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Picky Eating in Children: Associations with IQ and Executive Functioning

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Early Emotional Development Program

Washington University in St. Louis

Abstract

Picky eating is an under-researched behavior in children. The current study aims to assess what behaviors correlate with picky eating to better understand potential risk factors for Anorexia Nervosa. 111 children were evaluated at 5 and 6 years old, and a subset was evaluated again at 7 and 8 years old (n=36). Executive function and IQ were evaluated using parent reports and behavioral measures at baseline. Picky eating was reported by a parent questionnaire. Results showed deficits in shifting to be a predictor of higher picky eating behaviors at ages 5-6 years. Additionally, children who were reported extremely picky eaters at baseline made fewer errors in executive function conditions in Shape School. Furthermore, correlations showed picky eating at baseline was a strong predictor of picky eating at Time 2. Since children are currently at ages 7 and 8, reports of Anorexia Nervosa have not been obtained. The current study evaluated pre-established deficits for AN while finding some better and worse outcomes for picky eaters, which furthers the limited research on picky eating.

Predicting Anorexia Nervosa: Picky Eating, Overcontrol, IQ, and Executive Functioning

Picky eating is a behavior that is often overlooked by parents, as many children grow out of it as they get older. Picky eating falls on a spectrum of feeding difficulties and can be characterized as when a child consumes a limited variety of foods and commonly refuses to eat both familiar and novel foods, as well as a strong food preference. (Dovey et al., 2008; Taylor et al., 2015). Picky eating is critical to study, because it may be a precursor for psychopathology, specifically Anorexia Nervosa (AN) (Taylor et al., 2015). AN is a disorder accompanied by thoughts and pursuits of thinness combined with severe weight loss, along with distorted body image and intense anxiety around eating (Fairburn et al., 1999). Often, people with AN have a highly distorted perception of how they look and will continue to try and lose weight even if their health is at serious risk.

As picky eating is a newly researched phenomenon, there is relatively little research on picky eating and its associated outcomes in early childhood. The relative lack of literature is detrimental to early intervention methods as long-term health is linked to nutritional habits that children display in the early stages of their life, and intervention methods would help stop these behaviors from turning into psychopathology (Scaglioni et al., 2011). As one in three children become picky eaters, there needs to be a better understanding of which picky eaters develop pathology when they are older to mitigate those behaviors (McDermott et al. 2008).

It is essential to differentiate children who are picky eaters and eventually gain better eating habits versus those who will later develop AN. Through an examination, IQ, and picky eating behaviors, the current study aims to better understand children at higher risk of developing AN later in life. Obtaining a better understanding of AN precursors can lead to earlier and more effective interventions. Eating disorders (ED) are detrimental, as they have high mortality rates

and low recovery rates, so it is important to obtain a better understanding of why this behavior occurs and what factors are consistent precursors and risk factors of AN. Knowing early markers and risk factors will ultimately help guide early intervention to mitigate these factors from turning into a full-blown ED.

Overcontrol and Anorexia Nervosa

The DSM-5 describes AN as an ED where individuals with overvalued ideas about thinness combined with ritualistic behaviors around food, who fear or engage in persistent behaviors that interfere with weight gain, despite being a low weight (Brown et al., 2013; Serpell et al., 2002). Research suggests that AN is a chronic, often severe disorder with a poor prognosis (Serpell et al., 2002). Additionally, AN is reported to be a familial disorder, where AN phenotypes are common in family members (Kipman et al., 1999). Many studies have shown a higher risk for AN in female relatives of probands with AN versus female relatives without probands (Kipman et al., 1999).

Perfectionism is a prevalent characteristic in both AN and overcontrol (Gilbert et al., 2019; Dalsgaard et al., 2020). According to The Overcontrol in Youth Checklist (OCYC), overcontrol in children can be characterized by a pattern of a high need for control, perfectionism, rigidity, performance monitoring, and social comparison, which is a transdiagnostic risk factor correlated with psychiatric disorders, including AN. (Gilbert et al., 2019).

Picky Eating Prevalence

Picky eating is a common childhood characteristic. Mascola et al. (2010) found that 13% and 20% of children in their study were described as picky eaters at least one point between the ages of 2 and 11. However, if picky eating behaviors persist, it can pose a severe precursor for an

ED (Zohar et al., 2019). There is no widely accepted definition or characterization of picky eating and no set diagnostic assessment; there is a wide variety and little consensus of the prevalence. It is estimated that the "prevalence of picky eating ranges widely from 5.6% in 4-year-olds in the Netherlands (Tharner et al., 2014) to 50% in 2-year-olds in the USA (Carruth et al., 2004)" (Taylor et al., 2015, p. 352). Since each country has different methods of assessments and picky eating is under-researched, prevalence is highly unstable, explaining the different results and outcomes within a study. Results from Taylor et al. showed that early-onset picky eating was more frequent than late-onset, while only 8% of children were persistent picky eaters.

Picky Eating and Poor Outcomes

Picky eating can also be associated with poorer well-being. Taylor et al. (2015) explain that picky eating can eventually lead to adverse health-related outcomes. A four-year follow-up study conducted by Dahl and Sundelin (1992) showed worse health outcomes for children classified as picky eaters, as they were at later risk for problems with eating patterns and behaviors. Dahl and Sundelin (1992) did not focus on why these behaviors happened; rather, they showed that the trajectory from picky eating to problematic eating behaviors is a major possibility. In a study conducted in Israel by Zohar and colleagues, 1,055 mothers and children participated where picky eaters were reported as scoring lower in executive function (2019). Results showed that at the age of 3, picky eaters displayed a range of behavioral problems with poorly developed EF (Zohar et al., 2019).

Few studies have been conducted to see if picky eating in childhood can be predictive of picky eating later in life. McDermott et al. (2008) investigated whether picky eating behaviors persisted later in life if the child was reported to be a picky eater in preschool. Results showed a

main effect of a mother's diagnosis of AN and child picky eating. More specifically, this study focused on external factors that impinge upon the child's irregular eating, such as maternal health perception and parental views on the child. Internal, cognitive factors were not investigated, which will be researched in the current study. Results showed trends of the risk of picky eating in preschool and stability with anorexia symptoms in adolescence predicted by earlier digestive problems and picky eating (McDermott et al., 2008). The research included intervention strategies that should "be family orientated and include child, mother, and mother-child psychosocial approaches" (McDermott et al., 2008, p. 204). It was also acknowledged that very little is known about predictors of picky eating, so it is still necessary to identify predictors to further interventions to prevent irregular eating from turning into AN. Additionally, this study was part of a large cohort study in Australia, which provides a strong background, but is not entirely applicable to the United States since an appropriate assessment measure should consider country-specific reference values (Taylor et al., 2015). Another limitation is that this study did not account for a child's verbal IQ or developmental delays.

It is important to also understand how early picky eating can be classified, and when it starts to impact cognitive domains. Chatoor et al. (2004) found children who are more malnourished due to refusal to eat perform poorer cognitively. A study conducted in 2015 by Cano et al. studied nearly 4,000 children starting at 18 months, assessing them every 18 months until seven years old. The participants were placed in one of four categories: Children who were never picky eaters (51.4%); those who went through an early, transient phase of pickiness (31.9%); those who were consistently picky at each time point (5.5%) and those who were first described as picky at six years of age ("late-onset," 4.7%) (Cano et al., 2015). An additional 6.5% of the participants were not classified into one of the four trajectories and were not

included. Results showed that children in the transient and "late-onset" picky eating categories were not at an increased risk and were developmentally normal (Cano et al., 2015). However, children who were early and persistent picky eaters "were at increased risk of attention/hyperactivity behavioral problems, of oppositional behavior, and their risk for pervasive developmental delayed behavior problems was double that of children who were never picky eaters" (Zohar et al., 2019, p. 1250; Cano et al., 2016). More specifically, the persistent picky eaters were more at risk for ED, especially with emotional control and shifting. Cano et al.'s (2015 & 2016) study is more closely related to the current study but still lacks the component of AN development. There is still no research on the interconnectedness of AN with EF, IQ, and picking eating. The current study will take Cano's study one step further to see if AN is associated with IQ and EF deficits that parallel picky eating.

Picky eating is clearly associated with bad outcomes, but the health-related outcomes are scarcely researched. Zucker et al. (2015) examined the clinical significance of picky eating in relation to current psychiatric symptoms and risk factors of later psychiatric symptoms, as well as highlighted the significance of the prevalence of picky eating in preschool. Results showed that since picky eating in preschoolers was extremely prevalent, 14-20% of parents reported their preschoolers as picky eating; it was often dismissed as developmentally normal among clinicians and researchers (Zucker et al., 2015). However, this information is critical, because it has been associated with emotional, physical, and social impairments (Zucker et al., 2015). Due to the limited research on picky eating, there is also not a clear consensus of whether picky eating is an early marker or risk factor for AN (Taylor et al., 2015). The current study aims to distinguish between picky eaters to determine which child will continue to be persistent picky eaters and therefore be more at risk for AN later in life.

Intelligence Quotient and Executive Functioning in Anorexia Nervosa

Previous literature has established that executive functioning (EF) and a higher intelligence quotient (IQ) are connected to AN (Kothari et al., 2013). EF refers to a set of neurocognitive processes essential for behavioral and cognitive regulation and include inhibition, working memory, cognitive flexibility, goal selection, planning, and organization (Aarnoudse-Moens et al., 2009; Aarnoudse-Moens et al., 2012). There is still not a clear relationship in the literature that incorporates picky eating along with these established precursors. Research on eating disorders (ED) from a developmental perspective is minimal, creating a gap in the literature on research addressing data on the specific risk factors and resilience factors for pathology during childhood development (Steiner & Lock, 1998).

Growing evidence suggests that ED, including AN, can be characterized by particular neuropsychological profiles, along with IQ and EF (Zakzanis et al., 2010; Kothari et al., 2013; Lopez et al., 2010). More specifically, past research on the cognitive profiles of patients with AN showed impairments in specific executive functions, including attention (Ranseen & Humphries, 1992; Dobson & Dozois, 2004; Kothari et al., 2013), cognitive flexibility (Tchanturia et al. 2011; Tchanturia, 2012; Kothari et al., 2013), problem-solving (Shallice, 1982), and inhibition (Southgate, 2005; Rosval et al. 2006; Galimberti et al. 2012; Kothari et al., 2013). However, there are still inconsistent findings, with results showing no differences in EF for ED samples (Pieters et al., 2003; Gillberg et al., 2007; Galderisi et al., 2011). Where working memory can be referred to as the cognitive process that stores and manipulates a limited amount of information over a brief period (Baddeley, 1987, 1992). EF, and individual differences in EF, emerges in infancy (Blankenship et al., 2019), and deficits in EF reported in preschoolers had impairments

independent of IQ and processing speed, showing the EF can occur before the onset of AN (Aarnoudse-Moens et al., 2012).

As IQ and EF are impacted by AN, a study was conducted to evaluate the extent that students with AN differed from their peers academically. Dalsgaard et al. (2020) conducted a study in Denmark to compare students' academic performances with and without a psychological disorder. Results showed that students with AN "achieved statistically significantly higher grades on the final examination" compared to peers without AN (Dalsgaard et al., 2020, p. E1). Students who were diagnosed with AN had the highest grades compared to all peers, including those without AN. These findings correspond with previous research that found that high levels of perfectionism is characteristic of AN that correlates with higher academic achievement (Dalsgaard et al., 2020). Results are consistent with Lopez et al. (2010) finding that showed that patients with AN scored significantly higher than healthy controls on IQ tests.

It is also important to understand the timeline of the neuropsychological impairments found in ED. Kothari et al. (2013) conducted a study to explore if neuropsychological functioning impairments found in individuals with ED were present prior to the onset of the ED or secondary to the ED. Intelligence, attention, working memory, and inhibition were measured in both children who are at high risk of developing an ED, compared to children who are not (Kothari et al., 2013). Results showed the children whose mothers have AN showed higher IQ, increased working memory capacity, better visual-spatial functioning, and decreased attentional control, which might be "intermediate phenotypes on the pathway between genetic vulnerability and the development of an ED" (Kothari et al., 2013, p. 1). Results were inconsistent with previous research where children of AN mothers showed better performance in interpreting and

organizing visually perceived materials, whereas previous research suggests that this quality is impaired in individuals with AN (Lopez et al., 2008b; Kothari et al., 2013).

Furthermore, the results were inconsistent with previous findings which showed no impairment in working memory for high-risk groups. Children at-risk for an ED scored higher for working memory, which was only partially accounted for by maternal education and child IQ (Ohrmann et al., 2004; Kemps et al., 2006). The rationale is that working memory impairment contributes to the maintenance of the ED, rather than being a pre-onset risk factor (Kothari et al., 2013). Kothari and colleagues explain that further clarification of neuropsychological profiles is needed for those at high risk of developing an ED to identify vulnerable indications and target effective interventions. Overall, these findings indicate that high IQ, worse attentional control, and decreased inhibition are risk factors for AN. However, previous research on subjects' cognitive profiles with EDs has revealed impairments in attention and specific EFs, including cognitive flexibility and inhibition (Taylor et al., 2015). No research has associated picky eating behaviors with these cognitive deficits. This study emphasizes the importance of including a younger sample, so AN cannot be present, to ensure behaviors are not a result of the EDs but rather a precursor.

The Current Study

Sometimes showing signs of picky eating, high IQ, and low EF does not lead to an ED, so a clearer understanding of why only sometimes these behaviors manifest into an ED is needed. Again, there are relatively no studies about picky eating in children or combined with IQ and EF, and there is minimal data about early risk factors of AN. Picky eating is very broad and develops and changes as children grow up. The current study aims to find if there is a way to better predict the children who are picky eaters and eventually develop an ED. I aim to examine

associations in children's EF behaviors to see if there is a similar pattern between picky eating and pre-established neuropsychological profiles. This information will help determine if the combination of behaviors can be a stronger predictor of AN.

Based on past research, I hypothesize that children who are parent-reported picky eaters will have higher IQs (Dalsgaard et al., 2020; Kothari et al., 2013) and demonstrate poor EF abilities related to inhibition and attentional control but higher working memory (Zohar et al., 2019; Cano et al., 2015; Kothari et al., 2013). I hypothesize that children who are picky eaters and have the highest IQ and low EF will continue to exhibit picky eating at Time 2. More specifically, children with high IQ, low EF, six years old as picky eaters will be at higher risk of developing AN. It is important to note that we will not draw diagnostic conclusions from this study because we do not have longitudinal data to see if the children eventually develop AN.

Methods

Participants

Participants were first recruited when they were 5 or 6 years old, with a mean age of the child at baseline 5.90 (N= 111, SD=0.63)). The sample consisted of 54 females and 57 males with 74.8% of children identifying as White. The community sample from the St. Louis area was oversampled for children with overcontrol tendencies, along with perfectionism, self-criticism, and shyness. Healthy and overcontrolled children were recruited through flyers around the community, online platforms, and information talks at local elementary schools and childhood anxiety therapy clinics. Participants then completed a two-year follow-up assessment when the kids are 7 or 8 years. The current study had 33 children at the follow-up assessment when the analysis for T2 was conducted (mean age: 8.97, SD = 0.64). Children with Autism Spectrum

Disorder, chronic medical, neurological disorders, speech, language or cognitive delays or learning disabilities, and current psychotropic medication use were excluded from the study.

Participants who met the criteria signed informed consent and child assent before partaking in the study. Caregivers completed a series of questionnaires and clinical interviews. Children and caregivers were invited into the lab where cognitive assessments, electroencephalogram (EEG), and parent-child interactions were conducted. All assessments are part of a larger study focused on young children with overcontrolled tendencies. The larger study consisted of 134 caregiver-child participants, and 110 of these caregivers filled out the picky eating questionnaire. These 110 caregiver-child participants were included in the current study. The majority of the sample identified as White (n=83; 75.5%), 11 (10%) identified as Black, 14 (13%) as Multiracial, and 7 (6%) as Hispanic/Latinx ethnicity. The sample included 53 (48%) females. The Institutional Review Board at Washington University School of Medicine approved all procedures. The current stresses the importance of understanding the level of severity in which picky eating causes impairments, so clinicians know when to intervene to mitigate the effects of these behaviors from turning into pathology later in life.

Measures

Picky Eating Measure. Picky Eating was measured through a parent questionnaire as part of a psychiatric interview where the parents were asked questions about their child's eating behavior. A series of three questions were asked: Is your child a picky eater? Does your child eat a wide variety of foods? Does your child enjoy eating new foods? Parents were asked to rate their agreement with the questions on a scale from 1 (not at all) to 10 (very much). Codes were reversed for the second and third questions, and then scores were summed to create a picky eating score. A higher score indicated more severe picky eating, where a lower score indicated

low or no picky eating. The three items asked were part of a Nine Item Avoidant/Restrictive Food Intake disorder screen. The three-item portion of the Stanford Feeding Questionnaire was used to identify persistent picky eaters (Mascola et al., 2010; Stunkard et al., 1985).

Kaufman Brief Intelligence Test (KBIT-II). The KBIT second edition is an IQ scale that measured verbal and nonverbal intelligence during school age (Cohen et al., 2018).

Shape School. The Shape School is a storybook test that measures inhibition and switching processes using three conditions: the control, inhibition, and switching condition. (Aarnoudse-Moens et al., 2009; Espy, 1997). All conditions started with an initial practice block of 12 stimuli, where participants had to respond correctly to ensure they understood the new rules before proceeding to the experimental trial. Children were asked to point to the shapes depending on the rule and condition given at each trial. Children were given instructions at the start of each experimental trial to complete the task as fast as they can without making any mistakes. Children experienced all three conditions, where the control condition asked the child to name all of the shapes' colors in the order presented in the book. In the inhibition condition, the child had to name the shapes that had a happy face, as opposed to a sad face. Finally, the child was presented with the switching condition where they were asked to name the shape only if they were wearing a hat and smiling (rule from the previous condition). The current study measured the number of correct responses and response time for all three conditions.

Behavior Rating Inventory for Executive Function (BRIEF), Behavior Rating Inventory for Executive Function- Preschool (BRIEF-P). The BRIEF and the BRIEF-P were utilized to measure EF, where parents completed the BRIEF-P for their children younger than six years old, and the BRIEF was completed by parents, for children who are six years old or older. The parent-reported measure is an 86-item, well-validated rating scale ($\alpha = .98$) of their child's

behavioral manifestations of EF, scored on a 3-point scale from never, sometimes, and often, where higher scores indicated more significant impairment (Hawkey et al., 2018). Overlapping subscales of this measure included inhibitory control (Inhibition), cognitive and behavioral flexibility (Shifting), emotional regulation (Emotional control), working memory (Working memory), and ability to plan and organize cognition and problem-solving (Plan/organize) (Gioia et al., 2002; Zohar et al., 2019).

National Institutes of Health (NIH) Toolbox. The NIH Toolbox measures cognitive, emotional, motor, and sensory function. The current study uses the cognition domain and attention domain. The measurement of cognition evaluates executive functioning through the Flanker Inhibitory Control and Attention Test and NIH Toolbox Dimensional Change Card Sort Test, with a specific focus on spatial attention. The NIH toolbox focuses on shifting and inhibiting automatic responses that can interfere with achieving a goal. The NIH Toolbox measures attention through the Flanker Inhibitory Control and Attention Test. The NIH Toolbox Flanker Inhibitory Control and Attention Test (Flanker) measures attention and inhibitory control. It requires a participant to focus on a given stimulus while inhibiting attention to other stimuli (fish for ages 3-7 or arrows for ages 8-85). Trials include congruent "flankers" where the middle stimulus points in the same direction and incongruent "flankers" where the middle stimulus points in the opposite direction. Participants are given twenty trials, and if children aged 3-7 score at least 90% correct on the fish stimuli, they are presented with additional trials using arrows. The test takes around three minutes. The NIH Toolbox Dimensional Change Card Sort Test is a measure of cognitive flexibility and attention shifting. Participants are presenting with two target pictures along with two denominations (e.g., shape and color). Subjects are then asked to match a series of bivalent test pictures (e.g., yellow balls and blue trucks) to the target

pictures, first according to one dimension and then, after a number of trials, according to the other dimension. “Switch” trials are also conducted, where the participant must change the dimension being matched. This test takes approximately four minutes to administer (Slotkin et al., 2012). The total score and number of trials were measured for both tasks.

Results

Picky Eating was not associated with demographic variables: picky eating was not correlated with age (r=.14, p=.14), it did not differ by sex, (t(108)=.14, p=.89) and it did not differ by race (t(108)=-.49, p=.63) comparing White versus Minority participants, and so these variables were not used as covariates. An SPSS analysis was used to run Pearson correlations of Picky Eating at baseline with BRIEF, NIH Toolbox (card sort and flanker), Shape School (efficiency scores), and KBIT. See Table 1 for correlations between Picky Eating scores with Executive Function (BRIEF), Cognition and Attention (NIH Toolbox), Inhibition and Switching processes (Shape School), and IQ (KBIT).

BRIEF Results

Picky Eating showed no significant correlation with BRIEF-Preschool Inhibit T-Score (r=.14, p =.16) and no significance for BRIEF-Preschool Emotional Control T-Score (r=.11, p=.27). There was a significant positive correlation between Picky Eating at baseline and BRIEF-Preschool Shift T-Score (r=.24, p=.01), BRIEF-Preschool Plan/Organize T-Score (r=.91, p=.047), and BRIEF-Preschool Working Memory T-Score (r=.22, p=.03).

A regression was run for all BRIEF subscales to predict Picky Eating at baseline since it was associated with baseline Picky Eating in a few domains. The regression tested which domains of the BRIEF were most strongly associated with predicting Picky Eating. Only Shifting in the BRIEF-Preschool Shift T-Score showed significant results for predicted Picky Eating

(F(5,102)=2.01, R=.299, $\Delta R2$ =.09, p=.08; B(SE)=.17(.08), p=.038), while the Plan/Organize and the Working Memory T-scores were no longer significant (p's>.05).

NIH Toolbox Results

Additionally, there was no significant correlation between Picky Eating at baseline and the Card Sort Task (that already adjusts for age in the standardized score) (r=-.02, p=.81). Additionally, there was no significant correlation for the Flanker Task, (that already adjusts for age in the standardized score) (r=.10, p=.29).

Shape School Results

The correlation for Picky Eating at baseline and Shape School was examined for Inhibition Efficiency (the number correct- errors/time), Shift Efficiency (the number correct- errors/time), and Executive Function Efficiency (the number correct- errors/time). There were no significant correlations for Inhibition Efficiency (r=-.05, p=.63) or Shift Efficiency (r=.07, p=.48). There was a significant correlation between Picky Eating at baseline and Executive Function Efficiency (r=.21, p=.037). In order to understand what aspect of the Executive Function Efficiency relationship is related to Picky Eating, correlations were run evaluating the total correct responses and errors responses in this condition. There was no relationship between total correct responses (r=.11, p=.25), but there was a significant correlation with total errors (r=-.28, p=.004) in the executive functioning condition. See Figure 1.

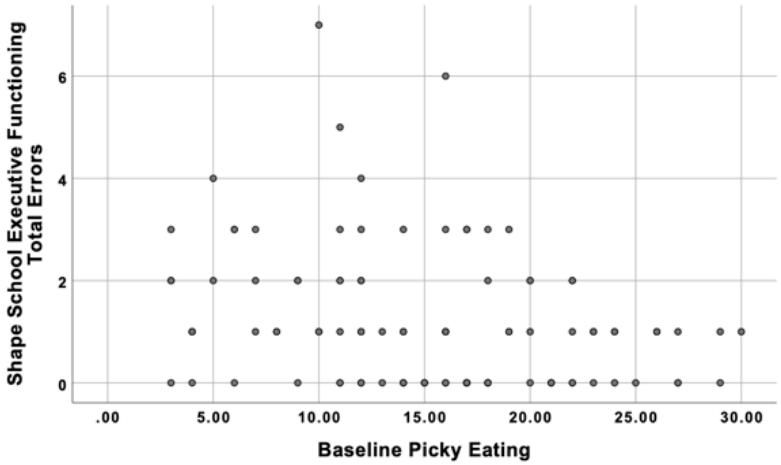

Figure 1 Baseline Picky Eating is negatively correlated with errors made.

KBIT Results

The correlation for Picky Eating at baseline and KBIT scores was not significant (r=.05, p=.58), N=124. The minimum IQ score was 68, the maximum IQ score was 176, and the average IQ score was 108.58, SD=14.90.

Table 1 Partial Correlations controlling for Picky Eating and Criterion Variables

	Pearson's Coefficient	Sig. (2-tailed)	N
BRIEF-Preschool			
Inhibition	.136	.161	108
Shift	239*	.013	108
Emotional Control	.107	.272	108
Plan/Organize	.191*	.047	108
Working Memory	.215*	.026	108
NIH Toolbox			
Card Sort (Age Corrected)	-.023	.814	107
Card Sort (Fully Corrected)	-.043	.676	95
Flanker (Age Corrected)	.103	.289	108
Flanker (Fully Corrected)	.041	.694	96
Shape School			
Inhibition Efficiency	-.047	.632	106
Shift Efficiency	.070	.481	104

	Executive Fxn Efficiency	.207*	.037	102
KBIT				
	Verbal	.090	.351	110
	Nonverbal	.076	.432	109
	IQ	.079	.417	109

BRIEF behavior rating inventory for executive functioning, NIH Toolbox National Institutes of Health Toolbox, KBIT Kaufman Brief Intelligence Test
*. Correlation is significant at the 0.05 level (2-tailed).

Picky Eating at Baseline and Post

There was a significant correlation at the 0.01 level where Picky Eating at baseline predicted Picky Eating at T2 (r=-.82, p<.001), n=26. Figure 2 displays the correlation between Picky Eating at baseline and Picky Eating at Time 2.

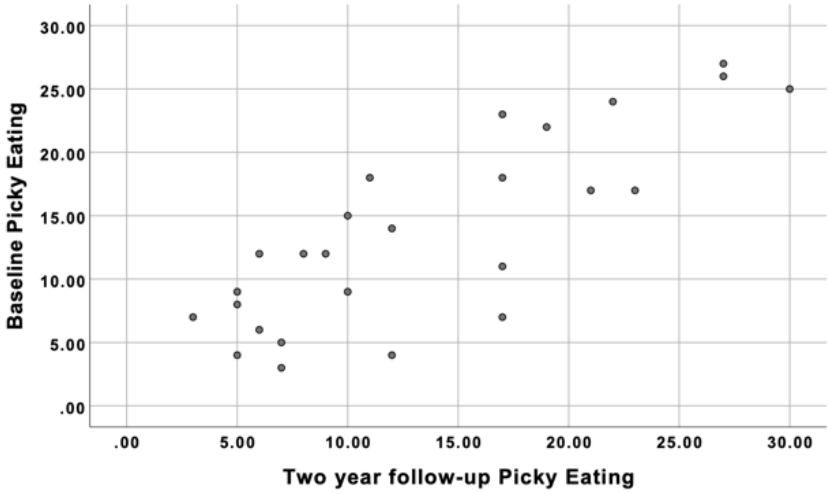

Figure 2 Correlation between Baseline Picky Eating and Two-Year Follow-up Picky Eating.

Baseline picky eating predicting post BRIEF

A correlation was run to see if baseline Picky Eating would predict deficits in the post-BRIEF assessments. No significant results were found. See Table 2.

Table 2 Correlations for Picky Eating and Post-BRIEF Data

	Pearson's Coefficient	Sig. (2-tailed)	N

BRIEF-Preschool	.154	.452	26
Inhibition	.154	.452	26
Shift	.083	.686	26
Initiate	.134	.513	26
Working Memory	.239	.240	26
Plan/Organize	.105	.609	26
Organization of Materials	.305	.130	26
Monitor	.073	.724	26

BRIEF behavior rating inventory for executive functioning

Picky Eating, IQ, and EF predicting PE at T2

To explore the interactive effects of EF with baseline Picky Eating predicting Picky Eating at Time 2, we completed moderation analyses using the PROCESS macro. Since results from the BRIEF showed Working Memory, Shift, and Plan/Organize as significant results in the correlation, those variables were used to examine the moderating role of EF on baseline Picky Eating predicting Time 2 Picky Eating. Three separate linear regressions were completed and none of the interactions were significant when examining moderation using the BRIEF. Specifically, Shifting (BRIEF) did not moderate the relationship between baseline and Time 2 Picky Eating, $F(3, 22)=15.70$, R2= .68, $p<.001$, Interaction: B(SE)=-.00 (.00), t=-.26, p=.79. Plan/Organize (BRIEF), also did not moderate this relationship, F(3, 22)= 16.06, R2= .68, $p<.001$, Interaction: B(SE)=.00 (.01), t=.31, p=.76 nor did the Working Memory (BRIEF) F(3, 22)= 16.56, R2= .69, $p<.001$, Interaction: B(SE)=.00 (.01), t=.14, p=.89.

Additionally, we also completed a separate linear regression examining the interactive effects of IQ with baseline Picky Eating predicting Time 2 Picky Eating. The interaction of baseline Picky Eating and IQ was also not significant, but was trending F(3, 21)= 19.30, R2= .73, $p<.001$, Interaction: (B(SE)=.01 (.01), t=1.32, p=.20) in the expected direction. The main effect of the BRIEF subscale was also not significant $p>.76$. A figure of the direction of effects of IQ is included N= 26.

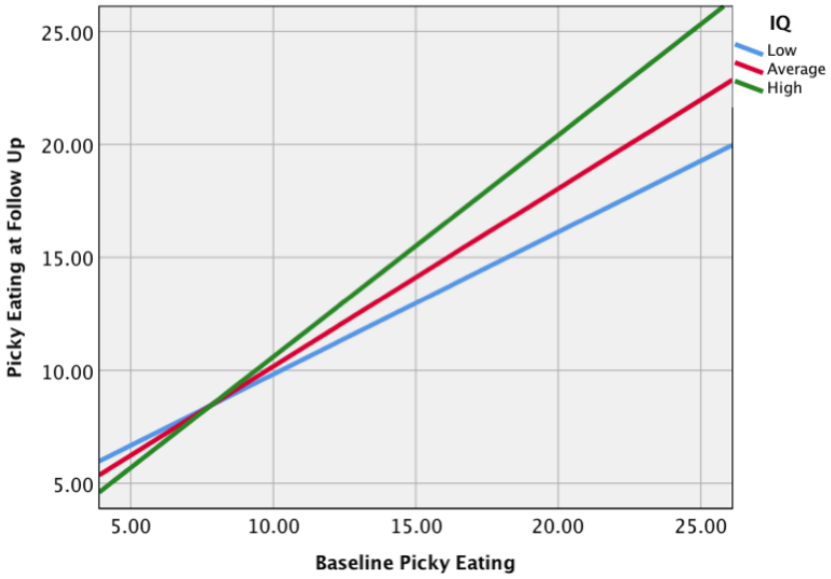

Figure 3 The trending interaction of baseline Picky Eating and IQ predicting follow-up Picky Eating.

Discussion

Results were inconsistent with the hypothesis and past studies because results did not show significance in a correlation between high IQ and picky eating (Dalsgaard et al., 2020; Kothari et al., 2013). Children who were picky eaters did not have a higher IQ. Furthermore, the results did not align with the hypothesis as there would be a significant correlation between picky eaters and Attentional Control (NIH Toolbox). Based on past literature, it would be expected that picky eaters would have impairments in attention as past studies revealed results that showed deficits, and other literature found attention control as an established deficit of AN (Zohar et al., 2019, p. 1250; Cano et al., 2016; Taylor et al., 2015). Results also showed inconsistent with previous findings that showed impairments in inhibition for those with AN (Taylor et al., 2015, Southgate, 2005; Rosval et al. 2006; Galimberti et al. 2012; Kothari et al., 2013). In the Shape School task, there were no significant deficits in Inhibition Efficiency or the BRIEF subscale for Inhibition.

When running the analysis there was a significant correlation between Picky Eating and Working Memory (BRIEF), where worse Working Memory was associated with high Picky Eating. Past literature has inconsistent findings where some results found children at risk for an ED scored higher for working memory, but Kothari et al. found poor working memory as a contributor to the maintenance of the ED rather than a risk factor (2013). So, the results would be most consistent with Kothari's findings. Based on these findings, our results show inconsistent with the previously stated hypothesis that children who are parent-reported picky eaters will have higher IQs and demonstrate poor EF abilities related to Inhibition and Attentional Control but higher Working Memory.

In addition to Working Memory, the BRIEF-P showed significant effects between Shifting and Plan/Organize, where picky eaters showed deficits in Shifting and Plan/Organize abilities. Since Planning/Organize and WM was not significant in the regression, it cannot be concluded that any of those variables are a strong predictor of picky eating. However, deficits in Shifting was a significant EF predictor of Picky Eating, with results trending in the right direction. Although not all significant, impairments in Shifting and Plan/Organize were consistent with past literature (Fowler et al., 2005; Cano et al.'s 2015 & 2016). There was no significant data to support that children who are picky eaters have deficits in emotional control or inhibition for the BRIEF-P.

Results also indicated there was no predictive ability that baseline Picky Eating would predict children who are picky eaters at T2 to have deficits in their post-BRIEF assessments. Although there was no association with deficits in inhibition, results were trending towards a lower correlation. It is also important to note the small sample size (N=26) due to the lack of participants who have yet to complete their post-visit.

Additionally, Shape School results found that children who were picky eaters did not correlate to deficits in Shifting. However, results found children who were extremely picky eaters at baseline made fewer errors during the last condition of executive function. When looking at the distribution of errors, few participants were making errors in general, but children with extreme Picky Eating made the fewest errors at baseline. This was shown in a negative correlation, and even though results did not show a strong effect, there was a visible negative correlation. It is important to note that at baseline children with higher PE made fewer correct responses, but were also the fastest in RT, which is unrelated to the number of errors, and showed no association with Inhibition Error. One reasoning for this could be due to the perfectionist characteristic that embodies people with AN (Gilbert et al., 2019; Dalsgaard et al., 2020).

There was a significant correlation between Picky Eating at baseline and Executive Function Efficiency. A second correlation was run at baseline to evaluate the errors associated with the individual measures. There was a significant correlation of Executive Function Efficiency ((correct answers- errors)/time), as well as a significant correlation at the .01 level for Executive Functioning Total Errors. There were no significant associations between Picky Eating and NIH Toolbox conditions. So, children who were reported as picky eaters did not show significant deficits in Cognitive Flexibility, Attention, or Inhibitory Control.

Results did show that children who were picky eaters at Time 1 were significantly likely to remain picky eaters at Time 2, where out of all the 36 children who completed their post-assessment and were picky eaters at age 5 & 6 were also picky eaters at age 7 & 8. This is important because it is less normal for children to be picky eaters at ages 7 and 8 as it is less typical for the developmental trajectory of children that age. Usually, children grow out of picky

eating when they are toddlers, but showing persistent picky eating at ages 7 and 8 is more likely to continue.

Lastly, the hypothesis that children who are picky eaters and have the highest IQ and low EF will continue to exhibit picky eating at Time 2 was not supported. Although results for IQ and Picky Eating at baseline and post were not significant, it was trending in the expected direction. Additionally, like past results reported at T2, it is important to note that the sample size for this analysis at Time 2 was 25, which resulted in the trend finding. So, the combination of high IQ and Executive Functioning deficits did not interact to better predict Picky Eating at Time 2. A higher baseline IQ and higher baseline Picky Eating interacted to predict the highest Picky Eating at Time 2.

Since the study was correlational in nature, we have not able to obtain data from children past age 8 at this time, so there are no causal conclusions that can be drawn to see if children with high IQ, low EF, and reported as picky eaters will be at higher risk of developing AN later in life. Furthermore, results that were found cannot be predictive as assessments were administered at the same time as picky eating reports, so there is no way to tell which behavior came first.

Future studies should obtain a more representative sample. In the current study, 74.8% of children were White. Additionally, the children were oversampled for overcontrol as the data was used from a larger study. Furthermore, studies should be more longitudinal, testing for AN later in the child's life. As results cannot be deemed casual due to the lack of data later in the child's life, AN developing later in life was not able to be confirmed. Further limitations of this study were that only 36 children completed their T2 assessment by the time the analysis of this

study was run. More information could have been gathered making the results more generalizable as well as providing more data on the trends of these behaviors.

Overall, children might grow out of Picky Eating after they are toddlers, but if at ages 5 and 6 are still not grown out of it, and continue to show picky eating behaviors at ages 7 and 8, children will most likely continue to show the deficits in EF. Therefore, further longitudinal research is needed to investigate the effects of picky eating to further understand the pathology associated as well as the deficits that are correlated with those behaviors and to better understand the predictive factors of AN. The current study shows some better and some worse outcomes for children who are picky eaters, but there are still a lot of unanswered questions that need to be further investigated.

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