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Behavioral Pediatrics Feeding Assessment Scale in Young Children With Autism Spectrum Disorder: Psychometrics and Associations With Child and Parent Variables

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Abstract

Objective The factor structure and validity of the Behavioral Pediatrics Feeding Assessment Scale (BPFAS; Crist & Napier-Phillips, 2001) were examined in preschoolers with autism spectrum disorder (ASD). **Methods** Confirmatory factor analysis was used to examine the original BPFAS five-factor model, the fit of each latent variable, and a rival one-factor model. None of the models was adequate, thus a categorical exploratory factor analysis (CEFA) was conducted. Correlations were used to examine relations between the BPFAS and concurrent variables of interest. **Results** The CEFA identified an acceptable three-factor model. Correlational analyses indicated that feeding problems were positively related to parent-reported autism symptoms, behavior problems, sleep problems, and parenting stress, but largely unrelated to performance-based indices of autism symptom severity, language, and cognitive abilities, as well as child age. **Conclusion** These results provide evidence supporting the use of the identified BPFAS three-factor model for samples of young children with ASD.

Key words: assessment; autism spectrum; eating and feeding disorders.

Autism spectrum disorder (ASD) is a heterogeneous neurodevelopmental condition, affecting approximately 1% of children (Elsabbagh et al., 2012; Fombonne, Quirke, & Hagen, 2011). ASD is characterized by core deficits in social communication skills, and the presence of repetitive or restricted behavior or interests (American Psychiatric Association, 2013) that are associated with significant individual, familial, and societal costs (Buescher, Ciday, Knapp, & Mandell, 2014). Parents of children with ASD are also challenged to address the wide range of developmental, cognitive, medical, and behavioral differences that commonly overlap and interact with ASD (Bauman, 2010; Gillberg, 2011; Szatmari et al., 2015). Of the difficulties associated with ASD, feeding problems stand out as being of particular social and biological significance. Prevalence estimates suggest that a substantial proportion of children with ASD (e.g., 46–89%; Ledford & Gast, 2006) display feeding problems, including oral/motor difficulties (e.g., chewing), food selectivity, and mealtime behavior problems. When mismanaged or untreated, feeding problems may become chronic, affecting day-to-day family functioning, and compounding the demands of raising a child with ASD. Parents report that they struggle to manage their children's feeding problems and worry about the potential negative effects on health and development (Rogers, Magill-Evans, & Rempel, 2012; Suarez, Atchison, & Lagerway, 2014).

Increasing recognition of the number of children with ASD presenting to feeding clinics (Schreck, Williams, & Smith, 2004), and growing concerns about the potential for feeding problems to have a negative impact on children with ASD and their families (Cornish, 1998) appear to have generated a recent surge in research. Sharp, Berry, and colleagues (2013) conducted a meta-analysis of 17 prospective studies of feeding problems in children with ASD that included a comparison group (82% of studies included typically developing comparisons), and noted that more than a quarter of identified studies were published since 2010. Findings from the meta-analysis suggested that although the types of feeding problems observed in children with ASD appear to be comparable with those observed in their peers, they are far more common. Specifically, children with ASD were approximately five times more likely to display behavioral (e.g., food selectivity by type and texture, maladaptive mealtime behavior) and/or skill-based (e.g., oral-motor problems such as difficulty chewing and swallowing) feeding problems than their peers. In addition, despite being comparable with their peers on indices of height, weight, and dietary intake (i.e., levels of energy, carbohydrate, and fat consumption), across studies, children with ASD displayed higher rates of nutritional deficits than their peers (e.g., lower calcium and protein intake), which may place them at increased risk for adverse long-term health outcomes.

Despite mounting evidence and an increasing awareness that children with ASD are at particular risk for feeding problems, limited research has examined patterns of feeding problems in well-characterized (i.e., samples with a confirmed diagnosis of ASD) samples of children with ASD. To date, the vast majority of feeding research in children with ASD has relied on single-item indicators of feeding problems that vary widely across studies (Sharp, Berry, et al., 2013). For example, some researchers have focused specifically on food selectivity (i.e., eating a restricted range of foods; Suarez, Nelson, & Curtis, 2013), whereas others have taken a broader approach including mealtime behavior problems, and skill-based feeding difficulties (Martins, Young, & Robson, 2008; Nadon, Feldman, Dunn, & Gisel, 2011). This inconsistency has contributed to conceptual confusion regarding which behaviors and difficulties constitute the construct of feeding problems in children with ASD, limited our understanding of the etiology of feeding problems in these children, and hindered the accurate identification of prevalence rates of feeding problems in children with ASD. For example, in the meta-analysis by Sharp, Berry, and colleagues (2013), prevalence rates varied as a function of the content of the questions used to identify feeding problems. The development of standardized measures of feeding problems in children with ASD is critical for the advancement of research and clinical efforts aimed at further understanding and mitigating feeding problems in children with ASD.

Historically, researchers (Schreck et al., 2004; Seiverling, Hendy, & Williams, 2011) interested in quantifying feeding problems in children with ASD using more than a single-item indicator have used a wide range of caregiver-report measures that were not established or standardized for use with children with ASD (e.g., The Children's Eating Behavior Inventory, Archer, Rosenbaum, & Streiner, 1991; Child Eating Behavior Questionnaire, Wardle, Guthrie, Sanderson, & Rapaport, 2001; Parent Mealtime Action Scale, Hendy, Williams, Camise, Eckman, & Hedemann, 2009). More recently, Lukens and Linscheid (2008) developed the Brief Autism Mealtime Behavior Inventory (BAMBI), in an attempt to meet the identified need for a standardized measure of feeding problems validated for use in children with ASD. The BAMBI consists of 18 items across three subscales: Food Refusal/Disruptive Behavior; Limited Variety; and Autism Features. Although the original validation study (Lukens & Linscheid, 2008) provided promising support for the validity and reliability of the BAMBI, subscales of the BAMBI (e.g., the Autism Features subscale) have not consistently performed as expected (Sharp, Jaquess, & Lukens, 2013), and developments in our understanding of feeding problems in children with ASD call into question the face validity of the BAMBI. Specifically, Lukens and Linscheid's (2008) decision to depart from established measures of pediatric feeding problems, and to develop the BAMBI to account for putative unique and autism-specific feeding problems seems premature in light of recent evidence suggesting that the types of feeding problems observed in children with ASD are not unique (Sharp, Berry, et al., 2013). Bearing these limitations and considerations in mind, there is a clear need for continued research to develop reliable, valid, and comprehensive measures of feeding problems in children with ASD.

Given evidence that the types of feeding problems observed in children with ASD are comparable with those observed in their peers, it would seem relevant to determine whether existing well-established measures of feeding problems are useful for understanding patterns of feeding problems in children with ASD. Thus, the purpose of the current study was to examine the utility of the Behavioral Pediatrics Feeding Assessment Scale (BPFAS; Crist & Napier-Phillips, 2001) for measuring patterns of feeding problems in a large, unselected, and well-characterized sample of preschoolers with ASD. The BPFAS is a comprehensive and widely used measure of behavioral and skill-based feeding problems. It is a reliable and valid measure that effectively discriminates children with clinically significant feeding problems in both normative and clinical populations (Crist & Napier-Phillips, 2001). Factor analysis of the BPFAS in the normative sample yielded five factors (i.e., picky eaters, toddler refusal-general, toddler refusal-textured food, older child refusal, stallers) that tap into oral-motor difficulties, food selectivity, and problematic mealtime behavior. Although the BPFAS has been used with children with ASD (Lukens & Linscheid, 2008; Martins et al., 2008), its utility for assessing patterns of feeding problems in unselected children with ASD is yet to be examined.

The primary goal of the present study was to establish the underlying factor structure of the BPFAS in our sample of preschoolers with ASD. The first step in our analysis was to examine how well the established five-factor measurement model (Crist & Napier-Phillips, 2001) fit the BPFAS data collected in our sample of preschoolers with ASD. We used confirmatory factor analysis (CFA) to test the null hypothesis that the original measurement model (Crist & Napier-Phillips, 2001) would fit our sample. After rejecting the null hypothesis, we used CFA to examine each of the five proposed factors of Crist and Napier-Phillips individually, and tested a competing one-factor model before using a categorical exploratory factor analysis (CEFA) to identify an alternative factor structure. Finally, we examined correlations between feeding problems and several child and parent variables of interest. Selection of variables for the correlational analyses was informed by previous research on feeding problems in children with ASD (Johnson et al., 2014; Sharp, Berry, et al., 2013) and the reasoning that feeding problems in preschoolers with ASD may be associated with variables tapping into more global functioning (e.g., cognitive, language, and adaptive behavior skills), those associated with general behavior problems (e.g., externalizing/disruptive behavior), variables reflecting somatic regulation difficulties (e.g., sleep), or variables measuring ASD-specific symptoms (e.g., repetitive behavior).

Method

Participants

Participants were recruited through an ongoing multisite (Canadian) longitudinal study of children with ASD and their families (the *Pathways in ASD* study). The larger study's purpose was to describe developmental trajectories in children with ASD, and to identify both individual and contextual factors associated with better outcomes. Families were recruited from five publicly funded regional ASD diagnostic programs. Each site's research ethics board approved the study, and families provided informed consent. Only one child per family participated, to ensure independence of observations. Participants met the following inclusion criteria: (1) recent (i.e., within 4 months) diagnosis of ASD, informed by the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000), Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003), and a clinician's best estimate; and (2) chronological age $\geq$2 years, and $\leq$5 years and 0 months. Exclusion criteria were (1) cerebral palsy or other neuromotor disorder interfering with study assessments, (2) known genetic or chromosomal abnormality, and (3) severe visual or hearing impairment. Participants were 374 children (314 male) with ASD with a mean age of 40.89 months (minimum = 23.77, maximum = 64.04) when their parents responded to the BPFAS (see Table I for full sample characteristics); of these, 347 provided complete BPFAS data. Independent samples *t* tests were used to compare the subsample that provided complete BPFAS data to the 27 who provided partial data. No sex differences were identified. However, participants with partial data were significantly younger at diagnosis (mean difference = 4.58 months; $p = .008$), younger when their parents completed the BPFAS (mean difference = 5.35 months; $p = .004$), and younger in terms of developmental age as indicated by the Merrill-Palmer-Revised (M-P-R) Scales of Development Index age-equivalent score (mean difference = 6.14 months; $p = .014$). The mean ADOS severity metric (Gotham, Pickles, & Lord, 2009) was also lower (i.e., indicated less severe ASD symptoms) for participants who provided partial data (mean difference = 0.80; $p = .020$).

Measures

Behavioral Pediatrics Feeding Assessment Scale

The BPFAS is a widely used parent-report measure of mealtime and feeding behavior (Crist & Napier-Phillips, 2001; Crist et al., 1994). It consists of 35 items; the first 25 of which focus on child behavior (e.g., *takes longer than 20 min to finish a meal; enjoys eating; has problems chewing foods*) and the last 10 of which provide an index of parental feelings about, and strategies for, addressing mealtime and feeding problems (e.g., *I get frustrated and/or anxious when feeding my child; I feel confident my child gets enough to eat*). Parents are asked to indicate how often the behavior occurs on a scale from 1 (*never*) to 5 (*always*). Positively phrased items are reverse-scored. Greater overall scores indicate higher levels of problematic mealtime and feeding behavior. Frequency scores for the 25 child-behavior items were used in the current analysis. Research on the BPFAS suggests that the first 25 items provide a reliable (e.g., Cronbach's $\alpha > .80$) and valid estimate of feeding problems across a range of non-ASD pediatric populations (e.g., normative group, children with cystic fibrosis, children with CHARGE syndrome, children with diabetes, and overweight/obesity; Crist & Napier-Phillips, 2001; Crist et al., 1994; Davis, Canter, Stough, Gillette, & Patton, 2014; Dobbelsteyn, Peacocke, Blake, Crist, & Rashid, 2008; Patton, Dolan, & Powers, 2006).

Table I. Sample Characteristics for Demographic Information and Variables of Interest

Characteristic	*N*	%	Mean	SD	Min–Max
Sex					
Boys	314	84			
Girls	60	16			
Child's age when caregiver completed the BPFAS (months)	374		40.89	9.26	23.77–64.04
Child's age at diagnosis (months)	374		38.26	8.66	19.17–59.57
Child's age-group					
2-year-olds	140	37.4			
3-year-olds	155	41.4			
4-year-olds	79	21.1			
Ethnicity					
White	272	72.7			
Other	102	27.3			
BPFAS child behavior total frequency score	374		53.1	11.9	28–96
ADOS severity metric	370		7.62	1.68	2–10
M-P-R Developmental Index age equivalent (months)	353		23.82	12.51	3–74
CBCL Internalizing *t*-score	364		60.26	9.31	37–85
CBCL Externalizing *t*-score	364		56.16	10.38	28–89
SRS Total *t*-score	340		76.12	13.26	47–111
RBS-R overall total	365		25.44	17.81	0–87
PLS-4 Total language standard score	354		65.66	19.44	50–136
VABS-II Adaptive Behavior Composite	364		73.01	10.26	48–101
CSHQ overall total	363		44.85	8.41	30–73
PSI-SF Total stress score	356		89.62	21.43	39–166

Note. *BPFAS* = Behavioral Pediatrics Feeding Scale, *ADOS* = Autism Diagnostic Observation Schedule, *M-P-R* = Merrill-Palmer-Revised, *CBCL* = Child Behavior Checklist, *SRS* = Social Responsiveness Scale, *RBS-R* = Repetitive Behavior Scale-Revised, *PLS-4* = Preschool Language Scale, Fourth Edition, *VABS-II* = Vineland Adaptive Behavior Scales, Second Edition, *CSHQ* = Children's Sleep Habits Questionnaire, *PSI-SF* = Parenting Stress Index-Short Form.

Autism Diagnostic Observation Schedule

The ADOS is an individually administered assessment of autism-related symptoms that uses semistructured activities to facilitate social interactions between the examiner and child (Lord et al., 2000). Observed behaviors are coded into predetermined categories to provide indices in the areas of social communication, and restricted and repetitive behavior. The autism severity metric, a measure of relative severity of autism-specific features, was used in the current analysis (Gotham et al., 2009). The ADOS has adequate test–retest reliability, and excellent interrater reliability and internal consistency.

M-P-R Scales of Development

The M-P-R Scales of Development is an individually administered, norm-referenced scale that measures cognitive, receptive language, and fine motor development in children aged 2–78 months (Roid & Sampers, 2004). The Developmental Index raw score was used in the current analyses. The M-P-R demonstrates adequate internal consistency (e.g., internal consistency for the Developmental Index = .98) and reliability (e.g., 3-week test–retest reliability for the Developmental Index = .89).

Preschool Language Scales-Fourth Edition

The Preschool Language Scales-Fourth Edition (PLS-4) is an individually administered, norm-referenced, language assessment for children between birth and 6 years 11 months (Zimmerman, Steiner, & Pond, 2002). The PLS-4 Total language standard score was used in the current analysis. The PLS-4 is a reliable (e.g., test–retest reliability for Total Language score ranges from .90 to .97) and valid measure that effectively identifies language-disordered children (sensitivity = .80; specificity = .88). Volden et al. (2011) validated the PLS-4 as an index of early semantic and syntactic skills in this sample of preschoolers with ASD.

Child Behavior Checklist

The Child Behavior Checklist (CBCL) is a widely used, valid, reliable, and norm-referenced, parent-report measure of externalizing and internalizing behavior in children (Achenbach & Rescorla, 2000). Parents are asked to indicate how well each of 99 problem items (e.g., *Can't sit still, restless, or hyperactive; Cries a lot*) characterized their child's behavior over the past 2 months using a scale from 0 (*not true*) to 2 (*very often true or often true*). Standard scores for the Internalizing and Externalizing subscales were used in the current analyses. Research supports the factor validity and the reliability of these subscales (Internalizing: Cronbach's $\alpha = .80$; Externalizing: Cronbach's $\alpha = .90$) in preschoolers with ASD (Pandolfi, Magyar, & Dill, 2009).

Social Responsiveness Scale

The Social Responsiveness Scale (SRS) is a 65-item parent-report measure of ASD symptoms, including social behavior (e.g., social awareness, reciprocal communication, social anxiety, or avoidance) and autistic preoccupations and traits (Constantino & Gruber, 2005). Parents indicate how often each item is true for their child on a scale from 1 (*not true*) to 4 (*almost always true*). The overall standard score was used for the current analyses; higher total scores indicate greater levels of ASD symptoms. The SRS has adequate validity and reliability. For example, maternal reports on the SRS are strongly and positively correlated with scores on the ADI-R (coefficients ranging from .65 to .71), establishing the convergent validity of the measure (Constantino et al., 2003). Scores on the SRS are stable across time and between raters; for example, 3-month test–retest reliability is .88, and the interrater reliability is .80.

Repetitive Behavior Scale-Revised

The Repetitive Behavior Scale-Revised (RBS-R) is a 43-item parent-report questionnaire measuring the presence and intensity of various types of restricted and repetitive behavior characteristic of ASD (Bodfish, Symons, Parker, & Lewis, 2000). Parents provide ratings on a scale from 0 (*behavior does not occur*) to 3 (*behavior occurs and is a severe problem*). The total raw score was used for the current analyses; higher total scores indicate greater levels of restricted and repetitive behavior. The RBS-R is valid and reliable (e.g., Cronbach's $\alpha > .80$; Lam & Aman, 2007). Mirenda et al. (2010) provided support for the RBS-R as a measure of repetitive behavior in this sample of preschoolers with ASD.

Vineland Adaptive Behavior Scales-Second Edition

The Vineland Adaptive Behavior Scales-Second Edition (VABS-II) is designed to measure adaptive functioning in children from birth to 18 years across the domains of communication, socialization, daily living skills, and motor skills (Sparrow, Cicchetti, & Balla, 2005). The measure is semistructured, consisting of open-ended questions used to gather in-depth information. The VABS-II has adequate validity and reliability (e.g., Cronbach's $\alpha > .75$). The standardized overall Adaptive Behavior Composite score was used in the current analyses.

Children's Sleep Habits Questionnaire

The Children's Sleep Habits Questionnaire (CSHQ) is a 35-item parent-report questionnaire that measures sleep problems in 2- to 10-year-olds (Goodlin-Jones, Sitnick, Tang, Liu, & Anders, 2008; Owens, Spirito, & McGuinn, 2000). Parents rate 33 unique items (i.e., two items appear twice across subscales) on a scale from *rarely* (0–1 night per week) to *usually* (5–7 nights per week); higher scores indicate more sleep problems. The CSHQ total raw score, which sums parents' responses across the 33 unique items, was used in the current analyses. The CSHQ is a valid and reliable (e.g., Cronbach's $\alpha = .68$ for community samples and .78 for clinical samples) measure of sleep problems that effectively discriminates between clinical and community samples (Owens et al., 2000). The CSHQ is commonly used as an index of sleep problems in children with ASD (Honomichl, Goodlin-Jones, Burnham, Gaylor, & Anders, 2002; Malow et al., 2006).

Parenting Stress Index-Short Form

The Parenting Stress Index-Short Form (PSI-SF) is a widely used parent-report measure of parenting stress (Abidin, 1995). Parents rate 36 items on a 5-point Likert scale from *strongly disagree* to *strongly agree*; higher scores indicate increased levels of parenting stress. The PSI-SF total raw score was used in the current analysis. The PSI-SF is valid and reliable (Cronbach's $\alpha > .80$; Abidin, 1995). Zaidman-Zait et al. (2011) provided support for the utility of the PSI-SF as an index of parenting stress in the current sample.

Data Analytic Plan

The analysis was conducted in three phases. First, we examined the psychometric properties of the BPFAS by evaluating the internal consistencies of the five factors and applying CFA to test the five-factor model of Crist and Napier-Phillips (2001). The model's five latent variables were specified as follows: (1) picky eaters factor (items 1, 3, 5, 6, 9, 10, 16, 18, 19, and 22); (2) toddler refusal-general factor (items 4, 7, 5, 17, 19, 20, and 23); (3) toddler refusal-textured foods factor (items 2, 4, 8, 11, and 18); (4) older child refusal-general factor (items 2, 9, 10, 12, 13, 20, 21, 23, 24, and child's age at completion of the BPFAS); and (5) stallers factor (items 3, 9, 13, 14, 17, 20, 22, and 23). In addition, CFA was used to examine the fit of each individual latent variable, and the fit of the Crist and Napier-Philips five-factor model, as well as a rival one-factor model. All factor analyses were conducted using Mplus version 7.0 (Muthén & Muthén, 1998–2012). In line with Brown (2006), we considered our CFA to be a hypothesis-driven approach, as the goal of the analysis was to determine whether the Crist and Napier-Phillips (2001) measurement model fit our data. Thus every effort was made to replicate directly the principal component analysis (PCA) by Crist and Napier-Phillips (2001). To this effect, the CFAs were applied to the subsample of 347 *Pathways in ASD* participants who had complete data, and items were specified as orthogonal (i.e., correlations among the five latent variables were set to zero). Maximum likelihood parameter estimates robust to non-normality of data were applied.

The comparative fit index (CFI), The Tucker–Lewis index (TLI), and the root mean square error of approximation (RMSEA) were used to assess the goodness of fit of each tested model. All three statistical indices are robust to the influence of sample size (Hu & Bentler, 1999). The CFI and TLI assess the fit of specified models relative to a null baseline model; values close to 1.0 are desired, with values >0.95 suggesting reasonable fit (Hu & Bentler, 1999). The RMSEA provides an index of how well the model parameters replicate the population covariances; small values are desired, with values <0.08 suggesting adequate model fit, and values approximating 0.06 indicating good model fit (Browne & Cudeck, 1993; Hu & Bentler, 1999). The chi-square goodness-of-fit statistic is influenced by sample size; however, we included it to provide a more complete picture of model fit. The internal consistencies of the overall scale and each unique factor were assessed using Cronbach's alpha (α); values of $\geq .70$ suggest acceptable internal consistency (Heppner, Kivlighan, & Wampold, 1999).

After rejecting the models examined by the CFAs (see Results), we used a data-driven approach, CEFA, to determine an alternative factor structure. No assumptions were made about the pattern among variables; factors were allowed to covary freely and thus are estimated from the data. The weighted least squares with mean and variance adjustment estimator was used, as recommended for Likert-type rating scales where non-normality might be of concern (Muthén, du Toit, & Spisic, 1997). Full-information maximum likelihood (FIML) estimation was used, to take advantage of the full data set ($n = 374$), as 4.5% of the data were missing. FIML correctly produces unbiased estimates that describe the entire sample. Specifically, FIML draws on the information in observed responses to infer what the complete model would look like if no data were missing (Little, Jorgensen, Lang, & Moore, 2014). To prevent overfactoring and ensure that factors were well-defined (i.e., ensuring that at least three items loading onto each factor improves stability; Brown, 2006), the analysis was restricted to a five-factor extraction (i.e., 25 items divided by five factors would result in at least three items loading on each factor). After running the CEFA, the Kaiser–Guttman rule (i.e., retaining only factors with eigenvalues ≥ 1) and scree plot examination were used to determine the number of plausible extracted factors. We then examined the RMSEA fit statistic for each of the derived factor solutions. PROMAX oblique factor rotations were applied to improve the interpretability of solutions with adequate RMSEA fit statistics. The PROMAX oblique factor rotation is the appropriate choice when factors are likely intercorrelated (Hendrickson & White, 1964). Empirical decisions for the factor analysis were based on multiple criteria. Each rotated factor solution was examined with respect to the (a) number of items that loaded on each factor, (b) magnitude of the loadings, and (c) interpretability of the items and factors. Specifically, Brown (2006) recommended that factor loadings >0.3 should be considered for applied research.

In the third phase, we examined the degree of association between each of the three identified factors and concurrent child and parent variables of interest. Unadjusted Spearman's rank order correlations were used because of the non-normality of the three factor scores and the variables of interest (Williams, Zimmerman, & Zumbo, 1995). Variables of interest included parent-report indices of adaptive functioning (VABS-II), ASD symptoms (RBS-R and SRS), problem behavior (CBCL), sleep problems (CSHQ), and parenting stress (PSI-SF), and performance-based indices of ASD symptoms (ADOS severity metric), developmental level (indexed by the M-P-R), and language ability (PLS-4), and, finally, the age of the child when the parent completed the BPFAS. Raw scores were used where available in order not to confound associations with chronological age. The VABS-II, PLS-4, and ADOS severity metric were not developed to yield total raw scores, thus we retained the standard scores for these three variables. The directionality and magnitude of the correlations were examined using Cohen's (1992) benchmarks for interpretation of effect sizes ($r = .10$–$.29$ suggests a small, .30–.49, a medium, and $>.50$, a large effect size).

Results

Phase 1: Internal Consistencies and CFAs

Internal consistencies for the five factors proposed by Crist and Napier-Phillips (2001) were evaluated. The picky eaters (Cronbach's $\alpha = .80$), stallers (Cronbach's $\alpha = .75$), and toddler refusal-general (Cronbach's $\alpha = .70$) factors, and the overall scale (Cronbach's $\alpha = .82$) demonstrated acceptable internal consistency. In contrast, the toddler refusal-textured foods (Cronbach's $\alpha = .26$) and the older children refusal-general (Cronbach's $\alpha = .30$) factors both demonstrated poor internal consistency. The fit statistics for the five-factor model, the rival one-factor model, and each of the latent variables are presented in Table II. None of the tested models had acceptable fit statistics, and thus, all were rejected. We performed a CEFA to determine the factor structure of the BPFAS in the present sample.

Phase 2: CEFA

All factors extracted based on the a priori decision to restrict the analysis to five factors emerged with eigenvalues >1.00, together explaining 53.97% of the variance. Fit was adequate (RMSEA < 0.08) for the two- (RMSEA $= 0.066$), three- (RMSEA $= 0.057$), four- (RMSEA $= 0.045$), and five-factor (RMSEA $= 0.035$) models examined. These four models were then each reassessed using a PROMAX (oblique) rotation. Following examination of the number of items loading onto each factor, magnitude of factor loadings, and interpretability of the factor loadings, the three-factor solution emerged as the most parsimonious and interpretable factor structure and thus was selected. Item 8 ("drinks milk") was excluded, as it loaded <0.30 on all factors. The three-factor solution accounted for 43.13% of the cumulative variance. Table III shows the loading matrix for the three-factor model (after removal of Item 8) and provides the means and standard deviations for each factor and each item; items are listed in their order in the BPFAS. We labeled Factor 1 as

Table II. Goodness-of-Fit Statistics for Models Tested Using Confirmatory Factor Analysis (N = 347)

Model	χ^2 statistic (*df*)	CFI	TLI	RMSEA
BPFAS replication: five-factor model	625.15* (260)	0.672	0.622	**0.064**
BPFAS: one-factor model	624.02* (275)	0.642	0.609	**0.060**
Picky eaters factor model	943.96* (266)	0.372	0.348	0.086
Toddler refusal-general factor model	1179.76* (293)	0.204	0.185	0.093
Toddler refusal-textured foods factor model	1359.17* (295)	0.045	0.029	0.102
Older children refusal-general factor model	1241.02* (290)	0.146	0.117	0.097
Stallers factor model	1151.44* (292)	0.229	0.207	0.092

Note. CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root mean square error of approximation; numbers in bold meet criterion for good model fit.

*$p < .001$.

Table III. The PROMAX Rotated Factor Loadings With a Three-Factor Solution of the BPFAS (Loadings <0.30 Are Omitted) With Descriptive Statistics for Each Factor and Each Item

Item #	Item description	Food acceptance $M = 15.37$ $SD = 4.58$	Medical/oral motor $M = 18.21$ $SD = 5.13$	Mealtime behavior $M = 24.17$ $SD = 7.19$	*M* (*SD*)
1	Eats fruits[a]	0.496			2.25 (1.32)
2	Has problems chewing food		0.720		1.75 (1.10)
3	Enjoys eating[a]	0.350	0.343	0.354	2.14 (1.01)
4	Chokes or gags at mealtime		0.765		1.63 (0.90)
5	Will try new food[a]	0.660			3.41 (1.05)
6	Eats meat and/or fish[a]	0.539			2.53 (1.32)
7	Takes longer than 20 min to finish a meal		0.331		2.77 (1.33)
8	Drinks milk				
9	Comes readily to mealtime[a]			0.485	2.58 (1.15)
10	Eats junky snack foods will not eat not eat at mealtime			0.533	2.15 (1.08)
11	Vomits just before, at, or just after mealtime		0.506		1.13 (0.50)
12	Eats only ground, strained, or soft food		0.629		1.69 (1.14)
13	Gets up from table during meal			0.556	3.28 (1.32)
14	Lets food sit in his/her mouth and does not swallow it		0.405		1.57 (0.88)
15	Whines or cries at feeding time			0.582	1.95 (1.06)
16	Eats vegetables[a]	0.719			2.99 (1.35)
17	Tantrums at mealtimes			0.640	2.04 (0.96)
18	Eats starches (for example, potato, noodles)	0.361			2.07 (1.10)
19	Has a poor appetite		0.306	0.453	2.26 (1.12)
20	Spits out food		0.407		2.20 (0.99)
21	Delays eating by talking			0.371	1.44 (0.82)
22	Would rather drink than eat			0.443	2.51 (1.27)
23	Refuses to eat meals but requests food immediately after the meal			0.691	1.94 (1.10)
24	Tries to negotiate what he/she will eat and what he/she will not eat			0.444	1.94 (1.25)
25	Has required supplemental tube feeds to maintain proper nutritional status		0.569		1.04 (0.33)

Note. [a]reverse scoring.

Food Acceptance (Cronbach's $\alpha = .71$), Factor 2 as Medical/Oral Motor (Cronbach's $\alpha = .71$), and Factor 3 as Mealtime Behavior (Cronbach's $\alpha = .81$). The three identified factors were significantly intercorrelated ($r_s = .40$–$.58$, p values $< .01$).

Phase 3: Correlational Analyses

Table IV presents the Spearman rank order correlations between the three identified BPFAS factors and the child and parent variables of interest. Positive correlations, varying from small to medium effect sizes, were found between each of the three factor scores and parent-reported autism symptoms (as indexed by both the SRS and the RBS-R). Parents who reported higher levels of autism symptoms (e.g., social and communication difficulties, and repetitive or restricted behavior) endorsed more feeding-related difficulties. In contrast, there was only a small negative correlation between the ADOS severity metric and the third factor (Mealtime Behavior), and no notable relation between the ADOS severity metric and the first two (Food Acceptance and Medical/Oral Motor). Positive correlations were found between each of the three factor scores and child problem behavior (indexed by the CBCL Internalizing and Externalizing subscales). Thus, parents who reported more problem behavior overall endorsed more feeding-related difficulties. Correlations of medium effect sizes were found between the Medical/Oral Motor factor and the Mealtime Behavior factor and both Internalizing and Externalizing behavior scores. Small to medium positive correlations were also observed between all three factors and child sleep difficulties (indexed by the CSHQ),

Table IV. The Spearman's Rank Order Correlation Coefficients Between Scores on the Three BPFAS Factors and Outcome Variables of Interest

	Food acceptance	Medical/ oral motor	Mealtime behavior
CBCL Internalizing total raw score	0.27	0.44	0.47
CBCL Externalizing total raw score	0.20	0.34	0.48
SRS Total raw score	0.20	0.28	0.34
ADOS severity metric	0.04	−0.06	−.10
RBS-R overall total	0.26	0.32	0.40
M-P-R Developmental Index raw score	−0.04	−0.02	0.12
PLS-4 Total language standard score	−0.09	0.02	0.05
VABS-II Adaptive Behavior Composite	−0.22	−0.11	−0.05
CSHQ Total raw score	0.19	0.27	0.35
PSI-SF Total stress score	0.17	0.33	0.38
BPFAS age at completion	0.05	0.00	0.19

Note. *ADOS* = Autism Diagnostic Observation Schedule, *CBCL* = Child Behavior Checklist, *SRS* = Social Responsiveness Scale, *RBS-R* = Repetitive Behavior Scale-Revised, *M-P-R* = Merrill-Palmer-Revised, *PLS-4* = Preschool Language Scale, Fourth Edition, *VABS-II* = Vineland Adaptive Behavior Scales, Second Edition, *CSHQ* = Children's Sleep Habits Questionnaire, *PSI-SF* = Parenting Stress Index-Short Form, *BPFAS* = Behavioral Pediatric Feeding Assessment Scale.

r = .10–.29 indicates small effect size.

r = .30–.49 indicates a medium effect size.

r > .50 indicates a large effect size (Cohen, 1992).

as well as parenting stress (indexed by the PSI-SF). Parents who reported more frequent problems related to their children's eating also reported many sleep problems for their children, and reported experiencing higher levels of parenting stress.

Small negative correlations were found between the first two factors (Food Acceptance and Medical/Oral Motor) and parent reports of children's adaptive functioning (indexed by the VABS-II), indicating that parents who indicated that their child was lower functioning also reported higher levels of medical or oral motor problems and food refusal. No substantial correlations were identified between the first two BPFAS factors (Food Acceptance and Medical/Oral Motor) and cognitive functioning (indexed by the M-P-R), or age at completion of the BPFAS. Further, no substantial relations were identified between any BPFAS factor score and children's language ability (as assessed by the PLS-4). Small positive correlations were found between the Mealtime Behavior factor and child's age and cognitive level, indicating that parents of children who were chronologically or developmentally older reported marginally higher levels of problematic mealtime behavior.

Discussion

The primary objective of this study was to examine the underlying factor structure of the BPFAS in preschoolers with ASD, using data gathered soon after diagnosis. To our knowledge, this study is the first to examine the factor structure of this well-established feeding measure in children with ASD. Moreover, this study is the first to examine the psychometric properties of any feeding measure in a large, representative, and well-characterized sample of preschoolers with ASD. A secondary goal was to examine patterns of relations among feeding problems identified by the BPFAS and several child and parent variables of interest.

CFAs of the extant five-factor structure of the BPFAS, each individual latent variable, and a rival one-factor model indicated that all tested models were unacceptable when applied to this large sample. Findings regarding the inadequacy of the five-factor structure are consistent with research indicating that this structure was not fully supported in samples of children with chronic illness (i.e., diabetes; Patton et al., 2006) or children who were overweight or obese (Davis et al., 2014). Methodological limitations inherent to the original factor analysis of the BPFAS (Crist & Napier-Phillips, 2001) may contribute to these findings. Crist and Napier-Phillips (2001) relied on PCA to derive the original factor structure, an approach that has been widely criticized for deriving biased estimates (Pett, Lackey, & Sullivan, 2003). PCA is a manifest variable procedure that represents the total weighted linear combinations of all observed variables. It assumes that all variables are orthogonal; it does not partial out variance that is unique to a particular observed variable (Jolliffe, 2005). Consequently, factors derived from PCA tend to overestimate the linear patterns among variables, potentially inflating factor loadings and limiting the identification of stable, generalizable factors. In addition to the limitations inherent to the use of PCA, Crist and Napier-Phillips used a sample that may have been underpowered for their analysis, further affecting the generalizability of the identified factor structure. Despite our awareness of these limitations, we followed recommendations (Brown, 2006) to adopt a hypothesis-testing approach to determining whether the Crist and Napier-Phillips (2001) measurement model fit our sample. By doing so, we provide empirical support for rejecting their five-factor model, as well as each of their five proposed latent variables, and the rival one-factor model. In turn, we built a compelling rationale for undertaking an exploratory approach to identify a factor structure that is more appropriate for our sample. A common factor analysis, adopting recent statistical approaches to accommodate missing data (i.e., FIML; see Little et al., 2014) and indicator variables (Muthén & Muthén, 1998–2012), was used to identify an alternative three-factor solution. All three factors had acceptable internal consistency, supporting the construct validity of the identified model in the present sample. However, it is possible that the pattern of missing data, wherein younger children were more likely to have partial data than older, may have impacted the generalizability of our findings to younger children. Further research is needed to establish the measurement invariance of this model across time, different age groups, and in samples of children with different levels of identified feeding problems.

Findings from the correlational analyses were largely consistent with previous ASD research (Johnson et al., 2014; Lukens & Linscheid, 2008; Sharp, Berry et al., 2013), and the broader literature on feeding problems (Hemmi, Wolke, & Schneider, 2011). Parents who endorsed higher levels of feeding problems were more likely to report that their children displayed higher levels of autism-related symptoms, higher levels of other regulatory problems such as sleep difficulties, and higher levels of internalizing and externalizing behavioral symptoms. Consistent with research suggesting that parents of children with ASD report experiencing substantial stress and exhaustion related to their children's feeding problems (Rogers et al., 2012; Suarez et al., 2014), parents who endorsed more feeding problems reported higher levels of parenting stress. Although some feeding problems showed association with adaptive behavior, feeding problems were largely unrelated to measures of cognitive and language functioning. Children with higher levels of food refusal (i.e., a higher score on the Food Acceptance scale) and feeding problems related to medical or oral-motor difficulties displayed lower levels of adaptive functioning, but no BPFAS factor was related to language abilities, and only Mealtime Behavior was marginally related to cognitive abilities. The pattern of correlations identified between feeding problems and cognitive functioning parallels the relationship between feeding problems and the age of the child at BPFAS completion. This finding may be an artifact of the inclusion of behavior unlikely to be displayed by younger children with ASD (e.g., "tries to negotiate") in the Mealtime Behavior factor.

Findings from the correlational analyses should be interpreted with caution. Researchers have long recognized that feeding problems stem from a dynamic interplay of biological, social, and behavioral factors (Crist & Napier-Phillips, 2001); thus, from a theoretical standpoint, it is not surprising that relationships were identified between parent reports of feeding, sleep, autism symptoms, broader behavioral problems, and parenting stress. However, the possibility that some correlational results are driven by shared method and reporter variance looms large, and constitutes a major limitation of the current study. The measures that are positively associated with the BPFAS are all parent-report measures, whereas those that are not associated with the BPFAS are performance-based. The only variable of interest for which we had both a parent-report and a performance-based index was ASD symptom severity. Findings related to ASD symptom severity indicate that parent-reported feeding problems are related to parent-report symptom indices, but not the performance-based ADOS severity metric. This pattern of findings is consistent with previous research that included both parent-report and performance-based indices of ASD severity (Johnson et al., 2014; Sharp, Jaquess et al., 2013). However, it remains possible that relationships between parent reports of feeding and sleep problems, autism symptoms, broader behavioral problems, and parenting stress are inflated in the present data. Research that includes multiple methods for assessing feeding problems (e.g., parent-report feeding problem questionnaires; mealtime diaries; mealtime observations) and outcome variables of interest could help to shed light on these relationships. Future research should also consider obtaining reports on behavior of interest from multiple sources. Performance-based measures (e.g., mealtime observations) are often obtained under specific well-controlled situations, and may not fully capture the broad range of behavior that parents and other caregivers observe under typical conditions. Obtaining multiple indices of feeding and other behavior of interest from multiple sources and using multiple methods will provide the most complete picture of patterns of feeding problems in children with ASD.

In sum, the present study identified an acceptable three-factor solution that can be applied when using the BPFAS to measure patterns of feeding problems in preschoolers with ASD. Although further research is needed to establish measurement invariance and shed further light on relations between parent-reported feeding problems and other variables, the identified three-factor solution appears to be both empirically and theoretically sound. Consistent with previous research (Johnson et al., 2014; Sharp, Berry, et al., 2013), parents endorsed relatively high rates of both skills-based (i.e., Factor 2: Medical/Oral Motor) and behaviorally based (i.e., Factor 1: Food Acceptance and Factor 3: Mealtime Behavior) feeding problems. These results do not preclude the possibility of other types of feeding problems in some children with ASD, but this may be rarer than manifestations of common feeding problems. These findings are encouraging because the broader field of pediatric feeding disorders has established interventions for managing these common feeding problems that might prove useful with this population. However, it is critical to note that clarification regarding the types of feeding problems commonly manifested by children with ASD does not minimize the potential impact of feeding problems on children with ASD and their families. It is entirely possible that the effects of feeding problems in children with ASD are additive, particularly in children and families who are trying to manage the range of behavioral challenges that often accompany ASD (e.g., sleep problems, disruptive behavior). Further, it is also conceivable that the persistence or resistance to treatment of these common problems may differ in this population. These are important empirical questions for future research that will need to be addressed with standardized measures of feeding problems, such as the BPFAS. For example, BPFAS data from the *Pathways in ASD* longitudinal study will allow us to examine the stability of patterns of feeding problems and their correlates in children with ASD across time. In the meantime, the BPFAS may be used to support clinical work, for example, screening for feeding difficulties and quantifying the impact of treatment in children with ASD.

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