

1 **A Bitter Sweet Asynchrony: The Relation Between Eating**
2 **Attitudes, Dietary Restraint On Smell And Taste Function**

3
4 Lorenzo D. Stafford

5 Megan Tucker, Nora Gerstner

6 Centre for Comparative & Evolutionary Psychology
7 Department of Psychology, University of Portsmouth, U.K.

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10 **Correspondence to be sent to: Lorenzo D. Stafford, Department of Psychology,**
11 **University of Portsmouth, King Henry Building, King Henry I Street, Portsmouth**
12 **PO1 2DY.U.K. Email: lorenzo.Stafford@port.ac.uk. Tel: 02392 846322. Fax:**
13 **02392 846300**

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Abstract

Research has demonstrated that individuals with eating disorders have an impaired sense of smell and taste, though the influence of eating attitudes, dietary restraint and gender in a non-clinical sample is unknown. In two studies (study1: 32 females, 28 males; study 2: 29 females) participants completed questionnaires relating to Eating Attitudes (EAT) and dietary restraint (DEBQ) followed by an odour (study1: isoamyl acetate, study 2: chocolate) threshold and taste test. In study 2 we also measured the number of fungiform papillae taste buds. Study one revealed that increases in pathological eating attitudes predicted poorer olfactory sensitivity (males/females) and lower bitterness ratings for the bitter tastant (females only), suggestive of poorer taste acuity. In study two we found that both eating attitudes and restraint predicted poorer sensitivity to an odour associated to a forbidden food (chocolate) and that increasing eating attitudes predicted higher sweetness ratings for the bitter tastant. Interestingly increases in restraint were associated with an increased number of fungiform papillae which was not related to bitter or sweet intensity. These findings demonstrate that in a young healthy sample that subtle differences in eating pathology and dietary restraint predict impaired olfactory function to food related odours. Further that perception of bitter tastants is poorer with changes in eating pathology but not dietary restraint.

Keywords

Eating Attitudes, Restraint, Odour, Taste, Forbidden food, Gender

1 **Introduction**

2 In western societies, eating related disorders are among the most frequently reported health
3 problems in young females (Grave, 2011). The seriousness of conditions such as anorexia
4 nervosa is underlined by the fact it has the highest mortality rate ($\approx 20\%$) of any psychiatric
5 illness (Vitiello & Lederhendler, 2000). The precise causes of eating related disorders are still
6 unknown but are likely a combination of psychological, environmental and biological factors
7 (Grave, 2011). To further understand this complex condition, the role of smell and taste function
8 has also been investigated. At the clinical end of the spectrum, work has shown evidence for
9 anorexics to have an impaired sense of smell (Aschenbrenner et al., 2008; Rapps et al., 2010;
10 Roessner, Bleich, Banaschewski, & Rothenberger, 2005) and taste (Aschenbrenner, et al., 2008;
11 Casper, Kirschner, Sandstead, Jacob, & Davis, 1980; Rodin, Bartoshuk, Peterson, & Schank,
12 1990). However, in non-clinical samples it is unclear whether more general attitudes relating to
13 eating behaviour are also associated with differences in smell and taste function. Attitudes
14 relating to eating behaviour can be measured with instruments such as the Eating Attitude Test
15 (EAT) (Garner & Garfinkel, 1979) which contain a series of questions relating to eating behavior,
16 with scores over a certain threshold, typical of individuals with eating disorders. Using the EAT,
17 work has shown across a sample of hospitalized anorexic, bulimic and control subjects that EAT
18 scores were negatively associated to olfactory function; that is, those with more disordered
19 attitudes toward eating had a poorer sense of smell (Aschenbrenner, et al., 2008).

20
21 Apart from the link between the chemical senses and pathological eating attitudes, it is also
22 important to examine more subtle differences such as dietary restraint.

23

1 Dietary restraint is believed to be an important component of the maintenance and perhaps
2 development of eating related disorders (Brewerton, Dansky, Kilpatrick, & O'Neil, 2000; Polivy
3 & Herman, 1993). Very few studies have examined smell and taste function in this population,
4 though one study reported no differences in response to a neutral odour between restrained and
5 unrestrained eaters (Kemmons & Murphy, 2006). From a different perspective, work has
6 examined the effect of food odour cues (pizza or cookies) on subsequent hedonics and
7 consumption of those same foods (I. Fedoroff, Polivy, & Herman, 2003). Results revealed that
8 restrained eaters consumed more of the food that was congruent with the odour cue, i.e. more
9 pizza was eaten when preceded by the pizza compared to cookie odour cue. This pattern was not
10 observed in unrestrained eaters and therefore suggests that restrained individuals were more
11 sensitive to food odours, at least in their effects on subsequent food consumption. We are not
12 aware of any research examining differences in taste in these populations.

13
14 To summarize, there is evidence for poorer olfactory/gustatory function in anorexics/bulimics,
15 but it is unclear whether differences in eating attitudes (EAT) and dietary restraint might predict
16 smell & taste function in a non-clinical sample. We also wished to examine whether associations
17 are evident in both male and female samples. Historically, eating disorders and dietary restraint
18 are thought of as applicable to mainly females, but there is evidence of a convergence of eating
19 disorder prevalence between males and females (Woodside et al., 2001); which therefore make it
20 important to look at both genders.

21

1 Additionally, the above research (Aschenbrenner, et al., 2008; Kemmotsu & Murphy, 2006;
2 Rapps, et al., 2010; Roessner, et al., 2005) has not examined olfactory sensitivity using a food
3 related odour, which given the topic under investigation would seem particularly important.
4

5 In the present study, individuals completed measures of eating pathology (EAT) and dietary
6 restraint (DEBQ) followed by an olfactory threshold test to a food related odour (banana/pear:
7 isoamyl acetate) and finally a taste test to bitter and sweet tastants. We tentatively predict that for
8 females, increases in EAT and DEBQ will be associated with poorer olfactory and gustatory
9 function. Since we are not aware of any previous research in males, our aim is mainly
10 exploratory. Finally, we included measures of BMI and hunger state, since research has shown
11 that these factors can influence olfactory sensitivity (Stafford & Welbeck, 2011).

12 In study 2, we extended the research to examine the effect of using a food odour (chocolate) with
13 particular relevance to those with eating disorders (Knight & Boland, 1989) as there is reason to
14 believe that sensitivity to these odours might actually increase with eating pathology.
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17 **Methods**

18

19 **Study 1**

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21 **Participants**

22 Sixty students (32 females, 28 males) from the University of Portsmouth participated in the study
23 and were aged between 18 and 32 years ($M = 20.4$ years, $SD = 2.2$ years). An online booking
24 system was used to advertise the study which was described as examining factors that influence
25 our sense of smell and taste.
26

1 Individuals who were pregnant or had allergies to certain odours/taste were advised not to
2 participate. The study protocol was given ethical approval from the department's ethics
3 committee (British Psychology Society guidelines).

4 5 **Design**

6 The study used a correlational design with the main variables being EAT, DEBQ and the various
7 olfactory and gustatory measures.

8 9 *Eating Attitudes Test*

10 The EAT-26 (Garner & Garfinkel, 1979) was used to assess aberrant attitudes toward food and
11 eating. The questionnaire comprises of 26 items (e.g. "Aware of the calorie content of foods that
12 I eat") and participants signify their level of agreement on a 6-point likert scale from 'Always' to
13 'Never'. Higher scores are indicative of dieting behavior and scores above "20" associated with
14 an eating disorder.

15 16 *Dutch Eating Behaviour Questionnaire*

17 Restraint was determined using the restraint sub-scale of the Dutch Eating Behaviour
18 Questionnaire (Van Strien, Frijters, Bergers, & Defares, 1986). This entailed participants to rate
19 their agreement to ten questions by ticking a box on a 5-point likert scale from never (1) to very
20 often (5). The minimum and maximum values a participant could score are 1 and 5.

21 22 23 *Hunger*

24 Hunger was measured using a Visual Analogue Scale (VAS), with a 100mm unmarked line
25 labelled "not at all" and "extremely" at either end, with the adjective "hunger" centred above the
26 line.

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1 *Olfactory Threshold Test*

2 The odour used for the threshold test was isoamyl acetate, a food associated (smell of
3 banana/pear) odour used frequently in olfactory food related work (Albrecht et al., 2009), which
4 was diluted in mineral oil (Nujol). The odourant was prepared using eleven 250ml squeeze
5 bottles(CJK Packaging, UK), in 11 dilution steps, starting at 0.06% (Step 1) with each
6 successive step diluted by a factor of two, to the lowest (Step 11). All chemicals were supplied
7 by Fisher Scientific (UK). Prior to the start of testing, participants were familiarized with the
8 odour of the strongest concentration, by squeezing the bottle under the participant's nose (\approx 2cm)
9 and gently waving it between each nostril to ensure optimal inhalation. The experimenter wore
10 cotton gloves (Boots, Portsmouth) to reduce any cross contamination of odours. Participants then
11 completed VAS on the pleasantness, sweetness, bitterness and intensity of the odour. To test for
12 olfactory threshold, participants were presented with three bottles (2 of which were blanks,
13 containing mineral oil only) at the weakest concentration. Following presentation of the last
14 bottle of the triplet (counterbalanced), participants were asked which bottle contained the odour
15 (1, 2 or 3). If the participant answered correctly (and it was the lowest concentration), they were
16 presented with the same triplet again (in a different order) and the task repeated until they made a
17 mistake, which resulted in the triplet containing the next (higher) concentration step being
18 presented. Participants threshold was established when they had made three consecutive correct
19 responses. The method of threshold testing used was similar to a previous study (Lam, Sung,
20 Abdullah, & van Hasselt, 2006).

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1 *Gustatory Test*

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3 Taste was examined using a kit which is part of a larger test from the ‘Sniffin sticks’ battery
4 (Burghart Instruments, West Germany) which has been used widely in research (Hummel, Kobal,
5 Gudziol, & Mackay-Sim, 2007; Seo & Hummel, 2009). In the test here, two bottles were used
6 with spray attachments: one bottle containing a sweet solution (1g sucrose in 10g water) and the
7 other containing a bitter solution (0.005g quinine hydrochloride in 10g water).
8 Participants were presented with each tastant (counterbalanced order) which was sprayed directly
9 onto the tongue by the experimenter. After each taste, they completed the same VAS ratings and
10 sipped some water before the next taste.

11
12
13 **Procedure**

14
15 All testing took place at the University’s department of psychology. Participants were instructed
16 not to consume anything (apart from water) within two hours of their appointed time, since this
17 may have affected their sense of smell and taste. Upon arrival, participants provided informed
18 consent and then had their height and weight measurements taken. Next, participants completed
19 the EAT and DEBQ questionnaires followed by the hunger VAS. Participants then performed
20 the olfactory and gustatory tests and finally were given a full debriefing. Participants received
21 course credit for participating in the study.

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1 **Data Analyses**

2
3 Preliminary analyses for the taste ratings revealed associations for the bitter tastant only. We
4 therefore completed hierarchical linear regression analyses separately for odour threshold and
5 bitter estimates (bitter tastant) using the predictor variables of Hunger, Gender, BMI, EAT and
6 DEBQ and their interactions.

9 **Results**

12 *Olfaction And Taste*

13 Participant characteristics are presented in Table 1.
14 For olfactory threshold, analyses revealed significant associations for EAT and an EAT x DEBQ
15 interaction (Table 2), suggesting that increases in these factors impair odour sensitivity. In terms
16 of taste, we found significant associations for EAT and an EAT x Gender interaction (Table 3),
17 which is explained by increases in EAT predicting lower bitter perception in females, $r = -.58$,
18 $p < .001$ but not males, $r = .00$, ns. An analyses of these differences using Fisher's r to z
19 transformation revealed this difference was significant, $Z = 2.43$, $p = .01$ (2-tailed).

21 **Discussion**

22
23 The study found that impairments to both smell and taste function were associated with increases
24 in pathological eating attitudes, but with some important differences. Whilst poorer sensitivity to
25 a food odour was predicted by both eating attitudes and dietary restraint, in contrast bitter taste
26 perception was predicted by eating attitudes for females only.

1 The finding that eating attitudes were associated to poorer odour sensitivity supports previous
2 work where a modest association between EAT and overall olfactory function was found in a
3 sample of hospitalized anorexics/bulimics and controls (Aschenbrenner, et al., 2008). The
4 present study extends that work by demonstrating that eating attitudes predict odour sensitivity
5 (threshold) to a food odour in both male and female non-hospitalized populations. The additional
6 novel finding that dietary restraint and eating attitudes were associated with poorer sensitivity
7 suggests that more subtle differences in eating behaviour are able to predict odour sensitivity. In
8 terms of taste function, it was interesting that eating attitudes predicted bitter perception for
9 females but not males. The absence of an association with dietary restraint suggests that the more
10 extreme measures of pathological eating, possibly more relevant for females are the most
11 accurate predictor of taste impairment.

12
13 Although this study found that increased EAT predicted a poorer sense of smell to a food odour,
14 since work (Knight & Boland, 1989) has shown that some foods have a special significance for
15 those with eating disorders, being termed 'forbidden food', it is unclear whether sensitivity to
16 those specific odours (e.g. pizza, chocolate) would be impaired or enhanced in those with more
17 pathological eating attitudes. There is reason to predict the latter, since previous work found
18 more of a highly forbidden food [pizza, mean rating of '6.1' on the 0-8 scale by Knight &
19 Boland, 1989] was consumed when preceded by a pizza but not other food cue (I. Fedoroff, et
20 al., 2003).

21

22

1 Additionally, the method for assessing olfactory threshold in study one was not as comprehensive
2 as those used in other work (e.g. (Albrecht, et al., 2009; Stafford & Welbeck, 2011)), in particular
3 the range of potential scores is more limited. It is therefore uncertain whether using additional
4 dilution steps and a more comprehensive method for measuring threshold would result in the
5 same pattern of findings. Study two aimed to address these theoretical and methodological points
6 using an odour associated to a food with the highest forbidden food index [chocolate, mean rating
7 of '7.8' on the 0-8 scale by Knight & Boland, 1989)]. To further our understanding of taste
8 function and eating behaviour, we also examined whether the number of fungiform papillae taste
9 buds varied with eating pathologies and restraint; the number of fungiform papillae on an
10 individual's tongue being an index of taste intensity (Miller & Reedy, 1990).
11 Work has also demonstrated that anorexic patients had fewer fungiform papillae compared to
12 controls (Woeckel, Jacob, Holtmann, & Poustka, 2008), and on this basis we predict a negative
13 association with EAT/DEBQ. Since the strongest effects in study 1 were for females, we
14 therefore tested females only in study 2.

15

16 **Methods**

17

18 **Study 2**

19 Study 2 used the same method as study 1 with the following additions.

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22 **Participants and Design**

23 Twenty-nine female students from the University of Portsmouth participated in the study and
24 were aged between 18 and 31 years ($M = 21$ years, $SD = 3$ years). The study used a correlational
25 design with the main variables being EAT, DEBQ and the various olfactory and gustatory
26 measures.

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2 *Olfactory Threshold Test*

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4 The odour used for the threshold test was a sweet smelling chocolate odourant (Code 0679,
5 Anglo brands , UK) which was diluted in propylene glycol (Fisher Scientific, UK). The
6 odourant was prepared using sixteen 250ml squeeze bottles, in 16 dilution steps, starting at 8%
7 (Step 1) with each successive step diluted by a factor of two using serial dilution to the lowest
8 (Step 16). The same basic procedure was used as study 1 but in this study, threshold was
9 determined using a single up-down staircase system until there were seven 'turning points', with
10 the mean of the last four points determining the threshold for the individual .

11

12 *Measure Of Fungiform Papillae*

13

14 The procedure used to measure the number of fungiform papillae was similar to previous work
15 (Zhang et al., 2009). First, participants were asked to dry their tongue with a piece of regular
16 filter paper. After this, they were instructed to place a piece of baking paper with a ¼-inch hole
17 (punch hole) on the tip of the tongue, with the hole being just right of centre; this acted as a
18 stencil. A mirror was also provided to facilitate this procedure. Next, using disposable gloves,
19 the researcher dabbed some cotton wool containing blue food colouring (Dr. Oetker) onto the
20 punch hole sized part of the tongue. Participants were then instructed to take off the baking paper
21 and to place a piece of filter paper on the coloured part of the tongue, in order to soak up the
22 superfluous colour. Lastly, a picture of their tongue was taken using a digital camera (Fujifilm
23 FinePix S2995) while participants were holding the tongue still with their lips.

24

1 The images were downloaded to a computer and analyzed in Windows Live Photo Gallery, by
2 extending the image and counting the fungiform papillae in the coloured circle. To check for
3 consistency in this measurement, a sample of images were scored by two researchers which
4 revealed a high degree of agreement (> 80%).

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7 **Procedure**

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9 The same procedure was used as study 1 with the addition of measuring fungiform papillae,
10 which was completed after the taste tests.

11

12 **Data Analyses**

13

14 We completed bivariate correlations between EAT and DEBQ and the various measures of the
15 olfactory and taste tests.

16

17 **Results Study 2**

18

19

20 *Olfactory Sensitivity*

21 Participant characteristics are presented in Table 4. Results revealed significant negative
22 correlations between odour and EAT and DEBQ (Table 5), hence as in Study 1, increasing
23 EAT/DEBQ scores were associated with poorer sensitivity.

24

25

1 *Taste Test And Fungiform Papillae*

2 The bitter tastant was rated as increasingly sweeter with increasing EAT/DEBQ scores, though
3 reaching significance for EAT only (Table 5). Interestingly, the number of fungiform papillae
4 were positively associated with DEBQ scores, which was against prediction. To explore this
5 further, we completed correlations between the number of fungiform papillae and the ratings
6 (bitter/sweet/intensity) for the bitter tastant, which did not produce any significant associations
7 (all p s > 0.20). We also completed a partial correlation between DEBQ scores and the number of
8 fungiform papillae, controlling for sweet ratings for the bitter tastant, which revealed a significant
9 association, $r(26) = .47, p = .01$. This suggests that in the study here, the number of fungiform
10 papillae do not relate to bitter taste acuity and the relationship between DEBQ and fungiform
11 papillae is not affected by any baseline differences in bitter taste acuity.

13 **Discussion**

14 The main findings were that olfactory sensitivity to an odour associated to a so called 'forbidden'
15 food was impaired with increasing eating pathology and dietary restraint. These findings extend
16 those of study 1 to demonstrate that utilizing a more comprehensive method of measuring
17 threshold with a wider range of dilutions, that the tendency toward higher pathological eating
18 attitudes and restraint predicting poorer sensitivity is likely applicable to food odours generally.
19 In terms of taste function, we found that for a bitter tastant, increases in perceived sweetness were
20 associated with higher EAT scores, compared to study 1 where for the same tastant, we found
21 decreases in estimated bitterness related to higher EAT scores.

22

1 Though these two findings might appear in contrast to one another, the direction of both findings
2 are the same; where for a bitter tastant, increases in eating pathology predict higher sweetness
3 and lower bitterness, which all suggest poorer acuity for a bitter tastant. The apparent positive
4 association between the number of fungiform papillae and dietary restraint was a surprise finding
5 and against prediction. Previous work found that compared to controls, anorexic females had
6 fewer fungiform papillae (Woeckel, et al., 2008), which could account for poorer taste acuity in
7 this population, although no taste tests were conducted in that work. In the present study, we
8 were able to demonstrate that there was no relationship between the number of fungiform
9 papillae and bitter taste acuity; in fact, by controlling for bitter taste ratings, we observed a
10 stronger association between restraint and number of fungiform papillae. One possibility to
11 explain these findings is that the number of fungiform papillae in dietary restrained individuals is
12 indexing a potential response to food cues. Relevant here, work in rodents has suggested that
13 salivary responses increase activity to cells in the fungiform papillae (Gilbertson, Avenet,
14 Kinnamon, & Roper, 1992). Separately, in humans, one study found that salivary responses to a
15 food cue were greater in those high in restraint (Brunstrom, Yates, & Witcomb, 2004).
16 Collectively, these two studies suggest that the increases in fungiform papillae with restraint
17 might be more connected with food reactivity rather than taste acuity.

18
19

1 **General Discussion**

2 The findings from the present research suggest those individuals combining pathological eating
3 attitudes and dietary restraint have a poorer sense of smell to food related odours.

4 At face value, these findings may appear at odds with previous research where restrained
5 individuals consumed more of a food when it was preceded by the congruent odour (I. Fedoroff,
6 et al., 2003). That study appeared to suggest that restrained eaters might have higher acuity to
7 food related odours. However, it is important to recognise that work did not show higher
8 sensitivity to a food odour in restrained versus non-restrained individuals, but rather a greater
9 influence of odour cue on subsequent food intake and hedonics. As the authors reflect, that could
10 be down to greater attention to forbidden foods and this that affects intake. Indeed, since a pizza
11 odour cue and separately, merely thinking about a pizza had equivalent effects on subsequent
12 pizza consumption (I. C. Fedoroff, Polivy, & Herman, 1997), could be interpreted as a more
13 general cognitive effect in restrained eaters, instead of some preferential processing of olfactory
14 information. One of the theories use to explain their findings was from the addiction field
15 (Tiffany, 1990), which proposes that drug seeking behaviour is maintained by automatic
16 processes when the drug is freely available. But when drug access is impeded in some way (e.g.
17 deprived state), more intentional (less automatic) processes are required to secure the drug, which
18 is when drug craving is more likely to arise, especially when drug associated cues are present.
19 This helps explain why preferential processing of highly forbidden food (akin to a drug) occurred
20 in restrained but not unrestrained individuals (I. Fedoroff, et al., 2003; I. C. Fedoroff, et al.,
21 1997). Additionally it helps delineate enhanced cognitive processing in a study where restrained
22 individuals who suppressed thoughts of chocolate subsequently consumed more chocolate than
23 those allowed to think about chocolate (Erskine & Georgiou, 2010).

24

1 Moreover, what we theorise here is that taking the addiction model also helps explain why we are
2 able to observe both facilitated attention to forbidden food odours but paradoxically poorer
3 olfactory sensitivity. For instance, alcohol dependent individuals exhibit greater attentional
4 processing to drug related stimuli (Johnsen, Laberg, Cox, Vaksdal, & Hugdahl, 1994) but also
5 impaired olfactory sensitivity (Rupp et al., 2003).

6
7 In terms of taste, the findings from both studies suggest lower acuity to bitter tastants for those
8 with increasing eating pathology. This finding is in general agreement with previous clinical
9 research where anorexics demonstrated poorer sensitivity to bitter but less so to sweet tastants
10 (Casper, et al., 1980). Eating disordered individuals also showed preserved sensitivity to sweet
11 tastants (Drewnowski, Halmi, Pierce, Gibbs, & Smith, 1987). Taken together, one could theorise
12 that those individuals with increased eating pathologies (EAT) have impaired bitter but not sweet
13 perception. Interestingly, one of the theories to explain taste function deterioration in eating
14 disorders such as bulimia is where the acid produced by vomiting causes impairments in taste
15 that are specific to those regions of the mouth (Rodin, et al., 1990). Though the present work did
16 not obtain such detailed participant information on specific eating disorders, given the lower EAT
17 mean (across both studies $M = 8.7$) compared to hospitalised bulimics [$M = 34.4$,
18 (Aschenbrenner, et al., 2008)], suggests that such a theory is unnecessary to explain poorer taste
19 function. In other words, since the severity of eating pathology was much lower in our sample,
20 but we still observed the trend for a poorer sense of bitter taste, all suggest that the consequences
21 of purging are unlikely to be the cause.

22

1 The fact that both eating pathology and dietary restraint predicted olfactory sensitivity, but only
2 the former predicted poorer taste acuity was interesting and worthy of reflection. It is well
3 known that the vast majority of food flavour experienced in the mouth derives from the olfactory
4 rather than solely the taste system. It appears that whereas more general aspects of eating related
5 behaviour (EAT/DEBQ) are able to predict broader chemosensory function, in contrast it is only
6 the more serious eating pathologies that relate to the narrower band of taste, specifically bitter
7 taste perception.

8
9 Considering the limitations of the work here, since we tested two food odours related to ‘sweet’
10 related foods (banana/pear & chocolate), it is unclear whether similar findings would be found in
11 savoury related odours. Additionally, the taste tests used in this research examined perception of
12 sweet and bitter tastants, but did not measure threshold sensitivity which future work should
13 address. Finally, although participants were advised not to consume anything (other than water)
14 two hours before the start of the study, it would be preferable to test participants at the same time
15 of the day to control for any possible confounding effects.

16 In conclusion, we found that across a healthy sample, increases in pathological eating attitudes
17 and dietary restraint were associated with a poorer sense of smell in males and females, whereas
18 only in females did eating attitudes predict poorer bitter taste acuity.

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1 **Table 1. Mean (SE) Participant Characteristics Dependent On Gender (Study 1)**

	Males (N=28)	Females (N=32)
Age	21.1 (0.3)	19.7 (0.4)
BMI	24.1 (0.7)	20.9 (0.5)
DEBQ	17.1 (0.7)	26.3 (1.6)
EAT	3.8 (0.6)	9.5 (1.1)
Threshold	10.0 (0.25)	9.7 (.47)
Bitter Taste (Bitter Ratings)	73.9 (5.1)	72.4 (4.4)
Bitter Taste (Sweet Ratings)	6.9 (1.4)	8.9 (1.3)

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1 **Table 2. Effects Of Hunger, BMI, Gender, DEBQ, EAT On Odour (Threshold) Sensitivity**
 2 **(Study 1)**
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Variable	Standardized (beta) coefficients	<i>t</i> -value	<i>p</i> -value
Hunger	-.14	-.10	.92
Gender	.68	.510	.61
BMI	-.23	-.16	.88
DEBQ	-.96	-.59	.56
EAT	-.56	-3.56	.001
EAT x DEBQ	-1.26	-2.19	.03
DEBQ x Gender	.85	1.04	.30
EAT x Gender	-.27	-.51	.61
EAT x DEBQ x Gender	-3.02	1.00	.32

5 Gender coded as 0 = males, 1 = females.
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1 **Table 3. Effects Of Hunger, BMI, Gender, DEBQ, EAT On Bitterness Ratings (Bitter**
 2 **Tastant) (Study 1)**

Variable	Standardized (beta) coefficients	<i>t</i> -value	<i>p</i> -value
Hunger	-.031	-.24	.81
Gender	.030	.23	.82
BMI	.23	1.56	.13
DEBQ	-.13	-.79	.44
EAT	-.45	-2.83	.006
EAT x DEBQ	-.11	-.18	.86
DEBQ x Gender	.40	.46	.65
EAT x Gender	-1.05	-1.95	.05
EAT x DEBQ x Gender	-2.60	-.84	.41

5 Gender coded as 0 = males, 1 = females.
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2 **Table 4. Mean (SE) Participant Characteristics (Study 2)**

Age	20.9 (0.6)
DEBQ	25.0 (1.7)
EAT	7.9 (1.6)
Threshold	10.8 (0.8)
Bitter Taste (Bitter Ratings)	61.3 (3.6)
Bitter Taste (Sweet Ratings)	13.3 (3.1)
Fungiform Papillae Number	19.9 (1.5)

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Table 5. Bivariate correlations Between EAT, DEBQ, And Olfactory & Gustatory Measures (n=29) (Study 2)

	1	2	3	4	5	6
1. EAT	1	.73**	-.53**	.42*	.25	-
2. DEBQ		1	-.50**	.32 ^a	-	.37*
3. Olfactory Threshold			1	-	-	-
4. Bitter Taste - Sweetness				1	-	.80**
5. Bitter Taste - Pleasantness					1	-
6. Fungiform Papillae						1

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Notes: '- ' = coefficient less than '2'.

^ap < .10; * p < .05; ** p < .01

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