, D. S., & Wilson, M. N. (2015). Preventing weight gain and obesity: Indirect effects of the family check-up in early childhood. *Prevention Science*, *16*(3), 408–419. https://doi.org/10.1007/s11121-014-0505-z

Sorensen, L. B., Damsgaard, C. T., Dalskov, S. M., Petersen, R. A., Egelund, N., Dyssegaard, C. B., Stark, K.D., Andersen, R., Tetens, I., Astrup, A., Michaelsen, K. F., Lauritzen, L. (2015). Diet-induced changes in iron and n-3 fatty acid status and associations with cognitive performance in 8-11-year-old Danish children: Secondary analyses of the Optimal Well-Being, Development and Health for Danish Children through a Healthy New Nordic Diet School Meal Study. *British Journal of Nutrition*, *114*(10), 1623–1637. https://doi.org/10.1017/S0007114515003323

Valcan, D. S., Davis, H., & Pino-Pasternak, D. (2018). Parental behaviours predicting early childhood executive functions: A meta-analysis. *Educational Psychology Review*, *30*(3), 607–649. https://doi.org/10.1007/s10648-017-9411-9

van IJzendoorn, M. H., Goldberg, S., Kroonenberg, P. M., & Frenkel, O. J. (1992). The relative effects of maternal and child problems on the quality of attachment: A meta-analysis of attachment in clinical samples. *Child Development*, *63*(4), 840–858. https://doi.org/10.1111/j.1467-8624.1992.tb01665.x

van IJzendoorn, M. H., Vereijken, C. M. J. L., Bakermans-Kranenburg, M. J., & Marianne Riksen-Walraven, J. (2004). Assessing attachment security with the attachment q sort: meta-analytic evidence for the validity of the observer AQS. *Child Development*, *75*(4), 1188–1213. https://doi.org/10.1111/j.1467-8624.2004.00733.x

Vernon-Feagans, L., Willoughby, M., & Garrett-Peters, P. (2016). Predictors of behavioral regulation in kindergarten: Household chaos, parenting, and early executive functions. *Developmental Psychology*, *52*(3), 430–441. https://doi.org/10.1037/dev0000087

Wachs, T. D. (1993). Nature of relations between the physical and social microenvironment of the two-year-old child. *Early Development and Parenting*, *2*(2), 81–87. https://doi.org/10.1002/edp.2430020202

Wachs, T. D., & Camli, O. (1991). Do ecological or individual characteristics mediate the influence of the physical environment upon maternal behavior. *Journal of Environmental Psychology*, *11*(3), 249–264. https://doi.org/10.1016/S0272-4944(05)80186-0

Waters, E. (1995). Appendix a: The Attachment Q-Set (Version 3.0). *Monographs of the Society for Research in Child Development*, *60*(2/3), 234. https://doi.org/10.2307/1166181

Wesnes, K. A., Pincock, C., Richardson, D., Helm, G., & Hails, S. (2003). Breakfast reduces declines in attention and memory over the morning in schoolchildren. *Appetite*, *41*(3), 329–331. https://doi.org/10.1016/j.appet.2003.08.009