AVOIDANT/RESTRICTIVE FOOD INTAKE DISORDER IN ADULTS: DESCRIPTIVE PSYCHOPATHOLOGY AND MEASURE DEVELOPMENT

Hana F. Zickgraf

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Supervisor of Dissertation

_____

Dr. Martin E. Franklin

Associate Professor of Psychology

Co-Supervisor of Dissertation

_____

Dr. Paul Rozin

Emeritus Professor of Psychology

Graduate Group Chairperson

_____

Dr. Sara Jaffee

Professor of Psychology

Dissertation Committee

Dr. Dianne Chambless (Chair), Professor of Psychology

Dr. Sara Jaffee, Professor of Psychology

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ABSTRACT

AVOIDANT/RESTRICTIVE FOOD INTAKE DISORDER IN ADULTS: DESCRIPTIVE PSYCHOPATHOLOGY AND MEASURE DEVELOPMENT

Hana F. Zickgraf, MA

Martin E. Franklin, PhD

Paul Rozin, PhD

Avoidant/Restrictive Food Intake Disorder (ARFID) is a new diagnosis, added to the fifth edition of the Diagnostic and Statistical Manual in 2013. ARFID is diagnosed in individuals whose limited food intake or narrow diet leads to weight loss, nutritional deficiency, dependence on nutritional supplements, or significant interference with daily functioning. ARFID is diagnosed when the eating restrictions are not caused by dissatisfaction with body shape or weight, but by 1) rejection of foods based on their sensory properties (picky eating), 2) limited appetite or apparent lack of interest in eating, or 3) fear of negative consequences, such as choking, vomiting, or gastrointestinal distress, from eating. To date there is little evidence that these behaviors are distinct from other forms of disordered eating, or that they lead to the nutritional and psychosocial symptoms of ARFID, particularly in adults. This dissertation provides initial evidence for the ARFID diagnosis, and identifies potential transdiagnostic mechanisms through which these eating behaviors might lead to ARFID symptoms. Chapters 1 and 2 present the descriptive psychopathology of ARFID symptoms related to adult picky eating. Chapter 1 demonstrates that adults with ARFID show similar levels of comorbidity and impairment to adults with symptoms of anorexia and bulimia, but that they can be differentiated from each other on measures of picky eating-specific eating behaviors. Chapter 2 shows that adult picky eaters report reduced dietary variety and intake of fruits and vegetables compared to non-picky eaters, and that picky eaters with ARFID symptoms report very low fruit and vegetable consumption, reduced protein consumption, and elevated snack and dessert intake. Chapter 3 describes the development and validation of a new self-report measure of the three ARFID eating behaviors. Chapter 4 is a replication of the studies presented in Chapters 1 and 2 in a sample of adults with ARFID symptoms due to each of the three eating behaviors. In addition, this study highlights cognitive-affective and associative learning processes through which each of the three eating behaviors might lead to significantly reduced food intake and the development of ARFID symptoms.

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Hana F. Zickgraf [1] (M.A.), Martin E. Franklin [2] (Ph.D.), & Paul Rozin [1] (Ph.D.)

1. Department of Psychology, University of Pennsylvania, 2. Department of Psychiatry, University of Pennsylvania Perelman School of Medicine

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ABSTRACT

One presentation of Avoidant/Restrictive Food Intake Disorder (ARFID) is characterized by picky eating, i.e., selective eating based on the sensory properties of food. The present study has two aims. The first is to describe distress and impairment in individuals with ARFID secondary to picky eating. The second is to determine whether eating behaviors hypothesized to be specific to picky eating can differentiate picky eaters with and without ARFID from typical eaters (e.g., individuals not reporting picky or disordered eating) and individuals who strongly endorse attitudes associated with anorexia and bulimia (eating disordered attitudes). Participants were recruited from Amazon's Mechanical Turk (N = 327) and an online support group for adult picky eaters (N = 77). Participants were grouped based on endorsement of picky eating, ARFID symptoms, and elevated eating disordered attitudes on the Eating Attitudes Test (EAT-26). The resulting four eating behavior groups were compared on measures of distress and impairment (e.g., anxiety/depression and , obsessive compulsive disorder symptoms, eating-related quality of life) and on measures of eating behaviors associated with picky eating (e.g., food neophobia, inflexibility about preparation and presentation of preferred foods, sensitivity to sensory stimuli, and eating from a very narrow range of foods). The groups were compared using one way ANOVA with post-hoc Tamhane's T2 tests. On measures of distress and impairment, participants with ARFID reported higher scores than both typical eaters and picky eaters without ARFID, and comparable scores to those with disordered eating attitudes. Three of four measures of picky eating behavior, eating inflexibility, food neophobia, and eating from a range of 20 or fewer foods, distinguished picky eaters with and without ARFID form typical eaters and those with disordered

eating attitudes. Picky eaters with ARFID reported greater food neophobia and eating inflexibility, and were more likely to eat from a narrow range of foods, compared to picky eaters without ARFID. Adult picky eaters can be differentiated from those with symptoms of anorexia and bulimia by their stronger endorsement of food neophobia and inflexible eating behaviors, and by eating from a very narrow range of foods. Picky eaters with ARFID symptoms can be differentiated from picky eaters without these symptoms on the basis of these three eating behaviors, and by their higher endorsement of internalizing distress, OCD symptoms, and eating-related quality of life impairment. This study provides evidence that ARFID symptoms exist independently of symptoms of other eating disorders and are characterized by several distinct eating behaviors. In a clinical analogue sample of disordered eaters, ARFID symptoms were associated with distress and impairment at levels comparable to symptoms of anorexia and bulimia.

INTRODUCTION

Picky eating is characterized by eating from a narrow range of accepted foods, rigidity about the preparation and presentation of preferred foods, and unwillingness to try new foods (Taylor, Wernimont, Northstone, & Emmett, 2015). Picky eating appears to be quite common across the lifespan, although prevalence estimates vary widely (e.g., 5.6-56%), likely because of the lack of a standardized, widely used instrument to measure picky eating behavior (Taylor et al., 2015). Although in most cases, picky eating does not interfere with weight status, growth, or psychosocial functioning, severe picky eating can lead to symptoms of avoidant restrictive food intake disorder (ARFID; American Psychiatric Association, 2013; Zucker et al., 2015). ARFID can be diagnosed in individuals of any age or developmental level whose restrictive eating leads to weight loss, nutritional deficiencies, dependence on nutritional supplementation or enteral feeding, or psychosocial impairment, and cannot be attributed entirely to shape and weight concerns or medical comorbidity (APA, 2013). Although one presentation of ARFID is described as "manifesting behaviorally as picky eating," to our knowledge there has not been a direct examination of the relationship between picky eating behavior and ARFID symptoms (APA, 2013, p. 335).

There is some evidence from the picky eating literature for an association between picky eating and symptoms of ARFID. Picky eating in children younger than five is a risk factor for underweight or poor growth (e.g., Antoniou et al., 2015; Dubois, Farmer, Girard, & Peterson 2007; Ekstein, Laniado, & Glick, 2010). Picky eating has been associated with lower fruit and vegetable consumption in school aged children (Galloway, Fiorito, Lee, & Birch, 2005) and with malnutrition in the elderly (Maitre et

al., 2014), and has been nominated as a barrier to healthy eating by several focus group samples (e.g., Lipman et al., 2011, Thompson, Cummins, Brown, & Kyle, 2015). Childhood picky eating has been associated with family stress and mealtime conflict (e.g., Jacobi, Schmitz, & Agras, 2008; Mascola, Bryson, & Agras, 2010), and in one online survey, adult picky eaters reported higher rates of eating-related quality of life impairment and eating-specific social anxiety compared to typically-eating peers (Wildes, Zucker, & Marcus, 2012).

Picky eating is a common behavioral variant, affecting a large minority of healthy adults and children. Although there are consistent reports of associations between picky eating and symptoms of ARFID, it is likely that only more severe picky eating is strongly associated with these outcomes, whereas less severe picky eating is relatively benign. However, as yet there are few validated measures of picky eating, and research on markers or measures of picky eating severity is in its very early stages. In addition, most of the literature linking picky eating behavior to outcomes consistent with ARFID symptoms was conducted prior to the publication of DSM-5, the first edition to include the ARFID diagnosis, and therefore does not directly assess ARFID symptoms.

The present study is the first to explore ARFID symptoms secondary to picky eating in adults. This study has two aims. The first is to describe symptoms of internalizing psychopathology, obsessive compulsive disorder, and reduced eating-related quality of life in individuals with ARFID secondary to picky eating. The second aim is to determine whether eating behaviors hypothesized to be specific to picky eating can differentiate picky eaters with and without ARFID from typical eaters and individuals who strongly endorse attitudes associated with anorexia and bulimia. In order to explore

these aims, participants were divided into four eating behavior categories on the basis of their self-reported eating attitudes and behaviors: picky eaters with ARFID symptoms secondary to their picky eating, picky eaters without ARFID symptoms, individuals reporting attitudes and behaviors associated with anorexia or bulimia (e.g., shape and weight concerns, dieting behaviors, fear of fatness; referred to throughout this manuscript as "disordered eating attitudes"), and participants reporting neither picky eating nor disordered eating attitudes (referred to as "typical eaters").

There is some symptom overlap between ARFID and typical and atypical anorexia nervosa. The consequences of the eating disturbance (e.g., weight loss and under-nutrition) are the same, although the severity threshold is higher for typical anorexia. The nature of the eating disturbance (e.g., restriction due to unrealistic shape and body weight concerns vs. restriction due to aversion to the sensory properties of food) distinguishes the two disorders (APA, 2013). Prior to the introduction of the ARFID diagnosis, individuals with ARFID were often referred to treatment designed for individuals with disordered eating attitudes consistent with restricting anorexia (Forman et al., 2015). In a series of retrospective chart reviews up to 2014, 12 - 22% of adolescents referred to eating disorder clinics meet criteria for ARFID rather than for a restricting eating disorder associated with weight and shape concerns and body image disturbance (e.g., Forman et al., 2015; Nicely, Lane-Loney, Masciulli, Hollenbeak, & Ornstein, 2014). In order to show that ARFID is distinct from other restricting eating disorders, it is necessary to show that individuals with self-reported ARFID symptoms can be differentiated from those with self-reported attitudes associated with anorexia and bulimia on the basis of either comorbidity or eating behavior. In addition, because

ARFID is a new diagnosis, this investigation is the first to show that an analogue clinical sample with ARFID shows comparable distress and impairment to a more established analogue clinical sample (e.g., risk for eating disorders based on self-report).

In childhood, picky eating has been concurrently and prospectively associated with internalizing psychopathology (Jacobi et al., 2008; Mascola et al., 2010; Taylor et al., 2015; Zucker et al., 2015). Adult picky eaters score higher than peers on measures of depression and obsessive compulsive disorder symptom severity, and report lower eating-related quality of life (Kauer, Pelchat, Rozin, & Zickgraf, 2015; Wildes et al., 2012). Because it is likely that only the most severe picky eating is actually impairing, we hypothesize that picky eaters with ARFID symptoms will report more OCD and internalizing symptoms, and greater eating related quality of life impairment than picky eaters without these symptoms. Consistent with the existing literature on disordered eating symptoms, we predict that participants who report disordered eating attitudes will also report higher levels of psychopathology and eating related quality of life impairment than picky eaters and participants who did not report any eating disturbance (e.g., Wildes et al., 2013).

Picky eaters across the lifespan eat from a narrow range of preferred foods (e.g., fewer than 20 different foods), refuse to try new foods (e.g., neophobia), are rigid and particular about the ways in which preferred foods are prepared or presented, and report heightened sensitivity to sensation across sensory modalities (e.g., Cermak, Curtin, & Bandini, 2010; Coulthard, & Blissett, 2009; Farrow & Coulthard, 2012; Galloway et al., 2005; Jacobi et al., 2008; Kauer et al., 2015; Mascola et al., 2010; Smith, Roux, Naidoo, & Venter, 2005; Wildes et al., 2012). Severity of picky eating has yet to be behaviorally

defined; if picky eaters who report ARFID symptoms score higher than picky eaters without ARFID symptoms on measures of neophobia, dietary rigidity, and sensory sensitivity, and are more likely to eat from a narrow range of foods, this supports the hypothesis that more pronounced picky eating behavior is a marker of picky eating severity and risk for ARFID. In the present study, picky eaters with and without ARFID are compared to participants who report disordered eating attitudes and to typical eaters, on measures of food neophobia, eating inflexibility, sensory sensitivity, and eating from a narrow range of foods (fewer than 20 individual foods; e.g., Kauer et al., 2015). We hypothesize that these variables will distinguish picky eaters from typical eaters and those with disordered eating attitudes, and participants with ARFID symptoms less severe picky eaters.

METHOD

Participants

Two samples were recruited for this study. One sample (N = 332, N = 327 after exclusions, see below) was recruited from Amazon's Mechanical Turk (MTurk), a website where workers are paid small sums of money to complete surveys. All MTurk participants were living in the United States and spoke English fluently. Although they are not representative of the US population, MTurk workers in the US are representative of the internet-using US population in terms of geographical location, race/ethnicity, education attainment, and occupation (Buhrmester, Kwang, & Gosling, 2011; Paolacci & Chandler, 2014). MTurk workers (and the population of internet users of which they are relatively representative) differ systematically from the general US population in that

they tend to be younger, better educated, and underemployed (Paolacci & Chandler, 2014; Shapiro, Chandler, & Mueller, 2013). The second sample (N = 91, N = 77 after exclusions) was recruited from an online support group for adult picky eaters (Picky Eating Adults Support; PEAS). These participants were recruited via several posts to the message board explaining the purpose of the research and given the option to be entered into a raffle to win one of four $25 Amazon.com gift cards after participating.

Measures

Demographics. Participants reported their ages and responded to two items assessing race/ethnicity and education attainment.

Picky eating. The picky vs. non-picky samples were selected based on responses to a single item: "I am a picky eater (e.g., I dislike many foods that most people eat, or I am particular about how my food is prepared/served)." As Taylor and colleagues note in their recent review of the picky eating literature (2015), there is no single agreed-upon measure of picky eating. However, agreement with this single selection item has been used to identify picky eaters in both childhood (e.g., Jacobi et al., 2008; Mascola et al., 2010) and adulthood (e.g., Kauer et al., 2015; Wildes et al., 2012). Some of these authors used a True/False response scale, whereas others selected picky and non-picky eaters based on extreme responses on a Likert scale. In the present study, we chose to use a broad selection criterion to identify picky eaters, as did Kauer and colleagues (2015) in one of the only previous studies of adult picky eating. Because our second study aim involves identifying measures of picky eating severity that might differentiate relatively unimpaired picky eaters from those reporting ARFID symptoms, we chose this broad selection criterion in order to better sample the full range of picky eating behaviors.

Participants who agreed with the statement "I am a picky eater" by responding 3-5 (e.g., "slightly agree," "agree," or "strongly agree") on a 0-5 Likert-type scale were classified as picky eaters, and those who responded 0-2 (e.g., "strongly disagree," disagree," or "slightly disagree") were classified as non-picky.

ARFID symptoms. Participants who reported that they were picky eaters responded to an author-developed questionnaire assessing the presence of the four criterion-A symptoms of DSM-5 ARFID: weight loss or difficulty maintaining weight, nutritional deficiency, dependence on nutritional supplementation, or psychosocial impairment (adapted from the Structured Clinical Interview for DSM-5; First, Williams, Karg, & Spitzer, 2015). See Appendix A for the full text of this measure. Participants who indicated that at least one ARFID symptom was present to "a significant" degree were classified as either ARFID-only or comorbid eaters, depending on their scores on the screening instrument for disordered eating (see below, Group assignment). A count variable represented the total number of significant symptoms endorsed.

Eating-related quality of life. The Clinical Impairment Assessment questionnaire is a measure designed to assess the quality of life impacts of eating, over-exercising, and weight and shape concerns (Bohn & Fairburn, 2008). Wildes and colleague (2012) modified this instrument to make it specific to the consequences of eating. Picky eating behaviors were not mentioned; the questions were asked about "eating habits" in general. Participants responded on a 4-point Likert scale (not at all – a lot) to 16 items assessing various consequences of eating behaviors over the past month, including "…made it difficult to concentrate," "…made you feel critical of yourself,"

"…stopped you from going out with others," and "…affected your work or school performance." Internal consistency was very high: α = .95.

Disordered eating attitudes. The Eating Attitudes Test-26 (EAT-26) is a validated screening tool for attitudes associated with anorexia and bulimia. The EAT-26 assesses concern with shape and weight, fear of fatness, perception of societal pressure to be thin, and binging, compensatory, and restricting behaviors. The EAT-26 uses a 1-6 Likert-type response scale and is scored by recoding responses such that scores of 1, 2, or 3 = 0 and 4 =1, 5 = 2, and 6=3. The resulting scores are summed. A score of 20 or higher is considered potentially indicative of disordered eating attitudes and behaviors (Garner, Olmstead, Bohr, & Garginkel, 1982). Internal consistency of this measure was high: α = .88. Participants also responded to nine items from the Eating Disorder Diagnostic Scale (Stice, Telch, & Rizvi, 2000) assessing the intensity of weight and shape-related cognitions and the frequency of restricting and compensatory behaviors. These items were summed to create a continuous score. Internal consistency for these nine items was good: α = .79. The EAT-26 is more sensitive to restrictive eating behaviors and attitudes than to binge eating; we chose to use this measure because our goal was to isolate the impact of picky eating on weight, nutritional status, and psychosocial functioning by identifying and separating individuals with restricting disordered eating, which leads to similar symptoms.

Internalizing distress. The 21-item version of the Depression, Stress, and Anxiety Scale (DASS-21) was used as a measure of general internalizing distress. The DASS-21 includes items assessing the degree to which participants have felt negative emotions during the past week. Although the scale has three factors, these factors were

highly correlated in the present samples: $r > .57$. The 21 items were summed to create a single variable assessing current internalizing distress (Henry & Crawford, 2005). Internal consistency for the full scale was excellent: $\alpha = .95$.

Obsessive Compulsive Disorder symptoms. The Obsessive Compulsive Inventory-Revised (OCI-R) is an 18-item instrument that measures distress/disturbance from six categories of obsessive compulsive behaviors: hoarding, ordering, checking, washing, obsessing, and neutralizing. The instrument can be summed to create a single variable assessing the severity of OCD symptoms. The instrument has been widely used in non-clinical populations, and a cut-off score of 21/72 has been shown to differentiate individuals with OCD from healthy and anxious controls (Foa et al., 2002). The 18 items of the OCI-R had excellent internal consistency: $\alpha = .92$.

Narrow range. All participants were asked whether they "only eat from a very narrow range of foods (fewer than 20 different individual foods)." This item was taken from Kauer and colleagues' (2015) survey; in that sample, a much greater proportion of picky than non-picky eaters endorsed this behavior.

Food neophobia. All participants responded to the Food Neophobia Scale (FNS), a 10-item scale measuring reluctance or unwillingness to try new foods (Pliner & Hobden, 1992). Participants used a 6-point Likert scale to respond to items such as "I don't trust new foods," "I am constantly sampling new and different foods (reversed)"and "If I don't know what is in a food, I won't try it." The FNS has been shown to predict eating behavior in the laboratory (e.g., Pliner & Hobden, 1992). Internal consistency in this sample was high: $\alpha = .96$.

Inflexible eating behavior. There is no existing instrument to measure the rigid eating behavior associated with picky eating severity. We developed the Inflexibility Index based on items from Kauer and colleagues' (2015) more exhaustive survey of eating behaviors that reflect inflexibility in accepting non-preferred foods and rigidity around the preparation and preparation of preferred foods (e.g., "the thought of eating a food I do not like fills me with anxiety; "I avoid letting different foods touch on my plate, even when they are both foods that I like"). See Appendix A for the full text of this measure. Participants responded to 12 items on a 0-5 Likert-type scale, and responses to the 12 items were summed to create scores ranging from 0-60. Unrotated principle components analysis (PCA) indicated that in the full sample, all items loaded on a single factor, with loadings > .50. Internal reliability for all 12 items was excellent: α = .92. See Appendix A for the full text of this measure.

Sensory sensitivity. All participants responded to an author-developed 11-item scale measuring over-responsivity to taste, texture, smell, and sound. Items were based on other instruments designed to measure self-reported sensory functioning in adults, including the SensOR Assessment (Schoen, Miller, & Green, 2008) and the Glasgow Sensory Questionnaire (Robertson & Simmons, 2013). See Appendix A for the full text of this measure. An unrotated PCA in the full MTurk sample indicated that all 11 items loaded on a single factor with loadings >.50. The scale was internally consistent: α = .82.

Procedures

Participants responded to all study instruments in a single online survey. Participation took 20-60 minutes. For both samples, two attention check questions and two questions designed to identify bots (by asking participants to select which of four

grammatically correct sentences did not make sense, e.g., "pigs eat red and anger") were used to ensure the quality of the data. All participants who consented to participate passed both the bot and attention checks. All study instruments and procedures were approved for human subjects by the Institutional Review Board of the University of Pennsylvania, and all participants provided informed consent prior to participating.

Group assignment. In order to address the potential overlap between symptoms of ARFID due to picky eating (weight loss, nutritional deficiency/supplement dependence, and psychosocial impairment) and potential consequences of the restrictive eating attitudes assessed by the EAT-26, participants were separated into four eating behavior categories: typical eating, picky eating only, disordered eating attitudes only, and ARFID symptoms only. Group assignment was based on self-described picky eating, endorsement of ARFID symptoms and score on the EAT-26.

Participants who agreed with the statement "I am a picky eater" also responded to questions assessing ARFID symptoms. All participants responded to the EAT-26. Participants who were not self-reported picky eaters were classified based on their response to the EAT-26 as either typical eaters or, if they scored a 20 or greater on the scale, as having disordered eating attitudes. Self-identified picky eaters who did not endorse any significant ARFID symptoms and scored lower than 20 on the EAT-26 were classified as picky eaters; those who endorsed ARFID symptoms and scored lower than 20 on the EAT-26 were classified as "ARFID only," and participants who scored 20 or greater on the EAT-26 and did not endorse significant ARFID symptoms were classified as having disordered eating attitudes.

Seventeen participants (12 from the PEAS sample) who reported at least one significant ARFID symptom and scored 20 or greater on the EAT-26 were excluded from all analyses. Two participants from the PEAS sample did not respond to the ARFID symptom questions; they were excluded from all analyses. See Table 1.1 for eating behavior group classifications.

Data analysis

One-way ANOVAs with Tamhane's T2 post-hoc comparisons (with no assumption of equal group size or homogeneity of variance) with listwise deletion for cases with missing data, were conducted to compare the four groups on all continuous dependent variables (Aim 1: eating-related quality of life, internalizing distress, disordered eating attitudes, OCD symptomatology; Aim 2: food neophobia, eating inflexibility, sensory sensitivity). A chi-square analysis with four degrees of freedom was conducted to compare the groups on proportion eating from a range of 20 or fewer foods; in order to minimize Type II error, the only post-hoc comparisons were made between picky eaters with ARFID and those without, and picky eaters without ARFID and participants endorsing eating disordered attitudes.

RESULTS

Sample descriptives

Support group members were older than MTurk participants (M_{MTurk}= 33.9 (SD = 10.54), M_{PEAS} = 40.9 (SD = 13.46), $t(99.19) = 4.24$, $p < .001$, $d = 0.58$) and a higher proportion of the support group sample was female (50.4% vs. 73.7%, $\chi^2(1) = 13.04$, $p < .001$, $r = .18$). Participants self-reported their education attainment. For both the

MTurk and PEAS groups, the modal education attainment was a 4-year college degree (see Table 1.1 for age and education attainment).

Both samples were more than 70% White. A significantly higher proportion of the PEAS sample was White vs. other racial groups, compared to the MTurk sample: $\chi^2(1) = 7.88$, $p = .01$, $r = .14$ (see Table 1.1 for race/ethnicity sample descriptives).

The proportion of women vs. men was higher in both the ARFID and disordered eating attitude categories; men and women were more equally represented in both the typical and picky eater categories (Table 1.3). One participant in the MTurk sample selected the "other" option for gender; this participant was a typical eater. One picky eater from the PEAS sample did not report a gender.

DSM-5 ARFID criteria

Self-identified picky eating was relatively common in the MTurk sample; 33% of participants (n = 109) agreed with the statement "I am a picky eater." All support group participants were self-identified picky eaters.

Compared to the support group, picky eaters in the MTurk sample endorsed significantly fewer symptoms of ARFID. Mean symptom endorsement in the picky MTurk sample was 1.44 (1.59) compared to 3.35 (1.68) in the support group sample; $t(184) = 7.88$, $d = 1.17$, $p < .001$. Mean significant symptom endorsement in the picky MTurk sample was 0.12 (0.47) compared to 0.81 (1.0) in the support group sample; $t(99.43) = 5.60$, $d = 0.88$, $p < .001$. See Tables 1.2 and 1.4 for the percentage of participants from each sample endorsing each ARFID symptom.

Study aim 1: Eating disturbance and comorbidity

One-way ANOVAs indicated that the four eating behavior groups differed significantly on all four variables. As hypothesized, participants endorsing eating disordered attitudes on the EAT-26 had significantly higher scores on a separate measure, the self-report version of the Eating Disorder Diagnostic Scale, compared to all other groups (p <.001). Picky eaters did not differ significantly from either typical eaters or participants with ARFID on this measure; however, participants with ARFID scored higher on this measure compared to typical eaters (p =.02).

Similar patterns emerged in the post-hoc comparisons for the measures of internalizing distress and OCD symptoms. Typical eaters and picky eaters did not differ from one another. Typical eaters scored lower than participants with disordered eating attitudes or ARFID symptoms (p <.01). Picky eaters reported lower scores than participants with eating disordered attitudes (p <.02), and, at a trend level, than participants with ARFID symptoms (p = .08 for internalizing distress and p = .095 for OCD symptoms). Participants with ARFID symptoms and those with eating disordered attitudes did not differ from each other on either measure.

A different pattern of group differences emerged for scores on eating-related quality of life impairment. On this variable, typical eaters scored lower than any other group (p <.001 for comparisons with ARFID symptoms and eating disordered attitude groups; p = .002 for comparison with picky eaters); picky eaters scored significantly higher than typical eaters and significantly lower than participants with ARFID symptoms or eating disordered attitudes (p <.001), and participants with ARFID symptoms and eating disordered attitudes did not differ from one another. See Table 1.5 for group means and *F*-statistics for these analyses.

Study aim 2: Picky eating severity markers

Overall mean comparisons suggested that the four eating behavior groups differed significantly on all four variables (Tables 1.6 and 1.7). Identical patterns of results emerged for food neophobia and inflexible eating behaviors; typical eaters had significantly lower scores on both variables than any other eating group; picky eaters reported significantly higher scores than either typical eaters or participants with eating disordered attitudes. Participants reporting ARFID symptoms had significantly higher scores than any other eating group. All post-hoc differences were significant at the p <.001 level, with the exception of the difference between typical eaters and participants with disordered eating attitudes, who differed on eating inflexibility at p <.01 and on food neophobia at p <.05.

Post-hoc contrasts revealed that group difference on sensory sensitivity were less marked; typical eaters differed from the three other groups at the p <.001 level. Participants in the ARFID group scored significantly higher than picky eaters (p = .02), but neither group differed significantly from the disordered eating attitude group, whose mean score was between that of picky eaters and ARFID participants.

Finally, the four groups differed significantly on the proportion of participants who reported eating from a range of 20 or fewer foods: Cramer's V = .49, p <.001. Exploratory post-hoc chi square tests with one degree of freedom were conducted to compare picky eaters to ARFID-only participants and to participants with disordered eating attitudes. A significantly higher proportion of ARFID participants compared to picky eaters reported eating from a range of 20 or fewer foods: $\chi^2(1) = 14.50$, $\phi = .28$, p <.001. The proportion of picky eaters who reported eating from a narrow range of foods

was significantly higher than the proportion of participants with disordered eating attitudes, although the effect size was smaller: $\chi^2(1) = 4.3$, $\phi = .15$, $p = .04$.

DISCUSSION

The present study is a first effort to understand the characteristics of the picky eating presentation of Avoidant/Restrictive Food Intake Disorder (ARFID) in a sample of community-dwelling adults. Self-reported picky eating was quite common, with 33% of this MTurk sample expressing agreement with the statement "I am a picky eater." ARFID symptoms were less common: 3.1% of the MTurk sample (9.2% of MTurk picky eaters) endorsed the presence of significant ARFID symptoms. Unsurprisingly, the support-group picky eaters were more likely than MTurk picky eaters to endorse symptoms of ARFID: 48.1% of this sample (all of whom were picky eaters) reported experiencing ARFID symptoms due to their picky eating.

Replicating and extending findings by Wildes and colleagues (2012), we found that picky eating and symptoms of ARFID can exist independently of restricting disordered eating attitudes or behaviors in internet-using adults. Participants with ARFID endorsed comparable levels of eating-related quality of life impairment, internalizing distress, and OCD symptomatology to an established clinical analogue population, adults endorsing elevated disordered eating attitudes. We also showed that picky eating in the absence of ARFID symptoms does not appear to be associated with significant comorbidity, although picky eaters endorsed more impaired eating-related quality of life than typical eaters on a measure of interference and impairment related to eating behaviors. This finding adds to the existing literature on the relationship between adult

picky eating and symptoms of OCD, depression, and social anxiety, demonstrating that, among internet using adults, picky eating does not appear to be associated with elevated symptoms of psychopathology unless it is severe enough to lead to symptoms of ARFID (e.g., Kauer et al., 2015; Wildes et al., 2013)

In our second study aim, we attempted to identify markers of picky eating severity that can be used to differentiate picky eaters from individuals with other eating disturbances (e.g., disordered eating attitudes), and picky eaters with ARFID symptoms from those without. We explored four features of picky eating, selected based on prior phenomenological research on child and adult picky eating, that might differ between more and less severe picky eaters, and that we expected to differentiate picky eaters from both typical eaters and those endorsing disordered eating attitudes. Contrary to our hypothesis, based on previous findings in child and adult picky eaters (e.g., Coulthard & Blussett, 2009; Farrow & Coulthard, 2012; Kauer et al., 2015; Smith et al., 2005), degree of self-reported sensory sensitivity did not strongly differentiate picky eaters with or without ARFID from participants with disordered eating, nor did it differentiate picky eaters with ARFID symptoms from less severe picky eaters. Three other features of picky eating, rigid eating behaviors, food neophobia, and eating from a range of 20 or fewer foods, clearly differentiated picky eaters from typical eaters and those reporting eating disordered attitudes, and picky eaters with ARFID symptoms from those without. To our knowledge, our study is the first to identify potential markers of picky eating severity which may be useful in the assessment of picky eating and ARFID and in measuring outcomes in clinical practice and clinical trials for treatment of these feeding problems.

Limitations

A major limitation of this study was that it relied on self-report. In addition, because ARFID is a new diagnosis and adult picky eating, while common, is very under-studied, we relied on author-developed questionnaires when previously validated questionnaires were not available to assess the constructs of interest (e.g., the presence of ARFID symptoms secondary to picky eating). Further evidence for the reliability and validity of this instrument from independent samples is needed, but our initial findings support its use to identify individuals with symptoms of ARFID in the internet-using population. Our findings suggest promising directions for future research, but should be replicated and extended using additional methodologies, including behavioral observation, diagnostic interviewing, and psychophysiological testing.

A second major limitation to the present study was the use of two distinct, and demographically different, samples. Because ARFID is a very low-baserate disorder, we chose to sample a group of participants who were more likely to experience the psychopathology of interest (e.g., support-seeking adult picky eaters). As is often the case, participants from this semi-clinical sample differed in several significant demographic ways from those in the unselected Mechanical Turk sample. Because of low power in the MTurk sample (just 3.1% of participants endorsed ARFID symptoms in this sample) and because of the lack of typical eaters in the PEAS sample, it was not possible to replicate our major findings within either sample independently. This study is a preliminary exploration of a previously under-recognized population. Our findings should be interpreted with caution, and replicated in better-characterized and more representative samples.

Finally, this study focused on the presentation of ARFID characterized by picky eating. Our findings on symptom correlates and features of ARFID symptoms only apply to the picky eating presentation of ARFID; our study does not include ARFID symptoms due to limited appetite/interest in food or avoidance of eating because of fear of negative consequences. Future research should explore the prevalence of these three types of feeding disturbance in the adult population, and the degree to which they co-occur in the same individuals.

Conclusions

This study is the first to explore the features of ARFID secondary to picky eating in an adult sample. Our findings demonstrate that ARFID symptoms are relatively common among internet-using adult picky eaters, and very common in adult picky eaters who seek support on the internet. Participants with ARFID symptoms experienced eating-related impairment, internalizing distress, and OCD symptoms at levels comparable to individuals with disordered eating attitudes, yet there is no evidence-based treatment for ARFID in adults and typically developing school-aged children, and very little treatment research has been conducted in these populations. In the 2006 National Eating Disorder QI Collaborative study, adolescents with ARFID who presented underweight were less likely than those with other restricting eating disorders to achieve weight recovery, and more likely to drop out of family-based therapy and medical management (e.g., Forman et al., 2014). These findings suggest that efficacious treatments for anorexia and bulimia nervosa are not as acceptable or helpful to individuals with ARFID. There is evidence for the efficacy of intensive behavioral, applied behavior analysis-based treatments for feeding problems in chronologically or developmentally young children (Lukens &

Silverman, 2014). However, this treatment is not appropriate for typically developing adults or older children. There is a clear need for developmentally appropriate treatments for individuals whose picky eating leads to significant impairment.

This study also introduced several novel instruments, including the ARFID symptom checklist used to identify picky eaters experiencing weight loss, nutritional deficiencies, nutritional supplement dependence, or psychosocial impairment. Although this instrument has not yet been used outside of the development sample, its ability to identify a group reporting significant comorbidity and impairment, and distinctive eating behaviors, supports its usefulness as a screening instrument for ARFID. In addition, our finding that picky eaters who report significant picky-eating related impairment also endorse higher levels of food neophobia and eating inflexibility, and are more likely to eat from a range of 20 or fewer foods, introduces several behavioral markers of picky eating severity, and identifies potential outcomes of interest in future studies of picky eating and ARFID treatment.

Table 1.1. *Sample descriptives: Age, race, education attainment*

		Mechanical Turk	**Support group**
Age *M (SD)*			
		33.92 (10.54)	40.88 (13.46)
Education attainment *N (%)*			
	High school or less	41 (12.5%)	6 (7.8%)
	Some college	74 (22.6)	18 (23.4)
	2 year degree	44 (13.5)	9 (11.7)
	4 year degree	88 (27.2)	31 (40.3)
	Advanced degree	34 (10.4)	13 (16.9)
	Missing	45 (13.8)	0
Race/ethnicity *N (%)*			
	African American	20 (6.2%)	2 (2.6%)
	East Asian	12 (3.7)	0
	Hispanic	12 (3.7)	0
	Multiracial	17 (5.2)	4 (5.2%)
	Native American	1 (0.3)	0
	Southeast Asian	8 (2.4)	0
	White	255 (78.0)	71 (92.2)
	Missing	1 (0.3)	0
Total *N*		327	77

Table 1.2. *Eating behavior classification by sample*

	Full sample	**Mechanical Turk**	**Mechanical Turk picky eaters**	**Support group picky eaters**
Typical eater	46.8%	57.8%	NA	NA
Picky eater only	32.2	27.5	82.6%	51.9%
Eating disordered attitudes	9.4	11.6	8.3	0
ARFID	11.6	3.1	9.2	48.1
N	404	327	109	77

Table 1.3. *Proportion of women in eating behavior categories*

	Full sample		**Mechanical Turk sample**	
	n	% female	*n*	% female
Typical eater	189	45.0	189	44.4
Picky eater only	130	54.5	90	47.8
Eating disordered attitudes	38	76.3	38	76.3
ARFID	46	73.9	10	70.0

Table 1.4. *Percent of self-identified picky eaters endorsing ARFID symptoms*

	Mechanical Turk picky eaters (*n* = 105)			**Support Group** (*N* =77)		
	None	**Some**	**Significant**	**None**	**Some**	**Significant**
Weight loss	71.6% (78)	23.3% (26)	2.8% (3)	87.0% (67)	11.7% (9)	1.3% (1)
Nutritional deficiencies	65.1 (71)	32.1 (35)	0.9 (1)	35.1 (27)	61.0 (47)	3.9 (3)
Dependence on nutritional supplements	63.3 (69)	28.4 (31)	5.5 (6)	33.8 (26)	51.9 (40)	14.3 (11)
Occupational interference	85.3 (93)	12.8 (14)	0	58.4 (45)	33.8 (26)	7.8 (6)
Social interference	81.7 (89)	15.6 (17)	0.9 (1)	15.6 (12)	53.2 (41)	31.2 (24)
Family interference	82.6 (90)	13.8 (15)	1.8 (2)	35.1 (27)	42.9 (33)	22.1 (17)

Table 1.5. *Group differences: eating-related quality of life and psychopathology variables*

Eating behavior classification			**EAT-26** (0-40)	**EDDS** (0-9)	**EQoL** (0-5)	**DASS-21** (0-57)	**OCI-R** (0-72)
	n	*M (SD)*					
Typical eater	189		5.71_{a}	2.49_{a}	3.75_{a}	9.96	9.61_{a}
			(4.83)	(1.94)	(5.79)	(10.86)	(10.01)
Picky eater	130		5.41_{a}	$2.64_{a,c}$	6.72_{b}	$10.99_{a,c}$	$11.52_{a,c}$
			(5.62)	(1.82)	(7.99)	(9.97)	(10.93)
Eating disordered attitudes	38		28.95_{b}	5.03_{b}	15.66_{c}	20.11_{b}	20.16_{b}
			(7.30)	(1.31)	(9.72)	(12.83)	(15.58)
ARFID	47		6.68_{a}	3.45_{c}	17.31_{c}	$16.28_{b,c}$	$15.85_{b,c}$
			(5.51)	(1.91)	(11.48)	(12.87)	(10.20)
One-way ANOVA		***F*(3)**	**209.76***	**21.53***	**54.23***	**11.67***	**12.03***
		η^2	**.61**	**.14**	**.29**	**.08**	**.08**

Within groups *df* = 397-400

(*p <.001). Means appearing in the same column with different subscripts are significantly different at the *p* <.05 level (Tamhane's T2).

Table abbreviations: EAT-26: Eating Attitudes Test-26; EDDS: Eating Disorder Diagnostic Scale; EQoL: Eating-related Quality of Life impairment; DASS-21: Depression, Stress, and Anxiety Scale-21; OCI-R: Obsessive Compulsive Inventory-Revised

Table 1.6. *Group differences and F-statistics for continuous picky eating variables*

Eating behavior classification			**Eating inflexibility**	**Food neophobia**	**Sensory sensitivity**
			(0-60)	(0-50)	(0-55)
	n	*M (SD)*			
Typical eater	189		13.07_{a}	12.59_{a}	25.55_{a}
			(8.50)	(8.39)	(8.95)
Picky eater	130		29.99_{b}	31.61_{b}	30.79_{b}
			(13.82)	(11.82)	(9.82)
Eating disordered attitudes	38		19.27_{c}	18.26_{c}	$34.08_{b,c}$
			(9.48)	(11.76)	(8.22)
ARFID	47		43.02_{d}	43.51_{d}	35.66_{c}
			(11.39)	(8.68)	(9.19)
One-way ANOVA	**413**	***F*(3)**	**122.16***	**169.78***	**21.93***
		η^2	**.48**	**.56**	**.14**

*p <.001

Within groups *df* = 393, 403

Means appearing in the same column with different subscripts are significantly different at the $p < .05$ level (Tamhane's T2).

Table 1.7. *Narrow range eating behavior*

Eating disorder classification	***n***	**Proportion eating from a range of 20 or fewer foods**
Typical eater	189	8.99
Picky eater	130	41.54
Eating disordered attitudes	38	23.68
ARFID	47	74.47
χ^2(4)		**95.37****

**significant at p <.001;, p <.001 (χ^2(1))

CHAPTER 2: FRUIT AND VEGETABLE INTAKE AND DIETARY VARIETY IN ADULT PICKY EATERS

Hana F. Zickgraf[1] (M.A.), & Katie Schepps[1] (B.A.)

1. Department of Psychology, University of Pennsylvania

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ABSTRACT

Picky eating has been associated with altered nutrient intake and reduced consumption of fruits and vegetables in middle childhood. Findings from two studies reported here provide empirical support for the perception that adult picky eaters also have significantly different diets from their peers. Adult picky eaters were compared to their non-picky peers on dietary variety (Study 1), and self-reported daily intake of fruits, vegetables, protein, dairy, starches and grains, desserts, snack foods, and soda (Study 2). In Study 1, picky eaters reported eating less varied diets than peers; their variety was particularly low for vegetables, fruits, and fish. In Study 2, picky eaters reported fewer daily servings of fruits and vegetables, and were more likely to report diets that omitted fruits and vegetables and/or failed to meet the recommended 5 daily servings; these findings were more pronounced among picky eaters who reported experiencing symptoms of Avoidant/Restrictive Food Intake Disorder due to picky eating. Food neophobia and rigid, inflexible eating behavior, two characteristics of picky eating, were each negatively related to daily fruit and vegetable intake; eating inflexibility was also associated with reduced dietary variety. Although as many as 35% of otherwise healthy adults identify themselves as picky eaters, very little research has explored dietary variety or daily fruit and vegetable intake in these individuals. This gap in the literature is striking given widespread public health concern with improving diet quality in an effort to fight rising rates of obesity and related morbidity.

INTRODUCTION

Higher rates of fruit and vegetable consumption have been consistently linked to improved health outcomes, including lower rates of obesity and obesity-related diseases, heart attack, stroke, and some cancers, and lower rates of mortality (e.g., Dauchet, Amouyel, Hercberg, & Dallongeville, 2006; Ford & Mokdad, 2001; He, Nowson, & MacGregor, 2006; Van Duyn & Pivonka, 2000; Wang et al., 2014). Rates of obesity and vascular disease are rising in the United States, making the promotion of fruit and vegetable intake a significant public health priority (USDA 2015; USDA and U.S. Department of Health and Human Services, 2010). However, despite decades of public health interventions aimed at educating the public about the USDA's dietary guidelines, and local, state, and federal efforts aimed at improving food security and promoting access to fruits and vegetables, the percentage of adults reporting consumption of 5 or more daily servings of fruits and vegetables has remained virtually unchanged at 20-30% across the 1990's and the first decade of the 21st century (e.g., Blanck, Gillespie, Kimmons, Seymour, & Serdula, 2008; Guenthe et al., 2013; Stables et al., 2002).

A recent meta-analysis examining dose effect in the relationship between fruit and vegetable consumption and mortality found a significant dose effect up to a threshold of five daily servings, providing empirical support for these guidelines (Wang et al., 2014). Self-reported dietary variety is associated with better dietary quality, including greater nutrient adequacy and lower consumption of added sugars and saturated fat, and specifically with increased consumption of vegetables and fruit (e.g., Drewnowski, Renderson, Driscoll, & Rolls, 1997; Foote, Murphy, Wilkens, Basiotis, & Carlson, 2004; Krebs-Smith, Smiciklas-Wright, Guthrie, & Krebs-Smith, 1987; Murphy et al., 2006).

Diets omitting one or more food groups are particularly strongly associated with an increased risk of mortality (Kant, Schatzkin, Harris, Ziegler, & Block, 1993).

One way to improve dietary quality on a population level is to identify behaviors and characteristics that might interfere with adherence to dietary recommendations and guidelines. One potential behavior is selective, neophobic (e.g., "picky") eating. In a recent review of the literature on picky eating, Taylor and colleagues (2015) proposed the following definition for "picky eating," citing previous work by Lumeng (2005) and Ekstein, Laniado, & Glick, 2010: "unwillingness to eat familiar foods or try new foods,[1] severe enough to interfere with daily routines to an extent that is problematic" (Taylor, Wernimont, Northstone, & Emmett, 2015, p. 350). Picky eating also appears to be characterized by inflexible eating behavior, e.g., rigidity about how preferred foods should be prepared and presented, and refusal of even preferred foods if the preparation or presentation are different than usual (e.g., Kauer, Pelchat, Rozin, & Zickgraf, 2015). Picky eating was once considered to be a passing and usually benign childhood phase. Point prevalence estimates for children aged 1.5 to 12 years range from 5.6-59% in international samples, with the majority of studies estimating a prevalence of significant picky eating between 15-20% (e.g., Taylor, et al., 2015). However, picky eating appears to remain common in adulthood: in one community sample of adults, approximately 35% reported that they were picky to at least some degree (Kauer et al., 2015).

[1] Pickiness, defined as refusal of familiar foods leading to a narrow diet, and food neophobia, defined as refusal to try new foods, are sometimes treated as distinct constructs; this distinction has been supported by exploratory factor analysis of parent-report data in a sample of toddlers (Rigal, Chabanet, Issanchou, Monnery-Patris, 2012). However, the two behaviors are closely related, and in Rigal and colleagues' data, the picky eating and neophobia factors were highly correlated (r = .67), leading these authors to suggest that the two behaviors were facets of the same underlying construct (2005). Taylor and colleagues' 2015 review of the literature found further empirical support for treating refusal of new and familiar food as facets of the same construct, and included both behaviors in their working definition of "picky eating."

Picky eating that is problematic enough to lead to weight loss, nutritional deficiency, dependence on nutritional supplements, or impairment in psychosocial functioning can be diagnosed as Avoidant/Restrictive Food Intake Disorder (ARFID). A diagnosis new to DSM-5, ARFID can be diagnosed in individuals of any age with severe selective eating not due to body shape or weight concerns. Despite the fact that ARFID is characterized by picky eating leading to altered energy or nutrient intake, relatively little attention has been paid to picky eaters' diet and nutrition. Picky eaters under the age of six have been found to be at risk for underweight or poor growth compared to typically-eating peers (e.g., Taylor et al., 2015). By middle childhood, picky eating does not appear to be associated with body weight; however, at this age picky eaters appear to consume less varied diets than peers, and may be particularly likely to reject vegetables and fruits (Galloway, Fiorito, Lee, & Birch, 2005; Xue et al., 2015). In the elderly, picky eating is associated with reduced dietary variety and increased risk for malnutrition (Maitre et al., 2014). Food neophobia, a correlate of picky eating, is associated with reduced liking for fruits and vegetables (Knaapila et al.,, 2011) and with reduced dietary variety (Hursti & Sjoden, 1997; Nicklaus, Boggio, Chabanet, & Issanchou, 2005) in young adult samples.

To date there has been very little research on the relationship between adult picky eating and dietary variety or intake, and to our knowledge, none of the previous studies on this topic have included measures of picky eating severity. In Study 1, picky and non-picky eaters were compared on self-reported dietary variety. It was hypothesized that self-identified adult picky eaters would report reduced variety across food groups, but particularly for fruits and vegetables. We also hypothesized that eating inflexibility (e.g.,

rigidity about brand, preparation, and presentation of preferred foods), a behavior associated with picky eating and used here as a measure of picky eating severity, would be inversely correlated with self-reported dietary variety (e.g., Kauer et al., 2015; Taylor et al., 2015). In Study 2, we explored the hypothesis that picky eaters, particularly those who report meeting criteria for ARFID (e.g., weight loss, nutritional deficiency, dependence on nutritional supplements, or marked interference with psychosocial functioning) due to their picky eating, would report lower daily consumption of fruits and vegetables, and would be more likely than non-picky peers to completely omit one or both food groups from their daily diet and to fall below the recommended five daily servings of fruits and vegetables. Finally, we hypothesized that continuous measures of picky eating severity (e.g., food neophobia, and eating inflexibility) would be inversely correlated with self-reported daily fruit and vegetable intake.

STUDY 1 INTRODUCTION

In Study 1, English-speaking adults living in the US and recruited online responded to a dietary variety questionnaire, reporting whether they regularly ate, would be willing to eat if offered, or would be unwilling to eat, each of a list of 107 foods beverages, and condiments, including sub-lists of fruits, vegetables, meats, and fish. Participants also responded to a measure of inflexible eating behavior, a feature of picky eating habits in children and adults and a potential marker of picky eating severity (e.g., Taylor et al., 2015; Kauer et al., 2015). This measure was included to explore the hypothesis that severity of picky eating is continuously related to dietary variety.

STUDY 1 METHOD

Participants

Participants were a convenience sample of 139 adults aged 18 and over recruited via Amazon's Mechanical Turk. Mechanical Turk is a platform where workers are paid small amounts of money to complete online tasks. Several surveys of Mechanical Turk workers have found that these individuals are representative of the adult internet-using population in their geographic distribution, race/ethnicity, age, education attainment, and employment (Buhrmester, Kwang, & Gosling, 2011). Mechanical Turk workers, and the broader population of adult internet users, are younger and more highly educated than the general US population (Paolacci & Chandler, 2014; Shapiro, Chandler, & Mueller, 2013). In order to recruit a larger sample of picky eaters, we recruited participants through two separate recruitment advertisements, or Human Intelligence Tasks (HITs). The HIT for picky eaters was titled "PICKY EATER survey!" and the HIT for unselected participants was titled "Nutrition knowledge survey." The two HITS were cross-linked, and an identical study description was provided within each HIT. They only differed in one sentence, which directed participants who clicked on the "nutrition knowledge" survey but identified as picky eaters to participate through the "picky eater" HIT, and participants who clicked on the "picky eater" HIT but did not identify as picky to participate through the "nutrition knowledge" HIT. This was done in order to obtain approximately equal numbers of picky and non-picky eaters. Of the full sample (including the seven non-meat-eating participants excluded from the analyses; see below), 60 participants (43.5%) responded to the "picky eater" HIT, 58 (40.0%) responded to the "nutrition knowledge" HIT, and data on HIT were unavailable from 20 participants (14.5%), 10 non-picky and 10 picky. Of the participants for whom HIT data were available, 45 (77.6%) who responded to the "nutrition knowledge" HIT were

classified as non-picky, and 43 (71.7%) who responded to the "picky eater" HIT were classified as picky (see below, Materials, for a description of the item used to classify picky and non-picky eaters). Participants' Mechanical Turk Worker IDs were collected and checked to ensure that no participant took both surveys. Participants were paid $3.

Study instruments, procedures, and consent and debriefing documents were approved by the Institutional Review Board of the University of Pennsylvania.

Materials

Demographics and other eating restrictions. Participants reported their age and responded to questions about race/ethnicity and education attainment. They also responded to three true/false questions assessing whether they were vegetarian, vegan, or pescatarian. Definitions of each of these terms were also provided (e.g., for vegetarian, "I eat eggs and dairy but no meat or fish").

Picky eater status. As yet there is no gold-standard instrument for identifying or assessing childhood or adult picky eaters (Taylor et al., 2015). Researchers exploring picky eating in children (Jacobi et al., 2008; Mascola et al., 2010) and adults (Kauer et al., 2015; Wildes et al., 2012) have selected their picky eating samples on the basis of responses to the question "do you consider yourself (your child) to be a picky eater?" Participants responded to this item on a 0-5 Likert-type agree/disagree scale. Participants who responded 0-2 were coded as non-picky, and participants who responded 3-5 were coded as picky; this binary response item has been used in previous research to identify adult picky eaters (e.g., Kauer et al., 2015). Among picky eaters, 20 (32.8%) selected a response of "3" (anchor: "slightly agree"), 32 (53.5%) selected "4" ("agree") and 9 (14.8%) selected "5" (strongly agree"). Among non-picky eaters, 18 (25.4%) selected "0"

("strongly disagree"), 30 (42.3%) selected "1" ("disagree"), and 23 (32.4%) selected 2 ("slightly disagree").

Dietary variety. Participants responded to a questionnaire that assessed willingness to eat 107 common and uncommon foods, beverages, and condiments/ingredients (See Appendix A for the full list). This list of foods was adapted from several published food frequency and variety questionnaires used to assess nutritional intake in American adults, and comprehensive lists of commonly consumed foods in the US including those surveyed in the National Health and Nutrition Examination (e.g., Cade, Thompson, Burley, & Warm, 2002; Day, McKeown, Wong, Welch, & Bingham, 2001; Feskanich et al., 1993). For each food, participants indicated whether they ate it regularly (at least once over a typical 7 day period), whether they ate it occasionally or would be willing to eat it if it was served to them, or whether they never or almost never ate it. Scores were calculated for the percentage of foods participants were willing to eat from the full list, and from the vegetables (33 items), fruits (22 items), meat (11 items), and fish (16 items) included in the questionnaire.

Inflexible eating behaviors. Participants responded to the Inflexibility Index (IFI), an author-developed measure (Zickgraf, Franklin, & Rozin, 2016; Appendix B) of inflexible attitudes and behaviors around food and eating (e.g., "if I dislike a food, I will not eat it under any circumstances;" "If two foods that I normally like touch each other on the plate, I prefer not to eat them"). The 12 items used in this measure were selected from a larger set of items on which picky and non-picky eaters were found to differ significantly in the sample obtained by Kauer and colleagues (2015). Item selection was theoretically-driven; items all relate to rigidity about how preferred foods are prepared

and presented, and refusal to eat non-preferred foods. None of the items relate to preferences for, or aversions to, specific food items, categories of food, or tastes, textures, or other sensory properties of food. This measure, therefore, is believed to capture willingness to eat non-preferred foods or preferred foods that are prepared or presented in new ways (e.g., mixed together, touching non-preferred foods, different brands), and not the content of participants' diets. In this study, we chose to use this measure to test the hypothesis that eating inflexibility, a proxy for picky eating severity, is related to food choices (e.g., dietary variety). Exploratory factor analyses conducted in the development sample suggest that this measure has a single-factor solution (Zickgraf et al., 2016). Participants receive a score ranging from 0-60 reflecting their endorsement of eating inflexibility. Internal reliability in the present sample was excellent: $\alpha = .90$.

Procedure

Participants responded to all surveys online in a single session. Data collection took place in March 2015. After clicking the link to the survey, participants read a consent document and provided their consent to participate electronically by endorsing a Yes/No item at the end of the consent document. Participants next responded to two items designed to detect bots (participants chose which of four grammatically-correct sentences did not make semantic sense, e.g., "pigs eat red and anger"). All participants who provided consent passed the bot checks. Questionnaires were presented in the same order for all participants; the picky eater self-identification question was asked first, followed by the IFI and the dietary variety measure. After finishing the study, participants were directed to a debriefing page, which described the study aims in greater detail, reviewed the research on adult picky eating, provided nutrition information, and

directed concerned participants to online resources for anxiety, depression, obsessive compulsive disorder, and disordered eating.

Data analysis

Because percentage data violate the assumptions of parametric tests comparing group means, Mann-Whitney U tests were used to test the null hypothesis that picky and non-picky eaters differed in the percentage of foods from each of five lists that they were willing to eat. The Bonferroni critical *p*-value for five statistical tests was $p = .01$. *r*-type effect sizes for the relationship between eating behavior group (e.g., picky vs. non-picky) and rank score were calculated by dividing the *z*-score for the group difference in mean ranks by the square root of the overall sample size: $r=z/\sqrt{N}$ (Fritz, Morris, & Richler, 2012). Student's t-tests were used to compare the groups on mean endorsement of inflexible eating behaviors. Pearson's product-moment correlations were used to explore the relationship between dietary variety and inflexible eating behavior.

STUDY 1 RESULTS

Sample descriptives

The full sample was 45.3% female ($n = 63$) and 54.7% male ($n = 76$). The proportion of men and women self-identifying as picky was not statistically different; 47% of picky eaters were women ($n=31$) and 53% were men ($n=35$); $\chi^2(1) = 0.14$, $r = -.03$, $p = .71$. The mean age of the sample was 35.37 years ($SD= 10.16$); picky eaters and non-picky eaters did not differ in age: $t(137) = 0.02$, $d = 0.002$, $p=.98$. The sample was largely white (80.6%), with 5% identifying as African American, 5% as East Asian, 5% as Hispanic/Latino, 2.2% as multiracial, 0.7% as Native American and 1.4% as "Other."

Five picky eaters (7.6%) and two non-picky eaters (2.7%) identified as vegetarians, pescatarians, or vegans (the group difference in proportion omitting some or all animal products was not statistically significant; $\chi^2(1) = 1.7$, $r = .11$, $p = .19$). These participants were excluded from the dietary variety analyses.

Dietary variety

Picky eaters were willing to eat a lower percentage of foods from the full list and from each of four sub-categories: fruits, vegetables, meats, and fish. These differences were moderate-large and significant, remaining robust against correction for multiple hypothesis tests (Bonferroni critical *p* value = .01). The group difference was particularly pronounced for willingness to eat fruits and vegetables and fish. See Table 2.1 for group mean percentage willing to eat and mean inflexibility score, and Table 2.2 for mean ranks, test statistics, and effect sizes.

Inflexible eating behavior

There was a very large and significant difference between picky and non-picky participants in inflexible eating behavior score. Picky eaters' mean score was 27.72 (11.30), compared to a mean of 10.21 (7.27) for non-picky eaters; $t(99.53) = 10.40$, $p < .001$, $d = 1.84$. Eating inflexibility was significantly inversely correlated with overall dietary variety and percentage of vegetables, fruits, fish, and meats consumed (Table 2.3).

STUDY 2 INTRODUCTION

In Study 1 we found that picky eaters reported lower dietary variety compared to non-picky eaters, and that dietary variety was inversely associated with inflexible attitudes towards food and eating. These findings were particularly pronounced for fruit,

vegetable, and fish variety. However, our findings from Study 1 do not rule out the possibility that picky and non-picky eaters consume comparable daily servings of fruits and vegetables (and protein-containing foods including meat and fish), within the range of food they are willing to eat. Indeed, many findings linking dietary variety to dietary quality suggest that dietary quality is most impaired when one or more food group is avoided entirely (Kant et al., 1993). In Study 2, we explore the degree to which picky eating is associated with actual alterations in patterns of self-reported daily consumption, the proportion of picky, severely picky, and typical eaters who report omitting fruits, vegetables, or both from their diets entirely and the proportion from each group reporting at least 5 daily servings of fruit and vegetables. We also explore the relationship between severity of picky eating and daily diet, and the association between two measures of eating behavior associated with pickiness (eating inflexibility and food neophobia) and self-reported daily dietary patterns. Food neophobia, a feature of picky eating, has previously been associated with reduced dietary variety in young adult samples, and in particular to reduced fruit and vegetable variety (e.g., Knaapila, et al., 2011; Nicklaus et al., 2005). However, this study is the first to our knowledge to explore the relationship between individual differences in willingness to try new foods, and self-reported daily intake of fruits and vegetables.

STUDY 2 METHOD

Participants

Participants were recruited from two online sources: Amazon's Mechanical Turk and an online support group and forum for adult picky eaters (Picky Eating Adult Support; http://pickyeatingadults.com/). Mechanical Turk participants were paid $3 for their participation, and support group members were entered into a raffle to win one of

four $25 Amazon.com gift cards. The same study description was used to recruit both Mechanical Turk and Picky Eating Adult Support participants.

Study instruments, procedures, and consent and debriefing documents were approved by the Institutional Review Board of the University of Pennsylvania.

Materials

Picky eater status was assessed using the same single item and dichotomized 0-5-point Likert scale described above, in Study 1 Measures.

Severe picky eating. All picky participants were asked the degree to which their picky eating habits resulted in 1) weight loss/difficulty maintaining weight, 2) nutritional deficiency, 3) dependence on nutritional supplements, or 4) psychosocial impairment. These four markers of severity were chosen based on the diagnostic criteria for Avoidant/Restrictive Food Intake Disorder, a psychiatric diagnosis for individuals whose picky (or otherwise restrictive) eating leads to significant health and/or psychosocial impairment (American Psychiatric Association, 2013). This author-developed measure is based on the Structured Clinical Interview for DSM-5 ARFID section, as well as self-report items used in prior studies (First, Williams, Karg, & Spitzer, 2015; Wildes et al., 2013). Participants responded to each of the six items on a scale with three anchors: not present, present to some degree, present to a significant degree. Participants who reported that they experienced at least one of these four negative consequences of picky eating to "a significant" degree were classified as severe picky eaters. The distributions of responses to the picky eater status item were as follows: among picky eaters (*N*= 119), 42 (36.8%) chose "3" ("slightly agree" with the statement "I am a picky eater"), 37 (32.5%) chose "4" ("agree"), and 35 (30.7%) chose "5" ("strongly agree"). Among severe picky

eaters (N = 40), three (7.5%) chose "3," five (12.5%) chose "4", and 32 (80%) chose "5." Among non-picky eaters (N = 175), 62 (35.4%) chose "0" ("strongly disagree"), 73 (41.7%) chose "1" ("disagree"), and 40 (22.9%) chose "2" (slightly disagree").

Disordered eating cognitions. Participants responded to the Eating Attitudes Test, 26-item version (EAT-26), a validated measure of restricting and compensatory behaviors, and excessive shape and weight concerns associated with disordered eating. The EAT-26 has a validated clinical cut-off (scores of 20 or greater on a 0-40 measure). This cut-off was used in the present sample to exclude participants with potential disordered eating attitudes and behaviors (Garner, Olmsted, Bohr, & Garfinkel, 1982).

Inflexible eating behaviors. Participants responded to the Inflexibility Index (IFI), described above in Study 1, Measures. Internal reliability in the present sample was excellent: α = .91.

Food neophobia. Participants responded to the 10-item Food Neophobia Scale (FNS), a validated measure of willingness to try new foods (Pliner & Hobden, 1992). Whereas picky eating is defined as rejection of both new and unfamiliar foods, food neophobia refers only to refusal or reluctance to try new foods (e.g., Rigal et al., 2012; Taylor et al., 2015). The FNS does not contain any items relating to willingness to consume specific foods, including fruits and vegetables. Internal reliability was excellent: α = .96.

Daily servings. Participants were asked to self-report the number of servings consumed in a typical day across nine categories: fruits, vegetables, protein, starches/carbohydrates, dairy, snack foods, desserts, soda, and water. Participants were told that a food serving was approximately ½ cup of the food, and that a serving of water

or soda was approximately 12oz. They were given examples of starches ("bread, potatoes, pasta, rice"), protein ("meat, fish, eggs, nuts"), dairy ("milk, cheese"), snacks ("chips, pretzels"), and desserts ("ice cream, cake, cookies, candy"). Participants responded on an 11-point scale ranging from 0 servings to 10 or more servings.

Procedure

Participants responded to all surveys online in a single session. Data for this study were collected between June and August 2014. The procedure used to obtain informed consent was the same as that used in Study 1 and described above. Participants responded to the same bot-detection items as those in Study 1. Questionnaires were presented in the same order for all participants; the picky eater self-identification question was asked first, followed by the IFI, the FNS, the daily intake measure, and the eating disorders screen. In addition, because this was a longer survey than the one used in Study 1, participants responded to two attention-check items embedded in a questionnaire near the end of the survey. All participants who provided consent passed the bot and attention checks. After completing the survey, participants were directed to a debriefing document that provided more information about the study aims, information about adult picky eating, and referral to online resources for anxiety, mood, and eating disorders.

Data analysis

Generalized linear models with a Poisson distribution were used to analyze the count variable representing self-reported daily servings from each food group. Likelihood ratio χ^2 tests with two degrees of freedom were used to assess overall model fit, and picky and severely picky eaters' self-reported daily servings were compared to those of typical eaters using Wald χ^2 with one degree of freedom. The generalized linear procedure was

used to run binary logistic models predicting the odds of reporting zero servings of fruit, vegetables, or both on an average day, and the probability of reporting 5 or more daily servings of fruit and vegetables, with typical eaters as the reference group. Pearson's product-moment correlations were used to explore the continuous relationships between eating inflexibility, food neophobia, and daily servings.

STUDY 2 RESULTS

Sample descriptives

Fifty six participants were excluded from the present analysis because they endorsed clinically significant symptoms of disordered eating. The goal of the present study was to explore the effect of picky eating on daily dietary intake, and because adult picky eaters are no more likely than their non-picky peers to endorse eating disorder symptoms (e.g., Kauer et al., 2015) these participants were excluded in order to remove a potential alternate source of variability in the daily intake data. As in Study 1, we excluded 35 participants who reported that they were vegetarians, vegans, or pescatarians. The three eating groups (picky, severe picky, and typical) did not differ in the proportion of participants reporting that they were vegan, vegetarian, or pescatarian; $\chi^2(2) = 1.58$, $V = .07$, $p = .45$. After exclusions, the Mechanical Turk sample included 268 participants (81.5%) and the Picky Eating Adult Support sample included 61 (18.5%)[1].

The full sample after exclusions was 50.5% female ($n = 166$) and 48.6% male ($n = 160$) (two people identified their gender as "other"). The proportion of men and women self-identifying as picky was not statistically different; 44% of non-picky (n=76) and 53% (n=60) of picky eaters were women; $\chi^2(1) = 2.44$, $r = -.09$, $p = .12$. Women were

[1] This is a subset of the sample used in Zickgraf, Franklin, & Rozin (2016), *Journal of Eating Disorders 4(1), 26.*

more likely than men to identify as severely picky: 77% of severe picky eaters were women; $\chi^2(1) = 6.82$, $r = .21$, $p = .009$. The mean age of the sample was 35.5 years (*SD*= 11.49); picky eaters' mean age was 35.1 (*SD*= 11.17), and non-picky eaters' mean age was 34.6 (*SD*= 10.61). Severe picky eaters' mean age was 40.4 (*SD*= 14.80), but a one-way ANOVA with post-hoc comparisons using Tamhane's T2 suggested that this difference was not significant. The sample was largely white (80.8%), with 5.4% identifying as African American, 3.3% as East Asian, 3.3% as Hispanic/Latino, 5.1% as multiracial, 1.8% as Southeast Asian and 0.3% as "Other."

Dietary patterns

Group means for number of self-reported daily servings of each food group, and eating inflexibility and food neophobia scores, are reported in Table 2.4. In this sample, it was possible to explore differences between more and less severe picky eaters as well as between picky and non-picky eaters. For each food group with the exception of dairy, picky eater status (typical, picky, or severe picky) was a significant overall predictor of daily servings (likelihood ratio χ^2). For every category of food with the exception of soda and dairy products, severe picky eaters reported different dietary patterns compared to typical eaters. In the case of self-reported servings of fruits, vegetables, and water, picky eaters also differed significantly from typical eaters. As hypothesized, these effects were particularly pronounced for daily servings of fruits and vegetables.

Exponentiated Poisson regression coefficients represent the difference in expected raw counts, or the percent difference in expected counts, compared to the reference group. For every one daily serving of fruit reported by typical eaters, picky eaters ate approximately 40% less (0.58 servings). For every serving of vegetables reported by the

typical group, picky eaters ate 50% less (0.53 servings). Picky eaters reported drinking less water and more soda compared to typical eaters: 20% less water (0.29 servings, 3.2oz) and 55% more soda (1.55 servings, 6oz). Picky eaters also reported consuming fewer overall servings of food (11%, 0.89 servings); this difference was significant at the $p < .05$ level (Table 2.5).

For every serving of fruit reported by typical eaters, severe picky eaters ate approximately 60% less (0.34 servings). They ate 75% fewer servings of vegetables (0.25 servings for typical eaters' one). Severe picky eaters also reported consuming more servings of carbohydrates by 40% of a serving (1.42), 85% more dessert food servings (1.86), and almost twice as many servings of snack foods (1.97). Severe picky eaters reported eating less protein by approximately a third of one serving (0.69) and drinking less water by 25% of a serving, or approximately 4oz (0.75). Severe picky eaters did not differ from typical eaters in their total daily number of servings across all food categories; unlike picky eaters, severe picky eaters did not report higher soda consumption compared to typical eaters.

Picky eating classification was strongly associated with reduced odds of reporting five daily servings of fruits/vegetables, and of eating at least one daily serving of either fruits, vegetables or both (see Table 2.6 for sample proportions and Table 2.7 for logistic regression results). Compared to typical eaters, picky eaters were less likely to eat at least one serving of fruit (OR = 0.23) or vegetables (OR = 0.05), or to eat the recommended 5 daily servings of fruits and vegetables (OR = 0.25). Odds ratios associated with fruit and vegetable consumption for severe picky eaters were even lower; for at least one serving of fruit, OR = 0.10, for vegetables, OR = 0.01, and for five fruits or vegetable servings

per day, OR = 0.03. A significant minority of picky eaters (17.7% of picky eaters and 37.5% of severe picky eaters) reported eating neither fruits nor vegetables in a typical day, which was very uncommon in the typical group (1.71%, only three participants; OR picky = 12.30, OR severe = 34.5).

Inflexible eating behavior and neophobia

Eating inflexibility and food neophobia were associated with daily servings from each food category (Table 8). There was a large, negative correlation between daily servings of vegetables and both inflexibility and neophobia. Both picky eating variables were negatively correlated with daily servings of fruit, and positively correlated with daily servings of starch, snacks, and dessert foods, with moderate effect sizes. The negative relationships between these variables and servings of protein, and the positive relationships with servings of dairy, were small, though still significant at the $p < .05$ level with the exception of the relationship between food neophobia and dairy intake. Both picky eating variables were associated with beverage intake; inflexibility and neophobia were associated with greater reported soda intake, and less water intake with small to moderate effect sizes.

DISCUSSION

The present studies are the first, to our knowledge, to provide empirical support for the perception that adult picky eaters have diets that are less varied and poorer in daily servings of fruits and vegetables compared to non-picky eaters. Our finding that self-identified picky eating is associated with lower dietary variety and altered daily dietary intake, including reduced fruit and vegetable intake, provides important evidence for the

validity of the term "picky eater" as a description of a specific pattern of eating behavior characterized by limited dietary range.

Consuming a varied diet high in fruits and vegetables contributes to the prevention of cancer and heart disease (e.g., Block et al., 1992; Kant et al., 1993; 2000; Ness & Powles, 1997). However, most adults in the US do not meet the recommended intake of fruits and vegetables in their daily diets. Several barriers to intake of plant-based foods have been identified. These include lack of access to fresh foods, the relative cost of calories from fresh versus processed foods, and the time and cooking knowledge needed to prepare plant-based foods (e.g., Beaulac, Kristjansson, & Cummins, 2007; Dwyer, Simpson, & Heeney, 2008; Lipman et al., 2011). In the present studies, we found empirical support for picky eating as a barrier to fruit and vegetable consumption; adults who self-identify as picky eaters reported lower dietary variety for fruits and vegetables. Picky eaters from a separate sample reported eating fewer daily servings of fruits and vegetables compared to typical eaters, were more likely to completely omit these foods from their diets, and were less likely to meet the recommended 5 daily servings. It appears that in the case of fruit and vegetables, lower dietary variety may be associated with reduced consumption; this hypothesis should be explored in future studies.

Results from Study 2 suggest that picky eating may be associated with unhealthy eating behaviors other than reduced fruit and vegetable intake, including increased consumption of dessert and snack foods and sodas compared to non-picky eaters. In Study 1, picky eating was associated with reduced fish and meat variety, whereas in Study 2, only more severe picky eaters reported reduced consumption of protein by approximately one third of a serving per day. It may be the case that only more severe

picky eaters in the Study 1 sample actually had reduced fish and meat variety, or that less severe picky eaters in Study 2 were more likely than more severe picky eaters to consume other protein sources, such as eggs and nuts. Although picky eaters in the Study 1 sample were not grouped according to severity (e.g., endorsement of ARFID symptoms), there was a positive correlation between eating inflexibility, a marker of picky eating severity, and dietary variety across all categories including meat and fish. Future research should explore differences between picky eaters of varying severity levels and typical eaters in their patterns of protein consumption.

Although the dietary data we collected was not sufficiently accurate to estimate the caloric or nutritional content of the self-reported daily diets of our sample, it appears that while picky eaters report eating marginally fewer servings of food during the day, severe picky eaters report comparable numbers of servings to typical eaters, appearing to compensate for their reduced fruit, vegetable, and protein consumption with higher consumption of more calorically-dense foods such as carbohydrates, snack, and dessert foods. Food neophobia and eating inflexibility, two measures of picky eating severity, were strongly negatively correlated with fruit and vegetable consumption, and positively correlated with carbohydrate, snack, and dessert consumption, providing further evidence for a continuous relationship between severity of picky eating behavior and poor dietary quality.

Limitations

A major limitation of the present studies was that they relied on self-report measures to assess dietary variety and daily intake. Self-report of food frequency and dietary variety has been found to systematically underestimate energy intake (e.g.,

Bedard, Shatenstein, & Nadon, 2004) and over-estimate consumption of plant-based foods (e.g., Marks, Hughes, & van der Pols, 2006). However, we used these measures to compare the relative variety of two groups, not to estimate precise dietary intake values. Furthermore, because of the tendency for participants to over-estimate their fruit and vegetable consumption when responding to food frequency questionnaires, our finding of relatively low fruit and vegetable intake among picky eaters might represent an over-estimate, and the problem of low fruit and vegetable consumption among picky eaters might be even greater than our results suggest.

Our daily dietary intake data come from a measure that has not been validated, and is likely imprecise as it relies on participants to make rough, general estimates of their typical dietary consumption. Other validated measures of dietary intake are intended to produce reliable estimates of average micro- and macronutrient intake, and can take 30 minutes or longer to complete. Because our primary aim was to compare the fruit and vegetable intake of non-picky eaters, picky eaters, and severe picky eaters, and the proportions of each group reporting omitting these food groups completely, but not to compare these groups on the micro- and macronutrient quality of their diets, we chose to use a shorter, less detailed measure.

Another limitation is the use of internet-based convenience samples. Both studies involved samples recruited from Amazon's Mechanical Turk using a study description that included mentions of food, nutrition, and picky eating behavior. Picky and non-picky participants were recruited through separate HITs in Study 1. Although each HIT contained an identical study description, the differing HIT names might have affected the makeup of the final samples. It might be the case that potential participants made the

decision not to participate in this study based on the name of one of the HITs, but would have chosen to participate had they seen the other HIT title first. In addition, the titles of both surveys, and the study information provided in the HITs, may have biased our sample towards an interest in food and nutrition. However, this sampling concern applies to both picky and non-picky eaters; if our picky eating sample is more interested in diet and nutrition than the population of picky eaters, they might be expected to have relatively better diets than other picky eaters. The demonstrated difference between picky and non-picky eaters might be even more robust in a sample without this bias.

This study represents a first effort to understand the relationship between adult picky eating and dietary variety and intake. Future research, using multiple assessment instruments (e.g., self-report, interview, observation, and detailed nutritional assessment) will provide stronger evidence and contribute to a more fine-grained understanding of the dietary choices of adults who identify as picky eaters.

Conclusions

If interventions aimed at increasing intake of fruits and vegetables and reducing intake of high-calorie processed foods are to succeed, it will be necessary to reach the subset of the adult population who identify as picky eaters. Picky eaters, as this study demonstrates, consume fewer types, and fewer daily servings, of fruits and vegetables than their non-picky peers, and at higher levels of severity, consume more servings of carbohydrates and snack and dessert foods. Increasing knowledge of USDA's dietary guidelines and access to healthy foods may fail to effect dietary change among those who restrict their food intake due to neophobia, rigid and inflexible attitudes about food, and aversion to the sensory properties of foods. Individuals with severe picky eating,

particularly those whose picky eating is severe enough to lead to the weight, nutrition, or psychosocial consequences associated with Avoidant/Restrictive Food Intake Disorder (ARFID), may be at particularly high risk for poor dietary quality.

There are no empirically supported interventions for picky eating or for its clinically-significant manifestation, ARFID. Picky eating behavior, including eating so restrictive as to lead to the weight loss, nutritional deficiency, nutritional supplement dependence, and/or marked psychosocial impairment that are diagnostic of ARFID, appears to be modifiable through systematic exposure to novel foods, combined with rewards and cognitive coping strategies (e.g., Birch & Marlin, 1982; Fischer, Luiselli, & Dove, 2015; Lukens & Silverman, 2015). However, there has been very little study of the effectiveness of interventions for reducing picky eating behavior, and increasing liking for fruits and vegetables, in adults. This paper highlights the need for more research on the prevalence, etiology, mechanisms, and treatment of picky eating and Avoidant/Restrictive Food Intake Disorder.

Table 2.1. *Means and standard deviations for Study 1 variables*

	Non-picky (n = 71)		Picky (n = 61)		Total (N = 132)	
	M	SD	M	SD	M	SD
Vegetables	80.15%	21.38	57.63%	29.54	69.74%	27.77
Fruits	84.76	21.46	64.38	30.94	75.34	28.08
Meat	75.93	17.93	65.13	20.14	70.94	19.66
Fish	65.23	31.16	38.93	32.54	53.08	34.31
All foods	78.15	15.77	59.64	21.18	69.60	20.60
Inflexibility score	10.21	7.27	27.72	11/30	18.30	12.79

Table 2.2. *Mann-Whitney U test for equality of rank scores*

	Mean rank					
	Non-picky	Picky	*U*	*z*	*r*	*p*
Vegetables	80.53	50.17	1169.5	4.56	.40	<.001
Fruits	80.53	50.17	1169.5	4.58	.40	<.001
Meat	76.23	55.17	1474.5	3.20	.28	.001
Fish	80.36	50.37	1181.5	4.51	.39	<.001
All foods	82.50	47.88	1029.5	5.19	.45	<.001

Table 2.3. *Correlation matrix: inflexibility score and dietary variety*

	Inflexibility score (0-65)
Overall variety	-.54**
Vegetable variety	-.52**
Fruit variety	-.44**
Fish variety	-.37**
Meat variety	-.31**

**p <.001

Table 2.4. *Means and standard deviations for Study 2 variables*

	Typical eater (*n* = 175)		**Picky eater** (*n* = 114)		**Severe picky eater** (*n* = 40)		**Total** (*N* = 328)	
	M(SD)	*range*	*M(SD)*	*range*	*M(SD)*	*range*	*M(SD)*	*range*
Fruits	2.04 (1.43)	0-7	1.19 (1.07)	0-5	0.70 (0.85)	0-3	1.59 (1.35)	0-7
Vegetables	2.55 (1.45)	0-7	1.35 (1.28)	0-6	0.65 (1.10)	0-6	1.91 (1.54)	0-7
Protein	3.14 (1.69)	1-10	2.79 (1.69)	0-9	2.18 (1.72)	0-8	2.90 (1.72)	0-10
Carbohydrates	2.97 (1.78)	0-10	3.17 (1.61)	0-8	4.23 (2.26)	0-8	3.18 (1.83)	0-10
Dairy	2.15 (1.46)	0-8	2.13 (1.64)	0-8	2.48 (2.15)	0-8	2.18 (1.62)	0-8
Snack foods	1.60 (1.34)	0-7	1.98 (1.87)	0-10	3.15 (2.27)	0-10	1.92 (1.73)	0-10
Desserts	0.95 (0.93)	0-6	1.17 (1.42)	0-7	1.77 (1.66)	0-9	1.13 (1.24)	0-7
Total servings of all foods	15.39 (5.84)	6-38	13.71 (6.03)	4-37	15.15 (6.59)	5-38	14.78 (6.03)	4-38
Soda	1.05 (1.77)	0-10	1.62 (2.13)	0-10	1.25 (1.71)	0-8	1.27 (1.90)	0-10
Water	5.35 (2.64)	0-10	4.19 (2.43)	0-10	4.00 (3.13)	0-10	4.79 (2.69)	0-10
Inflexibility score	12.76 (8.29)	0-45	29.47 (13.06)	0-58	42.88 (11.41)	8-59	22.53 (15.18)	0-59
Neophobia score	12.44 (8.37)	0-48	30.71 (11.18)	8-50	43.48 (8.81)	15-50	22.51 (14.86)	0-50

Table 2.5. *Poisson multinomial regression, eating category on self-reported daily intake*

	Likelihood ratio χ^2(2)	**Eating category [a]**	***β* [95% CI]**	**Wald χ^2(1)**	***p***
Fruit	57.85**	picky	-0.54 [-0.73, -0.68]	29**	<.001
		severe picky	-1.07 [-1.46, -0.34]	29.31**	<.001
Vegetables	100.18**	picky	-0.64 [-0.84, -0.45]	42.04**	<.001
		severe picky	-1.37 [-1. 89, -0.84]	26.19**	<.001
Carbohydrates	14.88 *	picky	0.06 [-0.06, 0.19]	0.86	.33
		severe picky	0.35 [0.17, 0.54]	13.76**	<.001
Protein	11.91*	picky	-0.12 [-0.26, 0.02]	2.95	.09
		severe picky	-0.37 [-0.62, -0.11]	8.00*	.005
Dairy	1.76	picky	-0.01 [-0.19, 0.16]	0.02	.90
		severe picky	0.14 [-0.14, .43]	0.95	.33

	Likelihood ratio $\chi^2(2)$	**Eating category [a]**	***β* [95% CI]**	**Wald $\chi^2(1)$**	***p***
Snacks	27.89**	picky	0.22	3.95*	.047
			[0.003, 0.43]		
		severe picky	0.68	27.63**	<.001
			[0.43, 0.93]		
Desserts	17.71**	picky	0.20	2.23	.14
			[-0.06, 0.47]		
		severe picky	0.62	14.46**	<.001
			[0.30, 0.94]		
Total servings of all foods	13.82*	picky	-.12	5.37*	.02
			[-.21, -.02]		
		severe picky	-.02	.05	.83
			[-.12, .13]		
Soda	17.32*	picky	0.44	6.08*	.01
			[0.09, 0.79]		
		severe picky	0.18	0.52	.47
			[-0.31, 0.67]		
Water	25.23**	picky	-0.24	13.67**	<.001
			[-0.37, -0.11]		
		severe picky	-0.29	5.18†	.02
			[-0.54, -0.04]		

[a] Reference category = typical eaters; *p<.05 **p<.001

Table 2.6. *Descriptive statistics: Percent reporting at least one daily serving of fruit, vegetables, no servings of either, of five daily servings of fruit and/or vegetables*

	Typical eater (n = 175)	**Picky eater** (n = 113)	**Severe picky eater** (n = 40)	**Total** (N = 328)
One or more: fruit	91.43%	70.8%	52.5%	79.28%
One or more: vegetables	98.29	72.57	42.5	82.62
No fruit or vegetables	1.71	17.70	37.50	11.59
Five daily servings	43.43	15.04	2.50	28.66

Table 2.7. *Logistic regression, eating category on self-reported daily fruit and vegetable intake*

	Likelihood ratio $\chi^2(2)$	**Eating category [a]**	***β*** **[95% CI]**	**Exp(*β*)** **[95% CI]**	**Wald $\chi^2(1)$**	***p***
Fruit	37.88**	picky	-1.48	0.23	18.97**	<.001
			[-2.15, -0.82]	[0.12, 0.44]		
		severe picky	-2.27	0.10	29.68**	<.001
			[-3.08, -1.45]	[0.04, 0.24]		
Vegetables	85.29**	picky	-3.08	0.05	24.67**	<.001
			[-4.29, -1.83]	[0.01, 0.16]		
		severe picky	-4.35	0.03	42.89**	<.001
			[-5.65, -3.05]	[0.003, 0.05]		
No fruit or vegetables	46.46**	picky	2.51	12.30	15.78**	<.001
			[1.27, 3.75]	[3.56, 32.52]		
		severe picky	3.54	34.47	28.08**	<.001
			[2.23, 4.85]	[9.30, 127.7]		
Five daily servings	48.36**	picky	-1.47	0.25	23.26*	<.001
			[-0.87, -2.06]	[0.13, 0.42]		
		severe picky	-3.40	0.03	11.02**	.001
			[-1.39, -5.41]	[0.01, 0.13]		

[a] Reference category = typical eaters *p<.01 **p<.001

Table 2.8. *Correlation matrix: inflexibility, neophobia, and daily servings*

	Inflexibility	**Food neophobia**
Food neophobia	.81**	1
Vegetables	-.52**	-55**
Fruits	-36**	-39**
Protein	-.14*	-.21**
Starch	.32**	.24**
Dairy	.18*	.07
Snacks	.41**	.35**
Desserts	.32**	.25**
Soda	.17*	.11*
Water	-.22**	-.27**

**p<.001; *p<.05

CHAPTER 3: DEVELOPMENT AND VALIDATION OF THE NINE ITEM AVOIDANT RESTRICTIVE FOOD INTAKE DISORDER SCREEN (NIAS)

Hana F. Zickgraf[1] (M.A.) & Jordan M. Ellis[2] (M.A.)

1. Department of Psychology, University of Pennsylvania 2. Department of Psychology, East Carolina University

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ABSTRACT

Avoidant/Restrictive Food Intake Disorder (ARFID) is an eating or feeding disorder characterized by inadequate nutritional or caloric intake leading to weight loss, nutritional deficiency, supplement dependence, or significant psychosocial impairment. DSM-5 lists three distinct eating behaviors that can lead to symptoms of ARFID: avoidance of foods due to their sensory properties (e.g., picky eating; PE), poor appetite or limited interest in eating, or fear of negative consequences from eating. Despite increasing interest in ARFID and PE, empirical research is limited by the lack of validated instruments to measure these eating behaviors. The present study describes the development and validation of the nine-item ARFID screen (NIAS), a brief multidimensional instrument to measure ARFID-associated eating behaviors. Participants were 450 adults recruited on Amazon's Mechanical Turk, 505 adults recruited from a nationally-representative subject pool, and 845 young adult college students completing surveys for psychology course credit. Exploratory and confirmatory factor analyses provided evidence for three factors. The NIAS demonstrated high internal consistency and adequate test-retest reliability. The subscales demonstrated convergent and discriminant validity with other measures of PE, appetite, and fear of negative consequences, and with measures of psychopathology and eating-related impairment. The NIAS is a brief, reliable instrument that may be used to further investigate ARFID-related eating behaviors.

INTRODUCTION

Avoidant/Restrictive Food Intake Disorder (ARFID) is a new diagnosis to DSM-5, intended to capture individuals with eating pathology that causes significant impairment but is not driven by fear of weight gain or distorted body image. ARFID can be diagnosed in individuals of any age whose limited intake or restricted dietary variety leads to insufficient caloric and/or nutritional intake and causes one or more of the following symptoms: 1) weight loss, 2) nutritional deficiency, 3) dependence on nutritional supplements, or 4) psychosocial impairment. DSM-5 lists and briefly describes three categories of eating disturbance that can lead to the symptoms of ARFID: avoidance of many foods based on their sensory properties ("picky eating;" PE), low appetite or limited interest in eating, and fear of negative consequences, such as choking or vomiting, from eating (American Psychological Association, 2013).

Although DSM-5 briefly describes how these eating behaviors might lead to ARFID symptoms, it does not cite any research linking these behaviors to ARFID-like outcomes (e.g., weight loss, nutritional deficiency, supplement dependence, eating related impairment). Prevalence estimates for ARFID and ARFID-associated eating behaviors are nonexistent or highly inconsistent. This might be due, in part, to the limited number of self-report assessment instruments to measure these behaviors. Of the three, PE has attracted the most research attention, but recent reviews of the PE literature highlighted the lack of psychometrically sound measures (e.g., Taylor, Wernimont, Northstone, & Emmet, 2015). There are validated self-report measurements of appetite, food motivation, fear of choking, and specific phobia of vomiting (e.g., Boschen, Veale, Ellison, & Reddell, 2013; Budak et al., 2017; Hunot et al., 2016) but these have yet to be used explicitly in the assessment of ARFID symptoms. Whereas picky eating by definition

refers to a restrictive eating behavior (e.g., Taylor et al., 2015), existing measures of appetite and vomiting or choking phobia do not explicitly assess restricted/limited eating associated with these constructs.

Although limited, the literature offers some evidence linking each of the three ARFID-associated eating behaviors to ARFID symptoms across the lifespan. In children under 6, PE is associated with slow growth and risk for underweight (e.g., Antoniou et al., 2016; Dubois, Farmer, Girard, Peterson, & Tatone-Tokuda, 2007; Ekstein, Laniado, & Glick, 2010). Studies that report the relationship between PE and BMI in adults have found no relationship (e.g., Ellis, Galloway, Webb, & Martz, 2016; Kauer, Pelchat, Rozin, & Zickgraf, 2015; Zickgraf, Franklin, & Rozin, 2016). However, adult PE is associated with eating-related impairment, including social eating anxiety and reduced eating-related quality of life (Wildes, Zucker, & Marcus, 2012; Zickgraf et al., 2016), low fruit and vegetable intake and reduced overall dietary variety in adults (Zickgraf & Schepps, 2016), and with increased risk of malnutrition in the elderly (Maitre et al., 2013). In a study that assessed ARFID symptoms secondary to PE, only picky eaters with one or more of the four symptoms required to diagnose ARFID reported elevated eating-related impairment (Zickgraf et al., 2016). These findings suggest that continuous measures of PE could be used to explore the severity of PE and assess risk for ARFID.

Empirical research linking appetite and motivation to eat to ARFID-like outcomes in adults is limited. The Child Eating Behavior Questionnaire (CEBQ) and the recently-validated adult version (AEBQ) assess appetite and interest in eating across the lifespan (Hunot et al., 2016; Wardle, Guthrie, Sanderson, & Rapoport, 2001). In studies using these measures, food responsiveness and enjoyment of eating are positively associated

with BMI, whereas slow eating and satiety responsiveness are negatively associated with adiposity (e.g., Hunot et al., 2016; Sleddens, Kremers, & Thijs, 2008; Webber, Hill, Saxton, Van Jaarsveld, & Wardle, 2009). However, most samples in which BMI is explored continuously include very few underweight participants, making it difficult to draw firm conclusions about the relationship between appetite and underweight from this literature. DSM-5 suggests that when anxiety and depression cause loss of appetite, this can lead to ARFID symptoms (APA, 2013). The CEBQ and AEBQ assess under-eating in response to negative affect, and this construct is also inversely correlated with BMI in adults and children (Hunot et al., 2016; Sleddens et al., 2008; Webber et al., 2010), but has not been linked to underweight or weight loss in any age group (e.g., de Barse et al., 2015; McCarthy et al., 2015). To our knowledge, there is no published research on the association of appetite and interest in eating with eating-related psychosocial impairment, or with nutritional or caloric intake in adults. However, the associations between adiposity and measures of satiety responsiveness, food motivation, and emotional undereating suggest that at their extremes, these characteristics could lead to ARFID symptoms.

DSM-5 describes conditioned anxiety associated with food intake following a traumatic experience such as intubation, invasive medical procedures involving the GI tract, choking, or persistent vomiting, as potentially leading to ARFID symptoms (APA, 2013). Specific phobia of choking, which often has its onset after a choking incident, is usually associated with food refusal or restriction, leading to weight loss and/or significant psychosocial and family interference in a majority of adult cases (de Roos & de Johng, 2006; McNally, 1994; Franko, Shapiro, & Gagne, 1997). Few studies have

addressed eating behavior in adults with specific phobia of vomiting (SPOV), but the available evidence suggests that most adults (75-90%) with SPOV report some food avoidance, and in one sample, 34% of SPOV participants reported significantly restricting their diets (e.g., Holler, van Overveld, Jutglar, & Trinka, 2013; Lipsitz, Fyer, Paterniti, & Klein, 2001; Veale, Costa, Murphy, & Ellison, 2012). In this study, individuals with significantly restricted diets were more likely to be underweight, and they reported greater functional impairment across multiple domains compared to individuals with SPOV who do not restrict their eating (Veale et al., 2012). Although not mentioned by DSM-5, fear of lower GI distress in individuals with functional GI disorders, might also lead ARFID symptoms. Individuals with IBS often manage their symptoms through restricted diets, despite a lack of evidence for the efficacy of such diets, which are often initiated by patients themselves with little input from doctors (e.g., Chey, 2013). To our knowledge there have been no empirical studies of maladaptive eating restrictions, and their health and functional consequences, in individuals with functional GI disorders. The development of a self-report measure of fear-related avoidance of eating will help to identify specific fears and conditions that are associated with ARFID risk.

Research on ARFID and its subclinical manifestations is limited by the availability of validated measures to assess these constructs in adults. The purpose of the study was to validate a brief self-report instrument that explicitly addresses eating restriction associated with the three ARFID-associated eating behaviors. The nine-item ARFID screen (NIAS) will be useful in exploring the pattern of psychopathological comorbidities and health-related outcomes shared by, or unique to, the three ARFID-

related eating behaviors. As diagnostic instruments for ARFID are validated, the NIAS might prove useful as a self-report screening instrument for ARFID.

Measures of constructs related to each of the three ARFID-like eating behaviors were included to assess convergent and divergent validity of the subscales. Measures of PE behaviors, including food fussiness/refusal, food neophobia, and rigid inflexible eating behaviors, were expected to be related to the PE, but not Fear or Appetite subscales. Measures of appetite and enthusiasm for eating, and external and emotional eating, were expected to be independently related to Appetite, but not Fear or PE. BMI was expected to be uniquely related to Appetite. Self-reported IBS symptoms, vomit-phobia related avoidance and distress, swallowing anxiety, and anxiety associated with visceral sensation, were expected to be related to Fear but not to PE or Appetite. We predicted that the relationship with vomit phobia-related avoidance would be stronger than that with distress, because the NIAS Fear scale explicitly assesses an avoidance behavior.

Symptoms of high-functioning adult autism spectrum (ASD) traits, sensory over-responsivity (SOR), and sensitivity to disgust, were predicted to be related to PE, based on the definition of PE as being driven by sensory aversions to food (APA, 2013), findings linking SOR to PE in children (e.g., Monnery-Patris et al., 2015; Smith, Roux, Naidoo, & Venter, 2005) and adults (Kauer et al., 2015; Raudenbusch, van der Klaauw, & Frank, 1995; Zickgraf et al., 2016), the high rate of food selectivity in children on the autism spectrum (e.g., Cermak, Curtin, & Bandini, 2010), and previous findings linking disgust sensitivity to adult PE (Kauer et al., 2015). Measures of psychopathology, including anxiety, depression, disordered eating, and obsessive compulsive disorder, as

well as eating-related quality of life impairment, were included to explore the relationships of the NIAS subscales with comorbidity and distress. PE across the lifespan has been linked to anxiety, depression, and OCD (e.g., Kauer et al., 2015; Mascola et al., 2010; Wildes et al., 2012; Zucker et al., 2015). There is less empirical support for a relationship with Appetite, although DSM-5 explicitly links this presentation to comorbid anxiety and depression (APA, 2013). We expect Fear to be related to measures of anxiety and OCD.

METHOD

Participants

Sample 1: Mechanical Turk, selected. English-speaking adults living in the US were recruited from Amazon's Mechanical Turk (MTurk), a platform where workers are paid to complete online tasks including surveys. We recruited through five separate recruitment advertisements, or Human Intelligence Tasks (HITS), in order to recruit participants who experienced the eating difficulties of interest. The HIT titles were "Research on eating habits," and "Research on eating habits related to…" irritable bowel syndrome (IBS), fear of vomiting, poor appetite/limited interest in eating, and picky eating. Four attention check questions were embedded in the survey. A total of 488 people participated in the study. Data from 33 participants (6.8%) who failed one or more attention check were discarded, and an additional five participants (1.0%) did not respond to the NIAS. In the final sample (N = 450), 94 participants (20.9%) were recruited through the picky eating HIT, 77 (17.1%) were recruited though the poor appetite HIT, 94 (20.9%) were recruited through the IBS HIT, 90 (19.8%) were recruited through the vomiting HIT, and 95 (21.1%) were recruited through the "Research on eating habits"

HIT. Five participants failed to answer a question asking through which HIT they participated (1.1%). The final sample was 48.6% female and 50.8% male; one participant reported their gender as "other," (0.2%) and four participants did not report gender (0.9%). The sample was 75% Caucasian, 10% African American, 8% Asian, 0.2% Native American, and 6.8% multiracial. 7% identified as Hispanic/Latino. The mean age of the sample was 33.6 years old (*SD* = 9.5). Data from this sample were used in Step 1 (establishing the factor structure of the NIAS through exploratory factor analysis) and Step 3 (convergent and divergent validity).

Sample 2: Semi-representative parent sample. A sample of US adults who were parents/guardians of children ages 5-17 was recruited through Qualtrics' nationally representative consumer and psychology research panel service. These participants were recruited for a separate study of their children's eating behavior, but they also responded to the self-report NIAS, which was used in the present study. Qualtrics recruits paid participants from marketing research panels and through social media, and uses participant-reported demographic information to create representative subject pools from which participants are randomly sampled. The present sample was recruited for representativeness on geographic location, ethnicity, and educational attainment. From this representative subject pool, participants who reported that they were the parent of a child between the ages of 5-17 were eligible to participate in the study. Three thousand, six hundred, and eighty eight Qualtrics panel workers were screened, and the final sample included 505 participants (13.7% of those screened). Of those screened, 2,088 were ineligible because they did not have children in the specified age group (56.6%), 456 (12.4%) did not provide consent to participate in research, 470 (12.7%) began the study

but did not complete the NIAS, 167 (4.6%) failed at least one of seven embedded attention checks, and two (0.1%) passed the attention checks but completed the survey in under five minutes. In the final sample, 69.5% of respondents were female, with a mean age of 36.6 years (SD = 8.6). Data from the semi-representative parent sample were used in Step 2, a CFA analysis confirming the fit of the model selected in Step 1.

Sample 3: College undergraduate sample. The undergraduate sample included 845 University of Pennsylvania students participating in research for psychology course credit. Five hundred and thirty four were recruited for a separate study of parent/child resemblance in eating habits. To address potential selection bias in this sample, which was recruited through an advertisement that mentioned eating habits, an additional 311 students were recruited the following semester, through an advertisement that made no mention of eating behavior. All undergraduate participants responded to the NIAS and to convergent/divergent validity measures. The two undergraduate samples were compared on their scores on the NIAS and validity measures using independent-samples t-tests or Mann-Whitney U tests for non-normally distributed variables. Test statistics were converted into r-type effect sizes for ease of interpretation. The groups did not differ on NIAS picky eating, appetite, or total scores, but the second wave sample scored higher on the fear subscale (z = -2.18, r= .07, p = .03). The samples differed on the food neophobia scale and EAT-26, with the second wave sample scoring higher on both measures ($t_{neo}(741.5)$ = -2.05, r = .06, p = .04; z_{EAT} = -2.42, r = .08, p = .02), but not on any of the other convergent validity measures. Because they did not differ on most measures, and because effect sizes associated with significant group differences were very small, the samples were combined for all analyses. These data were used in Step 3 to explore

convergent and discriminant validity in a young adult sample not explicitly recruited for the ARFID-associated eating behaviors of interest. The three-factor solution was also confirmed in the full undergraduate sample. Students in the second wave of the undergraduate sample were recontacted two weeks after participating, and asked to complete the NIAS again, within one week of receiving the request to participate. Two hundred participants (64%) participated in the follow-up study. These data were used in Step 4 to establish the test-retest reliability of the NIAS.

The full undergraduate sample was 68.6% female and 29.7% male; 1.7% did not indicate gender. Mean age was 19.9 years (SD = 2.5); 97.5% of participants were between the ages of 18-22. The sample was 51.5% White, 24.1% Asian, 9.9% multiracial, and 5% African American. 7.2% identified as Hispanic/Latino. 2.2% of participants indicated a race/ethnicity of "other." The test-retest sample was 73.5% female, 53.5% White, 27.5% Asian, 3% African American, and 1.5% "other. 5% identified as Hispanic/Latino. Mean age of the test-retest sample was 19.84 (2.91) with 97% of participants between 18-22 years.

Measures

Adult eating behavior questionnaire (AEBQ). The AEBQ is a validated 35-item measure of adult eating behaviors associated with food approach and avoidance (Hunot et al., 2016). The AEBQ has eight factors. The four food approach factors are Hunger, Food Responsiveness, Emotional Over-Eating, and Enjoyment of Food. The four food avoidance factors are Satiety Responsiveness, Emotional Under-Eating, Food Fussiness, and Slowness in Eating. The AEBQ was included in the present study to explore convergent validity with the NIAS PE scale (Food Fussiness), and Appetite scale

(Hunger, Satiety Responsiveness, Emotional Under-Eating, Emotional Over-Eating Slowness in Eating, Food Responsiveness, and Enjoyment of Food). The MTurk sample and the second wave of the undergraduate sample responded to the AEBQ.

Dutch eating behavior questionnaire (DEBQ). The DEBQ is a three-factor measure of behaviors associated with over-eating and binge eating in adults: External Eating (eating in response to external rather than internal hunger cues), Emotional Eating (eating in response to negative affect), and Restraint (restriction of eating in the presence of internal hunger cues; Cacialanza et al., 2004). The DEBQ was included to explore the convergent validity of the External and Emotional Eating subscales with the Appetite scale of the NIAS. The first wave undergraduate sample responded to the DEBQ.

Food neophobia scale (FNS). The FNS is a 10-item measure of reluctance or anxiety about trying new foods, one behavioral component of picky eating (Pliner & Hobden, 1992; Taylor et al., 2015). Participants from both the MTurk and undergraduate samples responded to the FNS to assess convergent validity with the NIAS PE scale.

Inflexibility index (IFI-10). The IFI is a 10-item measure of refusal of preferred foods that are not prepared/presented in specific ways, another behavioral component of PE (Taylor et al., 2015). The measure has demonstrated high internal consistency ($\alpha >$ .90) in two samples (Zickgraf et al., 2016; Zickgraf & Schepps, 2016). Self-reported adult picky eaters report higher scores on the IFI compared to adults with typical eating or symptoms of restricting eating disorders (Zickgraf et al., 2016), and scores on this measure predict dietary variety in adults (Zickgraf & Schepps, 2016). Participants from both the MTurk and undergraduate samples responded to the IFI-10 to assess convergent validity with the NIAS PE scale.

Emetophobia questionnaire (EMET-Q). The EMET-Q is a 13-item, three factor measure of specific phobia of vomiting (Boschen et al., 2013). The EMET-Q assesses beliefs about the danger/likelihood of vomiting (Distress/danger), avoidance of situations that may cause nausea or prevent relief from nausea (Nausea avoidance), and avoidance of vomit or people who may vomit (Contamination avoidance). It does not address avoidance of eating or of specific foods/food groups. Participants from the MTurk sample and the second wave of the undergraduate sample responded to the EMET-Q to assess convergent validity with the NIAS Fear scale.

Swallowing anxiety scale (SAS). The SAS is a 10-item measure of swallowing difficulty and anxiety (Budak et al., 2017). The SAS was included for convergent validity with the NIAS Fear subscale. The SAS was added to the second wave of undergraduate data collection while data collection was ongoing. One hundred and sixty one participants responded to the SAS during the initial survey administration.

Visceral Sensitivity Index (VSI). The VSI is a 15-item, unidimensional measure of lower gastrointestinal (GI) symptom-specific anxiety (Labus et al., 2004). Participants from the MTurk sample and the second wave of the undergraduate sample responded to the VSI to assess convergent validity with the NIAS Fear scale.

Eating attitudes test (EAT-26). The EAT-26 is a self-report measure of symptoms of restricting eating disorders, including fear of fatness, weight and shape preoccupation, and drive for thinness (Garner, Olmsted, Bohr, & Garfinkel, 1982). The EAT-26 was included in both samples to assess convergent and discriminant validity with a measure of an eating disorder other than ARFID. Adult PE has previously been shown

to be associated with other disordered eating symptoms, although effects are usually small (e.g., Kauer et al., 2015; Wildes et al., 2012).

Clinical impairment assessment—ARFID version (CIA-A). The CIA is a 16-item self-report measure of psychosocial interference from disordered eating (Bohn, Doll, Cooper, O'Connor, Palmer, & Fairburn, 2008; Bohn & Fairburn, 2008). The original CIA assesses interference from eating behavior as well as compensatory behavior including over-exercising and purging. Wildes and colleagues (2012) modified the CIA to assess interference from eating behavior only, in order to assess impairment from adult picky eating, which is not associated with compensatory behaviors. The CIA-A was included in both the MTurk and undergraduate samples in order to explore the relationship of each NIAS scale with eating related interference.

Depression, stress, and anxiety scale (DASS-21). The DASS-21 is a brief measure of symptoms in the past week (Lovibond & Lovibond, 1995). The 7-item depression and anxiety scales were included in both the MTurk and undergraduate samples to explore the relationship of each NIAS scale with comorbid mood and anxiety disorder symptoms.

Obsessive compulsive inventory – revised version (OCI-R). The OCI-R is an 18-item measure of obsessive compulsive symptoms (Foa et al., 2002). The OCI-R was included in the MTurk and first undergraduate sample to assess the convergent validity of the NIAS PE and Fear scales with a measure of OCD.

Autism spectrum quotient (AQ). The AQ is a measure of autism spectrum symptoms in adults without an ASD diagnosis (Woodbury-Smith, Robinson, Wheelwright, & Baron-Cohen, 2005). The AQ was included in the MTurk and first wave

of the undergraduate sample to assess the convergent validity of the NIAS PE scale with a measure of ASD symptoms.

Sensory over-responsivity inventory (sensOR). The sensOR is a measure of heightened sensitivity to, and distress caused by, common and usually non-noxious sensory experiences (Schoen, Miller, & Green, 2008). Respondents indicate on a binary scale whether they avoid or are bothered by each of a list of 77 sensory experiences across multiple domains including touch, audition, vision, smell, taste, and movement. The sensOR was included for convergent validity with the PE scale. Seven items about food tastes, smells, and textures were removed.

Disgust scale – revised version (DS-R). The DS-R is a 25-item measure of sensitivity to disgust elicited by microbes, bodily fluids and waste, death, and body envelope violations (Olatunji et al., 2007). Two items that about willingness to consume novel foods (monkey meat and vanilla ice cream with ketchup) and four items related to willingness to consume common foods potentially contaminated by microbes (soda, milk, chocolate, and soup) were removed in order to remove potential content overlap with picky eating. The resulting 19-item scale was administered in the MTurk sample to assess convergent validity with the NIAS PE scale.

Data analysis

Data were analyzed using RStudio version 1.0.44 and IBM's SPSS version 24.0 (IBM Corp., 2016; RStudio Team, 2016). Data from the Mechanical Turk sample was used for exploratory factor analysis (EFA) to identify a well- fitting model for the NIAS (Step 1) and to establish convergent and divergent validity of the NIAS (Step 3). Data from the semi-representative parent sample were used in Step 2 to confirm the factor

structure identified in Step 1, using confirmatory factor analysis (CFA). The full undergraduate sample was used to establish convergent and divergent validity in Step 3, and the second wave undergraduate sample was used to explore the NIAS' two-week test-retest reliability (Step 4).

Step 1: Factor retention and exploratory factor analysis. Multivariate normality among the NIAS items was assessed using the R MVN package to generate chi-square QQ plots and Madeira's test (Korkmaz, Goksuluk, & Zararsiz, 2016). The analyses were conducted using the R psych package (Revelle, 2014). Scree (Cattell, 1966) and parallel plots (Horn, 1965; Ledesma & Valero-Mora, 2007) were generated, and Very Simple Structure (VSS), Velicer minimum average parcel (MAP), and Bayesian information criterion (BIC) were computed for models with 1-5 factors. The exploratory factor analysis (EFA) used an ordinary least squares estimator with oblimin rotation.

Model fit was assessed with the comparative fit index (CFI), the standardized root mean square residuals (SRMR) and the root mean square error of approximation (RMSEA; Browne & Cudeck, 1992; Hu & Bentler, 1999). RMSEA near 0 represents excellent fit. RMSEA ≤.06 with a lower confidence interval of 0 is usually interpreted to reflect close model fit, and an RMSEA confidence interval that exceeds .08 is interpreted as relatively poor fit (Hu & Bentler, 1999). Other guidelines for RMSEA exist, including interpreting an RMSEA between .08 – 1.0 as reflecting minimally acceptable fit (e.g., Hooper, Coughlan, & Mullen, 2008). SRMR ≤ .08 is interpreted as acceptable model fit, with SRMR ≤ .05 reflecting good fit (Hu & Bentler, 1999). CFI is a sample-size adjusted index of model fit compared to a null model. CFI > .95 is interpreted as reflecting good model fit (Hu & Bentler, 1999).

Step 2: Confirmation of factor structure. In both the semi-representative and undergraduate samples, confirmatory factor analysis (CFA) with robust weighted least squares estimation (WLS) was computed using the R lavaan package (version 0.5-20; Rossel, 2012) to test the fit of the empirically and theoretically derived 3-factor correlated factors model. Because the data were not multivariate normal (Madeira's $p < .001$), highly skewed indicators were treated as categorical (Bentler, 1983; Browne, 1984; Yu, 2002). Model fit was assessed using the CFI and RMSEA. SRMR has not been developed for WLS estimation; weighted root mean residual (WRMR) was used instead. WRMR < 1 indicates good model fit (Yu, 2002). Internal reliability of the factors was assessed using alpha (α) and hierarchical omega (ω_h; factor saturation; Revelle & Zinbarg, 2009). These analyses were conducted in R using psych (Revelle, 2014) and semTools (semTools Contributors, 2016).

Step 3: Convergent and discriminant validity. These analyses were conducted using SPSS version 24.0. The distributions of the NIAS subscale scores were examined for each sample. Significant skewness was defined as skewness >1 or <-1 (Kim, 2013). When variables were significantly skewed, nonparametric statistical analyses were used to minimize the impact of outliers (Kim, 2013). Zero-order Pearson's r Spearman's ρ and parametric or nonparametric partial correlations with casewise deletion were used to explore specific relationships between the three ARFID-like eating behaviors and measures of related constructs. The independent associations between the NIAS subscales and IBS symptoms (full criteria, subclincal symptoms, no symptoms) in the MTurk sample were explored using multinomial logistic regression.

Step 4: Test-retest reliability. ICC(2,1), conducted in SPSS, version 24.0, was used to assess two-week test-retest reliability (Shrout & Fleiss, 1992). Absolute agreement (difference from original score) and Consistency (relative rank in sample) were assessed.

RESULTS

Step 1: Exploratory factor analysis

Examination of both the scree plot and parallel analysis plots suggested that a three-factor solution best fits the data, with three eigenvalues greater than 1.0, and with eigenvalues from the sample data dropping below the 95th percentile parallel analysis plot between three and four factors. VSS was maximized at two factors, but other statistics indicated that a three-factor solution best fit the data: Velcier MAP statistic achieved a minimum of .07 with 3 factors. BIC and RMSEA also achieved minima at three factors (Table 3.S1).

EFA with ML estimation and oblimin rotation was computed for a three-factor solution. Fit statistics indicated that this solution had excellent fit: $\chi^2(12) = 15.0$, $p = .24$, CFI = 1.00, RMSEA = .0005 [0, .06], SRMR = .009. Each NIAS item loaded on the theoretically-predicted scale, with loadings < .2 on other factors (Table 3.1). All items displayed high communality. The three-factor solution accounted for 71% of the overall variance with each factor accounting for a roughly equivalent proportion (picky = .25, appetite = .23, fear = .23). Each subscale, and the full scale, demonstrated excellent internal consistency. The factors were moderately-to-strongly intercorrelated (Table 3.2).

Step 2: Confirmatory factor analysis

In the semi-representative sample, the robust WLS model had good absolute fit, and excellent fit compared to the null model: Minimum function test statistic (robust) $\chi^2(24) = 70$, $p < .001$, CFI = 1.0, RMSEA = .06 [.05, .08], $p = .11$ WRMR = .48. All items loaded significantly, $p < .001$. Model fit was adequate in the undergraduate sample. Minimum function test statistic (robust) $\chi^2(24) = 149$, $p < .001$, CFI = .98, RMSEA = .08 [.07, .09], $p < .001$, WRMR = 0.93. All item loadings were significant, with $p < .001$. See Table 3.3 for standardized factor loadings. The subscales and total score demonstrated high internal consistency and factor saturation (Table 3.4).

Step 3. Convergent and divergent validity

The distributions of the NIAS scales were examined for normality in all three samples. All three NIAS scales were normally distributed in the MTurk sample. In the semi-representative and the undergraduate samples, the PE subscale was normally distributed, but the Appetite and Fear subscales and the full scale were significantly positively skewed and kurtotic. Parametric zero-order and partial correlations were used in the MTurk sample, and their nonparametric equivalents were used in the undergraduate sample. Results are reported in Table 3.5. All measures used to show convergent and divergent validity demonstrated acceptable to excellent internal consistency (α = .70 to .95) in both samples, except for the AEBQ hunger awareness subscale in the undergraduate sample (α = .67) and the AEBQ food responsiveness subscale in the MTurk sample (α = .63). See supplemental materials for detailed descriptive statistics of these measures (Table 3.S2).

PE, Appetite, and Fear-related eating behaviors. In both samples, PE, was independently related with AEBQ food fussiness, food neophobia (FNS), and eating

inflexibility (IFI-10). There was a small, but significant, independent positive association between Fear and eating inflexibility in both samples. Appetite was unrelated to all three PE-validity scales.

Appetite was inversely related to AEBQ enjoyment of food, food responsiveness, and emotional over-eating, and positively related to emotional undereating, slow eating, and satiety responsiveness. Appetite was not related to the AEBQ hunger awareness scale, but there was a moderate, positive association between Fear and hunger in the MTurk sample. Fear was also positively associated with AEBQ emotional over-eating in this sample, but not in the undergraduate sample. In the undergraduate sample, Appetite was inversely related to DEBQ emotional over-eating, as well as to external eating and restraint. PE was unrelated to the DEBQ scales, but Fear was positively related to restraint. Appetite was negatively correlated with BMI; PE and Fear were unrelated to BMI.

In the MTurk sample, Fear was positively associated with beliefs about the likelihood of vomiting (EMET-Q Distress/danger), and efforts to avoid contamination related to vomiting (EMET-Q Contamination avoidance). Fear was positively associated with EMET-Q Nausea avoidance and visceral sensitivity (VSI) in both samples. Data on swallowing anxiety (SAS) were only available from the undergraduate sample; scores on this measure were independently related to both Fear and PE.

Distress and psychopathology. The NIAS scales were related to measures of distress and psychopathology, although the pattern of results was somewhat inconsistent between the two samples. In each sample, all zero-order correlations with anxiety and depression symptoms were small-moderate and significant. When partial correlations

were examined, fear was related to DASS-21 anxiety in both samples; in the MTurk, but not undergraduate, sample, Appetite was also related to anxiety. In the undergraduate sample, none of the partial correlations between NIAS scales and depression rose to significance, and effect sizes were small; however, in the MTurk sample, there were small but significant positive partial correlations with Appetite and Fear. The partial relationship between Fear and OCD was significant and positive in each sample; in the MTurk sample, PE was also related to OCD symptoms. Fear was related to eating-related quality of life impairment (CIA-A) in each sample, with the small correlation between PE and impairment rising to significance in the MTurk sample. In both samples, PE and Fear, but not Appetite, had small but significant independent relationships with non-ARFID eating disorder symptoms (EAT-26).

Temperament. Disgust sensitivity (DS-R), non-gustatory sensory over-responsivity (sensOR), and autism spectrum traits (AQ) were explored as potential temperamental correlates of adult feeding problems. Data on the AQ were available from both the MT and undergraduate samples; in each sample, only the PE scale had a significant and positive relationship with the AQ. DS-R data were only available from the MTurk sample; only the PE scale was related to DS-R score, with a small, positive effect. sensOR data were only available from the undergraduate sample; both PE and Fear had small, but significant, positive relationships with sensory sensitivity.

Step 4. Test-retest reliability

All three NIAS subscales and total score demonstrated adequate two-week test-retest reliability in the second wave undergraduate sample (ICC > .6), both in relative rank and difference from original score. For the PE and appetite subscales, the lower

bound of the 95% confidence interval for ICC was greater than the cut-off of .6 suggested by Shrout and Fleiss to reflect adequate reliability (1979). See supplemental materials for test-retest statistics (Table 3.S3).

DISCUSSION

Avoidant/restrictive food intake disorder was added to DSM-5 to clarify the diagnosis of individuals with health- or psychosocially impairing eating behavior who would not have met criteria for a DSM-IV eating disorder and were above the cut-off age of 6 for DSM-IV feeding disorder, or who have another psychological diagnosis causing significant eating impairment (APA, 2013). ARFID is a new diagnosis, and as yet there is very little research on its phenomenology or mechanisms. Research on ARFID and ARFID-associated eating behaviors is particularly limited in adult populations. The purpose of this study was to develop a brief, multidimensional measure of restricted eating behavior caused by each of the three ARFID eating subtypes: Picky eating, poor appetite/limited interest in eating, and fear of negative visceral consequences from eating.

An exploratory factor analysis supported a theoretically derived three-factor structure. This factor solution was confirmed in a large, semi-representative, unselected, sample of adults, and in a college student sample. In each of the three samples, the NIAS subscales and total score demonstrated high internal consistency and factor saturation (α and $\omega_h > .80$). This finding supports the addition of ARFID subtypes to DSM-5; although the three NIAS scales are intercorrelated, they represent distinct constructs. The NIAS subscales and total score also demonstrated adequate two-week test-retest reliability, with both relative and absolute scores remaining relatively stable. ICC values are influenced by between-subjects variability (Weir, 2005). Because both the Fear and

Appetite subscales were positively skewed, with more than 50% of participants in the full undergraduate sample scoring 0, the ICCs presented here might estimate the lower bound of test-retest reliability in this population.

The three NIAS subscales demonstrated convergent and divergent validity with existing measures of related eating behaviors, with BMI, and with measures of psychopathology/ interference and temperament. The only predicted relationship that did not appear in the eating behavior analyses was between Appetite and AEBQ hunger awareness. Appetite was related to other AEBQ scales that measure both physiological (e.g., satiety responsiveness) and motivational (e.g., food responsiveness, enjoyment of food) aspects of appetite and interest in eating. Appetite was also negatively associated with eating in response to cues other than hunger, including emotional and external eating. Finally, Appetite was related to emotional under-eating, consistent with DSM-5's description of this ARFID-associated eating behavior as being secondary to psychopathology or intense emotional distress (APA, 2013).

Unexpectedly, Fear was positively related with AEBQ food responsiveness, hunger awareness and emotional over-eating in the MTurk sample. None of these associations were replicated in the young adult sample. However, in this sample Fear was positively associated with DEBQ restraint. Unlike picky eaters, who avoid disliked or novel foods, or individuals who are unmotivated to eat in general, people who restrict their eating because of feared consequences might avoid foods that they once enjoyed and would still prefer to eat in the absence of feared consequences. This intentional avoidance of preferred foods might be associated with more attention to food and hunger cues and with effortful exercise of self-control around food (e.g., restraint), a similar

pattern to that observed in low-weight restrained eaters and individuals with anorexia/bulimia symptoms (e.g., Hollitt et al., 2009; Nummenmaa, Hietanen, Calvo, & Hyona, 2011). However, these results were inconsistent, and further study is needed to clarify the relationship between restrictions due to feared consequences and restrained eating.

Fear was also unexpectedly positively associated with inflexibility, but not with neophobia or food fussiness. This association might reflect attention to how food is prepared in order to minimize cross-contamination, destroy foodborne pathogens, or avoid ingredients that are perceived triggers for GI upset; 75-90% of adults with SPOV report engaging in rituals around eating, including checking for visible contaminants, excessive washing, and over-cooking (Veale et al., 2011; McNally, 1995).

In each sample the NIAS subscales were associated with psychosocial impairment related to eating, although the pattern of associations was different between the two. The lack of an association between PE and impairment in the undergraduate sample was unexpected; PE has consistently been associated with eating-related quality of life impairment in adults (e.g., Ellis et al., 2016; Wildes et al., 2012; Zickgraf et al., 2016). However, these studies all explored zero-order relationships with PE. In the present study, there were significant zero-order correlations between PE and the CIA in both samples; this is the first study to explore the independent relationship between PE and eating-related quality of life impairment controlling for two other related and potentially impairing eating behaviors.

As predicted, Fear was independently and positively related with anxiety and OCD symptoms in both samples. The positive relationship between Appetite and both

anxiety and depression in the MTurk sample is consistent with DSM-5, which describes one potential manifestation of ARFID as significant loss of appetite due to emotional distress (APA, 2013). PE was not associated with anxiety or depression in either sample, and associated with OCD only in the MTurk sample. PE has been related to anxiety, depression, and OCD in previous adult studies, although these studies explored the relationship between PE and eating-related anxiety (Ellis et al., 2016; Wildes et al., 2013), reported relationships between specific domains of PE behavior and anxiety or depression (e.g., Ellis et al., 2016) or only found associations between severe PE and anxiety, OCD, or depression (Kauer et al., 2015; Zickgraf et al., 2016).

In both of the present samples, PE and Fear, but not Appetite, were associated with disordered eating symptoms. Small, positive associations between PE and disordered eating symptoms have previously been reported in the adult literature (e.g., Kauer et al., 2015; Ellis et al., 2016; Zickgraf et al., 2016). To our knowledge, this is the first report of a positive association between disordered eating and fear of vomiting, choking, or GI distress from eating.

As predicted, PE was uniquely related to ASD-like traits in both samples. The AQ assesses multiple domains of ASD symptoms, including restricted interests, social cognitive difficulties, and behavioral and temperamental rigidity. Further exploration of the relationship between PE and specific ASD traits is needed to highlight potential cognitive and interpersonal mechanisms underlying problematic PE. Cognitive and behavioral rigidity, including dichotomous thinking and set-shifting deficits have been implicated in the pathophysiology of anorexia and bulimia, as well as ASD (e.g., Tchanturia et al., 2004; Zucker et al., 2007).

Findings in the collge student sample indicated that PE and Fear, but not Appetite, were independently associated with sensory over-responsivity. The relationship with PE was consistent with DSM-5's definition of PE as avoidance of food due to aversion to its sensory properties (APA, 2013), and with previous studies of adult PE (e.g., Kauer et al., 2015; Raudenbusch et al., 1994; Zickgraf et al., 2016). To our knowledge, this is the first report of an association between sensory over-responsivity and fear of negative consequences from eating. As predicted, disgust sensitivity was only related to PE, consistent with previous findings on adult PE (Kauer et al., 2015).

Limitations and future directions

The NIAS Fear and Appetite subscales, as well as the total score, were non-normally distributed in two non-clinical samples. Although this might make the measure's use in research more difficult (e.g., requiring transformations or the use of nonparametric/robust statistical analyses), this is a meaningful feature of the scale and provides information about the constructs it measures. The NIAS Appetite and Fear subscales evidently measure behaviors that are relatively unusual. Results from this study suggest that dietary restriction and avoidance of food/eating due to lack of appetite/interest or fear of choking, vomiting, or GI distress do not exist at subclinical levels in the majority of healthy adults, whereas picky eating behavior is distributed normally throughout the adult population.

Although many analyses in this manuscript relied on an undergraduate sample, this is in some ways a strength of the present study. This study provides evidence for the factor structure, internal consistency, and convergent/divergent validity across the adult lifespan. The validation of the NIAS in a college student sample supports its use in a

commonly studied population at high risk for disordered eating (e.g., Hoerr, Bokram, Lugo, Bivins, & Keast, 2002).

Conclusions

The recent addition of ARFID to DSM-5 has highlighted a need for validated measures of the eating behaviors DSM-5 lists as potentially contributing to ARFID symptoms. The research supporting these behaviors as manifestations of a clinical disorder is very limited, particularly in adult populations. Of the three, there is the most evidence linking PE to comorbidity and ARFID symptoms, and distinguishing it from symptoms of other eating disorders. However, the relationship between PE and the other two behaviors is not well understood, and there has been little research exploring the correlates of restricted eating due to appetite or fear. The NIAS will allow researchers to explore the clinical correlates of, and relationships among, picky eating, appetite/ motivation to eat, and fear of negative consequences from eating that lead to eating restrictions. Results from the present study support the construct, convergent, and divergent validity, and the internal consistency and test-retest reliability of the NIAS for adults ages 18-65, including those who self-identify as having ARFID-like eating difficulties.

Table 3.1. *Exploratory factor analysis loadings and commonalities*

Item	**Factor 1** (PE)	**Factor 2** (Appetite)	**Factor 3** (Fear)	h^2
1. I am a picky eater	**.82**	.01	.01	.68
2. I dislike most of the foods that other people eat	**.85**	-.01	-.03	.69
3. The list of foods that I like and will eat is shorter than the list of foods I won't eat	**.76**	.07	.02	.65
4. I am not very interested in eating; I seem to have a smaller appetite than other people	.07	**.75**	.02	.58
5. I have to push myself to eat regular meals throughout the day, or to eat a large enough amount of food at meals	.00	**.85**	-.07	.72
6. Even when I am eating a food I really like, it is hard for me to eat a large enough volume at meals	.02	**.82**	.00	.77
7. I avoid or put off eating because I am afraid of GI discomfort, choking, or vomiting	-.03	.06	**.90**	.84
8. I restrict myself to certain foods because I am afraid that other foods will cause GI discomfort, choking, or vomiting	.08	-.13	**.89**	.74
9. I eat small portions because I am afraid of GI discomfort, choking, or vomiting.	.04	.15	**.79**	.73

Table 3.2. *Factor and full scale intercorrelations & reliability (MTurk sample)*

	PE	Appetite	Fear	Full scale	α	ω_h
Picky eating	1	-	-	-	.86	.94
Appetite	.57	1	-	-	.87	.95
Fear	.31	.48	1	-	.90	.96
Full scale	.77	.83	.74	1	.87	.94

Table 3.3. *CFA standardized loadings*

NIAS Item/Subscale	Standardized Loadings	
	Semi-representative	**Undergraduate**
Picky eating		
I am a picky eater	.77	.80
I dislike most of the foods that other people eat	.84	.93
The list of foods that I like and will eat is shorter than the list of foods I won't eat	.87	.69
Appetite/interest		
I am not very interested in eating; I seem to have a smaller appetite than other people	.88	.74
I have to push myself to eat regular meals throughout the day, or to eat a large enough amount of food at meals	.89	.80
Even when I am eating a food I really like, it is hard for me to eat a large enough volume at meals	.86	.79
Fear		
I avoid or put off eating because I am afraid of GI discomfort, choking, or vomiting	.98	.87
I restrict myself to certain foods because I am afraid that other foods will cause GI discomfort, choking, or vomiting	.95	.77
I eat small portions because I am afraid of GI discomfort, choking, or vomiting.	.91	.84

Table 3.4. *Factor and full scale intercorrelations and reliability*

					Semi-representative		Undergraduate	
	PE	**Appetite**	**Fear**	**Full scale**	α	ω_h	α	ω_h
PE	-	.42	.51	.80	.87	.87	.84	.84
Appetite	.33	-	.42	.85	.87	.87	.82	.82
Fear	.19	.45	-	.80	.93	.93	.86	.85
Full scale	.75	.67	.79	-	.90	.94	.82	.90

Note: Correlations for undergraduate sample presented below the diagonal.

Table 3.5. *Convergent/divergent validity*

Measure/Subscale		Mechanical Turk sample		Undergraduate sample	
		Zero-order correlation (*r)*	Partial correlation	Zero-order correlation (ρ)	Partial correlation
Adult eating behavior questionnaire (AEBQ)$_c$					
Food Fussiness	PE	.76**	.59**	.72**	.70**
	A	.45**	.10*	.25**	-.01
	F	.24**	.01	.18**	.02
	Total	.58**	-	.57**	-
Enjoyment of food	PE	-.46**	-.18**	-.26**	-.10
	A	-.60**	-.43**	-.50**	-.39**
	F	-.32**	-.05	-.31**	-.08
	Total	-.56**	-	-.46**	-
Hunger awareness	PE	.04	.10	.09	.10
	A	.05	-.09	-.03	-.09
	F	.25**	.29**	.05	.07
	Total	.15*	-	.07	-
Food responsiveness	PE	-.18**	-.04	-.12*	.002
	A	-.28**	-.29**	-.37**	-.35**
	F	.04	.18**	-.12*	.08
	Total	-.17**	-	-.26**	
Slow eating	PE	.36**	-.003	.004	-.08
	A	.62**	.23**	.23*	.22**
	F	.41**	.15*	.11	.002
	Total	.36**	-	.15*	

Measure/Subscale		Mechanical Turk sample		Undergraduate sample	
		Zero-order correlation (*r)*	Partial correlation	Zero-order correlation (ρ)	Partial correlation
Satiety responsiveness	PE	.35**	.002	.09	.03
	A	.62**	.48**	.21**	.33**
	F	.41**.	.17**	.12*	.02
	Total	.58**	-	.37**	-
Emotional over-eating	PE	-.02	.05	.09	.17*
	A	-.11*	-.19**	-.21**	-.22**
	F	.11*	.17**	-.12*	-.03
	Total	0	-	-.07	-
Emotional under-eating	PE	.11*	-.08	-.02	-.10
	A	.29**	.26**	.18**	.14*
	F	.12*	-.01	-16*	.10
	Total	.21**	-	.11	-
Dutch Eating Behavior Questionnaire (DEBQ)$_b$					
Restraint	PE	-	-	-.02	-.01
	A	-	-	-.07	-.12*
	F	-	-	.08	.12*
	Total		-	-.03	-
External eating	PE	-	-	-.10*	.01
	A	-	-	-.31**	-.25**
	F	-	-	-.17**	-.04
	Total		-	-.24**	-

Measure/Subscale		Mechanical Turk sample		Undergraduate sample	
		Zero-order correlation (*r)*	Partial correlation	Zero-order correlation (ρ)	Partial correlation
Emotional eating	PE	-	-	.05	.10*
	A	-	-	-.15*	-.17**
	F	-	-	-.05	.04
	Total		-	-.05	-
Food Neophobia Scale (FNS)[a]	PE	.81**	.67**	.72**	.69**
	A	.41**	-.02	.28**	.03
	F	.28**	.08	.21**	.04
	Total	.59**	-	.59**	-
Inflexibility Index (IFI-10)[a]	PE	.68**	.56**	.58**	.53**
	A	.45**	.07	.32**	.09
	F	.33**	.13*	.29**	.14**
	Total	.60**	-	.55**	-
Emetophobia Questionnaire (EMET-Q)[c]					
Distress/danger	PE	.16*	.10*	.03	.03
	A	.14*	-.01	-.001	-.002
	F	.22**	.17**	-.02	-.02
	Total	.22**	-	.02	-
Contamination avoidance	PE	.17**	.08	.03	.03
	A	.17**	.02	-.01	-.04
	F	.23**	.17**	.05	.05
	Total	.24**	-	.02	-

Measure/Subscale		Mechanical Turk sample		Undergraduate sample	
		Zero-order correlation (*r)*	Partial correlation	Zero-order correlation (ρ)	Partial correlation
Nausea avoidance	PE	.25**	.06	.09	.05
	A	.35**	.09*	.08	-.05
	F	.52**	.42**	.23**	.21**
	Total	.47**	-	.15**	-
Visceral Sensitivity Index $(VSI)_c$	PE	.32**	.11*	.09	-.01
	A	.42**	.07	.20**	-.003
	F	.69**	.60**	.43**	.38**
	Total	.61**	-	.30**	-
Swallowing Anxiety Scale $(SAS)_d$	PE	-	-	.22*	.16*
	A	-	-	.22*	.05
	F	-	-	.33**	.26**
	Total	-	-	.33**	-
Body mass index $(BMI)_a$	PE	-.03	.05	-.11*	-.07*
	A	-.15*	-.15*	-.15**	-.12**
	F	.01	.04	-.02	.06
	Total	-.08	-	-.13**	-
Clinical impairment inventory $(CIA\text{-}A)_a$	PE	.24**	.10*	.09*	.06
	A	.31**	.08	.05	-.06
	F	.39**	.28**	.12**	.17**
	Total	.40**	-	.13**	-
Depression, Stress, & Anxiety Scale $(DASS\text{-}21)_a$					

Measure/Subscale		Mechanical Turk sample		Undergraduate sample	
		Zero-order correlation (*r)*	Partial correlation	Zero-order correlation (ρ)	Partial correlation
Anxiety	PE	.15**	-.003	.12*	.06
	A	.30**	.14*	.16**	.05
	F	.34**	.25**	.21**	.15**
	Total	.34**	-	.21**	-
Depression	PE	.14*	-.003	.10*	.06
	A	.26**	.15*	.12*	.05
	F	.23**	.14*	.12*	.07
	Total	.26**	-	.14**	-
Autism Spectrum Quotient (AQ)$_b$	PE	.18**	.10*	.30**	.24**
	A	.16*	.03	.22**	.08
	F	.17*	.09	.19**	.08
	Total	.21**	-	.32**	-
Obsessive Compulsive Inventory (OCI-R)$_b$	PE	.22**	.11*	.07	.03
	A	.26**	.09	.12*	.05
	F	.26**	.16*	.13*	.09*
	Total	.32**	-	.12*	-
Eating Attitudes Test (EAT-26)$_a$	PE	.23**	.13*	.10*	.09*
	A	.26**	.08	.02	-.07
	F	.24**	.13*	.11*	.11*
	Total	.31**	-	.15*	-
Disgust Scale (DS-R)$_b$	PE	.32**	.21**	-	-
	A	.14*	-.04	-	-
	F	.13*	.03	-	-
	Total	.18**	-	-	-

Measure/Subscale		Mechanical Turk sample		Undergraduate sample	
		Zero-order correlation (*r)*	Partial correlation	Zero-order correlation (ρ)	Partial correlation
Sensory Over-responsivity Inventory (sensOR)$_a$	PE	-	-	.17**	.12*
	A	-	-	.16**	.06
	F	-	-	.17**	.09*
	Total		-	.22**	-

**p <.001; *p <.05;

Subscripts indicate undergraduate sample size/data collection wave; a: both waves, N = 813-825; b: first wave, N = 503-507; c: second wave, N = 305-307, d: second wave, N = 162

Table 3.S1. *Factor retention*

Factors	**VSS**	**MAP**	**RMSEA**	**BIC**
1	0.00	0.12	.08	997.55
2	**0.81**	0.09	.04	284.49
3	0.72	**0.07**	**.0005**	**-59.66**
4	0.73	0.11	.003	-23.02
5	0.71	0.20	.01	-0.32

Table 3.S2. *Descriptive statistics, convergent/divergent validity measures*

	Mechanical Turk sample				**Undergraduate sample(s)**			
	Mean (SD)	N	Range	α	Mean (SD)	N	Range	α
Adult eating behavior questionnaire (AEBQ)								
Food Fussiness	2.84 (1.07)	450	1-5	.90	2.14 (0.82)	311	1-4.6	.88
Enjoyment of food	3.54 (0.99)	450	1-5	.86	4.27 (0.68)	311	1-5	.83
Hunger awareness	2.86 (0.89)	450	1-5	.77	3.11 (0.72)	311	1-4.8	.67
Food responsiveness	2.89 (0.78)	450	1-5	.63	3.47 (0.75)	311	1-5	.70
Satiety responsiveness	2.91 (0.87)	450	1-5	.75	2.68 (0.71)	311	1-4.4	.70
Slow eating	2.91 (0.87)	450	1-5	.85	3.61 (0.98)	311	1-5	.82
Emotional over-eating	2.43 (1.06)	450	1-5	.90	3.02(0.87)	311	1-5	.84
Emotional under-eating	3.16 (1.10)	450	1-5	.88	2.71 (0.87)	311	1-5	.85
Depression, Stress, & Anxiety Scale (DASS-21)								
Anxiety	8.47 (9.58)	450	0-42	.89	6.30 (6.99)	816	0-38	.91
Depression	10.79 (12.22)	450	0-42	.95	7.43 (8.62)	816	0-42	.94
Autism Spectrum Quotient (AQ)	20.91 (7.23)	422	2-45	.80	17.9 (6.32)	510	2-40	.76

	Mechanical Turk sample				Undergraduate sample(s)			
	Mean (SD)	N	Range	α	Mean (SD)	N	Range	α
Obsessive Compulsive Inventory (OCI-R)	13.19 (13.41)	450	0-68	.94	17.88 (11.90)	508	0-57	.91
Eating Attitudes Test (EAT-26)	10.37 (10.50)	450	0-72	.88	7.98 (9.43)	800	0-53	.87
Dutch Eating Behavior Questionnaire (DEBQ)								
Restraint	-	-	-	-	14.97 (9.96)	507	0-40	.95
External eating	-	-	-	-	21.92 (7.31)	507	0-40	.87
Emotional eating	-	-	-	-	19.03 (13.81)	507	0-52	.97
Disgust Scale* (DS-R)	40.41 (13.81)	422	1-71	.89	-	-	-	-
Sensory Over-responsivity Inventory* (sensOR)	-	-	-	-	11.97 (9.07)	820	0-69	.91
Food Neophobia Scale (FNS)	26.32 (12.57)	451	0-50	.94	17.74 (10.23)	820	0-50	.86
Inflexibility Index (IFI-10)	21.46 (11.06)	451	0-47	.89	14.22 (9.57)	822	0-50	.88
Emetophobia Questionnaire (EMET-Q)								
Distress/danger	6.93 (3.75)	450	0-12	.89	5.13 (3.50)	304	0-12	.85
Contamination	7.78 (5.16)		0-24	.92	5.0 (4.56)	304	0-24	.91

	Mechanical Turk sample				**Undergraduate sample(s)**			
	Mean (SD)	N	Range	α	Mean (SD)	N	Range	α
Nausea avoidance	6.85 (6.22)	450	0-16	.89	2.91 (4.35)	304	0-16	.88
Visceral Sensitivity Index (VSI)	28.75 (20.19)	450	0-75	.92	12.86 (14.25)	308	0-68	.94
Clinical impairment inventory (CIA)	9.66 (10.14)	450	0-48	.94	7.49 (9.09)	818	0-48	.95
Body mass index (BMI)	26.51 (6.46)	450	16.5 – 59.99	-	22.38(3.53)	812	15-40	-

Table 3.S3. *Test-rest reliability: ICC(2,1) two-way random, single measures*

	PE	**Appetite**	**Fear**	**Total**
Absolute agreement	.76	.70	.62	.65
	[.70, .81]	[.61, .76]	[.53, .70]	[56, .72]
Consistency	.76	.69	.63	.65
	[.69, .81]	[.61, .76]	[.54, .71]	[56, .73]

CHAPTER 4: DIET AND PSYCHOPATHOLOGY IN ADULTS WITH SELF-REPORTED ARFID SYMPTOMS: A REPLICATION STUDY

Hana F. Zickgraf[1] (M.A.)

1 Department of Psychology, University of Pennsylvania

ABSTRACT

Objective: To establish the diagnostic validity of ARFID, it is necessary to describe the psychopathology of ARFID symptoms and related eating behaviors, including their co-occurrence with symptoms of other psychiatric disorders. Descriptive psychopathology represents the first step towards identifying the cognitive, affective, behavioral, and neurobiological mechanisms through which ARFID-related eating behaviors (ARFID-EBs) lead to health/psychosocial impairment. **Method**: 450 adults recruited on Amazon's Mechanical Turk responded to the Nine-item ARFID screen (NIAS), assessing ARFID-EBs, and the ARFID symptom checklist, assessing DSM-5 criteria to establish a possible diagnosis and subtype. They also responded to measures of psychiatric symptoms, of potential cognitive, affective, and behavioral mechanisms associated with each ARFID-EB, and of dietary variety and daily intake. Bootstrapped ANCOVAs adjusting for non-ARFID disordered eating symptoms were used to compare individuals with differing levels and types of ARFID symptomatology on measures of comorbidity and mechanisms. Nonparametric partial correlations were used to explore ARFID-EBs as predictors of dietary variety and intake. **Results**. Severity of comorbidity/impairment increased with level of ARFID symptomatology. ARFID symptom subtypes did not differ on measures of comorbidity, but there were clear group differences on measures of potential mechanisms. ARFID-EBs were each differentially related to intake and variety. **Discussion:** Findings support the inclusion of this diagnosis in DSM-5, indicating that three ARFID subtypes, characterized by different types of eating restriction, lead to impairment through distinct cognitive, affective, behavioral, and neurobiological mechanisms, and may be characterized by distinct food selection and intake behavior.

INTRODUCTION

Avoidant/restrictive food intake disorder (ARFID) is an eating disorder diagnosed in individuals whose highly selective eating behavior and/or limited food intake leads to insufficient nutritional or caloric intake accompanied by weight loss, nutritional deficiency, supplement dependence, and/or psychosocial impairment (APA, 2013). This diagnosis was added to the Fifth edition of the Diagnostic and Statistical Manual (DSM-5) to capture impairing eating pathology not driven by shape/weight concerns or body image disturbances and not characterized by compensatory behaviors or intentional caloric restriction. DSM-5 describes three very different patterns of eating (ARFID-related eating behaviors, ARFID-EBs) that could lead to symptoms of ARFID (e.g., weight loss, nutritional deficiency or supplement dependence, eating-related psychosocial interference). These are highly selective (picky) eating, low appetite or limited interest in eating, and fear of negative consequences from eating (e.g., choking, vomiting, gastrointestinal distress).

To date there has been little research on ARFID symptoms in adults. Of the three ARFID-EBs, picky eating has attracted the most attention. Picky eating in adulthood is associated with eating-related social anxiety, depression, obsessive compulsive disorder symptoms, eating-related impairment, limited dietary variety, limited fruit and vegetable intake, and, in the elderly, elevated risk for malnutrition (Kauer et al., 2015; Knaapila et al., 2015; Maitre et al., 2013; Wildes et al., 2012). Two studies published in 2016 directly addressed eating behavior and psychopathology in individuals with self-reported ARFID symptoms due to picky eating (Zickgraf, Franklin, & Rozin, 2016; Zickgraf & Schepps, 2016). In one of the two, adults whose picky eating led to the nutrition, weight, or

psychosocial symptoms of ARFID reported comparable levels of distress and comorbidity to individuals reporting elevated symptoms of anorexia or bulimia (Zickgraf et al., 2016). The second study reported an association between adult picky eating and reduced dietary variety, particularly for fruits and vegetables (Zickgraf & Schepps, 2016). Participants with symptoms of ARFID due to their picky eating reported lower daily fruit and vegetable consumption than other picky eaters, who in turn reported lower fruit and vegetable consumption than non-picky eaters. Picky eating is characterized by refusal of both new foods (e.g., food neophobia) and familiar foods that are prepared or presented in an unfamiliar or non-preferred way (e.g., Taylor, Weirmont, Northstone, & Emmett, 2015). These behaviors, measured continuously, are associated with reduced dietary variety and quality in adults (e.g. Knaapila et al., 2015; Siegrist, Hartmann, & Keller, 2013; Zickgraf & Schepps, 2016), suggesting that severity of picky eating behavior is a factor in the development of at least some ARFID symptoms.

There has been less research on ARFID symptoms caused by the other two presentations introduced in DSM-5: poor appetite/limited interest and fear of negative consequences. Two studies to date have explored ARFID-like outcomes of abnormal eating behavior in adults with specific phobia of vomiting (SPOV; Holler, van Overveld, Jutglar, & Trinka, 2013; Veale, Costa, Murphy, & Ellison, 2011). In a sample of 94 SPOV patients recruited in anxiety clinics and online support groups, 34% reported restricting their food intake or variety due to vomiting fear (Veale et al., 2011). Compared to participants with vomit phobia but no eating restrictions, those who reported eating restrictions related to vomiting fear were more likely to be underweight, reported more symptoms of depression, anxiety, and obsessive compulsive disorder, and

reported greater role impairment in multiple domains (Veale et al., 2012). In a German sample of 131 adults with SPOV, 61% reported some food restriction, and of these, 19.6% reported occupational interference related to the eating restriction, 18% reported avoiding family meals, and approximately 34% avoided restaurants or eating at other people's homes (Holler et al., 2013). The experience of nausea and efforts to avoid or reduce it appear to play a role in the development of ARFID-like symptoms in individuals with SPOV. In the German sample, a majority (73%) reported experiencing nausea at least once per week, but 91.8% of underweight participants reported nausea (Holler et al., 2013). Participants who reported avoidance of specific foods, or eating in specific circumstances to prevent nausea and vomiting trended towards lower BMI (Holler et al., 2013).

Specific phobia of choking is also associated with eating restrictions, often resulting in weight loss. The research on choking phobia is limited to case studies. In one case series of 10 adults presenting for choking phobia treatment, 60% reported weight loss, ranging from five to 50 pounds, and 60% reported restricting their diets to liquids or soft foods (Franko, Shapiro, & Gagne, 1997). In a review of 19 different adult cases, 11 cases (58%) reviewed involved weight loss of 10 pounds or more (McNally, 1994). Choking phobia often has an acute onset following a choking or near-choking incident, and the intensity of the food restriction or the type and number of avoided foods might be related to the nature of the index choking incident (e.g., Himle, Crystal, Curtis, & Fluent, 1991). Some patients with swallowing anxiety present with functional dysphagia, or difficulty swallowing with no evidence of a structural or motility problem sufficient to explain the severity of the difficulty. In one empirical study of 21 individuals with

functional dysphagia presenting to a hospital dysphagia clinic, 43.7% of the 16 who provided a weight history indicated that they were at least three pounds below their typical adult weight (Barofsky & Fontaine, 1998). As a group, these patients reported higher levels of psychological distress compared to a comparison group of dysphagia patients with a structural or motor cause for their swallowing difficulty, scoring particularly highly on measures of anxiety and interceptive awareness (Barofsky & Fontaine, 1998).

Feared consequences not associated with DSM-5 diagnoses might also cause ARFID-like eating restrictions and symptoms. For example, some individuals with functional gastrointestinal disorders (FGIDs), including functional dyspepsia, functional constipation, or irritable bowel syndrome (IBS), might develop maladaptive eating restrictions that could lead to ARFID symptoms. FGIDs are often managed through special diets, but there is little reliable empirical evidence to support such interventions, which are often designed by patients themselves and not medically supervised (e.g., Yao, Gibson, & Shepherd, 2013). Although many individuals with FGID identify specific foods as triggers of their symptoms, there is little evidence that individuals with FGIDs are more likely to have identifiable sensitivities than healthy controls (Chey, 2013). In fact, the Rome foundation working group, which publishes diagnostic guidelines and periodic literature reviews for the FGIDs, has suggested that anticipatory anxiety, conditioned food aversions, and anxious monitoring of benign GI sensations play a role in digestive distress after eating (Chey, 2013; Labus et al., 2004). To our knowledge there have been no descriptive studies of restrictive, avoidant eating habits in the FGIDs. The ARFID diagnosis and fear subtype could be useful to both clinicians and researchers as a

means to identify and describe people who experience impairing eating problems related to FGIDs. This line of research could help to elucidate common factors in the etiology or maintenance of problematic eating behaviors across populations and disorders.

The third ARFID-EB described by DSM-5 is undereating due to poor appetite or apparent lack of interest in eating (APA, 2013). In a recent study of the Adult Eating Behavior Questionnaire (AEBQ), a new measure of adult eating behavior, self-reported responsiveness to internal satiety cues was negatively associated with BMI, replicating a finding frequently reported in children (Hunot et al., 2016). However, this study did not explore satiety responsiveness in underweight individuals. Another potential mechanism of low appetite/motivation to eat is undereating in response to negative affect. There is very little research on emotional undereating, although this is the only potential mechanism for the appetite/interest presentation of ARFID in adults and adolescents described in DSM-5 (APA, 2013). The tendency to under-eat in response to negative affect was negatively associated with BMI in the same 2016 study that reported an association with satiety responsiveness (Hunot et al., 2016). In a small observational study, undergraduate participants who were underweight reported eating significantly less than normal- and overweight participants while experiencing negative affect (Gelibeter & Aversa, 2003).

Individual differences in responsiveness to internal hunger and satiety cues, eating in response to external food cues, increasing or decreasing food intake in response to emotional cues, and food reward and approach motivation are usually studied in the context of overweight and obesity, and when these constructs are explored in non-overweight adult populations, the samples include few or no participants with clinical

underweight (e.g., Hunot et al., 2016). However, findings from both adult and child samples consistently show that the appetitive approach and avoidance traits assessed by the AEBQ and original child version are associated with continuously measured adiposity, both concurrently, and, in childhood, prospectively (e.g., Hunot et al., 2016; Rodenburg, Kremers, Oenema, & van de Mheen, 2012). More research is needed to identify eating behaviors and traits associated with undereating that results in persistently inadequate caloric/nutritional intake and to clarify the phenomenology and potential mechanisms of this presentation of ARFID in adults.

The ARFID diagnosis is new and relatively understudied. The existing literature on subclinical manifestations of the eating behaviors identified by DSM-5 as contributing to ARFID broadly supports their inclusion as manifestations of disordered eating (e.g., Kauer et al., 2015; Ellis et al., 2016; Gelibeter & Aversa, 2003; Veale et al., 2012; Wildes et al., 2012). However, to date, only two studies have presented descriptive psychopathology of adult ARFID symptoms identified using DSM-5 criteria, and these studies only addressed ARFID symptoms due to picky eating (Zickgraf et al., 2016; Zickgraf & Schepps, 2016). To establish the diagnostic validity of ARFID and associated eating behaviors, there is a need to demonstrate its co-occurrence with other disorders and with cognitive, affective, and neurobiological constructs previously implicated in the pathophysiology of related disorders.

Extending findings reported by Zickgraf and colleagues (2016), the present study will explore the relationship of self-reported ARFID symptoms due to picky eating, poor appetite/low motivation to eat, and/or fear of negative consequences with measures of psychopathology (depression, anxiety, and OCD symptoms) and interference (eating-

related quality of life impairment). We hypothesized that ARFID would be associated with elevated levels of psychopathology and eating-related impairment, with participants meeting full ARFID criteria reporting greater comorbidity and impairment than those who report typical eating, ARFID-EBs but no ARFID symptoms, or subclinical symptoms of ARFID.

Exploratory analyses were conducted in the subsample of participants reporting ARFID symptoms primarily due to a single ARFID-EB (e.g., picky eating, appetite, or fear). We hypothesized that the subtypes would not differ from one another on measures of comorbidity or impairment, but that they would differ on selected measures of eating behaviors and traits found to be independently related to each ARFID-EB in a validation sample of undergraduates (Zickgraf & Ellis, 2018). ARFID-EB symptom groups were compared on measures of food neophobia and refusal of familiar foods (two behavioral components of picky eating, e.g., Taylor et al., 2015); measures of appetite (responsiveness to internal satiety cues), under-eating in response to negative affect (emotional under-eating) and interest in food (responsiveness to external food cues, enjoyment of food); and measures of gastrointestinal anxiety (visceral sensitivity) and avoidance of nausea. The behaviors/traits explored in this manuscript were chosen to reflect underlying cognitive, affective, and behavioral processes that might be implicated in the etiology of ARFID-EBs and their progression to ARFID symptoms (e.g., Kozak & Cuthbert, 2016). Although this is a correlational study, including these constructs in an exploration of the descriptive psychopathology of ARFID and related EBs will highlight areas for future research with study designs more appropriate for supporting causal inferences. This line of research could also lead to the development of interventions that

target mechanisms involved in the maintenance or etiology of ARFID symptoms and EBs.

Finally, we explored the relationship of self-reported dietary variety and intake with ARFID-EBs measured continuously using the Nine Item ARFID Screen (Zickgraf & Ellis, *in prep*), predicting that ARFID-EBs would be differentially associated with eating behavior. We hypothesized that individual differences in picky eating would be associated with lower dietary variety, reduced fruit and vegetable intake, and increased intake of energy-dense foods including snacks, desserts, and soda, directly replicating previous findings in adult PE (e.g., Zickgraf & Schepps, 2016).

To our knowledge, the only available studies of nutritional behavior in individuals with eating-related fears concern specific phobia of vomiting, and the most commonly avoided foods are meat, poultry, seafood, and eggs (Holler et al., 2013; Price, Veale, & Brewin, 2012; Veale et al., 2011). We predicted that Fear-related restrictions would be inversely associated with meat and fish variety. We also predicted that Fear restrictions would be associated with reduced daily protein intake, given that poultry, meat, fish, and eggs make the greatest combined contribution to total daily protein intake in the US (Phillips et al., 2015).

Because eating restrictions due to low appetite/interest have not been explored as predictors of dietary intake or variety, hypotheses related to this ARFID-EB were exploratory. We predicted that appetite-related eating restrictions would not be associated with dietary variety, but that they would be inversely correlated with number of daily servings of food. We also predicted that appetite-related restrictions would be associated with consumption of relatively more servings of snack and dessert foods compared to FV.

If individuals with appetite-related restrictions experience limited motivation to eat, they might be more inclined to eat calorically dense, highly palatable foods, which have a greater reinforcing value than less energy-dense foods (e.g., Epstein, Leddy, Temple, & Faith, 2007).

METHOD

Participants

We recruited English-speaking adults living in the US through Amazon's Mechanical Turk (MTurk). In order to ensure a sufficient sample size to explore differences between full-criteria and subclinical ARFID and between ARFID due to the three eating restriction subtypes, participants were recruited through 5 separate advertisements (or Human Intelligence Tasks; HITs) targeting picky eaters, individuals with poor appetite, individuals with vomiting or choking fears, and individuals with functional GI disorders including irritable bowel syndrome (IBS), as well as a generic HIT for individuals with no self-identified eating difficulties. Other than their titles, the HIT texts were identical, and the 5 HITs were cross-linked such that potential participants who selected one HIT were provided with descriptions of the other 4 HITs and asked to participate through the HIT that seemed most appropriate to them. Five hundred and four participants provided consent, and a total of 488 completed at least one study measure. Data from 33 participants (6.8%) who failed one or more attention-check items (see below, Procedures) and 5 participants (1%) who did not answer all screening measures were discarded.

Of the final sample (N = 450), 94 participants (20.7%) were recruited through the picky eating HIT, 77 (16.9%) through the poor appetite HIT, 94 (20.7%) through the IBS HIT, 90 (19.8%) through the vomiting HIT, and 95 (20.9%) through the general HIT.

Measures

Demographics: Participants reported their age, gender, and race/ethnicity.

Nine-item ARFID screen (NIAS). The NIAS is a brief self-report measure of eating restrictions caused by picky eating, appetite, and fear of negative consequences (Zickgraf & Ellis, *in prep*). The NIAS has three 3-item scales, which assess the severity of eating restrictions on a 0-5 Likert-type agree/disagree scale. The NIAS scales have excellent convergent and divergent validity with related eating behaviors. The scales have high internal consistency ($\alpha > .80$) and good test-retest reliability ($ICC(2,1) > .6$; Zickgraf & Ellis, *in prep*).

ARFID symptom checklist (ARFID-cl). The ARFID-cl is a 14-item self-report measure of ARFID symptoms, adapted by Zickgraf and colleagues (2016) from the Structured Clinical Interview for DSM-5 (First, Williams, Karg, & Spitzer, 2015). The ARFID-cl is co-administered with the NIAS; individuals who agree with at least one of the NIAS items (strongly agree, agree, or slightly agree) are directed to respond to the ARFID-cl. The first six ARFID-cl items assess whether the eating restrictions endorsed on the NIAS lead to 1) inadequate nutritional intake or inadequate caloric intake ("yes" or "no"), and 2) one or more of the Criterion A symptoms (weight loss, nutritional deficiency, supplement dependence, or psychosocial interference) to "some" or "a significant" degree, or "not at all." Participants who indicate that they experience one or more ARFID symptom to at least "some degree" are directed to respond to questions

about the causes of the symptom(s). The ARFID-cl assesses whether participants believe their ARFID symptoms to be caused by 1) picky eating, 2) poor appetite/limited interest in eating, 3) fear of vomiting, 4) fear of choking or food being "stuck" in the throat, 5) fear of lower GI distress/bowel problems including IBS, 6) pain or discomfort caused by illness or metabolic problem other than IBS, 7) restrictions due to shape/weight concerns, or 8) a strong drive to eat only clean, pure, or healthy foods. Participants respond to each of these eight items on a 4-point scale: 0 = "this did not contribute" to reported ARFID symptoms, 1 = "this did not contribute much," 2 = "this made a contribution," and 3 = "this was the sole or primary contributor."

Eating Attitudes Test (EAT-26). The EAT-26 is a screening instrument that assesses symptoms of anorexia, bulimia, and binge eating (Garner, Olmstead, Bohr, & Garfinkel, 1982). Continuous scores on the EAT-26 were used in ANCOVA analyses to adjust ARFID symptom group means on measures of psychopathology, interference, and eating behaviors related to each of the symptom presentations.

Depression, Stress, and Anxiety Scale (DASS-21). The DASS-21 is a brief screening instrument for past-week symptoms of mood, anxiety, and stress (Henry & Crawford, 2005). The DASS-21 depression and anxiety scales were used in the present study to explore the relationship of ARFID symptom severity and subtype to psychological comorbidity. The DASS depression and anxiety scales have demonstrated good convergent and construct validity in community and clinical samples (Henry & Crawford, 2005). Each scale has validated clinical ranges reflecting mild, moderate, and severe symptoms (Lovibond & Lovibond, 1995).

Obsessive Compulsive Inventory-Revised (OCI-R). The OCI-R is an 18-item measure of obsessive compulsive symptoms (OCD; Foa et al., 2002). The OCI-R assesses six domains of OCD symptomatology and also yields a total score reflecting overall symptoms. Possible OCI-R scores range from 0-72, with a score of 21 or greater identifying individuals with potentially clinically significant symptoms (Foa et al., 2002). OCD symptomatology has been associated with picky eating in several previous studies, and the OCI-R was included in the present study to explore comorbidity with ARFID and the ARFID presentations (Kauer et al., 2015; Wildes et al., 2012; Zickgraf et al., 2016).

Clinical impairment assessment-ARFID version (CIA-A). The CIA-A is a 16-item self-report measure of psychosocial interference from disordered eating (Bohn et al., 2008; Bohn & Fairburn, 2008). Possible scores range from 0-48, and a score of 16 or greater has been shown to identify individuals with clinically significant disordered eating (Bohn et al., 2008). Wildes and colleagues (2012) modified the CIA to assess interference from ARFID-like eating behaviors by altering the wording of the questions to assess only interference from "eating habits," and not interference from body image disturbance or compensatory behaviors (Wildes et al., 2012). The CIA-ARFID version (CIA-A) has been used to assess both interference due to picky eating and ARFID symptoms caused by picky eating, demonstrating validity as a measure of ARFID interference (Ellis et al., 2016; Wildes et al., 2012; Zickgraf et al., 2016). In the present study, the CIA-A was used to explore interference at varying levels of ARFID symptomatology.

Adult eating behavior questionnaire (AEBQ). The AEBQ is a multidimensional measure of eating behaviors in adults (Hunot et al., 2016). The AEBQ

has eight scales assessing different domains of food approach and avoidance behavior. Four AEBQ scales were included in the ARFID subtype analyses to assess the validity of the appetite/interest subtype and to highlight potential constructs underlying this presentation of ARFID symptoms. The satiety responsiveness scale was chosen to measure homeostatic eating, the food responsiveness and eating enjoyment scales were chosen to measure interest in eating and eating in response to environmental cues, and the emotional-undereating scale was chosen to measure reduced intake in response to emotional distress. These scales were independently related to the NIAS appetite scale in a validation sample of undergraduates (Zickgraf & Ellis, *in prep*). They were included in the ARFID subtype analyses and predicted to be elevated in participants reporting ARFID symptoms due to appetite/interest.

Food neophobia scale (FNS). The FNS is a validated, 10-item measure of food neophobia, a behavioral component of picky eating (Pliner & Hobden, 1992; Taylor et al., 2015).

Inflexibility index (IFI-10). The IFI is a 10-item measure of refusal of familiar foods, another behavior associated with picky eating (Taylor et al., 2015; Zickgraf et al., 2016).

The IFI and FNS were included for ARFID subtype analyses and predicted to be associated with picky eating-related ARFID symptoms.

Emetophobia questionnaire (EMET-Q). The EMET-Q is a 13-item measure of distress and avoidance associated with specific phobia of vomiting (Boschen, Veale, Ellison, & Reddell, 2013). The 6-item nausea avoidance subscale measures avoidance of means of transportation and places that cause or prevent relief from nausea (it does not

include items about avoidance of food or eating). In a previous study, the nausea avoidance subscale was found to be more strongly related to symptoms of the Fear presentation of ARFID than two other subscales measuring beliefs about the dangerousness of vomiting and avoidance of people who might be ill (Zickgraf & Ellis, *in prep*).

Visceral sensitivity index (VSI). The VSI is a measure of attention to, and anxiety about, sensations in the GI tract (Labus et al., 2004). The VSI was developed for studies of the mechanisms of symptom-specific anxiety in functional GI disorders, and scores on the VSI are strongly related to symptoms of the Fear presentation of ARFID (Zickgraf & Ellis, *in prep*).

The VSI and EMET-Q nausea avoidance scale were included in ARFID subtype analyses and predicted to be elevated in participants reporting ARFID symptoms due to fear of negative consequences.

Dietary variety questionnaire. Two measures of eating behavior were included in this study to explore characteristic eating patterns associated with each of the ARFID symptom subtypes. The dietary variety questionnaire was developed from food-frequency questionnaires used in previous studies of typical US dietary habits (Zickgraf & Schepps, 2016). The questionnaire lists 121 common foods and beverages. The version of this measure used by Zickgraf and Schepps listed 107 food items; an additional 14 items were added in response to feedback from early participants that two broader categories, "whole grains" and "nuts" should be expanded (e.g., "whole wheat," "bulger," "millet," "almonds," "walnuts," etc.) because some participants avoided some types of these foods but ate others. Participants report on a 3-point scale whether they 1) eat the food regularly

(at least once/week), 2) would be willing to eat the food if it was served to them, or whether 3) the food is not part of their diet. Responses are dichotomized to reflect whether the participant is willing or unwilling to eat the food. The number of foods from each category is summed and the proportion of the listed food that the participant is willing to eat is computed. Foods were grouped into the following categories: Vegetables (28 items), Fruits (22), Meat (11), and Fish (16). In an earlier study of the dietary habits of adult picky eaters, self-identified picky eating was negatively associated with dietary variety in each of these categories (Zickgraf & Schepps, 2016). For the present study, four additional lists were created; Animal protein (31 items) included dairy, eggs, meat, and fish, and Non-animal protein (18 items) included nuts, seeds, beans, legumes, and soy products. Lists of Dairy (3) and Starch/grains (10) were also created.

Dietary intake questionnaire. On the dietary intake questionnaire, participants are asked to estimate their typical daily number of servings of fruit, vegetables, dairy, protein, starches/grains, snack foods, desserts, soda, and water (Zickgraf & Schepps). A serving is defined for participants as approximately ½ cup of each food group and 12 oz. of soda or water; food categories are defined, using examples (e.g., protein is defined as "meat, fish, eggs, or nuts"). Participants respond on an 11-point scale, ranging from no servings to 10 or more. The dietary intake questionnaire was used in a prior study of eating behavior in individuals with picky eating, some of whom reported ARFID symptoms (Zickgraf & Schepps, 2016).

Procedures

Participants responded to all study instruments in a single online survey. Participation took 30-60 minutes. Four attention-check questions required participants to

select which of four grammatically correct sentences did not make sense (e.g., "planes yell on the dream"). Participants who failed one or more attention checks were excluded. All study instruments and procedures were approved for human subjects by the Institutional Review Board of the University of Pennsylvania, and all participants provided informed consent prior to participating.

Group assignment. For analyses related to distress and comorbidity, participants were divided into four groups based on their level of endorsement of ARFID-like eating restrictions and ARFID symptoms. Typical eaters disagreed with each of the nine NIAS items (strongly disagree, disagree, or slightly disagree on a 6-point Likert-type scale). The other three symptom groups were created based on responses to the ARFID-cl. Participants who endorsed both inadequate nutritional/caloric intake and at least one significant criterion A symptom and indicated that picky eating, appetite, and/or fear was a "sole or primary cause" were classified as meeting full ARFID criteria by self-report. Participants who 1) reported experiencing criterion A symptoms only to "some degree" or 2) denied experiencing inadequate caloric/nutritional intake were classified as having subclinical ARFID symptoms. Participants who endorsed restrictions on the NIAS but either denied inadequate intake/nutrition and criterion A symptoms or endorsed one or both but indicated that these symptoms were not solely or primarily caused by picky eating, appetite/interest, or fear were classified as having ARFID-EBs but no ARFID symptoms.

Participants who endorsed clinical or subclinical ARFID symptoms by self-report on the ARFID-cl were grouped according to the primary contributor to their symptoms (picky eating, appetite/interest, fear, or more than one of the three).

Fifty five participants who were vegetarians, vegans, or pescatarians were excluded from dietary variety and intake analyses, leaving a sample of 395 participants. ARFID symptom level and NIAS scores were both unrelated to avoiding animal products.

Data analysis

The relationship between ARFID symptomatology and comorbidity and impairment was explored using ANCOVAs in the full sample, with EAT-26 scores as a covariate in each model. Ninety five percent confidence intervals were calculated from 1000 bootstrapped samples. Non-parametric post-hoc comparisons with corrections were conducted on the bootstrapped group means. Power for these analyses was calculated using the R "pwr" package, post-hoc, based on the size of the smallest group (N = 61), and with an extra degree of freedom included for the single covariate in the model (Champely et al., 2017). There was adequate power (93%) to detect small effects. Post-hoc comparisons were computed using Tamhane's T2 tests, because the ARFID symptom group sizes and variances were unequal.

Exploratory analyses using the same method were conducted in the subsample of 123 participants with full and subclinical ARFID symptoms, exploring differences between each ARFID presentation (e.g., picky eating, appetite/interest, or fear of negative consequences) on measures of comorbidity and impairment, and on measures of eating behaviors related to each ARFID-EB. Sixteen participants who endorsed more than one primary cause for their ARFID symptoms were excluded from these analyses in order to increase power and improve interpretability of results. There was adequate power to detect large (92%) but not moderate (69%) or small (48%) effects.

The relationship between ARFID eating restriction endorsement and dietary variety and intake was explored using non-parametric partial correlations between intake and variety (which were nonlinear count variables) and each NIAS subscale, controlling for the other two subscales and for EAT-26 scores. Variables reflecting the ratio of discretionary foods to total food servings and fruits/vegetables to total food servings were computed and used to assess the relationship between Appetite symptoms and relative intake of highly palatable foods. Because these variables were normally distributed, this analysis was conducted using parametric partial correlations.

RESULTS

Sample descriptives

Participants were 48.6% female and 50.8% male; one participant reported their gender as "other," (0.2%) and 4 participants did not report gender (0.9%). The sample was 75% White, 10% African American, 8% Asian, 6.8% multiracial, and 0.2% Native American. 7% identified as Hispanic/Latino. All were living in the United States. The mean age of the sample was 33.6 years old (SD = 9.5). Fifty nine percent of participants with subclinical or full-criteria ARFID symptoms were women, vs. 45% of those without ARFID symptoms; this difference was significant, although the biserial effect size was small: $\chi^2(1) = 8.5$, $r = .14$, $p = .004$. See Table 4.1 for descriptive statistics on all study variables.

Participants with at least subclinical ARFID symptoms had higher scores on all NIAS subscales compared to those without ARFID symptoms. For PE, $t(446) = 6.22$, $d = 0.65$, $p < .001$. For Appetite, $t(446) = 8.31$, $d = 0.87$, $p < .001$. For Fear, $t(446) = 8.31$, d

= 0.98, p <.001. In both ARFID groups, and in the group screening positive for eating restrictions on the NIAS, scores on Picky eating were higher than scores on Appetite and Fear; overall, 55% of participants' highest subscale score was on the Picky eating scale, vs. 20% with high scores on Appetite or Fear. See Table 4.2 for detailed statistics on NIAS score across the four ARFID symptom levels.

On the ARFID-cl, more participants endorsed inadequate nutrition than endorsed inadequate caloric intake, although this difference was smaller for individuals meeting full ARFID criteria. Of participants with full or subclinical ARFID symptoms, 36% endorsed both inadequate caloric and nutritional intake; 10% endorsed only inadequate caloric intake, and 27% endorsed only inadequate nutrition. See Table 4.3 for detailed statistics on participant-reported ARFID symptoms on the ARFID-cl.

The ARFID symptom most frequently endorsed as significant was dependence on nutritional supplements. Participants who met full self-report criteria for ARFID and endorsed significant weight loss/difficulties maintaining weight trended towards a lower mean BMI compared to the ARFID participants who did not endorse these difficulties: $t(63) = -1.73$, $d = -0.57$, $p = .09$. The mean BMI of the 14 full-criteria participants endorsing weight loss was 22.8 (SD = 4.47), in the normal weight range, whereas the mean BMI of the 51 ARFID participants not endorsing this symptom was 26.2 (SD = 6.80), in the overweight range. The distribution of participants falling into the underweight, normal weight, overweight, and obese BMI ranges did not differ significantly between ARFID participants who did and did not endorse significant weight loss ($\chi^2(3) = 5.11$, $V = .28$, $p = .16$); however, 3 of 14 participants who endorsed weight loss symptoms were in the underweight range (21.4%) compared to 2 of 51 participants

who did not (3.9%). When data from the five subclinical participants who endorsed significant weight loss were included, the mean BMI rose to 25.10 (7.13). None of the subclinical participants who endorsed weight loss was categorized as underweight.

75.7% of participants with subclinical ARFID symptoms failed to meet full criteria because they did not endorse any of the Criterion A symptoms as present to a "significant" degree. (Participants had to endorse at least one symptom as present to at least "some" degree to qualify for the subclinical symptom group).

Comorbidity and impairment

ARFID symptom group was a significant predictor of anxiety symptoms when group means were adjusted for continuous EAT-26 score ($p\eta^2$= .05, p <.001). In post-hoc comparisons, the ARFID group adjusted mean was significantly greater than that of each of the other three groups. The typical and positive screen group means differed at a trend level (p = .053), and the typical group differed significantly from the subclinical group (p = .04), with the typical group reporting lower mean anxiety in both cases. The positive screen and subclinical group means did not differ significantly from one another. The group mean for the typical group was within the normal range of scores on the DASS-A (0-7), the subclinical group mean was within the mild range (8-9), and the ARFID symptom group mean was within the moderate range (10-14). Standard deviations for the adjusted means ranged from 8.5 to 8.8. See Table 4.4 for all adjusted means and the results of ANOVA and post-hoc analyses.

On the DASS-D, ARFID symptom group was a significant overall predictor: ($p\eta^2$ = .046, p <.001). The typical, positive screen, and subclinical group adjusted mean scores did not differ from one another. The ARFID symptom group scored significantly higher

compared to the three other groups (p's <.05). The ARFID group's mean score was in the moderate range (mild = 10-13, moderate = 14-20). Adjusted standard deviations ranged between 11.35 and 11.5 for the three lower symptom groups; the standard deviation of the ARFID group mean was 15.5.

The overall effect of ARFID symptom grouping on mean OCI-R score was significant: $p\eta^2 = .04$, $p < .001$. Only the ARFID symptom group mean was significantly different from that of the other groups (p's <.05). When chi-square analyses were used to explore the proportion of participants in each eating behavior group meeting the measure's suggested screening cut-off of 21, there was a small but significant effect of symptom group ($\chi^2(3) = 19.82$, Cramer's $V = .21$, $p < .001$). Visual inspection of proportions suggests that a smaller proportion of typical eaters and a higher proportion of ARFID participants meet the cut-off compared to the two middle groups (Table 4.5).

Mean scores on the modified clinical impairment assessment (CIA-A) differed significantly between each eating behavior group (the difference between positive screen and subclinical groups was at trend level, $p = .052$). The ARFID group's mean score of 15.59 (SD= 12.28) approached the measure's validated clinical cut-off score of 16. When the proportion of participants in each group scoring above the cut-off was examined using a chi square analysis, there was a significant and moderate overall effect ($\chi^2(3) = 42.40$, Cramer's $V = .31$, $p < .001$). A majority of ARFID participants (59%) scored above the cut-off (Table 4.6).

ARFID presentation group differences

See Table 4.7 for the breakdown of full criteria and subclinical ARFID participants falling into each of the ARFID-cl subtypes. Most participants (81.3%) nominated only a single subtype as the "sole or primary" cause of their symptoms.

Among participants endorsing ARFID symptoms due to feared consequences from eating, lower GI distress was the most commonly named feared consequence, followed by vomiting. A majority (74.6%) nominated only one feared outcome as a primary cause of their ARFID symptoms (Table 4.8).

In a set of exploratory ANCOVA analyses, the three ARFID symptom EB groups (picky eating, appetite, and fear) did not differ from one another on measures of anxiety, depression, or OCD symptoms, or on eating-related impairment on the CIA-A. Although these analyses were underpowered to detect small or medium effects, the near-zero overall effect sizes and small mean differences between groups suggested that the groups did not differ in OCD symptom endorsement, or clinical impairment. However, there were small-to-medium effect sizes associated with ARFID symptom/EB group on depression and anxiety symptoms. Because these differences were not significant, post hoc tests were not conducted, but visual inspection of group means suggests higher mean depression scores reported by the Appetite group compared to the Picky eating and Fear groups, and lower mean anxiety scores in the Picky eating group compared to the Appetite and Fear groups (Table 4.9).

When ARFID symptom EB groups were compared on measures of picky eating (the food neophobia scale and the inflexibility index), appetite (satiety responsiveness), interest in eating (food responsiveness and enjoyment of eating), and emotional under-

eating, and fear of negative consequences (visceral sensitivity index and emetophobia avoidance), groups differed in the expected direction on most variables.

The effects of ARFID symptom EB group on both picky eating variables were moderate and significant. Post-hoc comparisons revealed that the Fear subgroup reported lower scores on the FNS compared to the Picky eating group. The Appetite group did not differ from other group means. Group differences were clearer on the IFI-10; the Picky eating group mean score was significantly higher than that of the Appetite or Fear groups, which did not differ from each other (Table 4.10).

On the AEBQ scales assessing interest in eating and emotional under-eating, there were moderate and significant overall effects of ARFID symptom EB group, driven by significantly lower scores in the Appetite presentation group (p's <.05). On the AEBQ satiety responsiveness subscale, the pattern of results was less clear. There was a small overall effect of ARFID symptom group on satiety responsiveness, with the Appetite and Fear groups scoring higher than the Picky eating groups (Table 4.11).

There were differences between the scores of the Fear presentation group and those of the Picky eating and Appetite presentation groups on the visceral sensitivity index and the avoidance subscale of the EMET-Q, with the Fear presentation group reporting significantly higher mean scores. The Picky eating and Appetite group means did not differ from each other on either measure (Table 4.12).

Eating behavior

Descriptive statistics for self-reported dietary variety in the full sample are reported in Table 4.13. Hierarchical omega (ω_h) was computed for each of the dietary variety scales. Omega tests the average loading onto a common factor, *g*, allowing items

to load onto subfactors and for cross-loadings among subfactors (Revelle & Zindbarg, 2009). Omega is a measure of scale reliability, or the degree to which the scale items reflect a single underlying construct. With the exception of Dairy (which has only three items, not the required ≥ 6 for ω_h), there was evidence that each of the food variety scales represented a latent factor (Table 4.13).

Dietary variety

There were moderate-large and significant negative correlations between Picky EBs and dietary variety in every category. Fear EBs were independently anticorrelated with dairy, meat, and overall animal protein variety, though the effect sizes were smaller than those associated with Picky EBs. Appetite EBs were not independently related to dietary variety in any food category (Table 4.14).

Dietary intake

Descriptive statistics for the number of self-reported daily servings are presented in Table 4.15. Participants whose intake scores fell between the 25th and 75th percentiles reported consuming between 10 and 18 servings of food per day. Participants whose intake scores fell between the 5th and 95th percentile reported eating between 6-33 daily servings; seven participants (1.8%) reported eating 3-5 servings, and 11 (2.8%) reported eating 34 or more. On average, participants reported that 17% of their typical daily food intake was from snack and dessert foods, and approximately one third was from fruits and vegetables (Table 4.15).

As predicted, there was a significant independent relationship between Picky EBs and self-reported daily vegetable intake. There was also a positive independent relationship between Fear EBs and vegetable intake. There was a trend-level relationship

between Picky EBs and self-reported fruit intake, although the effect size was small. With variance shared with the other ARFID-EBs and anorexia/bulimia symptoms partialled out, Appetite EBs were not associated with total daily servings of food; there was a significant negative correlation between Picky EBs and total daily servings. No other relationships between continuously measured ARFID-EBs and daily food intake were significant (Table 16).

Appetite EBs were not associated with greater consumption of highly palatable foods or with lower consumption of plant-based foods relative to total daily servings (Table 4.17). Fear EBs were significantly and positively correlated with fruit/vegetable ratio, indicating that individuals scoring higher on the NIAS Fear subscale reported higher relative fruit/vegetable consumption.

DISCUSSION

The purpose of this study was to provide empirical support for the inclusion of Avoidant/Restrictive Food Intake Disorder (ARFID) in DSM-5 as a diagnosis for adults. DSM-5 lists three eating behaviors, picky eating, limited interest in eating, and fear of negative consequences from eating, that might lead to the nutritional and psychosocial symptoms of ARFID (e.g., weight loss, nutritional deficiency, supplement dependence, and functional impairment). However, the text cites no evidence supporting their causal relationship with ARFID symptoms, their distinctness from one another, or their distinctness from other forms of disordered eating, and does not address the conditions under which, or the mechanisms through which, these eating behaviors lead to the development of ARFID symptoms.

This study addresses some of these gaps in the evidentiary support for ARFID by describing the psychopathology of self-reported adult ARFID and associated eating behaviors, and by showing that participants perceive a causal relationship between their picky eating, limited interest in eating, or fear of aversive consequences from eating, and ARFID symptoms. A measure of non-ARFID disordered eating symptoms (e.g., fear of fatness, compensatory behaviors, and body image distortion) was included as a covariate in all analyses to demonstrate the distinctness of the ARFID eating behaviors (EBs) described in DSM-5 from other forms of disordered eating. Participants who attributed their ARFID symptoms to a single eating behavior were compared on measures of comorbidity and impairment, as well as measures of constructs believed to be specific to each presentation. These analyses provided initial descriptive psychopathology for three distinct ARFID subtypes characterized by different ARFID-EBs, and highlight some of the behavioral, affective, and cognitive mechanisms through which these eating behaviors might lead to ARFID symptoms. Although this was a correlational study, we present hypotheses and suggest directions for future research based on these findings. Finally, analyses exploring the relationship between continuously measured ARFID-EBs and self-reported dietary variety and daily intake were intended to identify characteristic patterns of food choice and intake associated with each potential ARFID subtype.

ARFID comorbidity and impairment

In the first set of analyses, we replicated and extended previous findings on adult ARFID symptoms due to picky eating in a sample recruited for fear of negative consequences and low appetite/limited interest in eating as well as picky eating. Participants who met full DSM-5 ARFID criteria by self-report reported higher adjusted

mean anxiety, depression, and obsessive-compulsive disorder (OCD) symptoms compared to participants with subclinical or no symptoms. Although mean symptom endorsement did not consistently differ between the other three ARFID symptom groups, there was a trend towards symptom endorsement increasing with level of ARFID symptoms (e.g., EBs but no symptoms, subclinical symptoms, and full symptoms). This pattern was most notable in adjusted mean anxiety, with the positive screen and subclinical groups reporting significantly higher anxiety symptoms than participants with no ARFID-EBs. Eating related impairment did significantly increase at every level of ARFID symptoms, suggesting that the ARFID-EBs and negatively affect quality of life even when they do not lead to full-criteria ARFID symptoms. This is consistent with earlier findings that picky eaters who did not report significant weight loss, nutritional deficiency, supplement dependence, or psychosocial interference from their picky eating still reported greater eating-related quality of life impairment than non-picky eaters (Zickgraf et al., 2016).

ARFID eating behavior subtypes

Although DSM-5 does not include specifiers for the type of ARFID-associated eating behavior, the results from analyses comparing participants who attributed their full- or subclinical ARFID symptoms to a single EB (picky eating, appetite, or fear of negative consequences) offer support for the validity of ARFID subtypes. Approximately 80% of participants nominated only one of the three ARFID-EBs as the sole or primary cause of their self-reported weight loss, nutritional deficiency, supplement dependence, or psychosocial interference from eating. Although they did not significantly differ on measures of comorbidity and impairment, the ARFID symptom EB groups did differ on

measures of traits and behaviors associated with each ARFID-EB (Zickgraf & Ellis, *in prep*).

Picky eating. Participants who nominated picky eating as the cause of their ARFID symptoms reported higher levels of both familiar and unfamiliar food rejection than other participants with ARFID symptoms. This is consistent with the definition of picky eating as characterized by a narrow diet due to frequent food rejection, and with previous findings linking severity of these behaviors to nutritionally inadequate diets in children (e.g., Taylor, Northstone, Wernimont, & Emmett, 2016) and adults (e.g., Zickgraf & Schepps, 2016). Executive functioning deficits implicated in other eating disorders, including impaired set-shifting, might help to account for the rigid food refusal behaviors that characterize picky eating (e.g., refusing to eat unfamiliar foods, or familiar foods presented in an unfamiliar way). Impairment in set shifting, the ability to move effectively and quickly between tasks (e.g., activities, thoughts), has been proposed as an edophenotype of anorexia and bulimia (e.g., Zucker et al., 2007; Roberts et al., 2007). Deficits in this neurocognitive function have been documented in participants in long term recovery from anorexia, as well as the unaffected sisters of women with anorexia (Holliday, Tchanturia, Landau, Collier, & Treasure, 2005; Tchanturia et al., 2004). Picky eaters may have difficulty disengaging their attention from small variations in appearance, taste, or texture, leading them to label familiar foods as too different to be accepted or to label foods as "new" that typical eaters would include in a broader and more flexible category of "familiar" foods. Future research should explore executive functioning and cognitive/behavioral rigidity in adult picky eating, and whether measures

of these general constructs help to account for variability shared by self-reported picky eating, disordered eating, and ASD traits (e.g., Zickgraf & Ellis, *in prep*).

Fear of negative consequence. Participants who attributed their ARFID symptoms to fear of negative consequences from eating reported significantly higher levels of visceral sensitivity than other participants with ARFID symptoms. Visceral sensitivity is a form of GI-specific anxiety (GSA) most commonly studied in the FGIDs (e.g., Labus et al., 2004). It is characterized by hyperawareness of benign sensations in the GI tract, usually accompanied by efforts to avoid or mitigate these sensations. Hyperawareness of, and efforts to avoid, internal experiences (e.g., experiential avoidance; Hayes, Strosahl, Wilson, & Bisset, 2004), has previously been implicated in the etiology and maintenance of anxiety disorders including panic disorder, generalized anxiety disorder, and social anxiety disorder, as well as disordered eating (e.g., Hayes, Wilson, Gifford, Follette, & Strosahl, 1996; Rawal, Park, & Williams, 2010; Troop & Treasure, 1997). Experientially avoidant individuals with specific GI-related fears ranging from choking to diarrhea are likely to attend to minor sensations in the relevant region of the GI tract and interpret them as predicting their feared consequence (e.g., Boschen, 2007). These patients may begin to avoid foods associated with these sensations, but because the sensations are benign and not usually triggered by a specific food (e.g., Chey, 2003), avoidance could gradually spread to many different foods or food categories. People with GI fears might also avoid eating at all in certain contexts, for example, in places where bathrooms are not available or at times when becoming ill would interfere with social or occupational activities (e.g., Hunt, Milonova, & Moshier, 2009). Eating avoidance would be negatively reinforced while also preventing exposure

to benign GI sensations, maintaining both the fear and avoidance. Over time, this highly reinforced avoidance of food and eating could lead to inadequate intake and result in weight loss, nutritional deficiency, supplement dependence, or significant psychosocial interference. Future research should include more generalized measures of experiential avoidance as a common cognitive-affective factor underlying ARFID symptoms characterized by fear of negative consequences from eating.

Finally, participants who reported ARFID symptoms due Appetite-related EBs were compared to other participants on four measures of eating traits that might cause the "apparent lack of interest in eating" described in DSM-5 (APA, 2013, p. 334). Participants in the Appetite subgroup had higher adjusted mean scores on a scale measuring under-eating in response to emotional distress; this was consistent with DSM-5's description of ARFID symptoms as being associated with "generalized emotional difficulties" in children and adolescents (APA, 2013, p. 335). Appetite EB participants reported elevated satiety responsiveness compared to the Picky EB group, although the Fear group scores on these measures were approximately as high. The elevated scores in the Fear EB group might be driven by GSA; excessive monitoring of GI sensations could enhance perception of satiety signals. On measures of eating in response to environmental (rather than internal, e.g., hunger or emotion) cues and enjoyment of eating, the Appetite EB group had significantly lower adjusted scores compared to both Picky and Fear EB groups.

Satiety responsiveness, food responsiveness, food enjoyment, and emotional undereating are distinct constructs and, potentially, different routes to energy balance disturbances (Hunot et al., 2016). Satiety responsiveness is an aspect of homeostatic

eating, or eating in response to physiological signals of energy stores (e.g., Kenny, 2011; Lutter & Nestler, 2009). High scores on the AEBQ satiety responsiveness scale might reflect dysregulation of internal satiety signaling (including mechanical stomach distention and gut peptide signaling), or inappropriate learned behavioral responses to normal satiety signaling (Lutter & Nestler, 2009). The experience of hunger in response to external food cues (e.g., food responsiveness) is a conditioned response, and this associative learning is enhanced by ghrelin, a gut peptide released by the stomach and small intestine that promotes food seeking and meal initiation and has also been implicated in reward learning (Lutter & Nestler, 2009; Walker et al., 2012). Low scores on this subscale might reflect dysregulation in gut-brain signaling affecting conditioned hunger, or they might be reflective of broader reward-learning deficits. Deficits affecting the experience of reward or motivation to experience reward, whether generalized or specific to food rewards, could also be implicated in low scores on the AEBQ food enjoyment scale (e.g., Lutter & Nestler, 2009). Individual differences in the sensitivity of neural reward circuitry have been implicated in numerous behavioral disorders, including binge eating, gambling, and substance abuse, as well as in maladaptive eating behaviors, including binge eating (e.g., Blum, Gardner, Oscar-Berman, & Gold, 2012; Davis et al., 2007).

It should be noted that there is no evidence that high levels of satiety responsiveness or emotional under-eating systematically lead to inadequate energy intake in adults. In the single adult sample in which these constructs have been studied, both were negatively correlated with BMI, but only 2.2% of participants in this sample were underweight (BMI < 18.5). In an environment where highly palatable, energy-dense

foods are relatively inexpensive and readily available and most adults lead sedentary lives (e.g., Katzmarzyk & Lee, 2012), undereating might help to maintain appropriate energy balance and prevent obesity under many circumstances, even if it is caused by dysregulated incentive salience systems, gut-brain communication, or maladaptive behavioral responses to hunger, satiety, or emotional distress (e.g., Hunot et al., 2016). Future research should explore the relationships between these appetitive traits and ARFID-like outcomes other than weight; to our knowledge, there has been no study of the relationship between appetitive traits and eating-related quality of life or dietary quality and nutritional adequacy.

There is also no evidence that low levels of food responsiveness or eating enjoyment on the AEBQ are maladaptive at all. Researchers who study these traits generally treat them as risk factors for overeating and obesity, and do not address outcomes associated with low scores (e.g., Hunot et al., 2016). The extent to which these scales capture traits associated with maladaptive eating behaviors or energy/nutritional outcomes at their lower extreme is uncertain, and further research is needed to understand how these appetitive approach traits relate to inadequate food intake and ARFID symptoms.

Dietary intake

The third study aim was to identify patterns of food choice and intake behavior associated with each of the ARFID-EBs. Replicating previous findings, picky eating behavior was negatively correlated with dietary variety in every category assessed, with a particularly strong effect for fruit and vegetables. As hypothesized, restricting due to fear of negative consequences was uniquely associated with reduced animal protein variety,

suggesting that individuals who fear vomiting, choking, or GI distress might avoid specific animal products that they perceive as spreading foodborne illness or being difficult to digest. Also as predicted, restricting due to appetite was not associated with dietary variety. Whereas picky eating is characterized by generalized food avoidance behaviors (e.g., rejecting new and familiar foods and eating from a narrow range), the food restriction and avoidance associated with fear is more specific, and appetite symptoms do not appear to be systematically associated with dietary range.

Results from self-reported intake were less consistent with our hypotheses. Picky eating was inversely correlated with fruit and vegetable intake, but the effect sizes were small ($r < .15$) and, for fruit intake, non-significant. Picky eating was also negatively related to total food intake, with a small effect size ($r < .15$); this replicates the finding reported by Zickgraf and Schepps (2016), but was unexpected in the present study, because variance in total food intake accounted for by the other ARFID-EBs and non-ARFID disordered eating symptoms was partialled out. Fear-related restriction was not related to protein intake, but contrary to our hypotheses, there was a small but significant positive correlation with vegetable intake. Fear was also positively related to the ratio of fruit/vegetable servings to total daily servings (e.g., a greater proportion of intake from fruits/vegetables). Participants with fear-related restriction might compensate for their reduced animal protein variety by consuming more plant-based sources of protein.

Intake results did not fully replicate those reported by Zickgraf and Schepps (2016), who found that picky eaters with and without ARFID symptoms ate fewer daily servings of fruit and vegetables, and that picky eating severity was inversely correlated with fruit/vegetable and protein intake and positively correlated with discretionary food

intake. In the present sample, continuously measured picky eating was not related to discretionary food proportion, or fruit, protein, snack, and dessert intake. This might be due in part to differences in sampling between the two studies. The present sample only included Mechanical Turk workers, whereas Zickgraf and Schepps also recruited participants from online support groups for picky eaters (2016). A majority (79%) of participants in the present sample were recruited through advertisements targeting Mechanical Turk workers with ARFID-like eating problems, whereas the MTurk workers who participated in the 2016 study were not recruited for any eating problems. The 2016 sample might therefore have included a greater range of picky eating behavior, with more participants on both extremes.

Finally, Appetite-related eating restrictions were not related to self-reported total daily food servings, or to relative intake of highly palatable snack and dessert foods. This finding was unexpected. It might suggest that individuals with Appetite-related restrictions eat irregularly from day to day, for example eating significantly less than usual only when experiencing negative affect or when meals are in direct competition with more motivating activities. These factors might lead to insufficient intake over time that is not reflected in a typical day's eating behavior. Individual differences in emotional undereating might be associated with ARFID symptoms only in the context of anxiety or depression, whereas other mechanisms of Appetite-related restriction (e.g., satiety responsiveness, reduced responsiveness to food cues, reduced eating enjoyment) might lead to limited food intake independently from mood state. To explore this hypothesis, future studies should prospectively explore the relationship between appetite/food intake and moods and activities. Prospective study designs, for example, of college students

going through final exams, or depressed patients receiving psychotherapy, could help to clarify the relationship between individual differences in emotional undereating and eating behavior as a function of acute stress or reduction in negative affect. Prospective studies of the relationship between food intake and engagement in other rewarding or motivating activities might clarify the relationship between food reward motivation and food intake.

Limitations

One limitation of this study is its reliance on self-report data to assign participants to groups. The ARFID symptom checklist is a new instrument, and to date it has only been used in two previous studies by our group (Zickgraf et al., 2016; Zickgraf & Schepps, 2016). The measure was based on the ARFID module from the DSM-5 Structured Clinical Interview (SCID), which is closely based on the language used to describe ARFID symptoms and rule-out criteria in DSM-5 (First et al., 2015). Both the SCID and the ARFID-cl rely on participant self-report to identify clinically significant weight loss, nutritional deficiency, and dependence on supplements. This is a limitation of both measures, and of the ARFID diagnosis itself; although intended to be assessed by psychologists and other mental health providers, three of four key symptoms of ARFID are health-related and rely on "clinical judgement" of, for example, whether weight loss is "significant," and whether an individual's diet is nutritionally deficient (APA, 2013, p. 534). A limitation of the ARFID-cl relative to the SCID-5, however, is its complete reliance on participant-perceived significance to establish likely ARFID diagnosis. The finding that likely ARFID diagnosis is associated with psychological comorbidity and eating-related distress, and subgroup analyses showing different eating behaviors/traits

between ARFID subtypes, supports the validity of the ARFID-cl. However, the criterion validity of this measure has not yet been established against objective data or clinician diagnosis.

Our measure of dietary intake was used in a previous study but has not been validated against existing measures of dietary intake (e.g., food diary, 24-hour recall interview, food frequency questionnaire). Self-reported food intake may underestimate total energy intake and over-estimate fruit and vegetable intake (Bedard, Shatenstein, & Nadon, 2004; Marks, Hughes, & van der Pols, 2006). There is some evidence that our participants may have over-reported fruit/vegetable intake; on average, participants reported that fruits and vegetables made up one third of their total daily food intake. This finding is inconsistent with estimates, based on nationally representative dietary surveys, that a majority of adults do not meet USDA dietary recommended five daily servings of fruits and vegetables (e.g., Bowman, Friday, Clemens, & Moshfegh, 2015; Moore & Thompson, 2015). If our participants systematically over-reported their fruit and vegetable intake, this might have obscured relationships with ARFID-EBs, and the observed relationship between picky eating behavior and reduced vegetable intake might underestimate the magnitude of the true relationship. However, one limitation of this study is that the extent to which the ARFID-EBs might be systematically associated with reporting of dietary intake is unknown.

Conclusions

This study builds on previous research to provide future support for the inclusion of ARFID as an eating and feeding disorder in DSM-5. ARFID symptomatology is associated with comorbidity, impairment, and, for some, eating behaviors that might

result in nutritional inadequacies (Zickgraf et al., 2016; Zickgraf & Schepps, 2016). ARFID is a new diagnosis, and although DSM-5 describes different eating behaviors that could lead to ARFID symptoms, picky eating, appetite, and fear are not identified as subtypes or presentations of ARFID. Descriptive psychopathology of ARFID and its potential subtypes is important for establishing the validity of the diagnosis and establishing its clinical utility and distinctness from similar disorders. However, the emphasis in ARFID psychopathology should be placed on identifying the psychological and physiological mechanisms and endophenotypes of ARFID, not establishing firm boundaries between ARFID and other diagnoses based on observed symptoms.

We found preliminary evidence to suggest that ARFID symptoms can be caused by a range of behaviors characterized by rigid selection/rejection of foods (picky eating), attention to, and efforts to avoid, GI sensations (fear), and individual differences in food reward influencing motivation to eat in response to homeostatic, affective, and external food cues (appetite). This study is the first to provide descriptive psychopathology of adult ARFID symptoms and subtypes. The primary goal was to identify directions for future research. This was not a diagnostic study, nor was it designed to demonstrate causal relationships between individual differences in eating behaviors and cognitive-affective traits and ARFID EBs or symptoms. The findings from this study concern higher-level behaviors than the proposed mechanisms. For example, we showed that participants who attribute their ARFID symptoms to picky eating endorse greater food neophobia and familiar food rejection than others with ARFID symptoms. There is evidence from other sources to suggest that these eating behaviors might be related to

rigid and perseverative personality characteristics, which, in turn, have been linked to specific aspects of executive functioning.

The present findings highlight areas for future research on underlying constructs, such as reward responsiveness, gut-brain signaling, associative learning, cognitive rigidity, and experiential avoidance, and their role in the etiology and maintenance of ARFID. Identifying specific factors implicated in the maintenance of ARFID-EBs that lead to significant ARFID symptoms will enable the development of targeted psychosocial or pharmacological interventions that treat symptoms by targeting mechanisms, while also deepening the field's understanding of basic psychological processes underlying the full spectrum of human behavior.

Table 4.1. *Sample descriptives*

Nine-item ARFID screen	Mean (SD)	N	Range	α
Picky eating	6.94 (4.08)	450	0-15	.86
Appetite/interest	5.66 (4.10)	450	0-15	.87
Fear of negative consequences	5.47 (4.43)	450	0-15	.91
Adult eating behavior questionnaire (AEBQ)				
Enjoyment of food	3.54 (0.99)	450	1-5	.86
Hunger awareness	2.86 (0.89)	450	1-5	.77
Food responsiveness	2.89 (0.78)	450	1-5	.63
Satiety responsiveness	2.91 (0.87)	450	1-5	.75
Emotional under-eating	3.16 (1.10)	450	1-5	.88
Depression, Stress, & Anxiety Scale (DASS-21)				
Anxiety	8.47 (9.58)	450	0-42	.89
Depression	10.79 (12.22)	450	0-42	.95
Obsessive Compulsive Inventory (OCI-R)	13.19 (13.41)	450	0-68	.94
Clinical impairment inventory (CIA)	9.66 (10.14)	450	0-48	.94
Eating Attitudes Test (EAT-26)	10.37 (10.50)	450	0-72	.88
	Mean (SD)	N	Range	α
Food Neophobia Scale (FNS)	26.32 (12.57)	450	0-50	.94
Inflexibility Index (IFI-10)	21.46 (11.06)	450	0-47	.89

	Mean (SD)	N	Range	α
Emetophobia Questionnaire (EMET-Q)				
Contamination avoidance	6.86 (6.22)	450	0-24	.89
Visceral Sensitivity Index (VSI)	28.75 (20.19)	450	0-75	.92
Body mass index (BMI)	26.51 (6.46)	450	16.5 – 59.99	-

Table 4.2. *NIAS endorsement by symptom group*

	No ARFID EBs (n = 61)	**EBs; No ARFID symptoms** (n = 250)	**Subclinical ARFID symptoms** (n = 74)	**ARFID symptoms** (n = 65)	**Full sample** (N = 450)
Endorsed any restriction (T/F)	0%	100%	100%	100%	86.4%
Endorsed PE (T/F)	0	92.8	90.5	95.4	80.2
Endorsed appetite (T/F)	0	44.0	60.8	94.6	46.7
Endorsed fear (T/F)	0	48.0	73.0	76.9	49.8
Subscale score	Mean (SD), *range*				
NIAS PE score	1.74 (1.62)	7.24 (3.64)	8.11 (3.55)	9.53 (3.86)	6.94 (4.08)
(0-15)	0-6	0-15	0-14	2-15	0-15
NIAS appetite score (0-15)	1.57 (1.75)	5.39 (3.72)	7.19 (3.95)	8.77 (3.85)	5.66 (4.10)
	0-6	0-15	0-15	0-15	0-15
NIAS fear score	1.38 (1.65)	4.92 (3.79)	7.55 (4.68)	9.04 (4.34)	5.47 (4.43)
(0-15)	0-6	0-15	0-15	0-15	0-15
Scores above the median					
NIAS PE	0%	59.6%	68.9%	72.3%	54.3%
(median = 7)					
NIAS appetite	6.6	52.8	70.3	89.2	54.7
(median = 5)					
NIAS fear	3.3	50.8	68.9	80.0	51.6
(median = 5)					

	No ARFID EBs (n = 61)	EBs; No ARFID symptoms (n = 250)	Subclinical ARFID symptoms (n = 74)	ARFID symptoms (n = 65)	Full sample (N = 450)
Scores > 1SD above the mean					
NIAS PE	0%	12.4%	18.9%	35.4%	14.9%
NIAS appetite	0	15.6	32.4	50.8	21.3
NIAS fear	0	12.4	43.2	55.4	22.0
Highest subscale score*					
NIAS PE	64.3%	57.2%	45.2%	35.9%	54.5%
NIAS appetite	25.0	5.6	6.8	7.8	7.5
NIAS fear	3.6	9.9	19.2	21.9	13.1

*Does not sum to 100% because participants with tied subscale scores were eliminated

Table 4.3. *Criterion A symptom endorsement by AFID group*

	Subclinical ARFID symptoms (*n* = 74)	**ARFID symptoms** (*n* = 65)	**Full sample** (*N* = 451)
DSM-5 Criterion A			
Inadequate nutrition	45.9%	86.2%	39.9%
Inadequate caloric intake	27.0	72.3	30.4
…leading to significant:			
Weight loss/difficulty maintaining weight	6.8	21.5	7.1
Nutritional deficiency	5.4	27.7	6.9
Supplement dependence	8.1	58.5	15.7
Psychosocial impairment	9.5	35.4	11.3
Any significant symptom	24.3	100	31.5
Nominated cause of Criterion A symptoms*			
Picky eating	27.0	30.8	8.9
Limited appetite/interest	21.6	27.7	7.5
Fear of negative consequences	59.5	60.0	18.4
Choking	9.5	18.5	4.2
Vomiting	16.2	24.6	6.2
GI distress/IBS	45.9	43.1	13.7

*does not sum to 100; some participants endorsed multiple causes

Table 4.4. *Bootstrapped adjusted means & ANCOVA test statistics and effect sizes*

			DASS-A	**DASS-D**	**OCI-R**	**CIA-A**
			(0-56)	(0-56)	(0-72)	(0-48)
	n		*M* (*SEM*)			
No ARFID EBs	61		5.80_{a} (1.11)	7.05_{a} (1.47)	11.18_{a} (1.50)	6.26_{a} (1.05)
EBs; No ARFID symptoms	250		7.77_{b} (0.54)	10.27_{a} (0.72)	12.61_{a} (0.73)	8.61_{b} (0.51)
Subclinical ARFID symptoms	74		8.62_{b} (1.0)	10.49_{a} (1.32)	12.48_{a} (1.35)	10.84_{c} (0.94)
ARFID	65		13.20_{c} (1.10)	16.39_{b} (1.92)	18.11_{b} (1.47)	15.59_{d} (1.01)
One-way ANCOVA		***F*(3, 455)**	**8.46****	**7.12****	**4.54***	**15.89****
		pη²	**.05**	**.05**	**.04**	**.10**

Note. Means appearing in the same column with different subscripts are significantly different. ***p* <.001 * *p* < .05

Table 4.5. *Proportion of participants meeting screening cut-off on the OCI-R*

	N	***n* (%) scoring ≥ 21**
No ARFID EBs	61	8 (13.11%)
EBs; No ARFID symptoms	250	55 (22.0)
Subclinical ARFID symptoms	74	22 (29.73)
ARFID	65	29 (44.62)
Total	450	114 (25.0)

Table 4.6. *Proportion of participants meeting screening cut-off on the CIA-A*

	N	***n* (%) scoring ≥16**
No ARFID EBs	61	6 (9.8%)
EBs; No ARFID symptoms	250	48 (19.2)
Subclinical ARFID symptoms	74	23 (31.10)
ARFID	65	35 (58.85)
Total	450	112 (24.89)

Table 4.7. *Reasons for Criterion A symptoms ("some" or "significant")*

	PE only	**Appetite only**	**Fear only**	**PE & appetite**	**Appetite & fear**	**PE & fear**	**PE, appetite, & fear**
Subclinical (*n* = 74)	20.3% (15)	17.6% (13)	54.1% (40)	2.7% (2)	1.4% (1)	4.1% (3)	0
Full criteria (*n* = 65)	18.5% (12)	18.5% (12)	47.7% (31)	6.2% (4)	6.2% (4)	9.2% (6)	3.1% (2)
Total (N = 139)	19.4% (27)	10.8% (25)	51.1% (71)	4.3% (6)	3.6% (5)	6.5% (9)	1.4% (2)

Table 4.8. *Nature of feared consequences nominated as reasons for Criterion A symptoms*

	Lower GI	**Vomit-ing**	**Chok-ing**	**Lower GI & vomit-ing**	**Vomit-ing & choking**	**Chok-ing & lower GI**	**Vomit-ing, choking, & lower GI**
Subclinical	61%	18.2%	4.5%	4.5%	0%	6.8%	4.5%
(*n* = 44)	(27)	(8)	(2)	(2)	(0)	(3)	(2)
Full criteria	43.6%	10.3%	10.3%	15.4%	7.7%	5.1%	7.7%
(*n* = 39)	(17)	(4)	(4)	(6)	(3)	(2)	(3)
Total	53.0%	14.4%	7.2%	9.6%	3.6%	6.0%	6.0%
(*N* = 83)	(44)	(12)	(6)	(8)	(3)	(5)	(5)

Table 4.9. *Bootstrapped adjusted means & ANCOVA test statistics and effect sizes*

			DASS-A	**DASS-D**	**OCI-R**	**CIA-A**
			(0-56)	(0-56)	(0-72)	(0-48)
	n		*M* (*SEM*)			
Picky eating	27		8.97	11.84	18.05	13.99
			(1.80)	(2.30)	(2.46)	(1.82)
Appetite	25		12.10	18.46	18.77	16.17
			(1.90)	(2.42)	(2.59)	(1.92)
Fear	71		12.50	13.25	16.05	14.71
			(1.13)	(1.40)	(1.52)	(1.13)
One-way ANCOVA		***F*(2, 120)**	1.26	2.10	0.60	0.35
		$p\eta^2$	.02	.045	.009	.006

Note. Means appearing in the same column with different subscripts are significantly different. ** $p < .001$ * $p < .05$

Table 4.10. *Picky eating variables; bootstrapped adjusted means & ANCOVA test statistics and effect sizes*

			FNS	**IFI-10**
	n		(0-60)	(0-60)
Picky eating	27		37.36_{a}	30.72_{a}
			(2.18)	(1.93)
Appetite	25		$30.06_{a,b}$	23.25_{b}
			(2.29)	(2.03)
Fear	71		29.02_{b}	23.09_{b}
			(1.34)	(1.19)
One-way ANCOVA		***F*(2, 120)**	5.44*	6.05*
		$p\eta^2$	.08	.09

Note. Means appearing in the same column with different subscripts are significantly different. ** $p < .001$ * $p < .05$

Table 4.11. *Appetite/interest variables; bootstrapped adjusted means & ANCOVA test statistics and effect sizes*

AEBQ scale (range 1-5):					
		Satiety responsiveness	**Emotional undereating**	**Food responsiveness**	**Eating enjoyment**
	n	*M* (*SE*)			
Picky eating	27	2.97_a (0.15)	2.89_a (0.21)	2.92_a (0.15)	3.17_a (0.19)
Appetite	25	3.59_b (0.16)	4.06_b (0.22)	2.25_b (0.16)	2.40_b (0.20)
Fear	71	3.39_b (0.09)	3.30_a (0.13)	3.11_a (0.09)	3.36_a (0.12)
One-way ANCOVA	***F*(2, 120)**	4.39*	5.31*	10.81**	8.60**
	$p\eta^2$	.07	.12	.15	.13

Note. Means appearing in the same column with different subscripts are significantly different.

**p <.001 * p < .05

Table 4.12. *Fear variables; bootstrapped adjusted means & ANCOVA test statistics and effect sizes*

			VSI	**EMETQ-avoid**
	n		(0-60)	(0-60)
Picky eating	27		28.24_a	6.42_a
			(3.30)	(1.23)
Appetite	25		30.26_a	7.20_a
			(3.47)	(1.30)
Fear	71		48.41_b	10.62_b
			(2.04)	(0.76)
One-way ANCOVA		***F*(2, 120)**	18.78**	5.40*
		$p\eta^2$	.24	.08

Note. Means appearing in the same column with different subscripts are significantly different. ** $p < .001$ * $p < .05$

Table 4.13. *Descriptive statistics: dietary variety*

	Percentage of listed foods consumed	**Number of listed foods consumed**		
	M (*SD*)	*M* (*SD*)	Range	ω_h
Vegetables	68.12% (28.76)	19.07 (8.05)	0-28	.78
Fruit	71.20 (29.24)	15.66 (6.43)	0-22	.85
Dairy	77.35 (31.93)	2.32 (0.96)	0-3	NA
Meat	66.04 (23.09)	7.26 (2.54)	0-11	.72
Fish	50.51 (25.87)	8.08 (5.74)	0-16	.82
Animal protein	59.85 (25.0)	18.56 (7.75)	0-31	.73
Non-animal protein	64.73 (30.43)	11.65 (5.48)	0-18	.71
Starch/grain	54.56 (32.78)	5.46 (3.28)	0-10	.81

Table 4.14. *ARFID-EBs (NIAS score) and dietary variety*

	Picky eating	**Appetite**	**Fear**
Vegetable variety	-.42**	-.004	.07
Fruit variety	-.34**	.02	.09
Dairy variety	-.18*	.07	-.19**
Fish variety	-.41**	-.003	-.07
Meat variety	-.36**	.01	-.11*
Non-animal protein variety	-.33**	-.001	.02
Animal protein variety	-.39**	.001	-.12*
Starch/grain variety	-.25**	.03	-.02

Partial ρ (controlling for 2 NIAS subscales & EAT-26); $^{**}p < .001$ $^{*}p < .05$

Table 4.15. *Descriptive statistics: dietary intake*

	M (SD)	**range**
Vegetables	2.65 (1.99)	0-10
Fruit	2.24 (1.82)	0-10
Dairy	1.95 (1.87)	0-10
Protein	2.98 (1.86)	0-10
Starch/grain	2.65 (1.84)	0-9
Snack foods	1.74 (1.91)	0-10
Dessert foods	1.20 (1.71)	0-10
Total food servings	15.41 (9.13)	3 – 67
Soda	1.24 (1.91)	0-10
Water	5.37 (2.71)	0-10
Discretionary proportion	0.17 (0.13)	0 - 0.58
Fruit/vegetable proportion	0.33 (0.16)	0 - 0.83

Table 4.16. *ARFID-EBs (NIAS score) and number of daily servings*

	Picky eating	**Appetite**	**Fear**
Vegetables	-.17*	.03	.14*
Fruit	-.10†	.09	.07
Dairy	-.03	.09	-.06
Protein	-.08	-.01	.02
Starch/grain	-.02	.03	-.05
Snack foods	-.05	.06	.04
Dessert foods	-.03	.10	.04
Total food servings	-.11*	.05	.03
Soda	.08	.09	-.03
Water	-.09	.01	.08

Partial ρ (controlling for 2 NIAS subscales & EAT-26) $^{**}p < .001$ $^{*}p < .05$ †$p < .10$

Table 4.17. *ARFID-EBs (NIAS score) and discretionary/FV proportion*

	Picky eating	**Appetite**	**Fear**
Discretionary proportion	.01	.04	-.01
Fruit/vegetable proportion	-.03	-.04	.13*

Partial *r* controlling for 2 NIAS subscales & EAT-26 **p <.001 * p < .05 †p <.10

REFERENCES

Altman, S. E., & Shankman, S. A. (2009). What is the association between obsessive–compulsive disorder and eating disorders? *Clinical Psychology Review, 29*(7), 638-646.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric Pub.

Antoniou, E. E., Roefs, A., Kremers, S. P. J., Jansen, A., Gubbels, J. S., Sleddens, E. F. C., & Thijs, C. (2015). Picky eating and child weight status development: a longitudinal study. *Journal of Human Nutrition and Dietetics*, 10.1111/jhn.12322.

Barofsky, I., & Fontaine, K. R. (1998). Do psychogenic dysphagia patients have an eating disorder? *Dysphagia, 13*(1), 24-27.

Beaulac, J., Kristjansson, E., & Cummins, S. (2009). Peer Reviewed: A Systematic Review of Food Deserts, 1966-2007. *Preventing chronic disease,6*(3).

Bedard, D., Shatenstein, B., & Nadon, S. (2004). Underreporting of energy intake from a self-administered food-frequency questionnaire completed by adults in Montreal. *Public health nutrition*, *7*(05), 675-681.

Bentler, P. M. (1983). Some contributions to efficient statistics in structural models: Specification and estimation of moment structures. *Psychometrika*, *48*(4), 493-517.

Blanck, H. M., Gillespie, C., Kimmons, J. E., Seymour, J. D., & Serdula, M. K. (2008). Trends in fruit and vegetable consumption among US men and women, 1994–2005. *Preventing chronic disease*, *5*(2).

Block, G., Patterson, B., & Subar, A. (1992). Fruit, vegetables, and cancer prevention: a review of the epidemiological evidence. *Nutrition and cancer*,*18*(1), 1-29.

Blum, K., Gardner, E., Oscar-Berman, M., & Gold, M. (2012). "Liking" and "wanting" linked to Reward Deficiency Syndrome (RDS): hypothesizing differential responsivity in brain reward circuitry. *Current pharmaceutical design*, *18*(1), 113-118.

Birch, L. L., & Marlin, D. W. (1982). I don't like it; I never tried it: effects of exposure on two-year-old children's food preferences. *Appetite*, *3*(4), 353-360.

Bohn, K., Doll, H. A., Cooper, Z., O'Connor, M., Palmer, R. L., & Fairburn, C. G. (2008). The measurement of impairment due to eating disorder psychopathology. *Behaviour Research and Therapy*, *46*(10), 1105-1110.

Bohn, K., & Fairburn, C. G. (2008). The clinical impairment assessment questionnaire (CIA). *Cognitive Behavioral Therapy for Eating Disorders*. New York, NY: Guilford Press.

Boschen, M. J. (2007). Reconceptualizing emetophobia: A cognitive–behavioral formulation and research agenda. *Journal of anxiety disorders*, *21*(3), 407-419.

Boschen, M. J., Veale, D., Ellison, N., & Reddell, T. (2013). The emetophobia questionnaire (EmetQ-13): Psychometric validation of a measure of specific phobia of vomiting (emetophobia). *Journal of anxiety disorders*, *27*(7), 670-677.

Bowman, S., Friday, J., Clemens, J., & Moshfegh, A. (2015). Vegetables, Fruit, and Whole Grains Consumption by US Adults at Meals and Snacks: WWEIA, NHANES 2011-12. *The FASEB Journal*, *29*(1 Supplement), 587-5.

Boyd, C., Abraham, S., & Kellow, J. (2010). Appearance and disappearance of functional gastrointestinal disorders in patients with eating disorders. *Neurogastroenterology & Motility*, *22*(12), 1279-1283.

Browne, M. W. (1984). Asymptotically distribution-free methods for the analysis of covariance structures. *British Journal of Mathematical and Statistical Psychology*, *37*(1), 62-83.

Browne, M. W., & Cudeck, R. (1992). Alternative ways of assessing model fit. *Sociological Methods & Research*, *21*(2), 230-258.

Budak, E., Taymur, İ., Önen, S., Kanat, B. B., Akdeniz, Ö., & Demirci, H. (2017). Symptoms of swallowing anxiety in panic disorder patients and associated psychopathologic factors. *Eating and Weight Disorders-Studies on Anorexia, Bulimia and Obesity*, 1-11.

Buhrmester, M., Kwang, T., & Gosling, S. D. (2011). Amazon's Mechanical Turk a new source of inexpensive, yet high-quality, data?. *Perspectives in Psychological Science*, *6*(1), 3-5.

Caccialanza, R., Nicholls, D., Cena, H., Maccarini, L., Rezzani, C., Antonioli, L., ... & Roggi, C. (2004). Validation of the Dutch Eating Behaviour Questionnaire parent version (DEBQ-P) in the Italian population: a screening tool to detect differences in eating behaviour among obese, overweight and normal-weight preadolescents. *European Journal of Clinical Nutrition*, *58*(9), 1217-1222.

Cade, J., Thompson, R., Burley, V., & Warm, D. (2002). Development, validation and utilisation of food-frequency questionnaires–a review. *Public health nutrition*, *5*(04), 567-587.

Cardona Cano, S., Tiemeier, H., Van Hoeken, D., Tharner, A., Jaddoe, V. W., Hofman, A., ... & Hoek, H. W. (2015). Trajectories of picky eating during childhood: a general population study. *International journal of eating disorders*, *48*(6), 570-579.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate behavioral research*, *1*(2), 245-276.

Chey, W. D. (2013). The role of food in the functional gastrointestinal disorders: introduction to a manuscript series. *The American journal of gastroenterology*, *108*(5), 694-697.

Cermak, S. A., Curtin, C., & Bandini, L. G. (2010). Food selectivity and sensory sensitivity in children with autism spectrum disorders. *Journal of the American Dietetic Association*, *110*(2), 238-246.

Coulthard, H., & Blissett, J. (2009). Fruit and vegetable consumption in children and their mothers. Moderating effects of child sensory sensitivity. *Appetite*, *52*(2), 410-415.

Dauchet, L., Amouyel, P., Hercberg, S., & Dallongeville, J. (2006). Fruit and vegetable consumption and risk of coronary heart disease: a meta-analysis of cohort studies. *The Journal of nutrition*, *136*(10), 2588-2593.

Davis, C., Patte, K., Levitan, R., Reid, C., Tweed, S., & Curtis, C. (2007). From motivation to behaviour: a model of reward sensitivity, overeating, and food preferences in the risk profile for obesity. *Appetite, 48*(1), 12-19.

Day, N. E., McKeown, N., Wong, M. Y., Welch, A., & Bingham, S. (2001). Epidemiological assessment of diet: a comparison of a 7-day diary with a food frequency questionnaire using urinary markers of nitrogen, potassium and sodium. *International Journal of Epidemiology*, *30*(2), 309-317.

de Barse, L. M., Tiemeier, H., Leermakers, E. T., Voortman, T., Jaddoe, V. W., Edelson, L. R., ... & Jansen, P. W. (2015). Longitudinal association between preschool fussy eating and body composition at 6 years of age: The Generation R Study. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 153.

de Roos, C., & de Jongh, A. (2008). EMDR treatment of children and adolescents with a choking phobia. *Journal of EMDR Practice and Research, 2*(3), 201-211.

Drewnowski, A., Renderson, S. A., Driscoll, A., & Rolls, B. J. (1997). The Dietary Variety Score: assessing diet quality in healthy young and older adults.*Journal of the American Dietetic Association*, *97*(3), 266-271.

Dubois, L., Farmer, A. P., Girard, M., & Peterson, K. (2007). Preschool children's eating behaviours are related to dietary adequacy and body weight. *European Journal of Clinical Nutrition*, *61*(7), 846-855.

Dubois, L., Farmer, A., Girard, M., Peterson, K., & Tatone-Tokuda, F. (2007). Problem eating behaviors related to social factors and body weight in preschool children: A

longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity, 4*(1), 9.

Dwyer, J., Needham, L., Simpson, J. R., & Heeney, E. S. (2008). Parents report intrapersonal, interpersonal, and environmental barriers to supporting healthy eating and physical activity among their preschoolers. *Applied Physiology, Nutrition, and Metabolism, 33*(2), 338-346.

Ekstein, S., Laniado, D., & Glick, B. (2010). Does picky eating affect weight-for-length measurements in young children? *Clinical Pediatrics*, *49*(3), 217-220.

Ellis, J. M., Galloway, A. T., Webb, R. M., Martz, D. M., & Farrow, C. V. (2016). Recollections of pressure to eat during childhood, but not picky eating, predict young adult eating behavior. *Appetite*, *97*, 58-63.

Epstein, L. H., Leddy, J. J., Temple, J. L., & Faith, M. S. (2007). Food reinforcement and eating: a multilevel analysis. *Psychological bulletin*, *133*(5), 884.

Fairburn, C. G., Cooper, Z., Shafran, R., & Wilson, G. T. (2008). Eating disorders: A transdiagnostic protocol.

Farrow, C. V., & Coulthard, H. (2012). Relationships between sensory sensitivity, anxiety and selective eating in children. *Appetite*, *58*(3), 842-846.

Feskanich, D., Rimm, E. B., Giovannucci, E. L., Colditz, G. A., Stampfer, M. J., Litin, L. B., & Willett, W. C. (1993). Reproducibility and validity of food intake measurements from a semiquantitative food frequency questionnaire. *Journal of the American Dietetic Association*, *93*(7), 790-796.

Foa, E. B., Huppert, J. D., Leiberg, S., Langner, R., Kichic, R., Hajcak, G., & Salkovskis, P. M. (2002). The Obsessive-Compulsive Inventory: development and validation of a short version. *Psychological Assessment*, *14*(4), 485.

First M. B., Williams J. B. W., Karg R. S., Spitzer R. L.: Structured Clinical Interview for DSM-5—Research Version (SCID-5 for DSM-5, Research Version; SCID-5-RV). Arlington, VA, American Psychiatric Association, 2015

Fischer, H., Furmark, T., Wik, G., & Fredrikson, M. (2000). Brain representation of habituation to repeated complex visual stimulation studied with PET. *Neuroreport*, *11*(1), 123-126.

Fischer, A. J., Luiselli, J. K., & Dove, M. B. (2015). Effects of clinic and in-home treatment on consumption and feeding-associated anxiety in an adolescent with avoidant/restrictive food intake disorder. *Clinical Practice in Pediatric Psychology*, *3*(2), 154.

Foote, J. A., Murphy, S. P., Wilkens, L. R., Basiotis, P. P., & Carlson, A. (2004). Dietary variety increases the probability of nutrient adequacy among adults. *The Journal of nutrition*, *134*(7), 1779-1785.

Ford, E. S., & Mokdad, A. H. (2001). Fruit and vegetable consumption and diabetes mellitus incidence among US adults. *Preventive medicine*, *32*(1), 33-39.

Forman, S. F., McKenzie, N., Hehn, R., Monge, M. C., Kapphahn, C. J., Mammel, K. A., ... & Woods, E. R. (2014). Predictors of outcome at 1 year in adolescents with DSM-5 restrictive eating disorders: Report of the national eating disorders quality improvement collaborative. *Journal of Adolescent Health*, *55*(6), 750-756.

Franko, D. L., Shapiro, J., & Gagne, A. (1997). Phagophobia: A form of psychogenic dysphagia a new entity. *Annals of Otology, Rhinology & Laryngology, 106*(4), 286-290.

Fritz, C. O., Morris, P. E., & Richler, J. J. (2012). Effect size estimates: current use, calculations, and interpretation. *Journal of Experimental Psychology: General*, *141*(1), 2.

Garner, D. M., Olmsted, M. P., Bohr, Y., & Garfinkel, P. E. (1982). The eating attitudes test: psychometric features and clinical correlates. *Psychological medicine*, *12*(04), 871-878.

Galloway, A. T., Fiorito, L., Lee, Y., & Birch, L. L. (2005). Parental pressure, dietary patterns, and weight status among girls who are "picky eaters". *Journal of the American Dietetic Association*, *105*(4), 541-548.

Geliebter, A., & Aversa, A. (2003). Emotional eating in overweight, normal weight, and underweight individuals. *Eating behaviors*, *3*(4), 341-347.

Garner, D. M., Olmsted, M. P., Bohr, Y., & Garfinkel, P. E. (1982). The eating attitudes test: psychometric features and clinical correlates. *Psychological Medicine*, *12*(04), 871-878.

Guenther, P. M., Casavale, K. O., Kirkpatrick, S. I., Reedy, J., Hiza, H. A. B., Kuczynski, K., J., … Krebs-Smith, S. M. (2013). Diet quality of Americans in 2001-02 and 2007-08 as measured by the Healthy Eating Index-2010. United States Department of Agriculture, Washington, DC. Available at http://www.cnpp.usda.gov/HealthyEatingIndex.

Hayes, S. C., Strosahl, K., Wilson, K. G., & Bissett, R. T. (2004). Measuring experiential avoidance: A preliminary test of a working model. *The psychological record*, *54*(4), 553.

Hayes, S. C., Wilson, K. G., Gifford, E. V., Follette, V. M., & Strosahl, K. (1996). Experiential avoidance and behavioral disorders: A functional dimensional approach to diagnosis and treatment. *Journal of consulting and clinical psychology*, *64*(6), 1152.

He, F. J., Nowson, C. A., & MacGregor, G. A. (2006). Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. *The Lancet*,*367*(9507), 320-326.

Henry, J. D., & Crawford, J. R. (2005). The short‐form version of the Depression Anxiety Stress Scales (DASS‐21): Construct validity and normative data in a large non‐clinical sample. *British Journal of Clinical Psychology*, *44*(2), 227-239.

Himle, J. A., Crystal, D., Curtis, G. C., & Fluent, T. E. (1991). Mode of onset of simple phobia subtypes: Further evidence of heterogeneity. *Psychiatry Research*, *36*(1), 37-43.

Holliday, J., Tchanturia, K., Landau, S., Collier, D., & Treasure, J. (2005). Is impaired set-shifting an endophenotype of anorexia nervosa?. *American Journal of Psychiatry*, *162*(12), 2269-2275.

Höller, Y., van Overveld, M., Jutglar, H., & Trinka, E. (2013). Nausea in specific phobia of vomiting. *Behavioral Sciences*, *3*(3), 445-458.

Hollitt, S., Kemps, E., Tiggemann, M., Smeets, E., & Mills, J. S. (2010). Components of attentional bias for food cues among restrained eaters. *Appetite, 54*(2), 309-313.

Hoerr, S. L., Bokram, R., Lugo, B., Bivins, T., & Keast, D. R. (2002). Risk for disordered eating relates to both gender and ethnicity for college students. *Journal of the American College of Nutrition, 21*(4), 307-314.

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal on Business Research Methods 6(1)*.

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrica, 30*(2), 179‑185.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

Hunot, C., Fildes, A., Croker, H., Llewellyn, C. H., Wardle, J., & Beeken, R. J. (2016). Appetitive traits and relationships with BMI in adults: Development of the Adult Eating Behaviour Questionnaire. *Appetite, 105*, 356-363.

Hunt, M. G., Milonova, M., & Moshier, S. (2009). Catastrophizing the consequences of gastrointestinal symptoms in irritable bowel syndrome. *Journal of Cognitive Psychotherapy, 23*(2), 160-173.

Hursti, U. K. K., & Sjoden, P. O. (1997). Food and general neophobia and their relationship with self-reported food choice: familial resemblance in Swedish families with children of ages 7–17 years. *Appetite*, *29*(1), 89-103.

IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp

Jacobi, C., Schmitz, G., & Agras, W. S. (2008). Is picky eating an eating disorder?. *International Journal of Eating Disorders*, *41*(7), 626-634.

Kant, A. K., Schatzkin, A., Graubard, B. I., & Schairer, C. (2000). A prospective study of diet quality and mortality in women. *Jama*, *283*(16), 2109-2115.

Kant, A. K., Schatzkin, A., Harris, T. B., Ziegler, R. G., & Block, G. (1993). Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *The American journal of clinical nutrition*, *57*(3), 434-440.

Katzmarzyk, P. T., & Lee, I. M. (2012). Sedentary behaviour and life expectancy in the USA: a cause-deleted life table analysis. *BMJ open*, *2*(4), e000828.

Kauer, J., Pelchat, M. L., Rozin, P., & Zickgraf, H. F. (2015). Adult picky eating. Phenomenology, taste sensitivity, and psychological correlates. *Appetite*, *90*, 219-228.

Kenny, P. J. (2011). Reward mechanisms in obesity: new insights and future directions. *Neuron*, 69(4), 664-679.

Kim, H. Y. (2013). Statistical notes for clinical researchers: assessing normal distribution using skewness and kurtosis. *Restorative dentistry & endodontics*, 38(1), 52-54.

Knaapila, A., Silventoinen, K., Broms, U., Rose, R. J., Perola, M., Kaprio, J., & Tuorila, H. M. (2011). Food neophobia in young adults: genetic architecture and relation to personality, pleasantness and use frequency of foods, and body mass index—a twin study. *Behavior genetics*, *41*(4), 512-521.

Korkmaz, S., Goksuluk, D., & Zararsiz, G. (2014). MVN: an R package for assessing multivariate normality. *The R Journal*, *6*(2), 151-162.

Kozak, M. J., & Cuthbert, B. N. (2016). The NIMH research domain criteria initiative: background, issues, and pragmatics. *Psychophysiology*, *53*(3), 286-297.

Kral, T. V., Eriksen, W. T., Souders, M. C., & Pinto-Martin, J. A. (2013). Eating behaviors, diet quality, and gastrointestinal symptoms in children with autism spectrum disorders: A brief review. *Journal of pediatric nursing*, *28*(6), 548-556.

Krebs-Smith, S. M., Smiciklas-Wright, H., Guthrie, H. A., & Krebs-Smith, J. (1987). The effects of variety in food choices on dietary quality. *Journal of the American Dietetic Association*, *87*(7), 897-903.

Kreipe, R. E., & Palomaki, A. (2012). Beyond picky eating: Avoidant/restrictive food intake disorder. *Current Psychiatry Reports, 14*(4), 421-431.

Kuschner, E. S., Eisenberg, I. W., Orionzi, B., Simmons, W. K., Kenworthy, L., Martin, A., & Wallace, G. L. (2015). A preliminary study of self-reported food selectivity in adolescents and young adults with autism spectrum disorder. *Research in autism spectrum disorders*, *15*, 53-59.

Labus, J. S., Bolus, R., Chang, L., Wiklund, I., Naesdal, J., Mayer, E. A., & Naliboff, B. D. (2004). The Visceral Sensitivity Index: development and validation of a gastrointestinal symptom-specific anxiety scale. *Alimentary pharmacology & therapeutics*, *20*(1), 89-97.

Lipsitz, J. D., Fyer, A. J., Paterniti, A., & Klein, D. F. (2001). Emetophobia: Preliminary results of an Internet survey. *Depression and Anxiety*, *14*(2), 149-152.

Lipman, T. H., Schucker, M. M., Ratcliffe, S. J., Holmberg, T., Baier, S., & Deatrick, J. A. (2011). Diabetes risk factors in children: A partnership between nurse practitioner and high school students. *American Journal of Maternal/Child Nursing*, *36*(1), 56-62.

Ljótsson, B., Andréewitch, S., Hedman, E., Rück, C., Andersson, G., & Lindefors, N. (2010). Exposure and mindfulness based therapy for irritable bowel syndrome–an open pilot study. *Journal of Behavior Therapy and Experimental Psychiatry*, *41*(3), 185-190.

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour research and therapy*, *33*(3), 335-343.

Lukens, C. T., & Silverman, A. H. (2014). Systematic review of psychological interventions for pediatric feeding problems. *Journal of Pediatric Psychology*, *39*(8), 903-917.

Lutter, M., & Nestler, E. J. (2009). Homeostatic and hedonic signals interact in the regulation of food intake. *The Journal of nutrition*, *139*(3), 629-632.

Maitre, I., Van Wymelbeke, V., Amand, M., Vigneau, E., Issanchou, S., & Sulmont-Rossé, C. (2014). Food pickiness in the elderly: Relationship with dependency and malnutrition. *Food Quality and Preference*, *32*, 145-151.

Marks, G. C., Hughes, M. C., & van der Pols, J. C. (2006). Relative validity of food intake estimates using a food frequency questionnaire is associated with sex, age, and other personal characteristics. *The Journal of nutrition*, *136*(2), 459-465.

Mascola, A. J., Bryson, S. W., & Agras, W. S. (2010). Picky eating during childhood: A longitudinal study to age 11 years. *Eating Behavior*, *11*(4), 253-257.

McCarthy, E. K., ní Chaoimh, C., Murray, D. M., Hourihane, J. B., Kenny, L. C., & Kiely, M. (2015). Eating behaviour and weight status at 2 years of age: data from the Cork BASELINE Birth Cohort Study. *European journal of clinical nutrition*.

McNally, R. J. (1994). Choking phobia: a review of the literature. *Comprehensive psychiatry*, *35*(1), 83-89.

Mennella, J. A., Daniels, L. M., & Reiter, A. R. (2017). Learning to like vegetables during breastfeeding: a randomized clinical trial of lactating mothers and infants. *The American Journal of Clinical Nutrition*, ajcn143982

Michels, K. B., & Wolk, A. (2002). A prospective study of variety of healthy foods and mortality in women. *International journal of epidemiology*, *31*(4), 847-854.

Moore, L. V., & Thompson, F. E. (2015). Adults meeting fruit and vegetable intake recommendations—United States, 2013. *MMWR Morb Mortal Wkly Rep*, *64*(26), 709-13.

Murphy, S. P., Foote, J. A., Wilkens, L. R., Basiotis, P. P., Carlson, A., White, K. K., & Yonemori, K. M. (2006). Simple measures of dietary variety are associated with improved dietary quality. *Journal of the American Dietetic Association*, *106*(3), 425-429.

Myers, K. P., & Sclafani, A. (2006). Development of learned flavor preferences. *Developmental psychobiology*, *48*(5), 380-388.

Ness, A. R., & Powles, J. W. (1997). Fruit and vegetables, and cardiovascular disease: a review. *International Journal of epidemiology*, *26*(1), 1-13.

Nicklaus, S., Boggio, V., Chabanet, C., & Issanchou, S. (2005). A prospective study of food variety seeking in childhood, adolescence and early adult life. *Appetite*, *44*(3), 289-297.

Nicely, T. A., Lane-Loney, S., Masciulli, E., Hollenbeak, C. S., & Ornstein, R. M. (2014). Prevalence and characteristics of avoidant/restrictive food intake disorder in a cohort of young patients in day treatment for eating disorders. *Journal of Eating Disorders*, *2*(1), 21.

Nummenmaa, L., Hietanen, J. K., Calvo, M. G., & Hyönä, J. (2011). Food catches the eye but not for everyone: A BMI–contingent attentional bias in rapid detection of nutriments. *PLoS One*, *6*(5), e19215.

Olatunji, B. O., Williams, N. L., Tolin, D. F., Abramowitz, J. S., Sawchuk, C. N., Lohr, J. M., & Elwood, L. S. (2007). The Disgust Scale: item analysis, factor structure, and suggestions for refinement. *Psychological assessment*, *19*(3), 281.

Oldershaw, A., Treasure, J., Hambrook, D., Tchanturia, K., & Schmidt, U. (2011). Is anorexia nervosa a version of autism spectrum disorders?. *European Eating Disorders Review*, *19*(6), 462-474.

Paolacci, G., & Chandler, J. (2014). Inside the Turk: understanding Mechanical Turk as a participant pool. *Current Directions in Psychological Science*, *23*(3), 184-188.

Perkins, S. J., Keville, S., Schmidt, U., & Chalder, T. (2005). Eating disorders and irritable bowel syndrome: is there a link?. *Journal of psychosomatic research*, *59*(2), 57-64.

Phillips, S. M., Fulgoni, V. L., Heaney, R. P., Nicklas, T. A., Slavin, J. L., & Weaver, C. M. (2015). Commonly consumed protein foods contribute to nutrient intake, diet

quality, and nutrient adequacy. *The American journal of clinical nutrition*, *101*(6), 1346S-1352S.

Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite*, *19*(2), 105-120.

Price, K., Veale, D., & Brewin, C. R. (2012). Intrusive imagery in people with a specific phobia of vomiting. *Journal of behavior therapy and experimental psychiatry*, *43*(1), 672-678.

Raudenbush, B., Van Der Klaauw, N. J., & Frank, R. A. (1995). The contribution of psychological and sensory factors to food preference patterns as measured by the Food Attitudes Survey (FAS). *Appetite*, *25*(1), 1-15.

Rawal, A., Park, R. J., & Williams, J. M. G. (2010). Rumination, experiential avoidance, and dysfunctional thinking in eating disorders. *Behaviour Research and Therapy*, *48*(9), 851-859.

Revelle, W. (2014). psych: Procedures for psychological, psychometric, and personality research. *Northwestern University, Evanston, Illinois*, *165*.

Revelle, W., & Zinbarg, R. E. (2009). Coefficients alpha, beta, omega, and the glb: Comments on Sijtsma. *Psychometrika*, *74*(1), 145-154.

Rigal, N., Chabanet, C., Issanchou, S., & Monnery-Patris, S. (2012). Links between maternal feeding practices and children's eating difficulties. Validation of French tools. *Appetite*, *58*(2), 629-637.

Robertson, A. E., & Simmons, D. R. (2013). The relationship between sensory sensitivity and autistic traits in the general population. *Journal of Autism and Developmental Disorders*, *43*(4), 775-784.

Rodenburg, G., Kremers, S. P., Oenema, A., & van de Mheen, D. (2012). Associations of Children's appetitive traits with weight and dietary behaviours in the context of general parenting. *PLoS One*, *7*(12), e50642.

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation Modeling. Journal of Statistical Software, 48(2), 1-36.

RStudio Team (2016). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA. URL <http://www.rstudio.com/>.

Schoen, S. A., Miller, L. J., & Green, K. E. (2008). Pilot study of the sensory over-responsivity scales: Assessment and inventory. *American Journal of Occupational Therapy*, *62*(4), 393-406.

semTools Contributors. (2016). *semTools: Useful tools for structural equation modeling.* R package version 0.4-14. URL <http://cran.r-project.org/web/packages/semTools/index.html>

Shapiro, D. N., Chandler, J., & Mueller, P. A. (2013). Using Mechanical Turk to study clinical populations. *Clinical Psychological Science*, 2167702612469015.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: uses in assessing rater reliability. *Psychological bulletin*, *86*(2), 420.

Siegrist, M., Hartmann, C., & Keller, C. (2013). Antecedents of food neophobia and its association with eating behavior and food choices. *Food Quality and Preference*, *30*(2), 293-298.

Sleddens, E. F., Kremers, S. P., & Thijs, C. (2008). The Children's Eating Behaviour Questionnaire: factorial validity and association with Body Mass Index in Dutch

children aged 6–7. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 49.

Smith, A. M., Roux, S., Naidoo, N. R., & Venter, D. J. (2005). Food choices of tactile defensive children. *Nutrition*, *21*(1), 14-19.

Stables, G. J., Subar, A. F., Patterson, B. H., Dodd, K., Heimendinger, J., Van Duyn, M. A. S., & Nebeling, L. (2002). Changes in vegetable and fruit consumption and awareness among US adults: results of the 1991 and 1997 5 A Day for Better Health Program surveys. *Journal of the American Dietetic Association*, *102*(6), 809-817.

Stice, E., Telch, C. F., & Rizvi, S. L. (2000). Development and validation of the Eating Disorder Diagnostic Scale: a brief self-report measure of anorexia, bulimia, and binge-eating disorder. *Psychological Assessment*, *12*(2), 123.

Taylor, C. M., Northstone, K., Wernimont, S. M., & Emmett, P. M. (2016). Picky eating in preschool children: Associations with dietary fibre intakes and stool hardness. *Appetite*, *100*, 263-271.

Taylor, C. M., Wernimont, S. M., Northstone, K., & Emmett, P. M. (2015). Picky/fussy eating in children: Review of definitions, assessment, prevalence and dietary intakes. *Appetite*, 95, 349-359.

Tchanturia, K., Morris, R. G., Anderluh, M. B., Collier, D. A., Nikolaou, V., & Treasure, J. (2004). Set shifting in anorexia nervosa: an examination before and after weight gain, in full recovery and relationship to childhood and adult OCPD traits. *Journal of psychiatric research*, *38*(5), 545-552.

Thompson, C., Cummins, S., Brown, T., & Kyle, R. (2015). What does it mean to be a 'picky eater'? A qualitative study of food related identities and practices. *Appetite, 84*, 235-239.

Troop, N. A., & Treasure, J. L. (1997). Psychosocial factors in the onset of eating disorders: Responses to life-events and difficulties. *British Journal of Medical Psychology*, *70*(4), 373-385.

U.S. Department of Agriculture (2015). Scientific report of the 2015 dietary guidelines advisory committee: Advisory report to the secretary of Health and Human Services and the Secretary of Agriculture. Washington, DC.

U.S. Department of Agriculture and U.S. Department of Health and Human Services. (2010). Dietary Guidelines for Americans, 2010 (7th ed.). Washington, DC. Available at http://www.cnpp.usda.gov/ dietaryguidelines.htm

Van Duyn, M. A. S., & Pivonka, E. (2000). Overview of the health benefits of fruit and vegetable consumption for the dietetics professional: selected literature. *Journal of the American Dietetic Association*, *100*(12), 1511-1521.

van Strien, T., Herman, C. P., & Verheijden, M. W. (2012). Eating style, overeating and weight gain. A prospective 2-year follow-up study in a representative Dutch sample. *Appetite*, *59*(3), 782-789.

Veale, D., Costa, A., Murphy, P., & Ellison, N. (2012). Abnormal eating behaviour in people with a specific phobia of vomiting (emetophobia). *European Eating Disorders Review*, *20*(5), 414-418.

Walker, A. K., Ibia, I. E., & Zigman, J. M. (2012). Disruption of cue-potentiated feeding in mice with blocked ghrelin signaling. *Physiology & behavior*, *108*, 34-43.

Wang, X., Ouyang, Y., Liu, J., Zhu, M., Zhao, G., Bao, W., & Hu, F. B. (2014). Fruit and vegetable consumption and mortality from all causes, cardiovascular disease, and cancer: systematic review and dose-response meta-analysis of prospective cohort studies. *British Medical Journal*, 349, g4490.

Wardle, J., Guthrie, C. A., Sanderson, S., & Rapoport, L. (2001). Development of the children's eating behaviour questionnaire. *Journal of Child Psychology and Psychiatry*, *42*(7), 963-970.

Webber, L., Hill, C., Saxton, J., Van Jaarsveld, C. H. M., & Wardle, J. (2009). Eating behaviour and weight in children. *International Journal of Obesity*, *33*(1), 21-28.

Weir, J. P. (2005). Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *The Journal of Strength & Conditioning Research*, *19*(1), 231-240.

Wildes, J. E., Zucker, N. L., & Marcus, M. D. (2012). Picky eating in adults: Results of a web‐based survey. *International Journal of Eating Disorders*, *45*(4), 575-582.

Woodbury-Smith, M. R., Robinson, J., Wheelwright, S., & Baron-Cohen, S. (2005). Screening adults for Asperger syndrome using the AQ: A preliminary study of its diagnostic validity in clinical practice. *Journal of Autism and developmental disorders*, *35*(3), 331-335.

Xue, Y., Lee, E., Ning, K., Zheng, Y., Ma, D., Gao, H., ... & Zhang, Y. (2015). Prevalence of picky eating behaviour in Chinese school-age children and

associations with anthropometric parameters and intelligence quotient. A cross-sectional study. *Appetite*, *91,* 248-255.

Yao, C. K., Gibson, P. R., & Shepherd, S. J. (2013). Design of clinical trials evaluating dietary interventions in patients with functional gastrointestinal disorders. *The American journal of gastroenterology*, *108*(5), 748-758.

Yu, C. Y. (2002). *Evaluating cutoff criteria of model fit indices for latent variable models with binary and continuous outcomes* (Doctoral dissertation, University of California Los Angeles).

Zickgraf, H.F., & Ellis, J. M. (2018). Initial validation of the Nine Item Avoidant/Restrictive Food Intake Disorder Screen (NIAS): A measure of three restrictive eating behaviors. *Appetite,* 123, 32-42.

Zickgraf, H.F., Franklin, M. E., & Rozin, P. (2016). The relationship among picky eating, Avoidant/Restrictive Food Intake Disorder, psychopathology, and eating behavior: An online study. Revise and resubmit decision, *Journal of Eating Disorders*.

Zickgraf, H. F., & Schepps, K. (2016). Fruit and vegetable intake and dietary variety in adult picky eaters. *Food Quality and Preference*, *54*, 39-50.

Zucker, N. L., Losh, M., Bulik, C. M., LaBar, K. S., Piven, J., & Pelphrey, K. A. (2007). Anorexia nervosa and autism spectrum disorders: guided investigation of social cognitive endophenotypes. *Psychological bulletin*, *133*(6), 976.

Zucker, N., Copeland, W., Franz, L., Carpenter, K., Keeling, L., Angold, A., & Egger, H. (2015). Psychological and psychosocial impairment in preschoolers with selective eating. *Pediatrics*, *136*(3), e582-e590.