



Diagnostic, clinical, and personality correlates of food anxiety during a food exposure in patients diagnosed with an eating disorder

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Abstract

Background Eating disorders are characterized by high levels of anxiety, especially while eating. However, little is known about anxiety experienced during meals and specifically what other variables may impact such anxiety.

Objective We sought to further quantify and understand the relationship between food anxiety, eating disorders, and related correlates (e.g., comorbid diagnoses, personality).

Methods In the current study [$N = 42$ participants diagnosed with an eating disorder ($n = 36$ participants with anorexia nervosa)], we quantified anxiety before, during, and after a meal using data from a food exposure session in a partial hospital eating disorder center. We examined diagnostic, personality, and clinical factors as correlates of food anxiety.

Results Participants were more likely to experience higher food anxiety if they had a current diagnosis of major depression, obsessive–compulsive disorder, or post-traumatic stress disorder (PTSD). Concern over mistakes was the strongest and most consistent correlate of food anxiety regardless of time during the meal that anxiety was assessed. Other significant correlates were fear of positive evaluation, social appearance anxiety, BMI, and trust.

Conclusions These findings show how diagnoses, perfectionism (concern over mistakes), and other correlates relate to anxiety during meals. Food exposure interventions may benefit from personalizations that address these factors.

Level of evidence IV Evidence from a randomized control trial, but from the first session before effects of the design would be present.

Keywords Fear of food · Exposure therapy · Anorexia nervosa · Social appearance anxiety · Perfectionism

Introduction

Eating disorders (ED) are serious psychiatric illnesses [21]. At the core of ED pathology is dysfunction in eating behaviors, which may include restriction, binge eating, purging, and/or other related behaviors [2]. In light of a robust and striking comorbidity between ED and anxiety disorders [20], and evidence of a shared transmission of ED and anxiety disorders [48], it has been proposed that anxiety might be a mechanism implicated in the development of maintenance of these dysfunctional eating behaviors [45, 46]. Indeed, individuals with ED and particularly those diagnosed with anorexia nervosa (AN), experience heightened anxiety when around food or when participating in a meal [1, 5, 27, 44]. However, there is strikingly little known about the specifics of anxiety surrounding food and mealtimes. For example, it is unknown how food anxiety differs by diagnosis and is impacted by other relevant clinical and personality variables.

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The research that has been conducted has implicated anxiety during mealtime as a possible mechanism underpinning calorie restriction. For example, higher pre-meal anxiety was associated with decreased caloric intake in patients with AN [46], and anxiety during meals is associated with eating psychopathology in adolescents [51]. Furthermore, mean anxiety during a meal is associated with increased frequency of disordered eating behaviors, such as nibbling or tearing food, which are characteristic behaviors in individuals with ED [11]. Additionally there is some literature showing that pre-meal (or anxiety before a meal) and average anxiety during and after a meal is associated with disordered eating, although these associations vary based on when anxiety is measured [5, 46, 51], showing that understanding anxiety during eating is of crucial importance, specifically understanding how different time points of anxiety experienced during eating are related to crucial clinical, demographic, and personality factors.

It has repeatedly been suggested that a better explication of the nature of eating-related anxiety in ED may yield significant advances in exposure-based treatments [23, 36, 37, 43]. To date, several trials have demonstrated the promise of using exposure therapy to treat anxiety during meals both within AN and across additional ED diagnoses, which in turn impacts ED behaviors [6, 27, 39, 44, 47]. However, while promising, exposure-based treatments have been stymied by a non-precise understanding of the nature of anxiety in the context of ED, and particularly as related to food consumption; a core feature of ED.

Taken together, the literature suggests: (1) that food anxiety may be a worthwhile target to help alleviate dysfunctional eating behaviors, and (2) that exposure interventions might be a tool that can help target food anxiety. However, there still remain many unanswered questions about food anxiety that can inform our development of exposure interventions. Specifically, there is no literature characterizing which individuals are more or less likely to experience food-related anxiety (over and above a diagnosis of an eating disorder). There is also no literature on what type of personality and clinical correlates may be associated with food anxiety (e.g., social anxiety, BMI). Identification of diagnostic, personality, and clinical correlates of food anxiety can help inform which patients may benefit from interventions, such as exposure therapy, that address food anxiety. This knowledge might lead to additional strategies to optimize treatment approaches. For example, if certain clinical correlates (e.g., concern over mistakes perfectionism) are associated with food anxiety, it may be beneficial to personalize treatment to target concern over mistakes in the hopes that this might decrease food-related anxiety.

In the current study, we conducted secondary analyses of clinical and personality characteristics of food anxiety during a brief exposure-based intervention [31] with the goal

of expanding existing knowledge relating to the correlates of food-related anxiety in those with ED. We focused specifically on diagnoses of anxiety disorders and depression, given their high rates of overlap with ED [38]. Further, we paid special attention to aspects of social anxiety and perfectionism (concern over mistakes), given that most meals are in social settings and social anxiety and perfectionism, specifically concern over mistakes (see for example: Bulik et al. [4]; Sassaroli et al. [41]; Halmi et al. [14]), are both related to eating disorders and anxiety both as a developmental and maintenance factor [29, 32] and a negative predictor of positive treatment outcome in the ED [13], as well as a treatable construct in evidence-based protocols [15, 26].

We included each of our clinical variables [Body Mass Index (BMI), fear of negative evaluation, social appearance anxiety, fear of positive evaluation] and personality variables (concern over mistakes, high standards, each of the five personality factors, trust, and achievement striving) because of the strong literature showing that these variables uniquely relate to eating disorder symptoms, as well as anxiety [4, 10, 29, 32, 33, 42, 53]. Specifically, we had two primary questions. First, are there diagnoses, beyond the diagnosis of an ED, which increase the likelihood of experiencing high food-related anxiety? Second, what are the personality and clinical correlates of food anxiety across several time points throughout a meal? We hypothesized that facets of social anxiety and perfectionism (specifically concern over mistakes) would be related to food anxiety, given the highly social nature of meals.

Methods

Participants

Participants were recruited from a community ED treatment center that provides partial hospitalization treatment to a multi-diagnostic array of ED. All participants met *DSM-IV* criteria for a diagnosis of AN, bulimia nervosa (BN), or eating disorder not otherwise specified (EDNOS), and were expected to be present for the 3 weeks they were enrolled in the study. Most participants met criteria for AN ($n = 36$), although we included data from all participants enrolled in the study (BN; $n = 3$; EDNOS $n = 2$; BED $n = 1$) because participants without a full diagnosis of AN still endorsed significant food anxiety and participated in the exposure intervention. We should note that there were no substantive changes to the results when analyzed both with and without participants with BN/EDNOS/BED. No participants were currently psychotic or manic. Participants were not allowed to take benzodiazepines for 8 h before the exposure. More details and demographics on our sample can be found in the paper by Levinson et al. [31].

Procedures

The Washington University Institutional Review Board approved the study. Participants gave written consent for their participation. The complete study protocol is available by request from the first author. More details on the full study procedure and the original trial that these data were used for can be found in Levinson et al. [31]. The results presented here do not overlap with the results presented in Levinson et al. [31]. In the current study we decided a priori to examine clinical and personality variables correlations with the first meal (before having done an exposure) because we would not expect to see an impact of exposure therapy prior to the first session.

Measures

Structured clinical interviews

Participants were given a formal assessment using two structured clinical interviews the Mini International Neuropsychiatric Inventory (MINI) [25] and the Structured Clinical Interview for *DSM-IV* ED Module to determine eligibility. Comorbid anxiety and depression was also assessed via the MINI.

Subjective units of distress scale (SUDS)

Anxiety was measured with the SUDS, which is a behavioral measure often used during exposure treatment and behavioral assessment to measure anxiety [52]. The SUDS scale has been shown to be a valid and reliable measure of state anxiety for both clinical and research outcomes [19]. SUDS ratings can range from 0 (completely calm) to 100 (highest anxiety). SUDS were measured before, during, and after the meal. After the meal participants were asked what their highest SUDS level was overall to create a measure of peak anxiety. Internal consistency (i.e., reliability between measurement points) for the SUDS scale across all time points was excellent ($\alpha \geq 0.96$).

BMI

BMI was assessed by either a licensed nurse or approved staff. BMI was measured by a medical grade Detecto Precision Scale and Height Tool. All participants were weighed in light clothing without shoes and were not informed of their weight.

The Mini-International Personality Item Inventory (MINI-IPIP)

Personality was measured by the MINI-IPIP [7], which is a 20-item short form measure of the five basic factors of personality: extraversion, neuroticism, agreeableness, conscientiousness, and openness. The internal consistency of all subscales of the MINI-IPIP was adequate to excellent ($\alpha \geq 0.63 - 0.91$), with the exception of the agreeableness subscale. We did not use the agreeableness subscale because this subscale did not have adequate internal consistency.

International personality item pool-NEO (IPIP-NEO-120)

Trust and achievement striving were measured using the 120-item IPIP-NEO-120 [18]. We specifically chose to assess trust (e.g., believe that others have good intention) and achievement striving (e.g., work hard), which are facets of agreeableness and conscientiousness, due to their potential association with ED [10, 33]. Research indicates good internal consistency for trust and achievement striving, and good convergent validity for these facets in two large internet-based samples. In this sample, trust had good internal consistency ($\alpha = 0.88$) and self-achievement had adequate internal consistency ($\alpha = 0.67$).

Frost multidimensional perfectionism scale (MPS)

Perfectionism was measured by the MPS [9], a 35-item self-report measure of perfectionism. Participants rated whether they agree with each statement on a five-point scale. The concern over mistakes and high standards subscales were used in this study because concern over mistakes has been shown to be the most relevant aspect of perfectionism in anorexia nervosa and high standards has also been hypothesized to play a role in ED [42]. Concern over mistakes indexes negative reactions to mistakes, the tendency to equate mistakes with a failure, and the belief that one will lose the respect of others because of mistakes [3]. High standards indexes excessive striving for overly high personal standards. Both of the subscales had good internal consistencies ($\alpha = 0.89$ and 0.90).

Social interaction anxiety scale (SIAS)

Social interaction anxiety was measured by the SIAS [34], which is a 20-item measure. The items describe anxiety-related reactions to a variety of social situations. Overall, research on the scale suggests good to excellent reliability and good construct and convergent validity. Internal consistency was excellent ($\alpha = 0.95$).

The social appearance anxiety scale (SAAS)

Social appearance anxiety was measured by the SAAS [16], which is a 16-item measure developed to assess anxiety about being negatively evaluated by others because of one's overall appearance, including body shape. Research on the psychometric properties of the SAAS has demonstrated high test–retest reliability, good internal consistency, good factor validity, incremental validity (e.g., it was a unique predictor of social anxiety above and beyond negative body image indicators), and divergent validity [16, 28]. Internal consistency was good ($\alpha=0.88$).

Fear of positive evaluation scale (FPES)

Fear of positive evaluation was measured by the FPES [50], which is a 10-item measure designed to assess fear of positive evaluation; two items in this scale are included as filler and are not scored in the total. The FPES has been shown to have excellent reliability, construct validity, and factorial validity [8, 50]. Internal consistency was good ($\alpha=0.84$).

The brief fear of negative evaluation (BFNE)

Fear of negative evaluation was measured by the BFNE [24], which is a 12-item version of the original Fear of Negative Evaluation Scale [49]. The items assess fear of negative evaluation, which has been theorized to be a central component of social anxiety. The BFNE has been shown to correlate with other measures of social anxiety and has excellent psychometric properties. Internal consistency was good ($\alpha=0.81$).

Treatment and assessment

For more details on the treatment intervention, please see Levinson et al. [31]. For the purposes of this study, participants completed four food exposure sessions across 2 weeks. We only used data from the first session before any treatment effects would be apparent. All participants were given the same combination of a sandwich, fruit, yogurt, and pretzels for meals to control for differences that differing foods across exposures could produce in anxiety levels. Exposure sessions were carried out in a group format with 2–5 participants during 45-min lunchtime meals and led by a trained CBT therapist (CAL). Using the context of a standardized exposure study that collected and quantified anxiety (SUDS) very precisely at standard intervals (very beginning of the meal, every 5–8 min, and very end of the meal) across the meals allowed us to closely examine correlates of anxiety. Participants were explicitly instructed to allow themselves to feel anxiety during the meal exposure (explained below) instead of avoiding anxiety via distraction or using

compulsive behaviors (i.e., cutting the food into tiny pieces). Participants were given an explanation of the SUDS, asked for their current SUDS level to assess understanding of the scale, and asked what their SUDS level would be during a meal. SUDS was then assessed rapidly during each of the exposure and participants were instructed to quickly give a number and return to eating.

Statistical analyses

First, we conducted *t* tests to determine if there were significant differences in food anxiety dependent on diagnosis. We correct for multiple comparisons (six *t* tests) using the Bonferroni correction, which set the *p* value at 0.008. We also used Cohen's *d* to determine effect size, classifying a small effect as 0.2, medium as 0.5, and large as 0.8 [40]. Next, we examined zero-order correlations between the personality and clinical variables and food anxiety. If there was a significant zero-order correlation between a variable and food anxiety, this variable was included in a multiple regression with the personality and clinical variables as predictors and anxiety as the outcome to test for unique relationships of the personality and clinical correlates with food anxiety.

Results

Diagnosis

Approximately 85% of participants met criteria for at least one comorbid diagnosis. As can be seen in Table 1, participants were more likely to experience higher food anxiety if they had a current diagnosis of major depression, obsessive–compulsive disorder, or post-traumatic stress disorder (PTSD) (versus not having those diagnoses). There were no significant differences in food anxiety based on a current diagnosis of social anxiety disorder, panic disorder, or generalized anxiety disorder.

Clinical and personality characteristics of food anxiety at time 1 meal exposure

Anxiety before the meal

As can be seen in Table 2, concern over mistakes, social appearance anxiety, and BMI (BMI) were significantly correlated with anxiety before the meal. When we entered these variables into a multiple regression, both social appearance anxiety and BMI were unique predictors of anxiety before the meal, whereas concern over mistakes was not (see Table 3).

Table 1 Diagnostic differences in anxiety before, during, after a food exposure

	SUDS before	SUDS during	SUDS after	SUDS peak
No MDD (n=17)				
<i>M</i> (SD)	44.12 (24.37)	48.39 (23.05)	49.71 (27.52)	68.26 (19.67)
MDD (n=24)				
<i>M</i> (SD)	65.06 (19.87)	69.54 (19.38)	69.38 (22.63)	82.88 (13.17)
<i>ES</i>	<i>d</i> =0.94	<i>d</i> =0.99	<i>d</i> =0.78	<i>d</i> =0.87
<i>p</i> value	0.007⁺	0.004⁺	0.02	0.01
No PD (n=33)				
<i>M</i> (SD)	54.98 (23.21)	60.56 (23.21)	61.09 (26.13)	75.55 (17.60)
PD (n=8)				
<i>M</i> (SD)	62.11 (27.75)	61.65 (24.94)	61.75 (29.02)	82.06 (17.42)
<i>ES</i>	<i>d</i> =0.28	<i>d</i> =0.04	<i>d</i> =0.02	<i>d</i> =0.37
<i>p</i> value	0.52	0.91	0.95	0.37
No SAD (n=16)				
<i>M</i> (SD)	51.24 (26.91)	54.50 (25.73)	57.75 (28.82)	70.84 (22.57)
SAD (n=25)				
<i>M</i> (SD)	59.66 (21.79)	64.78 (21.05)	63.44 (24.98)	80.64 (12.47)
<i>ES</i>	<i>d</i> =0.34	<i>d</i> =0.43	<i>d</i> =0.21	<i>d</i> =0.54
<i>p</i> value	0.30	0.19	0.52	0.13
No OCD (n=32)				
<i>M</i> (SD)	54.01 (24.62)	55.91 (23.64)	56.34 (26.70)	73.77 (18.46)
OCD (n=9)				
<i>M</i> (SD)	64.78 (20.46)	78.06 (10.20)	78.56 (16.53)	87.67 (6.91)
<i>ES</i>	<i>d</i> =0.48	<i>d</i> = 1.22	<i>d</i> =1.00	<i>d</i> =1.00
<i>p</i> value	0.20	0.001⁺	0.006⁺	0.001⁺
No PTSD (n=33)				
<i>M</i> (SD)	52.65 (24.82)	57.80 (24.02)	59.36 (27.16)	74.14 (18.27)
PTSD (n=8)				
<i>M</i> (SD)	71.74 (11.25)	73.03 (15.35)	68.88 (22.57)	87.88 (7.61)
<i>ES</i>	<i>d</i> =0.99	<i>d</i> =0.76	<i>d</i> =0.38	<i>d</i> =0.98
<i>p</i> value	0.003⁺	0.04	0.33	0.003⁺
No GAD (n=11)				
<i>M</i> (SD)	56.59 (28.30)	60.89 (27.19)	61.91 (29.82)	74.82 (24.69)
GAD (n=30)				
<i>M</i> (SD)	56.30 (22.70)	60.73 (22.13)	60.97 (25.49)	77.55 (14.56)
<i>ES</i>	<i>d</i> =0.01	<i>d</i> =0.01	<i>d</i> =0.03	<i>d</i> =0.13
<i>p</i> value	0.98	0.99	0.93	0.74

SUDS subjective units of distress, *MDD* major depressive disorder, *PD* panic disorder, *SAD* social anxiety disorder, *OCD* obsessive compulsive disorder, *PTSD* post-traumatic stress disorder, *GAD* generalized anxiety disorder, *ES* effect size

Significant *p* values are bolded

⁺Significant after Bonferroni correction of 0.008

Anxiety during the meal

As seen in Table 2, concern over mistakes, fear of positive evaluation, and trust were significantly correlated with anxiety during the meal. When we entered these variables into a multiple regression, both concern over mistakes and trust uniquely predicted anxiety during the meal, whereas fear of positive evaluation did not (see Table 3).

Anxiety after the meal

As seen in Table 2, concern over mistakes and fear of positive evaluation were significantly correlated with anxiety after the meal. When we entered these variables into a multiple regression, both concern over mistakes and fear of positive evaluation uniquely predicted anxiety after the meal (see Table 3).

Peak anxiety

As seen in Table 2, social interaction anxiety, fear of positive evaluation, concern over mistakes, trust, and BMI were correlated with peak anxiety. When we entered these variables into a multiple regression, only concern over mistakes was a significant predictor of peak anxiety, whereas social interaction anxiety, fear of positive evaluation, trust, and BMI were not (see Table 3).

Discussion

We found several consistent and significant positive clinical and personality correlates between food anxiety and concern over mistakes, social appearance anxiety, BMI, and trust. These findings add to the literature on food anxiety and represent an important starting point for the characterization and treatment of this type of anxiety. Importantly, findings revealed that these correlates differed depending on when food anxiety was measured, indicating distinct temporal trends. For example, we found that pre-meal anxiety (i.e., anticipatory anxiety before the meal) was consistently predicted by social appearance anxiety and (lower) BMI, whereas anxiety during the meal was predicted by concern over mistakes (perfectionism) and (lower) trust.

These findings show that it is important to assess anxiety across several points during a meal or food exposure, and that anxiety profiles across several points during a meal (before, during, peak, after) may each be unique types of anxiety characterized by different personality and clinical factors. Moreover, these findings offer specific targets for clinical interventions, delineated according to different time points within the meal.

Diagnostic characteristics associated with food anxiety

Regarding diagnostic characteristics, we found that individuals with a diagnosis of major depression, obsessive-compulsive disorder, or PTSD were more likely to demonstrate higher levels of overall food anxiety. We did not find this to be true for diagnoses of social anxiety disorder, panic disorder, or generalized anxiety disorder. However, specific

Table 2 Personality and clinical correlates of anxiety before, during, after a food exposure, and peak anxiety during food exposure

	Before	During	After	Peak	CM	HS	SAA	BMI	SIA	FPE	FNE	Extra	Neur	Consc	Open	Trust	Ac
Before	–																
During	0.76**	–															
After	0.64**	0.89**	–														
Peak	0.73**	0.87**	0.79**	–													
CM	0.37*	0.44**	0.45**	0.51**	–												
HS	0.25	0.19	0.23	0.26	0.52**	–											
SAA	0.35*	0.24	0.16	0.17	0.21	–0.17	–										
BMI	– 0.31*	–0.27	–0.25	– 0.32*	–0.43**	–0.41**	0.29	–									
SIA	0.24	0.27	0.20	0.32*	0.54**	0.10	0.22	–0.15	–								
FPE	0.30	0.38*	0.44**	0.39*	0.37**	0.03	0.19	–0.13	0.50**	–							
FNE	0.22	0.11	0.02	0.13	0.43**	0.00	0.57**	0.19	0.50**	0.27	–						
Extra	0.00	–0.12	–0.13	–0.17	–0.47**	–0.04	–0.08	0.14	–0.74**	–0.40**	–0.35*	–					
Neur	0.10	0.21	0.20	0.22	0.34*	0.37*	–0.02	0.07	0.18	0.12	0.04	–0.06	–				
Consc	0.01	0.06	0.09	0.11	0.28	0.32*	0.23	0.06	0.15	–0.04	0.19	–0.03	0.08	–			
Open	–0.05	0.01	0.07	0.00	–0.09	0.09	–0.07	0.20	0.02	0.06	–0.07	–0.11	0.02	–0.21	–		
Trust	–0.28	0.42**	–0.28	0.42**	–0.23	0.08	–0.24	0.20	–0.25	–0.39**	0.02	0.08	–0.19	0.01	0.03	–	
Ac	0.29	0.02	–0.73	0.09	0.04	0.37*	0.11	0.05	–0.19	–0.09	0.02	0.15	0.03	0.33*	0.09	0.04	–

Before subjective unit of distress (SUDS) scale before meal, *During* SUDS during meal, *After* SUDS after meal, *Peak* peak SUDS, *CM* concern over mistakes perfectionism, *HS* high standards perfectionism, *SAA* social appearance anxiety, *BMI* BMI, *SIA* social interaction anxiety, *FPE* fear of positive evaluation, *FNE* fear of negative evaluation, *Extra* extraversion, *Neur* neuroticism, *Agree* agreeableness, *Consc* conscientiousness, *Open* openness, *Trust* trust, *Ac* achievement striving

Bolded values are significant ** $p < .01$, * $p < .05$

Table 3 Multiple regression analyses of personality and clinical correlates unique prediction of food anxiety outcomes

	part <i>r</i>	<i>b</i> *	<i>p</i> value
Anxiety before the meal			
SAA	0.42	0.43	0.008
BMI	−0.36	−0.39	0.025
COM	0.12	0.12	0.480
Anxiety during the meal			
COM	0.36	0.33	0.023
Trust	−0.33	−0.30	0.037
FPE	0.21	0.19	0.197
Anxiety after the meal			
COM	0.37	0.34	0.019
FPE	0.36	0.34	0.021
Peak anxiety			
COM	0.41	0.43	0.013
SIA	0.03	0.03	0.844
FPE	0.15	0.13	0.404
Trust	−0.31	−0.26	0.070
BMI	−0.06	−0.08	0.666

SAA social appearance anxiety, COM concern over mistakes, BMI body mass index, FPE fear of positive evaluation, SIA social interaction anxiety

dimensions of social anxiety, mainly social appearance anxiety (i.e., fear of negative evaluation of one's appearance; Hart et al. [16]) and fear of positive evaluation, were unique correlates of food anxiety. These findings add to the literature relating to the comorbidity of anxiety and disordered eating [20], and further, suggest that social appearance anxiety may be a specific form of social anxiety (rather than a diagnosis of social anxiety disorder) that is uniquely related to food anxiety [30, 32].

Clinical characteristics associated with food anxiety

In terms of clinical characteristics, we found differential temporal trends throughout the meal. For instance, BMI was negatively correlated with anxiety experienced before the meal, in that the lower an individual's BMI, the more anxiety-provoking they find eating to be. Next, social appearance anxiety was correlated with anxiety experienced before the meal. Social appearance anxiety may be related to food anxiety because a mealtime setting represents an event during which one may be judged on appearance. This finding is consistent with results indicating that social appearance anxiety is a key risk factor for the development of eating disorder symptoms [29], and that social appearance anxiety is elevated in individuals with ED [22]. Additionally, fear of positive evaluation was related to anxiety experienced after the meal. Theoretically, fear of positive evaluation stems from the fear that in future experiences, expectations from

others will be higher if one performs well previously. Fear of positive evaluation may be related to food anxiety after the meal because participants may have been worried after completing the first food exposure that others would expect more of them during future exposure sessions. This finding has implications for how family members react and support individuals with ED during meals, suggesting that for those individuals high in fear of positive evaluation, praise should be used with care during refeeding. This finding adds to the body of literature on the relationship between fear of evaluation and ED as comparatively fewer studies have examined the association between fear of positive evaluation (vs fear of negative evaluation) and ED [29].

Personality characteristics associated with food anxiety

Interestingly, we also found that two primary personality characteristics were related to food anxiety. First, we found that higher trust was related to lower anxiety experienced during the meal. It may be especially important to build trust with patients before beginning exposure therapy as to facilitate anxiety reduction across the intervention. This finding is consistent with research that shows that patients who are trustful achieve greater improvement in therapy than those who are mistrustful [12]. We also found that concern over mistakes, an aspect of perfectionism that represents a tendency to experience negative reactions to mistakes or the tendency to equate mistakes with failure, was consistently associated with anxiety during and after the meal, as well as with peak anxiety levels. This finding is not surprising, as concern over mistakes has previously been linked to anxiety in general, as well as to EDs (e.g., Bulik et al. [4]). If an individual is quite concerned with making mistakes, especially in a social setting, it is possible that they would be more anxious in a performance setting or when facing a fear (in this case food and eating in a social setting) when it is possible for them to make mistakes. For example, individuals with EDs may experience disgust associated with eating [35] and hold beliefs centered on a self-defined "perfect" way of eating (e.g., putting a fork down between bites, chewing food ten times, or other ritualistic aspects that individuals with ED often engage in), which may result in increased anxiety about not achieving this 'perfect' standard. This finding also supports literature showing that concern over mistakes may be the aspect of perfectionism most relevant for ED [4] and that concern over mistakes is a modifiable aspect of perfectionism that decreases ED symptoms [26]. Thus, intervening on concern over mistakes, i.e., with treatments that target perfectionism, specifically concern over mistakes, may also assist with addressing food anxiety. We hope future research will explore this idea.

There were several limitations of the current study that must be considered. First, we had a relatively small sample size and, therefore, we may have had limited power to detect all possible correlates. However, we should note that despite the small sample size our effect sizes were medium to large, suggesting that even with the small sample we had robust findings. Second, we did not assess all possible correlates. For example, given that a diagnosis of major depressive disorder, PTSD, and obsessive–compulsive disorder was associated with higher levels of food anxiety, it would have been interesting to test if levels of obsessions, compulsions, or depression (i.e., measured dimensionally) were correlates of food anxiety. It also would have been important to include food intake and psychotropic medication usage as a possible correlate or confound. Additionally, anxiety was measured in a group setting which might impact reporting. We hope that future research will include these types of assessments in a similar intervention. Despite these limitations, this study represents a first step in our understanding of food anxiety. We hope that future researchers will consider exploring this type of anxiety in larger samples and across treatment interventions.

We think that there are several implications that stem from this research. As alluded to above, it could be that targeting individual personality and clinical correlates such as social anxiety and perfectionism could help maximize the benefits of exposure therapy. For example, exposure interventions are effective for social anxiety (e.g., Heimberg et al. [17]) and could be modified to specifically address social appearance anxiety. Recent research also shows that group interventions for perfectionism can reduce disordered eating behaviors [26]. Individuals who present with high levels of these clinical and personality correlates could participate in an adjunctive treatment that targets perfectionism and social anxiety, as well as utilizing exposures for food anxiety. Another crucial implication is that clinicians utilizing exposure therapy should assess anxiety before, during, and after the meal, as these types of anxiety appear to be unique and have several distinctive characterizing factors.

Overall, we found that there were several unique correlates of food anxiety. In particular, we found that social appearance anxiety, BMI, concern over mistakes, and trust were of specific relevance to food anxiety. We hope that future researchers will continue to address this important type of anxiety, which will hopefully lead to novel interventions designed to address the suffering associated with ED.

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Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval The Washington University IRB approved all procedures in this study and all the procedures performed in the current study were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendment.

Informed consent Informed consent was obtained for experimentation with human subjects.

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