The Associations Between Pathogen Disgust Sensitivity, Meat Preference, Plant Preference, and a Lifetime Prevalence of Anorexia Nervosa in a Finnish Population

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Abstract:

Anorexia Nervosa (AN) is a potentially debilitating mental illness with expensive treatment costs and oftentimes poor outcomes. Previous studies have found that having AN is associated with a vegetarian diet and that anxiety plays a role in food avoidance behavior, where ill individuals generally prefer low calorie foods over high calorie foods. The role of pathogen disgust sensitivity in meat and plant preference of AN individuals however has, to my knowledge, never been previously examined. The restriction of meat intake may be an adaptive response necessary to navigate food threats associated with pathogen risk at a time when the individual is more susceptible to disease. In the present study, the associations between pathogen disgust sensitivity, meat preference, plant preference and a lifetime prevalence of anorexia nervosa (AN-LTP) were examined. Individuals with AN-LTP were expected to prefer meats less than individuals without anorexia nervosa (non-AN); AN-LTP individuals were expected to prefer meats less than plants; and AN-LTP was expected to moderate the association between pathogen disgust sensitivity and food preferences. Data collection was conducted through survey methods as a part of the Genetics of Sexuality and Aggression project at Åbo Akademi University in Turku, Finland in 2019. For the present study, 8124 participants were included (416 women and 31 men with AN-LTP). Having AN-LTP was associated with different food preferences in comparison to non-AN individuals for men and women. Women with AN-LTP preferred meat less than plants, whereas for AN-LTP men, meat and plant preference did not differ. AN-LTP men preferred meats less than non-AN men. The AN-LTP and non-AN men groups did not differ in their plant preference. The AN-LTP women preferred meats less and plant more than non-AN women. Higher ratings of pathogen disgust sensitivity were associated with lower meat preference, and lower plant preference. No moderation of AN-LTP was found on the association between pathogen disgust sensitivity and meat and plant preference. Although food preferences differ between AN-LTP and non-AN individuals, the differences between the groups are not associated with differences in pathogen disgust sensitivity.

Keywords: Psychology, Anorexia Nervosa, Meat Preference, Plant Preference, Pathogen Disgust Sensitivity, Compensatory Prophylaxis Hypothesis

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Introduction

The aim of the present study was to examine the associations between *pathogen disgust sensitivity*, *meat preference, plant preference* and a *lifetime prevalence of anorexia nervosa* (AN-LTP). Previous studies have found that anorexia nervosa (AN) is associated with restricted food behaviors (Schebendach et al., 2019; Steinglass et al., 2015; Stoner et al., 1996), and that meats are restricted more than plants (Bardone-Cone et al., 2012; Sullivan & Damani, 2000). The restriction of meat intake may be an adaptive response necessary to navigate food threats associated with pathogen risk (Tybur et al., 2016). Meats more than plants pose potential risks to humans because of their pathogenic qualities. Individuals with AN may be especially vulnerable to the effects of pathogens due to their compromised immune system (see *compensatory prophylaxis hypothesis*; Fessler, 2002). The present study considered whether pathogen disgust sensitivity, a measure of how sensitive an individual is to pathogen cues, is associated with a decreased meat preference and whether having AN-LTP moderates the relationship between pathogen disgust sensitivity and the decreased meat preference.

Characteristics of AN

According to the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5; American Psychiatric Association, 2013) diagnostic criteria, AN is characterised by the following three features: a restriction in energy intake and significantly low body weight; an intense fear of gaining weight and behavior that interferes with weight gain; and disturbances in the way in which one's body weight is experienced or lack of recognition of the seriousness of the current body weight.

Though according to the DSM-5 the 12-month prevalence of AN is less than 0.4% among young females (The American Psychiatric Association, 2013), other studies reported a higher prevalence. For example, Nagl and colleagues (2016) found that the female lifetime prevalence of anorexia ranges from 0.6 to 5.4%. The large variation in the studied prevalence rates depend on the assessment methods, sampling strategies and population of interest. For example, a recent study by

by Silén and colleagues (2020) reported that 6.2% of females met the DSM-5 criteria for AN amongst young adults in Finland. The lifetime prevalence of eating disorders amongst males is much lower, ranging from 0.1-1.8% in a German community sample (Nagl et al., 2016), and specifically for AN, 0.3% in a Finnish study (Silén et al., 2020). In clinical populations, the female-to-male ratio of AN cases is approximately 10:1 (The American Psychiatric Association, 2013). The mortality rate of AN is the highest amongst the mental disorders (Welch & Ghaderi, 2014). One study found that the standard mortality ratio of anorexia was 5.35 (Fichter & Quadflieg, 2016) which is a rate of mortality more than five times higher than the general population matched for age and sex.

Physiological changes are typically found in individuals with AN, indicating that the disorder is potentially harmful to the whole body. Since AN is characterized by restricted eating and a very low body weight, the observed abnormalities in the immune system are like the changes observed in primary malnutrition (Gibson & Mehler, 2019). In a narrative review article Sjögren and colleagues (2019) described evidence indicating that AN is associated with changes in the gut microbiome and intestinal permeability. These biological changes in the gut and microbiome may explain the low grade-inflammation and increased risk of autoimmune disease found in AN (Herpertz-Dahlmann et al., 2017). The changes in the gut microbiome in AN individual's are found in acute and recovered individuals in comparison to healthy controls (Ruusunen et al., 2019; Sjögren et al., 2019) indicating that these physiological changes may not fully resolve after weight restoration. Due to the compromised immune system associated with the disorder, it was expected in the present study that AN-LTP individuals would exhibit decreased meat preferences which would be adaptive to the avoidance of potential pathogens.

Considering that the typical diagnostic features associated with AN include an inability to recognize the seriousness of the disorder as well as an often dangerously low weight, treatment of AN has unique challenges. These challenges lend to the high costs, poor recovery rates, high drop-out rates, and one-year relapse rates associated with treatment (Guarda, 2008). Since AN is characterized by restricted eating behavior and low weight, a key component in treatment is weight

restoration. Meal-based approaches where caloric intake is divided into meals and snacks is the most common refeeding method, with liquid supplements and nastrogastic feeding being used only for acute food refusal (Garber et al., 2016). As most refeeding programs follow general nutritional recommendations (Garber et al., 2016), more research is needed to develop bespoke diets offered in refeeding treatments so that the meal composition is better tailored to the needs of this unique group and thereby increase the probability that treatment will be successful. The present study could elucidate knowledge about the mechanisms that are associated with food-avoidance behaviors which could be informative to refeeding treatments.

Food preferences and Disgust Sensitivity in AN

Previous research on changes in food preferences in AN individuals reported a general disliking or restriction of high calorie foods and greater preference and consumption of low-calorie foods (Schebendach et al., 2019; Steinglass et al., 2015; Stoner et al., 1996). Research has found that anxiety plays a role in food avoidance in AN (Levinson & Byrne, 2015; Vanzhula et al., 2020) and an association has been found between having AN and following a vegetarian diet at the time of illness (Bardone-Cone et al., 2012; Sergentanis et al., 2020; Sullivan & Damani, 2000). As for the population in general, typically men consume more meat than women, and women consume more plants (Modlinksa et al., 2020). To my knowledge, no previous study has examined the role of pathogen disgust sensitivity and meat and plant preference in AN individuals.

Disgust is a valuable topic of study to inform treatment of AN. Unlike anxiety, disgust is not readily extinguished during exposure treatment therapies (Mason & Richardson, 2012). Indeed, a study by Hildebrandt and colleagues (2015) found that physiological measures of disgust were predictive of poor extinction in reversal learning tasks to food cues in AN individuals but not in healthy controls. A study by Harris and colleagues (2019) found that disgust is more strongly related to picky eating than anxiety in individuals with Avoidant Restrictive Food Intake Disorder (ARFID) and that disgust fully mediated the association between anxiety and ARFID. According to the DSM-5 (American Psychiatric Association, 2013), ARFID is a feeding and eating disorder characterized by

food avoidance and low weight, but does not include aspects of body dysmorphia or fear of gaining weight associated with AN. However, some features are similar between ARFID and AN such as traits of anxiety, obsessive-compulsive disorder, and attention-deficit/hyperactivity disorder. Additionally, ARFID is more common in families where a parent has an eating disorder and can in some individuals precede the development of AN. Since, to my knowledge, studies that examine the associations between disgust and food avoidance in AN are scarce, the results from the Harris and colleagues (2019) study on the association between disgust and picky eating in ARFID were included to elucidate relevant knowledge on this topic.

Characteristics of Disgust

According to an evolutionary perspective of emotions, disgust is an adaptive affective response that drives behavioral avoidance to pathogen cues in the environment (Curtis, Valeri et al., 2011; Rozin & Fallon, 1987). Disgust is a mechanism that protects the organism from disease (Oaten et al., 2009). Typical disgust cues include bodily products, poor hygiene and deformity, corpses, certain sexual behaviors, dirty environments, some foods (especially those that are decayed or spoiled), some animals, and violations of social norms (Curtis, Valerie & Biran, 2001; Rozin et al., 2016). In response to these cues, the body exhibits characteristic behaviors and physiological changes. Indeed, disgust is associated with an easily identifiable facial expression where the nose is wrinkled, the upper lip is raised, and the mouth agape with extended tongue (Rozin et al., 1994). In the body, disgust is associated with a strong visceral response, specific neural activity, and changes in gastric activity (Harrison et al., 2010). The disgusted individual will try to distance themselves from the disgusting object by withdrawing, stopping, or dropping the object, or shuddering (Curtis et al., 2011). These physiological and behavioral changes associated with disgust suggests that the body is preparing itself for the avoidance and expulsion of pathogens.

Pathogen Disgust Sensitivity

Tybur and colleagues (2009) described that pathogen disgust is one of three functionally distinct disgust domains. The three domains of disgust (i.e., pathogen, moral and sexual disgust) are

each adaptive to solve different problems that would have been advantageous in our ancestral environment. In the case of pathogen disgust, the function is to protect the individual from potentially harmful agents. The sexual domain functions to motivate the avoidance of costly sexual behaviors and moral disgust functions to motivate avoidance of antisocial norm violators. In the present study, the focus was on pathogen disgust and its function in navigating food threats.

Pathogen disgust sensitivity is a measure of an individual's reactivity towards pathogen cues. It can be measured with the *Three-Domain Disgust Scale* developed by Tybur and colleagues in 2009. Pathogen avoidance is a flexible mechanism that varies amongst individuals and in different contexts. Women tend to score higher on pathogen disgust sensitivity than men (Tybur et al., 2009). Tybur and Lieberman (2016) outlined an information processing model to describe how the expected value of contact is determined between an individual and a potential pathogen. According to this model, perceptual and sensory mechanisms must detect potential pathogens (i.e., a basic bottom-up processing system). This is coupled with a cost and benefit analysis of contact with the item. Together these processes determine the expected value of contact. In summary, the expected value of contact with an item is dependent on the detection of pathogens and relative costs and benefits of contact to the individual. If the costs of contact with potential pathogens are high, then the expected value of contact will be low. If on the other hand the benefits of contact outweigh the costs, then the expected value of contact will be high.

Evidence that supports the type of information processing model described by Tybur and Lieberman (2016) is described here which, though the examples are not directly related to AN, can help the reader understand why people are differently sensitive to pathogen cues. According to the compensatory prophylaxis hypothesis (Fessler, 2002), individuals whose physiological immune system is compromised are especially vulnerable to disease and may have a greater sensitivity to pathogen cues (Curtis et al., 2011). Curtis and colleagues (2011) described that there are advantages to modifying one's disgust sensitivity according to one's physiological state; at times when an individual may be more vulnerable to pathogens, upregulating disgust sensitivity and pathogen

avoidance behaviors may serve to keep the individual away from potentially harmful sources. In fact, people who have recently been sick show greater attentional bias towards pathogen cues (Miller & Maner, 2011) which is an adaptive sickness behavior response.

Additionally, certain types of cues in the environment are associated with greater risk of containing pathogens. Meats, as opposed to plants are associated with pathogenic properties that pose a greater risk to humans. Tybur and colleagues (2016) give two reasons to explain why meats are more threatening to humans. Firstly, meats are more biochemically like human tissue than plants and therefore pathogens that are in meats are more likely to be harmful to humans; and secondly, pathogens that can infect humans rapidly colonize deceased animals whose immune system can no longer fight against microbes. There is evidence that supports the theory of asymmetrical threat posed by meats in comparison to plants. For example, a study on women during the first trimester of pregnancy, a period when the immune system is suppressed and the fetus and mother are most vulnerable to pathogens, show greater food aversions to meats than to plants (Fessler, 2002). Since as previously described individuals with AN have a compromised immune system, it was expected in the current study that AN-LTP individuals would have meat and plant preferences that would be adaptive to pathogen avoidance.

In a study by Tybur and colleagues (2016) participants engaged in tasks where meats and plants were paired with cues to pathogens (an infected boil, an infected toe, a toilet covered with bodily wastes, or a pile of vomit) and asked to rate the food items on several dimensions. Across three studies results indicated that participants who viewed images of meats paired with cues to pathogens subsequently reported less desire to eat those meats and anticipated worse taste of the meats relative to a control condition. In contrast, participants who viewed the plants paired with cues to pathogens did not report less desire to eat plants nor were cues to pathogens associated with ratings for the anticipated taste of the plant items. These results are in line with a functional specialization account of food learning mechanisms being specialized to navigate the asymmetrical food threats posed by plants and meats. In the present study pathogen disgust sensitivity was

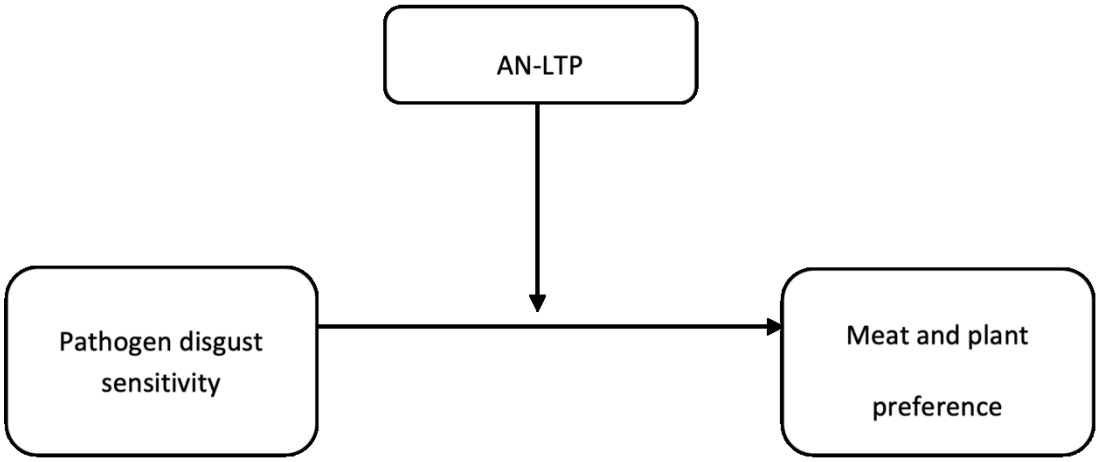
expected to be differently associated with meat and plant preferences to reflect the asymmetrical threat posed by the different food items as observed by Tybur and colleagues (2016).

Aim of the Current Study

The aim of the current study was to determine whether meat and plant preference among individuals with a AN-LTP differed from non-AN individuals. I was also interested in whether levels of pathogen disgust sensitivity were associated with meat and plant preference. Another aim was to determine whether AN-LTP moderated the relationship between pathogen disgust and meat and plant preference (see Figure 1). The moderation model proposed in Figure 1 shows AN-LTP as the moderator variable which changes the association between pathogen disgust sensitivity and meat and plant preference.

Figure 1

A Diagram of the Proposed Model Depicting AN-LTP as the Moderator Variable



Note. AN-LTP = lifetime prevalence of anorexia nervosa

Hypotheses

1. Men would prefer meats more than and plants less than women
2. Women would be higher on pathogen disgust sensitivity than men
3. Food preference would be different for individuals with AN-LTP and non-AN individuals
4. Having AN-LTP would be associated with lesser meat preference than non-AN individuals.
5. Plant preference would be greater for individuals with AN-LTP than non-AN individuals
6. Individuals with AN-LTP would report a greater plant preference than meat preference.
7. Pathogen disgust sensitivity would be negatively associated with meat preference.
8. There would be a positive association between pathogen disgust sensitivity and plant preference
9. The AN-LTP and non-AN groups would moderate the association between pathogen disgust sensitivity and meat preference. For individuals with AN-LTP the negative association between pathogen disgust sensitivity and meat preference would be larger and more significant than for non-AN individuals.
10. The AN-LTP and non-AN groups would moderate the association between pathogen disgust sensitivity and plant preference. For individuals with AN-LTP the positive association between pathogen disgust sensitivity and plant preference would be larger and more significant than for non-AN individuals.

The proposed research has potential to elucidate food avoiding behavior in AN. Knowledge on the potential associations between pathogen disgust and meat and plant preference could potentially, if results are clear-cut, inform treatments of AN.

Methods

Participants and Sampling Procedure

Data collection was conducted as a part of the Genetics of Sexuality and Aggression project at Åbo Akademi University in Turku, Finland (for complete details about data collection procedures see Tybur and colleagues, 2020). This large population-based data collection of twins and siblings of twins was conducted in November of 2018 and concluded in January 2019. Individuals were identified from the Central Population Registry in Finland and invited by mail if they were over 18 years of age, resided in Finland and had Finnish as their mother-tongue. A subset of individuals (*n* = 7,716) had participated in a similar data collection procedure before and had indicated willingness to participate in future studies (for more information about earlier cohorts see Johansson and colleagues, 2013). Of the 33,211 invitations sent to participate in the study, 9,564 responded (response rate of 29%) and 9,319 (97%) consented to their data being used for scientific purposes. Participants completed the survey online using an individual code to identify twin pairs and individuals from the same family. Participants were offered entry into a raffle containing 40 gift vouchers worth 100€ each to a network of companies in the retail and service sectors. Data collection was approved by the Ethics Review Board of Åbo Akademi University in Turku, Finland. Participants were informed that their participation was voluntary, anonymous and that they could terminate at any time without giving reason. Participants gave written informed consent in accordance with the Declaration of Helsinki before responding to the survey. The present study included the 8,124 participants[1] (2,784 men and 5,440 women) who indicated whether they have or ever have had AN, completed the pathogen disgust sensitivity subscale and the food preferences questionnaire. Participants were excluded if they did not complete all the items. An additional eleven individuals were excluded from the analysis because of missing age value due to a technical

[1] Only one person per family was included in some statistical analyses to control for the non-independence of genetically related individuals. The sample size was smaller in these analyses. The sample size was 5,747 when one person per family was included (1,649 men and 4,098 women) of which 432 individuals had AN-LTP (30 men and 402 women) and 5,315 in the non-AN group (1,619 men and 3,696 women)

glitch. In the present study 416 (7.65 %) women and 31 (1.11%) men reported that they have AN presently or have had AN at some point during their lifetime. The average age of the participants was 30.14 years (*SD* = 8.08), participants with AN-LTP were on average younger (M_{women} = 27.91, *SD* = 7.01 years; and M_{men} = 27.81, *SD* = 6.98 years) than the non-AN group (M_{women} = 30.40, *SD* = 8.08 years; and M_{men} = 30.21, *SD* = 8.15 years).

Variables

Anorexia Nervosa

A lifetime prevalence of having AN was assessed in the survey by asking respondents whether they have or have ever had AN. Answers were coded into (1) no and (2) yes.

Meat and Plant Preference

Food preferences were measured for the following twelve items: olive, radish, paprika, cabbage, cauliflower, asparagus, liver, sausage, mutton, bacon, reindeer, and moose. Six of the included food items were plants and six were meats. Participants were asked to report how much they liked each food on a 7-point scale ranging from “not at all” (1) to “very much” (7). Two composite variables were created, one *meat preference* score and the other *plant preference* score. These variables represent the total score for all six meat items for the first variable and all six plant items for the second variable for each participant. The range of these variables were originally from 6-42 which were transformed to 0-36 to be more intuitive. Higher scores on these variables mean a greater preference for the food items. Internal consistencies for these variables were acceptable across plant preference category (α = 0.78) and good across the meat preference category (α = 0.88).

Pathogen Disgust Sensitivity Variable

Pathogen disgust sensitivity was measured using the *Three Domain Disgust Scale* (Tybur et al., 2009). The scale was made up of twenty-one questions which measured sensitivity to pathogen, sexual and moral disgust. The pathogen disgust subscale asked participants to rate on a scale of (1) “not at all disgusting” to (7) “extremely disgusting” on the following seven items: stepping on dog poop; sitting next to someone who has red sores on their arms; shaking hands with a stranger who

has sweaty palms; seeing some mold on old leftovers in your refrigerator; standing close to a person who has body odor; seeing a cockroach run across the floor; accidentally touching a person's bloody cut. Total pathogen disgust sensitivity was calculated for each participant and coded into a composite variable. The range of this variable was originally from 7-49 which was transformed to 0-42 to be more intuitive. Higher scores mean greater levels of reported disgust sensitivity. The internal consistencies of the pathogen disgust sensitivity subscale were acceptable for women (α = 0.78) and good for men (α = 0.80).

Age and Gender

Age and gender were included in the present study and information was taken directly from the Central Population Registry. The options for gender were male (1) and female (2). Age was indicated as a value which for the participants included in the present study ranged from 18-61.

Statistical Analyses

All statistical analyses were conducted using IBM SPSS Statistics version 26. Multiple univariate analysis of variance (ANOVA) were conducted to determine the mean and standard deviation of each variable included in the study and whether differences between men and women on each of the variables were significant. Gender was a factor and only one person per family was included to control for the confounding effects of genetic relatedness, which was necessary because the sample consisted of twins and siblings of twins.

A multivariate analysis of covariance (MANCOVA) was conducted to study whether the food preference[2] of AN-LTP individuals differed from non-AN individuals. The multivariate test statistic accounts for the correlation between the outcome variables (meat and plant preference) and looks at whether AN-LTP and non-AN groups can be distinguished by some combination of these variables. The output for a MANCOVA in SPSS is appropriately followed by a univariate analysis of covariance (ANCOVA) to determine which variable (meat or plant preference) differ between the AN-LTP and

[2] Food preference here includes meat and plant preference

non-AN group. Repeated measures ANCOVA analyses were conducted to examine whether meat and plant preference were significantly different within each AN-LTP and non-AN group. For the MANCOVA, follow-up univariate ANCOVA and repeated measures ANCOVAs analyses only one person per family was included, age was included as a control variable, and analyses for men and women were conducted separately.

A generalized estimating equation (GEE) was conducted for the regression analyses to assess the relationship between pathogen disgust sensitivity, meat preference and plant preference. The GEE is a multilevel regression model which appropriately controls for the non-independence of genetically related individuals. Age and gender were included as control variables. The GEE procedure on SPSS 26 does not however give the option to calculate effect size. Following the example of Jern and colleagues (2020), a GLM procedure including one person per family to estimate effect size was used which appropriately controls for between-subject dependence.

Finally, moderation analyses were conducted using data from one person per family to assess whether AN-LTP moderated the association between pathogen disgust sensitivity and meat preference in the first moderation analysis; and pathogen disgust sensitivity and plant preference in the second moderation analysis. The *PROCESS* tool for SPSS was used to conduct the moderation analyses and predictors were mean centred. Gender and age were included as control variables in the moderation analyses.

Results

Descriptive Statistics and Gender Analyses

The descriptive statistics of the relevant variables for this study organized by gender for AN-LTP and non-AN groups are in Table 1. Results from the ANOVA analyses revealed that the difference in meat preference between men and women was large and in the expected direction F (1, 5745) = 733.31, $p < .001$; partial $\eta^2 = .113$, men preferred meats (M = 27.14, SD = 7.07) more than women (M = 20.10, SD = 9.56). The difference in plant preference was small and in the expected direction F (1, 5745) = 87.69, $p < .001$; partial $\eta^2 = .015$, women preferred plants (M = 24.72, SD = 7.17) more than men (M = 22.75, SD = 7.28). Furthermore, the difference in pathogen disgust sensitivity rating was of medium effect size and in the expected direction F (1, 5745) = 366.21, $p < .001$; partial $\eta^2 = .06$, women had higher pathogen disgust sensitivity rating (M = 23.52, SD = 7.76) than men (M = 19.16, SD = 7.94).

Table 1

Descriptive Statistics and ANOVA Results of the Difference Between Men and Women on Included Variables

Variable	Women (n = 4,098)			Men (n = 1,649)			F (1,5745)	η^2
	M (SD)	Range		M (SD)	Range			
		Min	Max		Min	Max		
Age	30.27 (8.21)	18.15	58.23	31.17 (8.22)	18.24	60.16	13.90*	.002
Meat Pref	20.10 (9.56)	0	36	27.14 (7.07)	0	36	733.31*	.113
Plant Pref	24.72 (7.17)	0	36	22.75 (7.28)	0	36	87.69*	.015
PDS	23.52 (7.76)	0	42	19.16 (7.94)	0	42	366.21*	.06
AN status	1.10 (0.23)	1	2	1.02 (0.13)	1	2	110.02*	.019

Note. M = mean, SD = Standard Deviation, Min = Minimum, Max = Maximum, η^2 partial = eta partial squared, Pref = Preference, PDS = Pathogen disgust sensitivity, AN = Anorexia Nervosa. AN status 1 = non-AN and 2 = AN-LTP (lifetime prevalence of anorexia nervosa). One person per family was included. * $p < .01$ significance level.

Results of Meat and Plant Preference Analyses for AN and Non-AN Individuals

Results from the MANCOVA analysis indicated that AN-LTP or non-AN had a small and significant association with food preference when controlling for age for both men F (2, 1645) = 6.79, p = .001; partial η^2 = .008 and women F (2, 4094) = 33.31, p < .001; partial η^2 = .016. This was in line with the third hypothesis and expectations that food preference would be different for AN-LTP and non-AN individuals.

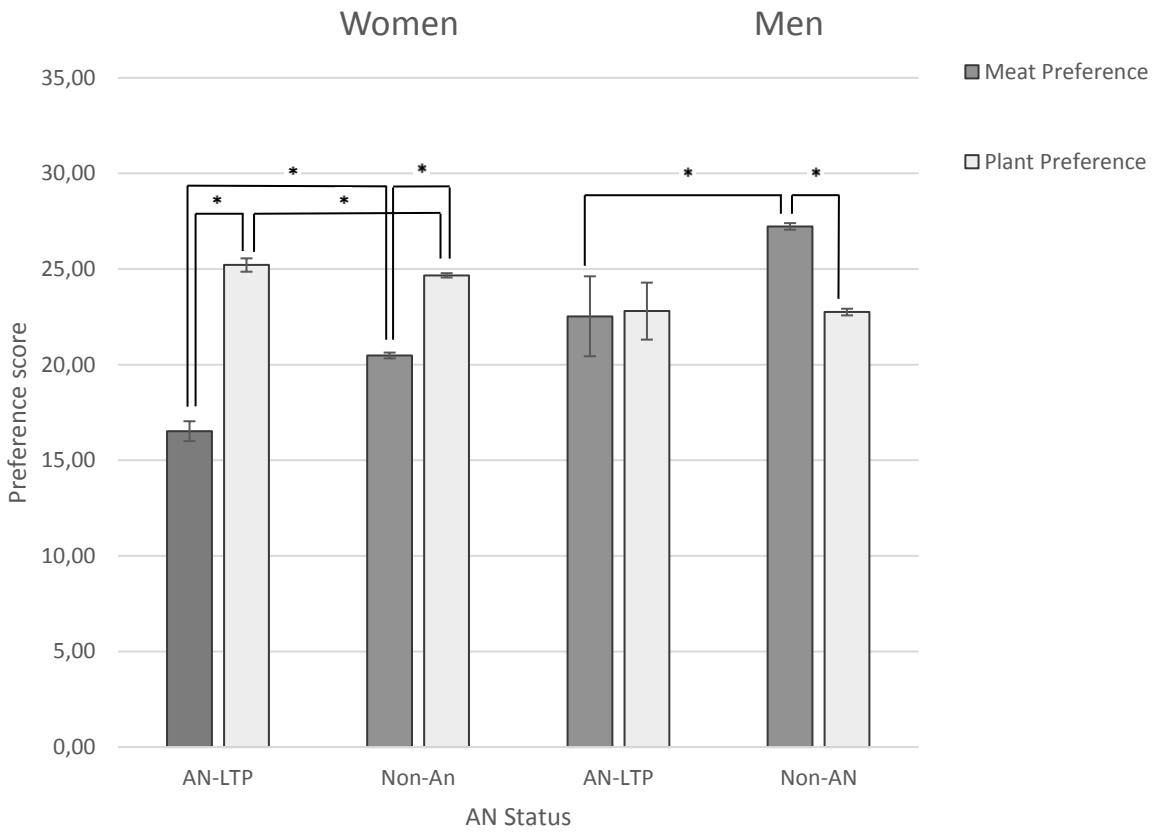
According to results from the repeated measures ANCOVA (see Figure 2), AN-LTP women preferred meats (M = 16.52, SD = 10.40, Range = 0-36) less than plants (M = 25.21, SD = 7.13, Range = 0-36), the difference between meat and plant preference in AN-LTP women was small F (1, 400) = 11.49, p < .001; partial η^2 = .028. Non-AN women also preferred plants (M = 24.67, SD = 7.17, Range = 0-36) more than meats (M = 20.48, SD = 9.39, Range = 0-36) and the difference in preference was also small and significant F (1, 3694) = 23.96, p < .001; partial η^2= .006. Results from the follow-up univariate ANCOVA for women revealed a small association between AN-LTP and meat preference F (1, 4095) = 49.43, p < .001; partial η^2 = .12, where AN-LTP women preferred meats less than non-AN women. Results also revealed a small association between AN-LTP and plant preference F (1, 4095) = 9.17, p = .002; partial η^2 = .002, where AN-LTP women preferred plants more than non-AN women. Results for women were in line with the fourth, fifth and six hypotheses.

According to results from the repeated measures ANCOVA, AN-LTP men preferred meats (M = 22.53, SD = 11.27, Range = 0-36) less than plants (M = 22.80, SD = 8.41, Range = 4-36) though the difference was not significant F (1, 28) = 1.48, p = .235; partial η^2 = .05. Non-AN men preferred meats (M = 27.23, SD = 6.94, Range = 0-36) more than plants (M = 22.75, SD = 7.26, Range = 0-36), and this difference was of medium effect size and significant F (1, 1617) = 120.86, p < .001; partial η^2 = .07. Results from the follow-up univariate ANCOVA for men revealed a small association between AN-LTP and meat preference F (1, 1646) = 11.78, p = .001; partial η^2 = .007, where AN-LTP men preferred meats less than non-AN men. The association between AN-LTP and plant preference F (1, 1646) =

0.40, p = .53; partial η^2 < .001 was not significant, the plant preference of AN-LTP and non-AN men did not differ. Results for men were in line with the fourth but not the fifth or six hypotheses.

Figure 2

Meat and Plant Preference Among AN-LTP and non-AN Men and Women



Note. The preference score for meats and plants are included here for both AN-LTP and non-AN men and women (error bars show standard errors). AN = Anorexia Nervosa, AN-LTP = lifetime prevalence of anorexia nervosa. Only one individual per family included.

* indicates a significance level of p < .01

In summary, four hypotheses were at least partially confirmed in the analyses of the meat and plant preference of AN-LTP and non-AN individuals. All four hypotheses were confirmed for women and two were confirmed for men. Among both men and women, having AN-LTP was significantly associated with different food preference in comparison to non-AN individuals. Women with AN-LTP preferred meat less than plants, whereas for AN-LTP men, the preference for meats and plants were more similar. Although no significant difference was observed in the meat and plant preferences of AN-LTP men, AN-LTP men did show lesser preference for meats than non-AN men which was expected. The AN-LTP and non-AN men groups did not significantly differ in terms of their plant preference. For women, the AN-LTP group preferred meats less than non-AN group and preferred plants more than AN group.

Results from GEE Analyses of Pathogen Disgust Sensitivity, Meat and Plant Preference

Results from the GEE analyses (see Table 2) showed that higher ratings of pathogen disgust sensitivity were associated with lower preference for meat (η^2 partial = .002)[3], though the effect size was small. The results from this analysis supported the seventh hypothesis which predicted that greater sensitivity to pathogen cues would be negatively associated with meat preference. Contrary to expectations, a larger negative association between pathogen disgust sensitivity and plant preference was observed (η^2 partial = .016) thus the eighth hypothesis was not supported. Based on previous research it was expected that pathogen disgust sensitivity would be associated with a lesser preference for meat and either a positive or no association with preference for plants. The results from these GEE analyses revealed however that pathogen disgust sensitivity was associated with both lesser preference for meats and plants with the strongest effect size being for plants.

[3] As the GEE procedure does not calculate effect size, effect size was estimated using a GLM procedure with only one individual per family.

Table 2

Associations Between Pathogen Disgust Sensitivity and Meat and Plant Preference Controlling for Age and Gender

Variable	Wald χ^2	*p*	*B*	*SE*	η^2 partial
		Meat Preference			
Pathogen disgust sensitivity	13.03	<.001	-0.06	0.017	.002
Gender (Men)	140.70	<.001	6.72	0.566	.015
Age	146.53	<.001	0.15	0.012	.023
Gender x Pathogen disgust sensitivity	<0.001	.989	<0.001	0.024	<.001
		Plant Preference			
Pathogen disgust sensitivity	62.78	<.001	-0.11	0.014	.016
Gender (Men)	16.40	<.001	-2.31	0.569	.003
Age	369.67	<.001	0.22	0.011	.061
Gender x Pathogen disgust sensitivity	0.45	.505	-0.02	0.027	<.001

Note. Associations of pathogen disgust sensitivity, gender, age and gender x pathogen disgust sensitivity and food preference for *N* = 8124 individuals; men = 2784, women = 5340. Wald $\chi 2$ = Wald Chi-square, *p* = significance level, *B* = unstandardized regression coefficient, *SE* = standard error of the regression coefficient, and η^2 partial = eta partial squared given here. Effect size was estimated using a univariate general linear model procedure with only one individual per family.

Moderation Analysis

Results from the moderation analyses (see Table 3) showed that no significant moderation of AN-LTP on the association between pathogen disgust sensitivity and meat preference *B* = 0.04*,* 95% CI [-0.07, 0.15], *t* = 0.70, *p* = .49 or plant preference *B* = -0.01, 95% CI [-0.10, 0.07], *t* = -0.31, *p* = .75 while controlling for age and gender was found. In other words, the association between

pathogen disgust sensitivity and meat and plant preference stayed the same regardless of whether an individual had AN-LTP or not. The results of the moderation analyses do not support the nineth or tenth hypotheses and expected moderation of AN-LTP on the association between pathogen disgust sensitivity and meat and plant preference.

Table 3

Moderation Analyses of AN status, Pathogen Disgust Sensitivity and Meat and Plant Preference

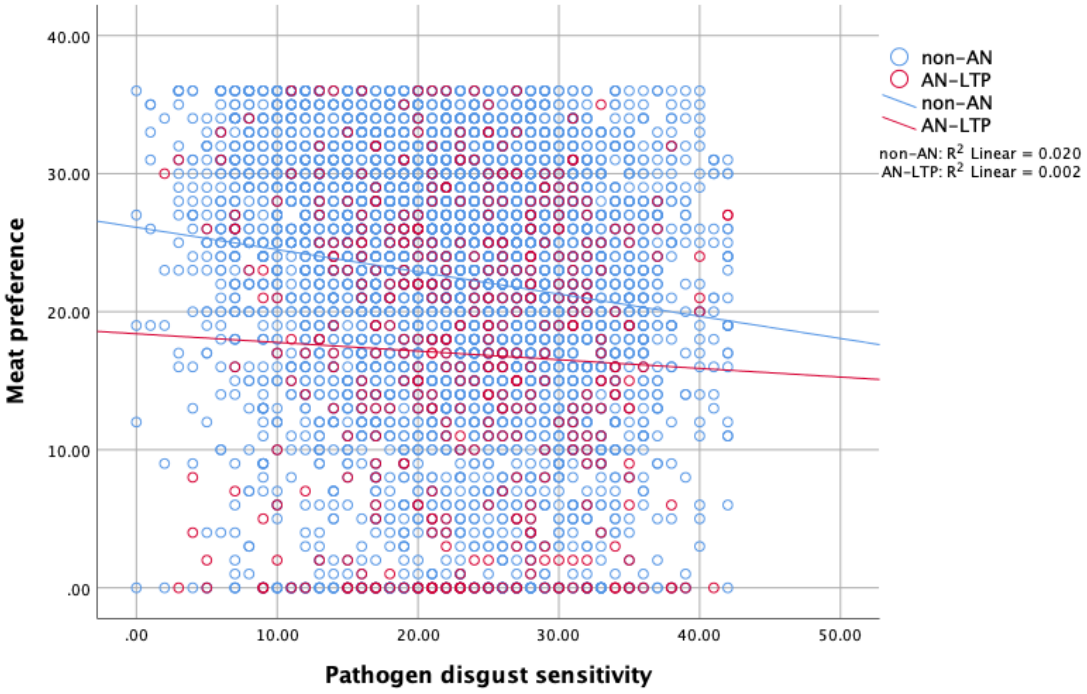
Variable	*B*	*SE*	95% CI	*t*	*p*
			Meat Preference		
Pathogen disgust sensitivity	-0.06	0.01	[-0.09, - 0.03]	-3.91	<.01
AN-LTP	-3.65	0.45	[-4.52, -2.77]	-8.15	<.01
Interaction (pathogen disgust x AN-LTP)	0.04	0.06	[-0.07, 0.15]	0.70	.49
Gender (Women)	-6.36	0.27	[-6.88, -5.84]	-23.91	<.01
Age	0.15	0.01	[0.13, 0.18]	10.88	<.01
			Plant Preference		
Pathogen disgust sensitivity	-0.12	0.01	[-0.14, -0.10]	-10.12	<.01
AN-LTP	1.11	0.35	[0.42, 1.80]	3.15	<.01
Interaction (pathogen disgust x AN-LTP)	-0.01	0.04	[-0.10, 0.07]	-0.31	.75
Gender (Women)	2.59	0.21	[2.18, 3.00]	12.34	<.01
Age	0.22	0.01	[0.20, 0.24]	19.56	<.01

Note. B = Unstandardized regression coefficient, *SE* = standard error of the regression coefficient, 95% CI = 95% confidence interval *t* = *t*-value and *p* = significance level are reported here. Moderation analysis includes only one individual per family. AN-LTP = lifetime prevalence of anorexia nervosa. *N* = 5747; men = 1649, women = 4098. Meat Preference R^2 = 0.15 (p < .01), Plant Preference R^2 = .10 (p < .01).

Though the results of the moderation analyses were non-significant, a scatter plot (see Figure 3) is included of pathogen disgust sensitivity and meat preference ratings for AN-LTP and non-AN individuals which can be observed and described. A clear group of AN-LTP individuals reported not liking meats at all (rating of 0), and the low preference for meats was distributed across the range of pathogen disgust scores. The slope of the fit line for AN-LTP individuals was nearly flat, AN-LTP individuals with high pathogen disgust sensitivity scores preferred meats only a little bit less than AN-LTP individuals with low pathogen disgust sensitivity scores. The slope of the fit line for non-AN individuals was much steeper, non-AN individuals who had low scores on pathogen disgust sensitivity showed a large preference for meats and that preference for meats clearly decreased as pathogen disgust sensitivity scores increased. At the highest levels of pathogen disgust non-AN individuals nearly had the same level of preference for meats than AN-LTP individuals.

Figure 3

Scatter Plot with Fit Lines of Meat Preference and Pathogen Disgust Sensitivity Rating for AN-LTP and Non-AN Individuals

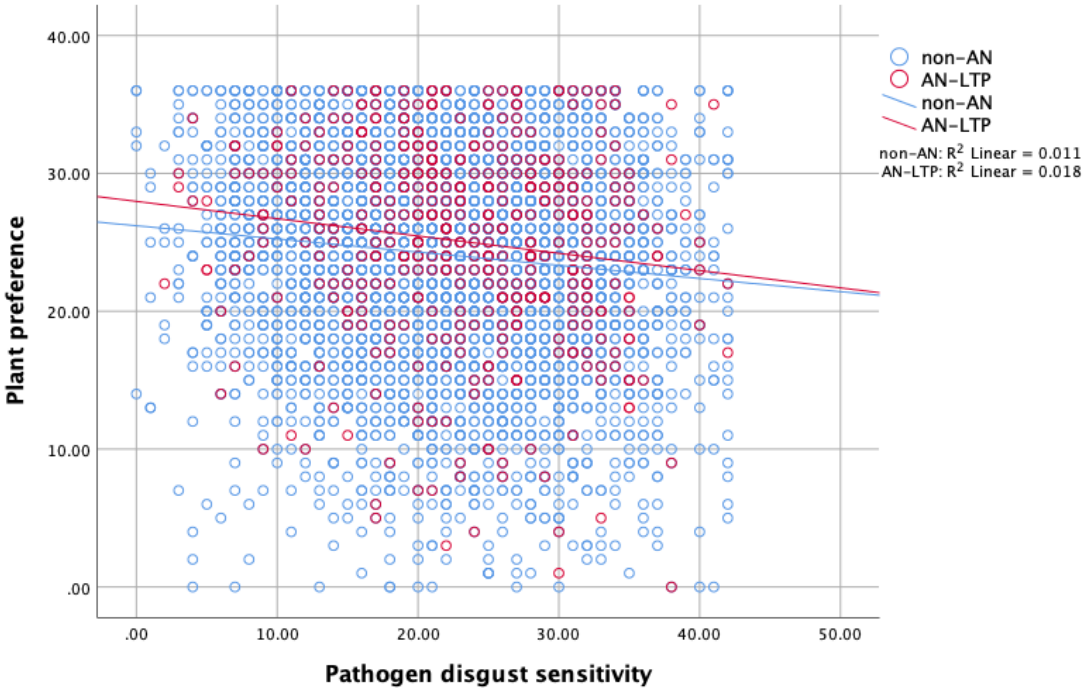


Note. AN = lifetime prevalence of anorexia nervosa. p = .49

A scatter plot of pathogen disgust sensitivity and plant preference ratings for AN-LTP and non-AN individuals (see Figure 4) is also included. For AN-LTP and non-AN individuals higher pathogen disgust sensitivity scores were associated with lower plant preference. Since the results of the moderation analysis were non-significant and were not in the direction that was expected based on previous research, the observed differences between AN-LTP and non-AN groups cannot be generalized to the population.

Figure 4

Scatter Plot with Fit Lines of Plant Preference and Pathogen Disgust Sensitivity Rating for AN-LTP and Non-AN Individuals



Note. AN = lifetime prevalence of anorexia nervosa. $p = .75$

Discussion

The aim of the current study was to determine whether meat and plant preference among individuals with AN-LTP differed from non-AN individuals. The associations between pathogen disgust sensitivity and meat and plant preference were also examined. Finally, a moderation analysis was conducted to determine whether AN-LTP moderated the relationship between pathogen disgust sensitivity and meat and plant preference.

Results from the gender analyses confirmed the first and second hypotheses and revealed that men preferred meats more and plants less than women, and women had higher ratings of pathogen disgust sensitivity than men. As for the analyses of individuals with a lifetime prevalence of anorexia nervosa, the results indicated that AN-LTP and non-AN individuals had different meat and plant preference, which was expected. The third to sixth hypotheses were partially supported. For women, the third to sixth hypotheses were fully supported and in line with expectations from previous research, whereas only two hypotheses were supported for men. Since AN is more common and more studied among women, the meat and plant preference of AN men and AN women would be understandably different. Additionally, in the current study a large group size discrepancy between the women and men groups (the group consisting of men was considerably smaller than the female group) could explain why results for men were not as robust. For women, having AN-LTP was associated with lower meat preference and greater plant preference in comparison to non-AN individuals. Significant differences in meat and plant preference for women were found between the AN-LTP and non-AN groups as well as within each group. The AN-LTP men group disliked meat more than the non-AN group, which was significant and expected. However, the AN-LTP men had nearly equal preference for meats and plants, whereas non-AN men preferred meats more than plants. This suggests that meat preference in male AN-LTP individuals could be affected in the expected direction even if there was no significant difference between meat and plant preference within the (relatively small) AN-LTP men group.

The results for women are in line with previous research that has found an association between having AN and following a vegetarian diet at the time of illness (Bardone-Cone et al., 2012; Sullivan & Damani, 2000). For men, eating disorders may be fundamentally different than for women. Whereas the goal for women may be to be thinner, the goal for men may be to get fitter and shed fat without losing muscle. This could explain the nearly equal preference for meats and plants among AN-LTP men. Another possible reason for these findings could be that men in general prefer meats more than women regardless of their AN status.

To my knowledge, the current study was the first to examine and compare the meat and plant preference of AN-LTP and non-AN individuals. Considering the large sample size in the current study, the evidence for the existence of different meat and plant preference of AN-LTP and non-AN individuals in the Finnish population is strong. The sample size**s** of previous studies examining the eating habits of AN individuals (see Bardone-Cone et al., 2012**;** Paslakis et al, 2016**;** Schebendach et al., 2019; Steinglass et al., 2015**)** have been smaller, ranging from 22 to 67 in each study with no included males.

The results from the current study are consistent with the theory that pathogen disgust sensitivity is functionally specialized for navigating food threats. The results indicated a small negative association between pathogen disgust sensitivity and meat preference, which was expected and supported the seventh hypothesis (that pathogen disgust sensitivity would be negatively associated with meat preference). Results also indicated a larger negative association between pathogen disgust sensitivity and plant preference, which was not in line with expectations and theory of the asymmetrical threat posed by different food items as described by Tybur and colleagues (2016). According to this theory, meats more than plants are threatening to humans because of their potentially pathogenic properties. The results from the present study rather suggested that pathogen disgust sensitivity is more specialized for navigating the threats posed by plants than meats.

Although the results from the GEE analysis of pathogen disgust sensitivity and meat and plant preference were not in line with expectations, others have had similar surprising results. Fessler and colleagues (2003) found that disgust sensitivity was positively associated with meat consumption, meaning that individuals who consumed meat more frequently had higher levels of disgust sensitivity. Additionally, Fessler and colleagues (2003) found that the greatest meat eaters had higher levels of disgust sensitivity in comparison to the vegetarians in the study. A study by Egolf and colleagues (2018) found that food disgust sensitivity ratings were associated with variety seeking for both meats and plants. Meats that were more unusual such as venison, lamb, and ostrich were negatively correlated with food disgust sensitivity whereas those meats that were more common such as poultry and processed meats were not.

It is possible that the avoidance of plant pathogens could be adaptive in addition to the avoidance of meat pathogens. A study by Balique and colleagues (2015) outlined evidence of the risk that plant viruses pose to humans. According to this study, animal and plant viruses are closely related; our exposure to plant viruses in foods, soil, and water is extensive; and plant viruses have been found in human fecal samples. Another possible explanation for the findings could be that other food-factors are more strongly related to pathogen disgust sensitivity, and the division between meats and plants may not be the most meaningful one.

Finally, results from the moderation analyses did not support the nineth or tenth hypotheses, that is, that AN-LTP would moderate the association between pathogen disgust sensitivity and meat and plant preference. The association between pathogen disgust sensitivity and meat and plant preference were not significantly different between the AN-LTP and non-AN groups, nor were results in the expected direction based on previous research. These results were not surprising considering that the AN-LTP group in this study was comprised of individuals who were not necessarily actively ill. The results do not fit with the theory that meat avoidance in AN is an adaptive response to the physiological changes in the immune system to protect the individual from

potentially harmful pathogens in meat at a time when the body and immune system are compromised.

The results of the present study suggest that although the meat and plant preference of AN-LTP individuals differ from non-AN individuals, the differences are not associated with differences in pathogen disgust sensitivity ratings. Other factors can likely better explain the meat and plant preference of AN-LTP individuals, for example anxiety about body size and weight.

Clinical Implications

The results of the present study could be useful in treatments for individuals with AN. Health care facilities and practitioners working with refeeding treatments should know that plant-based diets may be preferred by their AN patients. Nutritional interventions could provide meat and plant preference informed education to AN individuals about healthy eating habits. Finally, considering that the factors which motivate the meat and plant preference of AN individuals are not fully known, clinicians should ask relevant questions to their clients to find out and implement targeted treatment interventions.

Limitations

As previously mentioned, a limitation of the present study was that distinguishing between active AN individuals, recovered cases, and sickness severity was not possible from the data. The AN-LTP group in the present study represented a lifetime prevalence of having AN. This limitation could explain why the hypothesis of the moderation of AN-LTP on the association between pathogen disgust sensitivity and meat and plant preference was not supported. The group of men with AN-LTP was small in comparison to women with AN-LTP. This difference could possibly explain why the differences in meat and plant preference observed in men were not as robust as those observed in women. Having AN is associated with higher levels of alexithymia which means a greater difficulty recognizing or describing one's emotions (Westwood et al., 2017). According to Beadle and colleagues (2013), alexithymia did not resolve in AN individuals even after weight restoration. In the present study, individuals in the AN-LTP group were possibly less accurately able to report their

affective responses to pathogen cues in the Three Domain Disgust Scale (Tybur et al., 2016) in comparison to those without AN, which could have affected the results. Using physiological measures of disgust could have yielded different results.

Recommendations

Reaching a better understanding of the contributing factors to meat and plant preference of AN individuals is important. Future studies should distinguish between active AN illness and recovered cases which could possibly yield more robust and significant results. Knowledge in this area could help inform treatment of individuals with AN. Studies measuring physiological responses of AN individuals to pathogen cues or using self-report measures on strictly clinical populations are two examples of how research in this area could proceed. Additionally, based on the results of the current study more research on pathogen disgust sensitivity and meat and plant preference in general is warranted. In this field it would be valuable to study the associations between pathogen disgust sensitivity and specific food related factors.

Conclusions

Though the preference for meats and plants between AN-LTP and non-AN individuals differ, the differences do not depend on pathogen disgust sensitivity ratings. Support for the theory that pathogen disgust sensitivity is an adaptive affective mechanism to protect individuals from potentially disease-causing pathogens at a time when an individual is more vulnerable to disease as in the case of active AN illness was not found. However, since the current study did not distinguish between active illness, recovered cases and sickness severity, interpretation of these results are limited.

Pathogen disgust sensitivity is associated with differences in meat and plant preference. Higher scores of pathogen disgust sensitivity were associated with lower preference for meats and plants with the largest association being for plants. The present study did not find support for the theory of the asymmetrical threat posed by meats over plants and rather results suggest the opposite.

Future studies should distinguish between individuals with active AN illness, recovered cases as well as different sickness severity. Future research could also examine the different food-related factors that are associated with pathogen disgust sensitivity.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders, fifth edition*. American Psychiatric Association.

Balique, F., Lecoq, H., Raoult, D., & Colson, P. (2015). Can plant viruses cross the kingdom border and be pathogenic to humans? *Viruses, 7*(4), 2074-2098. https://doi.org/10.3390/v7042074

Bardone-Cone, A. M., Fitzsimmons-Craft, E. E., Harney, M. B., Maldonado, C. R., Lawson, M. A., Robinson, D. P., & Smith, R. (2012). The inter-relationships between vegetarianism and eating disorders among females. *Journal of the Academy of Nutrition and Dietetics, 112*(8), 1247-1252. https://doi.org/10.1016/j.jand.2012.05.007

Beadle, J. N., Paradiso, S., Salerno, A., & McCormick, L. (2013). Alexithymia, emotional empathy, and self-regulation in anorexia nervosa. *Annals of Clinical Psychiatry: Official Journal of the American Academy of Clinical Psychiatrists, 25*(2), 107-120. https://pubmed.ncbi.nlm.nih.gov/23638441/

Curtis, V., de Barra, M., & Aunger, R. (2011). Disgust as an adaptive system for disease avoidance behaviour . *Philosophical Transactions: Biological Sciences, 366*(1563), 389-401. https://doi.org/10.1098/rstb.2010.0117

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: Is hygiene in our genes? *Perspectives in Biology and Medicine, 44*(1), 17-31. https://doi.org/10.1353/pbm.2001.0001

Egolf, A., Siegrist, M., & Hartmann, C. (2018). How people's food disgust sensitivity shapes their eating and food behaviour. *Appetite, 127*(1), 28-36. https://doi.org/10.1016/j.appet.2018.04.014

Fessler, D. M. T. (2002). Reproductive Immunosuppression and diet: An evolutionary perspective on pregnancy sickness and meat consumption . *Current Anthropology, 43*(1), 19-43. https://doi.org/10.1086/324128

Fessler, D. M. T., Arguello, A. P., Mekdara, J. M., & Macias, R. (2003). Disgust sensitivity and meat consumption: a test of an emotivist account of moral vegetarianism. *Appetite, 41*(1), 31-41. https://doi.org/10.1016/S0195-6663(03)00037-0

Fichter, M. M., & Quadflieg, N. (2016). Mortality in eating disorders - Results of a large prospective clinical longitudinal study. *International Journal of Eating Disorders, 49*(4), 391-401. https://doi.org/10.1002/eat.22501

Garber, A. K., Sawyer, S. M., Golden, N. H., Guarda, A. S., Katzman, D. K., Kohn, M. R., Le Grange, D., Madden, S., Whitelaw, M., & Redgrave, G. W. (2016). A systematic review of approaches to refeeding in patients with anorexia nervosa. *International Journal of Eating Disorders, 49*(3), 239-310. https://doi.org/10.1002/eat.22482

Gibson, D., & Mehler, P. S. (2019). Anorexia nervosa and the immune system- A narrative review. *Journal of Clinical Medicine, 8*(11), 1915. https://doi.org/10.3390/jcm8111915

Guarda, A. S. (2008). Treatment of anorexia nervosa: Insights and obstacles. *Physiology & Behavior, 94*(1), 113-120. https://doi.org/10.1016/j.physbeh.2007.11.020

Harris, A., Romer, A., Hanna, E., Keeling, L., LaBar, K., Sinnott-Armstrong, W., Strauman, T., Wagner, H. R., Marcus, M., & Zucker, N. (2019). The central role of disgust in disorders of food avoidance. *International Journal of Eating Disorders, 52*(5), 543-553. https://doi.org/10.1002/eat.23047

Harrison, N. A., Gray, M. A., Gianaros, P. J., & Critchley, H. D. (2010). The embodiment of emotional feelings in the brain. *Journal of Neuroscience, 30*(38), 12878-12884. https://doi.org/10.1523/JNEUROSCI.1725-10.2010

Herpertz-Dahlmann, B., Seitz, J., & Baines, J. (2017). Food matters: How the microbiome and gut–brain interaction might impact the development and course of anorexia nervosa. *European Child & Adolescent Psychiatry, 26*, 1031-1041. https://doi.org/10.1007/s00787-017-0945-7

Hildebrandt, T., Grotzinger, A., Reddan, M., Grief, R., Levy, I., Goodman, W., & Schiller, D. (2015). Testing the disgust conditioning theory of food-avoidance in adolecents with recent onset anorexia nervosa. *Behaviour Research and Therapy, 71*, 131-138. https://doi.org/10.1016/j.brat.2015.06.008

Jern, P., Sola, I., & Ventus, D. (2020). Do women's relationship satisfaction and sexual functioning vary as a function of their male partners' premature ejaculation symptoms? *Journal of Sex & Marital Therapy, 46*(7), 630-638. https://doi.org/10.1080/0092623X.2020.1766612

Johansson, A., Jern, P., Santtila, P., Von Der Phalen, B., Eriksson, E., Westberg, L., Nyman, H., Pensar, J., Corander, J., & Sandnabba, N. K. (2013). The genetics of sexuality and aggression (GSA) twin samples in Finland. *Twin Research and Human Genetics, 16*(1), 150-156. https://doi.org/10.1017/thg.2012.108

Levinson, C. A., & Byrne, M. (2015). The fear of food measure: A novel measure for use in exposure therapy for eating disorders. *The International Journal of Eating Disorders, 48*(3), 271-283. https://doi.org/10.1002/eat.22344

Mason, E. C., & Richardson, R. (2012). Treating disgust in anxiety disorders . *Clinical Psychology: Science and Practice, 19*(2), 180-194. https://doi.org/10.1111/j.1468-2850.2012.01282.x

Miller, S. L., & Maner, J. K. (2011). Sick body, vigilant mind: the biological immune system activates the behavioral immune system . *Psychological Science, 22*(12), 1467-71. https://doi.org/10.1177/0956797611420166

Modlinksa, K., Adamczyk, D., Maison, D., & Pisula, W. (2020). Gender differences in attitudes to vegans/vegetarians and their food preferences, and their implications for promoting sustainable dietary patterns- A systematic review. *Sustainability, 12*(16), 6292. https://doi.org/10.3390/su12166292

Nagl, M., Jacobi, C., Paul, M., Beesdo-Baum, K., Höfler, M., Lieb, R., & Wittchen, H. (2016). Prevalence, incidence, and natural course of anorexia and bulimia nervosa among adolescents and young adults. *European Child & Adolescent Psychiatry, 25*(8), 903-918. https://doi.org/10.1007/s00787-015-0808-z

Oaten, M., Stevenson, R. J., & Case, T. I. (2009). Disgust as a disease-avoidance mechanism. *Psychological Bulletin, 135*(2), 303-21. https://doi.org/10.1037/a0014823

Paslakis, G., Kühn, S., Schaubschläger, A., Schieber, K., Röder, K., Rauh, E., & Erim, Y. (2016). Explicit and implicit approach vs. avoidance tendencies towards high vs. low calorie food cues in patients with anorexia nervosa and healthy controls. *Appetite, 107*, 171-179. https://doi.org/10.1016/j.appet.2016.08.001

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*(1), 23-41. https://doi.org/10.1037/0033-295X.94.1.23

Rozin, P., Haidt, J., & McCauley, C. (2016). Disgust. In L. F. Barrett, M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of Emotions* (4th ed., pp. 815-834). Guildford Publications.

Rozin, P., Lowery, L., & Ebert, R. (1994). Varieties of disgust faces and the structure of disgust. *Journal of Personality and Social Psychology, 66*(5), 870-881. https://doi.org/10.1037//0022-3514.66.5.870

Ruusunen, A., Rocks, T., Jacka, F., & Loughman, A. (2019). The gut microbiome in anorexia nervosa: relevance for nutritional rehabilitation. *Psychopharmacology, 236*(5), 1545-1558. https://doi.org/10.1007/s00213-018-5159-2

Schebendach, J. E., Uniacke, B., Walsh, B. T., Mayer, L. E. S., Attia, E., & Steinglass, J. (2019). Fat preference and fat intake in individuals with and without anorexia nervosa. *Appetite, 139*(1), 35-41. https://doi.org/10.1016/j.appet.2019.04.008

Sergentanis, T. N., Chelmi, M., Liampas, A., Yfanti, C., Panagouli, E., Vlachopapadopoulou, E., Michalacos, S., Bacopoulou, F., Psaltopoulou, T., & Tsitsika, A. (2020). Vegetarian diets and eating disorders in adolescents and young adults: A systematic review. *Children, 8*(1). https://doi.org/10.3390/children8010012

Silén, Y., Sipilä, P. N., Raevuori, A., Mustelin, L., Marttunen, M., Kaprio, J., & Keski-Rahkonen, A. (2020). DSM-5 eating disorders among adolescents and young adults in Finland: A public health concern. *International Journal of Eating Disorders, 53*(5), 790-801. https://doi.org/10.1002/eat.23236

Sjögren, M., Frostad, S., & Barfod, K. K. (2019). Dysbiosis of the microbiota in anorexia nervosa: pathophysiological implications. In H. Himmerich, & I. J. Lobera (Eds.), *Anorexia and Bulimia Nervosa* (). IntechOpen. https://doi.org/10.5772/intechopen.85253

Steinglass, J., Foerde, K., Kostro, K., Shohamy, D., & Walsh, B. T. (2015). Restrictive food intake as a choice-A paradigm for study. *International Journal of Eating Disorders, 48*(1), 59-66. https://doi.org/10.1002/eat.22345

Stoner, S. A., Fedoroff, I. C., Andersen, A. E., & Rolls, B. J. (1996). Food preferences and desire to eat in anorexia and bulimia nervosa. *The International Journal of Eating Disorders, 19*(1), 13-22. https://doi.org/10.1002/(SICI)1098-108X(199601)19:1<13::AID-EAT3>3.0.CO;2-Z

Sullivan, V., & Damani, S. (2000). Vegetarianism and eating disorders — Partners in crime? *European Eating Disorders Review, 8*(4), 263-266. https://doi.org/10.1002/1099-0968(200008)8:4<263::AID-ERV367>3.0.CO;2-2

Tybur, J. M., Laakasuo, M., Ruff, J., & Klauke, F. (2016). How pathogen cues shape impressions of foods: The ominvore's dilemma and functionally specialized conditioning . *Evolution and Human Behaviour, 37*(5), 376-386. https://doi.org/10.1016/j.evolhumbehav.2016.03.002

Tybur, J. M., & Lieberman, D. (2016). Human pathogen avoidance adaptations . *Current Opinion in Psychology, 7*, 6-11. https://doi.org/10.1016/j.copsyc.2015.06.005

Tybur, J. M., Lieberman, D., & Griskevicius, V. (2009). Microbes, mating and morality: Individual differences in three functional domains of disgust. *Journal of Personality and Social Psychology, 97*(1), 103-122. https://doi.org/10.1037/a0015474

Tybur, J. M., Wesseldijk, L. W., & Jern, P. (2020). Genetic and environmental influences on disgust proneness, contamination sensitivity, and their covariance. *Clinical Psychological Science, 8*(6), 1069. https://doi.org/10.1177/2167702620951510

Vanzhula, I. A., Sala, M., Christian, C., Hunt, R. A., Keshishian, A. C., Wong, V. Z., Ernst, S., Spoor, S. P., & Levinson, C. A. (2020). Avoidance coping during mealtimes predicts higher eating disorder

symptoms. *International Journal of Eating Disorders, 53*(4), 625-630. https://doi.org/10.1002/eat.23254

Welch, E., & Ghaderi, A. (2014). Mortality in anorexia nervosa - A look back at and beyond one of the most cited papers in the field. *Advances in Eating Disorders, 3*(2), 221-229. https://doi.org/10.1080/21662630.2014.968177

Westwood, H., Kerr-Gaffney, J., Stahl, D., & Tchanturia, K. (2017). Alexithymia in eating disorders: Systematic review and meta-analyses of studies using the Toronto Alexithymia Scale. *Journal of Psychosomatic Research, 99*, 66-81. https://doi.org/10.1016/j.jpsychores.2017.06.007