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Acute hunger modifies responses on the Three Factor Eating Questionnaire

Hunger and Disinhibition, but not Restraint, scales.

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Running head: Hunger modifies responses on TFEQ

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1 **Abstract**

2 It is widely assumed that responses on the Three Factor Eating Questionnaire
3 (TFEQ) represent long-term (trait) attitudes to eating behaviour. However, the
4 questionnaire requires agreement with a number of food related statements, and
5 it is possible that some are easier to agree with when assessed hungry than
6 sated. To test this potential state-dependency, participants completed a 100 mm
7 visual analogue scale rating of their current hunger at the time they completed
8 the TFEQ. Data were collected from two cohorts: Cohort 1 (507 women and 119
9 men) completed both measures on paper, while the hunger rating was
10 computerised in Cohort 2 (179 women). Regression analysis revealed significant
11 effects of rated hunger on scores on the hunger (TFEQ-H) and disinhibition
12 (TFEQ-D) but not restraint (TFEQ-R) subscales, with higher TFEQ-H and TFEQ-D
13 scores when participants were more hungry. In addition, 61 women and two
14 men from Cohort 1 completed the measures on two separate occasions. Here,
15 scores on TFEQ-H were higher on days when these participants were hungrier,
16 but no differences in TFEQ-D or TFEQ-R were found. Overall these data suggest
17 TFEQ-H could be interpreted as an indirect measure of current hunger, that
18 scores on TFEQ-D are partly moderated by hunger but TFEQ-R is a more trait-
19 like measure of restraint.

20

21 **Key words:**

22 Restraint, disinhibition, hunger

23

24 **Introduction**

25

26 Since its publication, the Three Factor Eating Questionnaire (Stunkard &
27 Messick, 1985) has become one of the most widely used psychometric tools
28 identifying individual differences in eating attitudes in studies of human
29 ingestive behaviour. As its name indicates, the questionnaire was devised to
30 measure three aspects of human eating, defined by the authors as restraint
31 (TFEQ-R), disinhibition (TFEQ-D) and hunger (TFEQ-H). Originally, these scales
32 were designed to measure long-term attitudes to eating and consequently scores
33 are often considered as long-term or trait measures (Barkeling, King, Näslund, &
34 Blundell, 2007; Bryant, King, & Blundell, 2008; Finlayson, Cecil, Higgs, Hill, &
35 Hetherington, 2012; Gallant, et al., 2013; Gallant, et al., 2010; Lattimore, Fisher, &
36 Malinowski, 2011). However, this implies that answers to items on the TFEQ
37 reflect long-term influences on each individual's eating and are thus insensitive
38 to the acute appetitive state of the participant. To our knowledge this
39 assumption has never been formally tested.

40

41 At present there are three widely used measures of restrained eating: TFEQ-R,
42 the restraint scale from the Dutch Eating Behaviour Questionnaire (DEBQ: Van
43 Strien, Frijters, Bergers, & Defares, 1986) and the Revised Restraint Scale (RRS:
44 Polivy, Herman, & Howard, 1988), which itself was developed from the original
45 attempt to measure habitual restrained eating (Herman & Mack, 1975).
46 Restraint is often initiated as a response to weight gain and all three measures
47 are based on responses to items that measure the tendency to cognitively control
48 eating behaviours and restrict intake due to concerns with current body weight.

49 The external focus restrained eaters makes it less likely that scores on restraint
50 scales will vary with acute hunger state.

51

52 However, both TFEQ-D and TFEQ-H measure attitudes and responses to food.

53 The TFEQ-D scale has been described variously as a measure of trait

54 disinhibition (Lattimore, et al., 2011; Neale, Mazzeo, & Bulik, 2003), uncontrolled

55 eating (Keskitalo, et al., 2008; Yeomans, Leitch, & Mobini, 2008) or opportunistic

56 eating (Bryant, et al., 2008; Finlayson, et al., 2012), reflecting a recognition that

57 the name disinhibition is confounded with the disinhibition effect arising from

58 the breakdown of dietary restraint. Indeed, a shortened version of the TFEQ

59 combined items from the original TFEQ-D and TFEQ-H scales into measure of

60 uncontrolled and emotional eating (Karlsson, Persson, Sjostrom, & Sullivan,

61 2000). High scores on TFEQ-D have been associated with higher body-weight

62 both on its own (French, Mitchell, Finlayson, Blundell, & Jeffery, 2014; Hays &

63 Roberts, 2008; Lawson, et al., 1995; Tepper & Ullrich, 2002), and in combination

64 with scores on TFEQ-R (Williamson, et al., 1995). In all cases, TFEQ-D is

65 interpreted as a longer term dispositional measure of self-reported tendency to

66 struggle to control eating. However, the statements underlying TFEQ-D typically

67 relate to situations that challenge the ability to resist eating, either by the

68 presence of desirable food or by emotional states that may promote eating. Thus

69 it is plausible that some participants might be more likely to respond positively

70 to these questions when more hungry than when sated.

71

72 The least researched of the three TFEQ subscales is TFEQ-H, originally seen as a

73 measure of susceptibility to hunger cues: i.e. a reflection of long-term individual

74 differences in responses to hunger rather than a state measure of hunger per se.
75 High scores on TFEQ-H have again been associated with higher body-weight
76 (Dykes, Brunner, Martikainen, & Wardle, 2004; French, et al., 2014), which runs
77 counter to the original idea that high scores on TFEQ-H might relate to greater
78 interoceptive awareness and consequently lower susceptibility to overeating.
79 However, as with TFEQ-D responses on hunger items could again be enhanced
80 by actual state hunger: for example, it seemed plausible that hungry individuals
81 might more readily agree with the statement “When I see a real delicacy, I often
82 get so hungry that I have to eat right away”. Indeed, some papers interpret
83 TFEQ-H as a measure of perceived or state hunger (de Castro & Lilenfeld, 2005;
84 Rutters, Nieuwenhuizen, Lemmens, Born, & Westerterp - Plantenga, 2009;
85 Williamson, et al., 1995), implying this is more an acute than trait measure,
86 although others describe TFEQ-H in trait terms (Barkeling, et al., 2007; Bond,
87 McDowell, & Wilkinson, 2001; e.g. Gendall, Joyce, Sullivan, & Bulik, 1998;
88 Provencher, et al., 2005). This uncertainty in the nature of the TFEQ-H measure
89 can be clarified by examining the acute sensitivity of TFEQ-H to actual hunger
90 when the TFEQ was completed.

91

92 The key question in the present paper thus relates to the sensitivity of responses
93 to the TFEQ to acute appetitive state. The majority of the scores on the original
94 51-item TFEQ derive from simple “True/False” statements which describe
95 various eating situations. Although the intention was to use this simple
96 questionnaire format to promote long-term responses, it is possible that the
97 degree to which someone agreed with these statements depended on their acute
98 hunger. The present study tested this idea by assessing how within and

99 between-person responses on all three TFEQ sub-scales varied as a function of
100 hunger at the time of completion to explicitly test the extent to which TFEQ
101 scores were sensitive to the self-reported hunger state at the time of testing.

102

103 **Methods**

104

105 *Design*

106 The study examined how scores on the three subscales of the TFEQ varied
107 depending on the rated hunger of the participant at the time when the TFEQ was
108 completed.

109

110 *Participants*

111 Participants were 805 male and female volunteers who completed the TFEQ and
112 at the same time rated their hunger. Most data were obtained as part of a
113 standardised recruitment process between 2006 and 2008: additional data came
114 from a subset of specific studies conducted between 2012 and 2014, where
115 participants again completed the TFEQ alongside a rating of current hunger. All
116 data collection was approved by the University of Sussex Science and Technology
117 Cross-Schools Research Ethics Committee (C-REC) and was conducted in line
118 with the British Psychological Society code of conduct, ethical principles and
119 guidelines. As this was an analysis of data originally collected for other purposes,
120 we confirm all participants consented to the use of their responses in future
121 research.

122

123

124 ***Procedure***

125 Data were collected from two cohorts of participants. Cohort 1 was collected
126 between 2006 and 2008 and comprised of staff and students at the University of
127 Sussex who completed a standardised recruitment questionnaires part of their
128 voluntary admission to the Sussex Ingestive Behaviour Unit (SIBU) participant
129 pool. This combined the standard 51-item TFEQ, a series of questions about
130 drinking habits, food aversions and allergies, and finally a single rating of hunger
131 presented as a 100mm visual analogue scale (VAS) below the instruction “Please
132 put a mark on the line to show how hungry you are right now, paying attention
133 to the descriptions at the end of the line”, with the end-anchors “Not at all
134 Hungry”, coded as zero, and “Extremely hungry”, coded as 100. The VAS rating
135 was on a separate page from all TFEQ measures. In total 626 completed
136 questionnaires were available for analysis in Cohort 1 (507 women and 119
137 men). Each person’s age at the time of completion was recorded (mean age:
138 males = 23.4 ± 5.9 , range 18-62 years; females = 21.6 ± 4.4 , range 18-61 years).

139
140 Of the participants in Cohort 1, 63 (59 women and 4 men) completed the
141 questionnaire more than once (separated by between 1 and 15 months). This
142 provided the opportunity to test how within-participant differences in rated
143 hunger altered the way they completed the TFEQ.

144
145 Data for Cohort 2 was collected later (2012-2014) from a further 179 female
146 participants who consented to be part of research studies in the SIBU. On this
147 occasion participants made computerised ratings of hunger alongside fullness,
148 thirst and desire to eat. Participants were asked “How Hungry do you feel right

149 now?" and responded on a similar 100mm VAS as in Cohort 1, with the end-
150 anchors "not at all hungry" (0) and "Extremely hungry" (100). This time,
151 however, the rating was completed on a computer. All participants completed
152 the TFEQ (on paper) straight after rating their appetite. Finally, Body Mass Index
153 (BMI: calculated from height and weight measurements) and age at the time of
154 testing was recorded (mean age = 20.6 ± 3.0 , range 18-38 years; mean BMI
155 $\text{kg}/\text{m}^2 = 23.2 \pm 3.6$, range = 17-37).

156

157 ***Data analysis***

158 The key question for this study was the extent to which ratings on the three sub-
159 scales of the TFEQ depended on a person's reported hunger at the time when the
160 TFEQ was completed. Principle analyses regressed Rated Hunger against each
161 TFEQ factor in separate regression models. Cohort (1 vs 2), Gender (male vs.
162 female), Age (years) were entered as control variables in the first step of each
163 model and their interaction with Hunger ratings were tested in a second step.
164 BMI was not included as these data were only available for the smaller Cohort 2.
165 Since 29 participants did not provide their age, analysis was on the 776 for
166 whom we had complete data. Where a participant had completed the
167 questionnaire twice, only data from their first questionnaire was included in
168 these analyses. In the regression analysis, the % variance accounted for by each
169 model (and specifically the variables of interest: rated hunger and the control
170 variables gender, age and cohort) can be taken as the effect size and these data
171 are reported throughout the results.

172

173 The second set of analysis examined data for those 63 participants from Cohort 1
174 who had completed the questionnaire twice. Here, individual hunger ratings
175 were used to nominally classify participants as More Hungry (i.e. the session
176 when their hunger score was highest) and Less Hungry (the session when their
177 rating was lower). The three TFEQ scores were then contrasted between the
178 More and Less Hungry conditions using 2-way ANOVA and report partial eta
179 values as measures of effect size.

180

181 **Results**

182 Across all participants, responses on the three TFEQ sub-scales were somewhat
183 related. TFEQ-R was significantly positively correlated with TFEQ-D ($r = 0.321, p$
184 < 0.001) but not with TFEQ-H ($r = 0.008, p = 0.817$). The strongest relationship
185 was noted for TFEQ-D and TFEQ-H subscales ($r = 0.462, p < 0.001$).

186

187 ***Relationship between TFEQ scores and rated hunger***

188 Regression analyses found significant effects of hunger at time of completion on
189 scores on TFEQ-H and TFEQ-D, but not TFEQ-R sub-scales (see **Table 1**). For
190 TFEQ-R, there was no significant effect of rated hunger or age. Gender
191 significantly influenced TFEQ-R, resulting from higher average TFEQ-R scores for
192 women (8.0 ± 0.2) than men (4.7 ± 0.3), which would be expected. There was
193 also a significant effect of test cohort on TFEQ-R, with scores tending to be higher
194 in Cohort 2 (9.2 ± 0.4) than Cohort 1 (7.1 ± 0.2). Since Cohort 2 only used
195 women, it is possible that the main effect of cohort is simply a reflection of this
196 gender difference. Overall these variables accounted for 7 % of the variance in
197 TFEQ-R. Rated hunger did not interact with age, gender or cohort to affect

198 TFEQ-R scores, and these interaction terms did not significantly improve the
199 regression model (R^2 change = 0.2 %, $p = 0.702$) and were removed from the
200 analysis.

201

202 There was a significant effect of hunger rating on TFEQ-D, with lower TFEQ-D
203 associated with less hunger (**Table 1**). As with TFEQ-R scores, there was no
204 effect of age on TFEQ-D but there was a significant effect of gender and a
205 marginal effect of cohort: women tended to have higher scores on average ($6.9 \pm$
206 0.1) than men (5.2 ± 0.3), and scores tended to be higher for cohort 2 (7.5 ± 0.2)
207 than cohort 1 (6.4 ± 0.1). These variables accounted for 6 % of the variance in
208 TFEQ-D. Rated hunger did not interact with age, gender or cohort to affect
209 TFEQ-R scores, and these interaction terms did not significantly improve the
210 regression model (R^2 change = 0.1 %, $p = 0.906$) and were removed from the
211 analysis.

212

213 Finally, there was a significant effect of rated hunger on TFEQ-H, larger than the
214 effect seen for TFEQ-D (Table 1), where increased hunger at the time of
215 completing the TFEQ was associated with higher TFEQ-H. This model accounted
216 for 13 % of the variance in TFEQ-H. Rated hunger did not interact with age,
217 gender or cohort to affect TFEQ-H scores, and these interaction terms did not
218 significantly improve the regression model (R^2 change < 0.01 %, $p = 0.474$) and
219 were excluded from the analysis.

220

221 Since we also had BMI data for Cohort 2 along with other appetite ratings, we
222 explored further predictors of TFEQ subscales in more detail with this smaller

223 cohort. BMI was not significantly related to TFEQ-R scores, but BMI was
224 positively associated with TFEQ-D (Beta = 0.30, $t(176) = 9.09$, $p < 0.001$) and
225 negatively associated with TFEQ-H (Beta = -0.14, $t(176) = -2.28$, $p = 0.024$).
226 Neither rated fullness or desire to eat were significantly related to any of the
227 TFEQ sub-scales.

228

229 ***Effects of relative hunger on TFEQ scores***

230 For the 63 participants who completed the TFEQ on two separate occasions,
231 analysis of actual rated hunger in the nominal More or Less hungry conditions
232 confirmed the difference was clear and significant (More Hungry, 54 ± 3 : Less
233 Hungry, 18 ± 2 ; $t(62) = 12.92$, $p < 0.001$). Average TFEQ scores were higher when
234 participants were More than Less hungry ($F(1,62) = 30.52$, $p < 0.001$, $\eta_p^2 = 0.33$),
235 but this depended on TFEQ subscale ($F(2,124) = 22.24$, $p < 0.001$, $\eta_p^2 = 0.26$). As
236 can be seen (Figure 1), while relative hunger had no significant effect on TFEQ-R
237 or TFEQ-D, TFEQ-H scores were significantly higher in the More than Less
238 hungry condition ($t(62) = 7.93$, $p < 0.001$).

239

240 **Discussion**

241

242 The key question posed in this paper was the extent to which responses on the
243 TFEQ are truly “trait” measures as has often been assumed, but which to our
244 knowledge has not previously been formally tested. The answer is that the
245 three sub-scales of the TFEQ differed in their dependence on appetitive state at
246 the time of questionnaire completion. Scores on TFEQ-R were independent of
247 rated hunger, consistent with restraint being a long term dieting-related attitude.
248 Scores on TFEQ-H were clearly influenced by actual hunger, with higher TFEQ-H
249 scores when tested more hungry. The surprising finding was the small but
250 significant influence of hunger on TFEQ-D scores.

251

252 Rated hunger at the time when the TFEQ was completed was associated with
253 scores on TFEQ-H: the more hungry an individual was, the more likely they were
254 to agree with items associated with the TFEQ-H scale. Moreover, where people
255 had completed the TFEQ twice, they scored higher on TFEQ on the day when
256 they were hungry than when more sated. Thus rather than being a trait
257 measure, these data strongly suggest that TFEQ-H is at least partially an
258 expression of actual hunger at the time when the questionnaire is completed.
259 Since the majority of items contributing to the TFEQ-H score are simple
260 True/False statements like “Since I am often hungry, I sometimes wish that while
261 I am eating, an expert would tell me that I have had enough or that I can have
262 something more to eat” (TFEQ item 8), it must be easier to agree with this if
263 hungry than sated. This questions the outcomes of studies that have interpreted
264 effects of TFEQ-H as trait effects of sensitivity to physiological hunger.

265 In contrast to TFEQ-H, TFEQ-R scores were clearly independent of hunger at the
266 time of completion, in line with the general interpretation of restraint as a
267 longer-term (trait-like) attitude to eating. What was unexpected was the small
268 but significant effect of rated hunger on TFEQ-D scores. Notably the within-
269 participant contrast of TFEQ-D scores between the same person tested hungry or
270 sated was also not significant. Given the small effect size of the influence of
271 hunger on TFEQ-D in the regression analysis, and the lack of effect when
272 contrasted between hungry and sated states, it is unlikely that hunger will have
273 significantly influenced the outcomes of studies which have tested effects of
274 TFEQ-D on other behaviours without controlling for acute hunger state.
275 However it does suggest it would be prudent to record actual hunger and covary
276 this in future studies exploring effects of TFEQ-D, and certainly to do so for
277 TFEQ-H. Indeed, for studies exploring differences between groups defined by
278 TFEQ scores but with smaller sized samples, the best approach would be to
279 standardise the level of hunger to minimise any potential effects of acute hunger
280 state.

281

282 As in previous studies, there was also evidence that scores on the sub-scales of
283 the TFEQ are inter-related. TFEQ-D and TFEQ-R were positively correlated here,
284 and similar positive correlations have been reported previously in some studies
285 both from the same study population (Brace & Yeomans, 2016) and elsewhere
286 (e.g. Contento, Zybert, & Williams, 2005; Dykes, et al., 2004; Van Strien, Cleven, &
287 Schippers, 2000), but notably other well-powered studies have not found this
288 relationship (e.g. Lawson, et al., 1995; Williamson, et al., 1995), and some even
289 reported lower disinhibition with increasing restraint (Westenhoefer, 1991). An

290 explanation for these differences may lie in the observation by Westenhoefer
291 (1991) that Dietary Restraint could be sub-divided into Rigid Control, which was
292 positively correlated with TFEQ-D, and Flexible Control, which was negatively
293 correlated with TFEQ-D. Thus the extent to which restraint and disinhibition
294 may vary between populations, reflecting the relative distribution of flexible and
295 rigid diet control amongst respondents. Weight status may also be key to the
296 relationship between TFEQ-R and TFEQ-D: in a previous study, a positive
297 relationship was noted between these measures in participants with a BMI
298 within what the author's defined as a healthy range for that population (between
299 18-27 kg/m²), but this relationship reversed in overweight and obese individuals
300 (Bellisle, et al., 2004). The current sample was largely normal weight (although
301 we only had actual weight measures for Cohort 2), which fits with the
302 relationship we found between TFEQ-R and TFEQ-D.

303

304 There was also a clear positive relationship between TFEQ-D and TFEQ-H scores
305 here, and in previous studies (Dykes, et al., 2004; Stunkard & Messick, 1985). In
306 contrast, TFEQ-R and TFEQ-H were unrelated here, and elsewhere (Dykes, et al.,
307 2004). The inter-relationships between responses on TFEQ subscales have led
308 some to question the overall validity of the TFEQ (Karlsson, et al., 2000) and
309 shorter versions have been developed with the aim of making these subscales
310 more distinct (de Lauzon, et al., 2004; Karlsson, et al., 2000) . Whether these
311 shortened versions are also sensitive to acute hunger state remains untested, but
312 given that they include items from the original TFEQ-H and have more response
313 categories our current data suggest they may be equally sensitive to acute
314 hunger.

315

316 Because the data collection for Cohort 1 was as part of a broader participant
317 recruitment, we did not have BMI data for that part of the dataset, but notably
318 for the more detailed data BMI and TFEQ-H were positively correlated, as has
319 been reported elsewhere (Bellisle, et al., 2004; Dykes, et al., 2004; Hays, et al.,
320 2002; Provencher, Drapeau, Tremblay, Despres, & Lemieux, 2003). However, this
321 does raise some limitations in how far the present data can be generalised:
322 Cohort 1 was an opportunity sample of undergraduates in a female-dominated
323 University, and a replication with a larger male population would be useful.
324 Likewise, the data are mainly from younger, healthy adults, and it would be
325 interesting to note whether similar relationships are seen in a more
326 representative population and in overweight/obese populations. Finally, it is
327 notable for the within-participants contrast that the average hunger on the
328 “More hungry” day was only 54pt on the 100pt hunger VAS, suggesting even the
329 “More hungry” condition did not represent a truly hungry state. This raises an
330 interesting issue which cannot be answered by the present dataset as to whether
331 acute studies conducted in a fasted state would generate larger differences in
332 state TFEQ responses, and this should be looked at in future studies.

333

334 In conclusion, the present data clearly show that the TFEQ-H scale is influenced
335 by hunger state rather, undermining the use of this scale to measure the trait
336 influence of sensitivity to hunger state. We also identify a weak influence of
337 hunger on TFEQ-D scores, suggesting that studies using that measure should
338 ideally co-vary actual hunger to remove any influence of current hunger state on
339 disinhibition scores.

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Table 1. Outputs from regression analysis of predictors of scores on the three TFEQ sub-scales. Values given are the unstandardised *b* values [bootstrapped 95 % CIs] and their associated significance from the entire cohort (n = 776).

Predictor	TFEQ-R		TFEQ-D		TFEQ-H	
	<i>b</i>	p	<i>b</i>	p	<i>b</i>	p
Hunger	<-0.01 [-0.02, 0.01]	0.772	0.01 [0.004, 0.02]	0.005	0.04 [0.03, 0.05]	0.001
Age	<0.01 [-0.08, 0.08]	0.930	-0.01 [-0.06, 0.04]	0.593	-0.02 [-0.07, 0.02]	0.342
Gender	-3.01 [-3.84, -2.15]	0.001	-1.66 [-2.30, -0.95]	0.001	0.10 [-0.50, 0.75]	0.750
Cohort	1.52 [0.46, 2.59]	0.006	0.53 [-0.02, 1.15]	0.070	0.01 [-0.58, 0.57]	0.978

Each regression model for each TFEQ sub-scale was significantly better than using the mean model to predict TFEQ R, D and H ($F(4,771) \geq 11.24, p < 0.001$). The interaction terms between Hunger and age, gender and cohort added in the second step were not significant and these variables were not included in the final model.

Figure 1. Scores on the three sub-scales of the TFEQ by the same participants when completed More (open bars) or Less (closed bars) hungry. Data are mean \pm SE, n=63.

