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Guilty pleasures: The effect of eating-related guilt on food addiction attributions
and snack choice

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3 Abstract

4 Despite being widely debated throughout the scientific community, the concept of food addiction
5 remains a popular explanation for overeating and obesity amongst the lay public. Overeating is often
6 accompanied by feelings of guilt and dietary concern, and this may lead people to attribute their
7 eating to an addiction in order to minimise personal responsibility. Research also indicates that food
8 addiction attributions and dietary concern may lead people to limit their exposure to tempting foods.
9 To test these ideas, we examined the effect of perceived overeating on food addiction attributions and
10 snack choice. Subjective ratings of guilt and dietary concern were indirectly manipulated by leading
11 female participants ($N=90$) to believe they had eaten more than (overeating condition), less than
12 (undereating condition), or roughly the same (control condition) amount of palatable foods in relation
13 to their own estimated consumption and to previous participants. Participants then rated the relative
14 importance of a list of explanations for their eating (including “the foods were really addictive”) and
15 selected a snack to take home with them. Ratings of guilt and dietary concern were highest in the
16 overeating condition, and lowest in the undereating condition, indicating that the manipulation had
17 been successful. However, findings revealed no effect of condition on food addiction attributions. As
18 predicted, participants in the overeating condition selected less tempting snacks than in the
19 undereating condition. However, this effect was not mediated by guilt/dietary concern. There was also
20 no association between food-addiction attributions and snack choice. These findings suggest that
21 perceived overeating affects snack choice but not food addiction attributions. Future research should
22 investigate whether food addiction attributions may be driven by feelings of guilt and dietary concern
23 following *longer-term* disinhibited eating patterns.

24
25 **Key words:** Attribution theory; Food addiction; Guilt; Dietary concern; Beliefs
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28

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Introduction

Worldwide rates of obesity have more than doubled in the past three decades, with approximately 1.9 billion people classified as overweight ($\text{BMI} > 25 \text{ kg/m}^2$), and 600 million classified as obese ($\text{BMI} > 30 \text{ kg/m}^2$) (World Health Organisation, 2016). This so-called ‘obesity epidemic’ has been attributed to a range of environmental, behavioural, and biological factors, and one theory holds that an ‘addiction’ to high-calorie foods may underlie some cases of obesity (e.g. Kenny, 2013). The concept of food addiction is widely debated throughout the scientific community, and several researchers have contested the view that food can be addictive in the same way as drugs of abuse (Carter et al., 2016; Hebebrand et al., 2014; Ziauddeen, Farooqi, & Fletcher, 2012). Despite this, the theory appears to receive much support from the lay public (Ruddock & Hardman, 2017). Recent surveys show that 86 per cent of community samples believe that certain foods are addictive, and 72 per cent hold the view that food addiction is to blame for the increased prevalence of obesity (Lee et al., 2013). Support for the food addiction concept appears to be particularly popular amongst those with increased weight status (Lee et al., 2013); for example, individuals with increased BMI were more likely to believe that they are addicted to food (Ruddock, Dickson, Field, & Hardman, 2015). In addition, research suggests that the term ‘food addiction’ is commonly used by members of the lay public to refer to a range of eating behaviours such as reward-driven eating, a preoccupation with food, and regular cravings (Ruddock et al., 2015).

Given the lack of *scientific* support for the concept, one possibility is that people may use food addiction to provide a more personally and socially acceptable attribution for overeating (Rogers & Smit, 2000). Specifically, it is thought that, by attributing eating to the ‘addictive’ effects of the food or to a biological ‘addiction’, perceptions of personal responsibility are minimised. This perspective is in accordance with Attribution Theory (Weiner et al., 1971; Weiner, 1974) which accounts for the tendency for individuals to

54 provide self-serving attributions for undesirable behaviours which emphasise the role of
55 *external* and *uncontrollable* causes, such as biological or environmental influences, and to
56 downplay the role of *internal* and *controllable* factors, such as personal choice (Sedikides &
57 Strube, 1995). Using this framework, the concept of ‘addiction’ is thought to implicate
58 uncontrollable influences upon behaviour and thus portrays the drug user or overeater as a
59 ‘helpless victim of disease’ (Davies, 2013).

60 Consistent with this idea, there is evidence that self-serving attributions, which
61 emphasise the role of uncontrollable and external influences, may be used as a means of
62 ‘excusing’ perceived overeating. In a recent study, participants who believed they had eaten
63 more than usual were more likely to attribute their eating to the size of the portion (an
64 external influence), compared to those who believed they had eaten less or roughly the same
65 as usual (Vartanian, Reily, Spanos, Herman, & Polivy, 2017). Similarly, self-reported
66 emotional eaters who were led to believe they had eaten more than previous participants (i.e.
67 norm violating feedback), were more likely to attribute their eating to negative emotions (i.e.
68 an uncontrollable factor) compared to those in a control condition (Adriaanse, Prinsen, de
69 Witt Huberts, de Ridder, & Evers, 2016). These findings suggest that there may be a *causal*
70 effect of perceived overeating on self-serving attributions. There is also evidence that self-
71 serving attributions are associated with dietary concerns and negative affect following eating.
72 In one study, participants who were primed to overeat experienced greater negative affect,
73 and were subsequently more likely to attribute their eating to an uncontrollable cause (i.e.
74 mental fatigue), compared to those in a control condition (Adriaanse, Weijers, de Ridder, de
75 Witt Huberts, & Evers, 2014). Negative emotional states following overeating, such as
76 increased guilt and concern, may therefore make it more likely that people will attribute their
77 eating to external causes (e.g. food addiction) as a way of minimising personal
78 responsibility.

79 Food addiction attributions and eating-related guilt and concern may also have
80 consequences for subsequent food choice. The concept of food addiction is often used to
81 denote a perceived lack of control around food (Ruddock et al., 2015) and, according to
82 predictions derived from self-efficacy theory, such low self-control beliefs may have
83 detrimental effects on healthy eating (Stephoe & Wardle, 2001). However, contrary to this,
84 there is evidence that being aware of one's limited capacity for self-control may help
85 motivate individuals to minimise their exposure to tempting foods. In one study, hungry
86 participants, who believed they had a *low* capacity for self-control, selected less tempting
87 snacks to take home with them (when given a monetary incentive to return the snack one
88 week later), compared to satiated participants who believed they had a *high* capacity for self-
89 control (Nordgren, van Harreveld, and van der Pligt, 2009). In another study, participants
90 who were led to believe that they had scored highly on an ostensible measure of food
91 addiction, demonstrated higher levels of dietary concern and subsequently exposed
92 themselves to tempting foods for less time than those who were led to believe they had low or
93 average levels of food addiction (Ruddock, Christiansen, et al., 2016). These findings
94 suggest that individuals who perceive themselves to be 'food addicts', and who experience
95 increased levels of dietary concern, may be particularly inclined to minimise their exposure to
96 tempting foods. Feelings of guilt may also affect the extent to which individuals expose
97 themselves to tempting foods. Indeed, it is thought that guilt serves as a reminder of one's
98 long-term goals, and motivates individuals to engage in behaviours which 'correct' a
99 perceived goal violation (Allard & White, 2015; Tangney et al., 2007). In support of this, a
100 recent meta-analysis has highlighted an important role of guilt in the implementation of a
101 variety of health behaviours (Xu & Guo, 2017).

102 Drawing on the above, the primary aim of the current study was to investigate
103 whether feelings of guilt and dietary concern following perceived overeating would lead

104 individuals to attribute their eating to a ‘food addiction’ and to the foods’ addictive
105 properties. Feelings of guilt and dietary concern were indirectly manipulated by leading
106 participants to believe they had eaten more than (overeating condition), less than (undereating
107 condition), or roughly the same (control condition) amount of palatable food as their own
108 estimated consumption and relative to previous bogus participants. It was predicted that those
109 in the overeating condition would demonstrate higher levels of guilt and dietary concern, and
110 would consequently be more likely to perceive themselves as food addicts (hypothesis 1) and
111 to attribute their eating to the ‘addictiveness’ of the foods (hypothesis 2), relative to those in
112 undereating and control conditions.

113 A secondary aim was to examine the effects of guilt and dietary concern on the extent
114 to which participants would minimise their exposure to tempting foods. In line with previous
115 research (Nordgren et al., 2009; Ruddock, Christiansen et al., 2016), we hypothesised that
116 individuals in the overeating condition would select less tempting snacks to take home with
117 them, compared to those in control and undereating conditions, and that this would be
118 mediated by higher levels of guilt and dietary concern (hypothesis 3). Finally, we explored
119 whether the selection of less tempting snacks would be associated with self-perceived food
120 addiction and low self-control beliefs, consistent with previous findings (Nordgren et al.,
121 2009; Ruddock, Christiansen, et al., 2016) (hypothesis 4).

122

123

124

Method

Participants

126 A power calculation was conducted using G*Power (Erdfelder, Faul, & Buchner,
127 1996). This determined that a total sample size of 84 was required to detect a medium-sized
128 main effect between three conditions ($\alpha = .05$, power = 0.8, $f = 0.35$) in a between-subjects

129 design. Medium-sized effects have been reported in previous similar research (Adriaanse et
130 al., 2014; Ruddock, Christiansen, et al., 2016). We slightly over-recruited to account for
131 participants guessing the aims of the study. Female staff and students ($N=90$) from the
132 University of Liverpool were invited to take part in a study which they were led to believe
133 was about memory and food intake. Participants were randomly allocated to one of three
134 conditions (i.e. overeating, undereating, or control), such that there were 30 participants in
135 each condition. As this was a preliminary study into food addiction attributions, only females
136 were recruited in order to minimize between-subject differences. Participants were excluded
137 from the study if they were currently dieting, or had any food allergies or intolerances.
138 Ethical approval was granted by the Institute of Psychology, Health and Society at the
139 University of Liverpool.

140 **Measures and materials**

141 *Ad libitum buffet lunch.*

142 The buffet lunch consisted of a variety of sweet and savoury high fat/sugar foods. In
143 total, the lunch comprised 2608 calories and 117.5g fat (see supplementary online materials
144 for more details). Plates and bowls were covertly weighed before and after consumption to
145 provide a measure of actual calorie intake.

146 *Guilt and dietary concern manipulation: Bogus datasheet.*

147 Levels of guilt and dietary concern were indirectly manipulated by exposing
148 participants to information about the amount of lunch food eaten by ostensible previous
149 “participants” via a bogus data sheet (see supplementary online materials for more
150 information). Such techniques have previously been used to manipulate beliefs about the food
151 consumption of previous ‘bogus’ participants (e.g. Robinson et al., 2014). In the current
152 study, the number of calories consumed by the bogus participants was based upon each
153 participant’s estimated number of calories consumed during the buffet lunch (i.e. estimated

154 intake). Participants in the overeating, undereating, and control conditions were led to
155 believe that previous ‘participants’ had consumed less than, more than, or roughly the same
156 as their estimated intake, respectively. In addition to this, participants were given bogus
157 feedback from the experimenter about the number of calories they themselves had eaten
158 during the buffet lunch. Participants in the overeating, undereating, and control conditions
159 were told by the experimenter that they had eaten more than, less than or roughly the same as
160 their estimated calorie intake, respectively (see supplementary online materials for more
161 details). Levels of guilt and dietary concern were expected to be highest in the overeating
162 condition, and lowest in the undereating condition.

163 ***Manipulation checks: Guilt and dietary concern ratings***

164 To ensure that the manipulation had been successful, participants were asked to
165 indicate their current level of guilt and dietary concern using two 100mm VAS scales. Each
166 scale was presented on a computer screen with the following instruction: “Earlier in the
167 experiment, you received some feedback on how many calories you consumed”. The Concern
168 scale was then preceded with “How CONCERNED did this feedback make you feel?”, and
169 the Guilt scale was preceded with “How GUILTY did this feedback make you feel?”. Both
170 scales were anchored with ‘Not at all’ to the left, and ‘Extremely’ to the right.

171 ***Self-perceived food addiction***

172 To assess the effect of condition on self-perceived food addiction (i.e. hypothesis 1),
173 participants were asked to “Please indicate the extent to which you agree with the following
174 statement: ‘I believe myself to be a food addict’”. Responses were provided on a 5-point
175 Likert scale ranging from ‘Strongly Disagree’ to ‘Strongly Agree’. This measure has
176 previously been used to assess self-perceived food addiction in groups of participants who
177 had been led to believe they had scored high, low, or average on an ostensible measure of
178 food addiction (Ruddock, Christiansen, et al., 2016).

179 ***Eating attributions***

180 To assess the effect of condition on participants' attributions for eating (i.e.
181 hypothesis 2), the following instruction was displayed on the computer screen: "What was the
182 most influential factor in determining how much of the buffet lunch you ate? Please indicate
183 by assigning values '1' (most influential) to '10' (least influential) to the reasons provided
184 below". Ten reasons were listed in the following order: 'I felt hungry', 'The foods were really
185 addictive', 'To relieve negative emotions (e.g. boredom, anxiety etc.)', 'I couldn't control
186 myself', 'I didn't want to turn down free food', 'I was craving something sweet/salty',
187 'Because they were just there', 'I liked the taste of the foods', 'Out of habit - I eat when I'm
188 watching TV', and 'I wanted to fill myself up'.

189 ***Temptingness ratings and snack selection***

190 To examine the effect of condition on snack selection (i.e. hypothesis 3), participants
191 were presented with the following six snacks: 70g pack Tesco chocolate rice cakes (336
192 kcals, 15.0g fat), 25g bag Walkers Baked Ready Salted crisps (102 kcals, 2.0g fat), 45g bar
193 Cadburys Dairy Milk (238 kcals, 13.7g fat), 35.6g Go Ahead Yoghurt break forest fruit
194 flavour (146 kcals, 3.6g fat), 25g bag Tesco mini jelly beans (93 kcals, 0.1g fat), 160g pack
195 Nairn's Gluten Free Oat cakes (774 kcal, 33.3g fat). Participants ranked the snacks in order
196 of temptingness, ranging from 1 (most tempting) to 6 (least tempting), and then selected one
197 of the snacks to take home with them. The key dependent variable for this measure was snack
198 selection (i.e. whether participants selected a more or less tempting snack). Importantly, a
199 lower score on this measure indicated the selection of more tempting snacks. It was
200 hypothesised that participants in the overeating condition would select less tempting snacks
201 to take home with them, compared to those in control and undereating conditions, and that
202 this would be mediated by increased guilt and dietary concern. This would indicate that

203 participants in the overeating condition were attempting to limit their exposure to tempting
204 foods.

205

206 *Food-related self-control ratings*

207 Participants' perceived ability to control their food intake was assessed on a scale
208 which ranged from 0 (extremely poor) to 8 (extremely good). The scale was presented
209 alongside the following instruction: "On a scale of 0-8, how would you rate your ability to
210 control your food intake?". This measure was incorporated to assess whether perceptions of
211 low self-control would be associated with the selection of less tempting snacks (hypothesis
212 4). Similar single-item scales have been used to assess self-control beliefs in participants who
213 had received bogus feedback about their capacity for self-control (Jones, Cole, Goudie, &
214 Field, 2012).

215 *Additional measures and eating behaviour trait questionnaires*

216 The Yale Food Addiction Scale (YFAS; Gearhardt, Corbin, & Brownell, 2009) ,
217 Three Factor Eating Scale (TFEQ; Stunkard & Messick, 1985), and a subjective measure of
218 hunger and fullness were included to provide descriptive information about the sample (see
219 supplementary online materials for more information about these measures).

220

221 Aside from temptingness ratings and the bogus datasheet, all measures were
222 presented, and responses recorded, on a laptop computer using Inquisit 3.0 software
223 (Millisecond Software, 2012).

224 **Procedure**

225 Figure 1. provides an overview of the study procedure. Participants were required to
226 attend two study sessions, 1 week apart. The first session took place between 12pm and 2pm
227 in order to coincide with usual lunch hours, and participants were asked to refrain from eating

228 or consuming any calorie-containing drinks for 3 hours beforehand. Upon arrival, participants
229 provided written consent, and completed a medical history questionnaire to ensure the
230 absence of any food allergies or intolerances. They then completed hunger and fullness VAS
231 scales before being presented with the *ad libitum* buffet lunch to be consumed while watching
232 a television (TV) programme. The experimenter gave the instructions to ‘eat as much of the
233 food as you wish’ and to ‘pay attention to the TV programme as there would be a memory
234 test afterwards’. The experimenter then started the TV programme (*Fawlty Towers*; episode
235 ‘The Kipper and the Corpse’) which was approximately 30 minutes in duration. The decision
236 to include a TV programme while eating the buffet lunch was two-fold. Firstly, it coincides
237 with the cover story that the study was looking into food intake and memory. Secondly,
238 watching television while eating has previously been shown to decrease one’s ability to
239 monitor food intake (e.g. Moray, Fu, Brill, & Mayoral, 2007), thus maximizing the
240 believability of our manipulation.

241 Once the programme had ended, participants were asked to estimate how many
242 calories they had consumed during the buffet lunch. The participant wrote down their
243 estimate which was then used by the experimenter to calculate the bogus calorie feedback.
244 Participants then completed hunger and fullness VAS scales, and a memory test which
245 consisted of 20 multiple-choice questions about the TV programme. While participants were
246 completing these tasks, the experimenter covertly calculated, and wrote down on the bogus
247 participant data sheet, the number of calories consumed by previous bogus participants (see
248 Table S1 for details about how these were calculated based on the participant’s estimated
249 intake). The experimenter then returned with the completed bogus participant datasheet and
250 informed the participant of the ‘actual’ number of calories they had consumed (i.e. bogus
251 intake), and wrote this value onto the bogus datasheet (see Table S1 in online supplementary
252 materials for details of how bogus intake was computed based on the participant’s estimate).

253 The participant was then asked to complete the gender and age columns on the datasheet (i.e.
254 gender and age). Participants were left alone with the datasheet for 1 minute while they
255 completed these columns. This was to provide participants with sufficient time to notice the
256 number of calories consumed by previous bogus participants in relation to the number of
257 calories they themselves had ostensibly consumed. As indicated above, participants in the
258 overeating, undereating, and control conditions were led to believe that previous
259 ‘participants’ had consumed less than, more than, or roughly the same as their estimated
260 intake, respectively (see supplementary online materials).

261 The bogus datasheet was then removed and participants completed the post-
262 manipulation measures, specifically the eating attributions rankings, guilt and concern VAS
263 scales, food-related self-control ratings, and the assessment of self-perceived food addiction.
264 For the snack selection measure, the experimenter then presented participants with six snack
265 foods which they were asked to rank in order of ‘temptingness’. After they had done this,
266 participants were asked to choose one snack to take home with them. Prior to selecting the
267 snack, participants were instructed that they would be required to keep the snack with them at
268 all times. They were told that if they returned the snack uneaten one week later, they would
269 ‘win’ £2 and be able to keep the snack. All snacks were worth less than the monetary
270 incentive offered to participants if they refrained from eating the snack over the ensuing 1-
271 week period (i.e. £2). The experimenter marked the selected snack with a sticker to ensure
272 that the returned snack was the original. A similar method has been used to examine the
273 effect of self-control beliefs on snack selection (Nordgren et al., 2009).

274 During the second session, participants confirmed whether or not they had eaten the
275 snack during the week and, if applicable, showed the experimenter the snack. Participants’
276 height and weight were taken and they completed the TFEQ-R, TFEQ-D and YFAS. Finally,
277 participants were fully debriefed and informed of the aims of the study. Importantly,

278 participants were told that the calorie feedback and details of previous participants, that they
279 had received in the previous session was bogus information designed to manipulate feelings
280 of guilt.

281 **Data analysis**

282 A multivariate analysis of variance (MANOVA) was conducted to ensure that groups
283 did not differ with regards to appetite ratings (i.e. hunger and fullness) before and after the
284 buffet lunch, estimated calorie intake, actual calorie intake, age, BMI, scores on the TFEQ-D,
285 TFEQ-R, and YFAS symptom count.

286 *Manipulation checks*

287 A MANOVA was conducted to ensure that the three conditions (i.e. undereating,
288 control, and overeating) had the expected effects on participants' ratings of dietary concern
289 and-guilt. In particular, we expected that those in the overeating condition would demonstrate
290 greater levels of dietary concern and guilt compared to those in the control and undereating
291 conditions. Those in the undereating condition were expected to demonstrate the lowest
292 levels of dietary concern and guilt.

293 *Hypotheses testing*

294 We hypothesised that, relative to those in undereating and control conditions, participants in
295 the overeating condition would *i*) have higher ratings of self-perceived food addiction
296 (hypothesis 1), *ii*) assign a lower rank (indicating greater importance) to the addictiveness
297 attribution (i.e. 'foods were really addictive') (hypothesis 2), and *iii*) select a less tempting
298 snack (i.e. snacks that were assigned a higher 'temptingness' rank) to take home with them
299 (hypothesis 3). The predicted effects of condition on each dependent variable (i.e. self-
300 perceived food addiction, addiction attribution rankings, and snack selection) were expected
301 to be mediated by higher subjective ratings of dietary concern and guilt in the overeating
302 condition, relative to control and undereating conditions.

303 To test our first hypothesis, a univariate ANOVA was conducted with condition (i.e.
304 overeating, undereating, control) as the independent variable, and self-perceived food
305 addiction as the dependent measure. Due to the non-parametric properties of the data, the
306 effects of condition on attribution rankings (hypothesis 2) and snack selection (hypothesis 3),
307 were analysed using Kruskal-Wallis tests. For both hypotheses 2 and 3, condition was
308 entered as the grouping variable. For hypothesis 2, rankings for each of the 10 eating
309 attributions were entered as dependent variables. For hypothesis 3, the dependent variable
310 was the temptingness rank that was assigned to the selected snack (i.e. lower ranks indicated
311 increased temptingness). Follow-up Mann-Whitney U tests were conducted to compare
312 snack selection between each of the three conditions.

313 Where significant main effects of condition were observed, mediation analyses were
314 conducted to examine whether these were mediated by guilt and/or dietary concern ratings.
315 Prior to analyses, conditions were dummy coded with the control condition as the reference
316 category (consistent with the procedure recommended by Hayes and Preacher, 2014). In each
317 model, condition (i.e. overeating vs. control/undereating vs. control) was entered as the
318 independent variable, and guilt or dietary concern ratings was entered as the mediator
319 variable. Figure 2 provides a schematic representation of the hypothesised relationship
320 between condition and each of the dependent variables, via guilt and dietary concern.
321 Mediation analyses were carried out using PROCESS (model 4) (Hayes, 2012). Please see
322 supplementary online materials for more details about the procedure used.

323 Finally, Spearman's correlation analyses were conducted to explore whether less
324 tempting snack selection would be associated with self-perceived food addiction and
325 *decreased* self-control beliefs (hypothesis 4).

326

327

328

Results

329 Preliminary analysis of the data revealed that BMI was positively skewed. Thus, using
330 the outlier labelling rule defined by Hoaglin and Iglewicz (1987), one participant in the
331 overeating condition (BMI = 40.18) was removed. Two participants (both in the overeating
332 condition) indicated that they had guessed the aims of the study and were therefore also
333 removed from subsequent analyses.¹ Participant characteristics, appetite ratings (before and
334 after the buffet lunch), and estimated and actual calorie intake are provided in Table 1.
335 Importantly, participants did not differ significantly between groups with regards to any of
336 these characteristics ($p>.13$). One participant (in the control condition) met the YFAS
337 diagnostic criteria for food addiction.

338 Manipulation check

339 There was a main effect of condition on ratings of dietary concern and guilt,
340 $F(4,168)=6.77, p<.001, \eta_p^2=.14$, (Figure 3). Pairwise comparisons revealed that levels of
341 dietary concern were significantly greater in the overeating condition relative to both control
342 ($p=.003$) and undereating conditions ($p<.001$). Control and undereating conditions did not
343 differ with regards to dietary concern ($p=.100$). Levels of guilt were greater in the overeating
344 condition compared to the undereating condition ($p<.001$). While they were in the expected
345 direction, guilt ratings in the overeating condition did not differ significantly from those
346 obtained in the control condition ($p=.052$). Guilt levels were significantly lower in the
347 undereating condition compared to the control condition ($p=.004$). These results indicate that
348 our manipulation had been successful.

349 Self-perceived food addiction (hypothesis 1)

350 Contrary to our first hypothesis, there was no effect of condition on participants'
351 responses to the assessment of self-perceived food addiction, $F(2,84)=.13, p=.878, \eta_p^2=.00$,

¹ The overall pattern of results remained the same when analyses were re-run with these three participants included.

352 (Table 2). Exploratory Pearson's correlation analyses revealed that self-perceived food
353 addiction was not significantly correlated with levels of guilt ($r=.088$, $p=.420$) or dietary
354 concern ($r=.056$, $p=.606$) (see Table S3 in supplementary online materials).

355

356 **Addictiveness attribution ranking (hypothesis 2)**

357 The hunger attribution ("I was hungry") was most frequently ranked as the first or
358 second most influential reason for eating across all participants (78.2%), while the emotional
359 eating attribution ("For emotional reasons") was most frequently ranked as the least or
360 second from least influential reason for eating (64.4%). Contrary to our second hypothesis,
361 the rank assigned to the addiction attribution ("foods are really addictive") did not differ
362 between conditions, $H(2)=.128$, $p=.938$, $\eta_p^2 =.00$ (Table 2). The rank assigned to all other
363 attributions also did not differ between conditions ($p_s>.055$)(see Table S2 in supplementary
364 online materials).

365 However, exploratory Spearman's correlation analyses revealed that, across the entire
366 sample, the rank assigned to the addiction attribution was negatively correlated with levels of
367 guilt and dietary concern (guilt: $r_s =-.314$, $p=.003$; concern: $r_s =-.218$, $p=.043$) (Table S3 in
368 supplementary online materials). This suggests a relationship between higher levels of guilt
369 following eating and rating the 'addictiveness of the foods' as a more influential reason for
370 eating.

371 **Snack selection (hypotheses 3 and 4)**

372 The majority of participants (62.1%) selected their most tempting snack to take home
373 with them. The Kruskal-Wallis test indicated that the temptingness of the snack selected
374 differed significantly between conditions, $H(2)=7.16$, $p=.028$, $\eta_p^2 =.07$. As predicted,
375 participants in the overeating condition selected significantly less tempting snacks (i.e. snacks
376 that had been assigned a higher rank) than those in the undereating condition, $U=265.50$, $Z=-$

377 2.62, $p=.009$. Snack selection did not differ significantly between those in the undereating
378 and control conditions, $U=342.50$, $Z=-1.93$, $p=.053$ (although there was a trend in the
379 expected direction such that those in the undereating condition selected more tempting
380 snacks) (Figure 4). Snack selection did not differ between the overeating and control
381 conditions, $U=357.00$, $Z=-.834$, $p=.404$.

382 Subsequent mediation analyses revealed no indirect effect of condition on snack
383 selection via guilt (undereating vs. control: $b=.08$, standard error (SE)=.15, 95% Confidence
384 Intervals (CIs)= -.17, .43; overeating vs. control: $b=-.05$, SE=.12, 95% CIs= -.44,.09) or
385 dietary concern (undereating vs. control: $b=.03$, SE=.10, 95% CIs = -.30, .11; overeating vs.
386 control: $b=.06$, SE=.17, 95% CIs = -.25, .42).

387 Contrary to predictions, there was no association between selected snack rank (i.e.
388 lower values indicate the selection of more tempting snacks) and self-perceived food
389 addiction ($r_s=-.044$, $p=.682$) or self-control ratings ($r_s=-.011$, $p=.923$).

390 **Exploratory analyses**

391 Exploratory correlation analyses revealed that self-perceived food addiction correlated
392 negatively with self-control ratings ($r= -.429$, $p<.001$), and positively with TFEQ-D ($r=.444$,
393 $p<.001$), and YFAS symptom count ($r=.341$, $p=.002$). These findings indicate that self-
394 perceived food addiction was associated with lower perceptions of self-control, and greater
395 dietary disinhibition, and YFAS symptom count.

396 Exploratory analyses revealed that the rank assigned to the ‘addictiveness of the
397 foods’ did not correlate with estimated calorie intake (i.e. prior to the manipulation) ($r_s=-$
398 $.030$, $p=.780$) or with actual calorie intake ($r_s=-.019$, $p=.858$). Please see supplementary
399 online materials (Table S3) for a correlation matrix showing correlation coefficients between
400 dependent variables and self-report measures included in the study. Finally, there was no
401 effect of condition on self-control ratings, $F(2,84)=2.48$, $p=.090$, $\eta_p^2=.06$.

402

Discussion

403 The primary aim of the current study was to investigate the extent to which perceived
404 overeating would lead participants to attribute their eating to a ‘food addiction’, due to
405 increased levels of dietary concern and guilt. While this idea has been previously discussed
406 in the literature (e.g. Rogers & Smit, 2000), to our knowledge it has not been empirically
407 tested until now. Specifically, it was predicted that individuals who were manipulated to
408 believe they had overeaten (overeating condition) would experience increased levels of guilt
409 and dietary concern, and would consequently be more likely to perceive themselves as food
410 addicts (hypothesis 1) and to attribute their eating to the ‘addictiveness’ of the foods
411 (hypothesis 2), than those in undereating and control conditions. We also predicted that those
412 in the overeating condition would select less tempting snacks to take home with them,
413 compared to those in control and undereating conditions, and that this would be mediated by
414 levels of guilt and dietary concern (hypothesis 3). Finally, we explored whether the selection
415 of less tempting snacks would be associated with self-perceived food addiction and low self-
416 control beliefs (hypothesis 4).

417 Levels of dietary concern and guilt were indeed highest in the overeating condition,
418 relative to undereating and control conditions, and lowest in the undereating condition
419 compared to overeating and control conditions. These findings indicate that our manipulation
420 had been successful. However, contrary to our first hypothesis, there was no effect of
421 condition on self-perceived food addiction. There were also no significant positive
422 correlations between self-perceived food addiction and ratings of guilt or dietary concern.
423 Instead, exploratory analyses revealed that self-perceived food addiction correlated
424 negatively with self-control ratings, and positively with two trait measures of addictive and
425 disinhibited eating (i.e. TFEQ-D and YFAS) that were obtained 1 week following the
426 manipulation. This is consistent with our previous findings (Ruddock, Field, & Hardman,

427 2016), in which individuals who perceived themselves as food addicts scored higher on trait
428 measures of disinhibited eating, than those who did not identify as food addicts.

429 Contrary to our second hypothesis, there was no effect of condition on the ‘foods
430 were addictive’ attribution for eating. However, across the entire sample, this attribution was
431 ranked as a more influential reason for eating in those with increased subjective ratings of
432 guilt and dietary concern. Furthermore, exploratory correlational analyses revealed that the
433 rank assigned to the addictiveness attribution was not associated with estimated or actual
434 calorie intake. These findings suggest that attributions about the addictive potential of certain
435 foods may be more closely related to negative emotions elicited following consumption of
436 these foods, rather than to actual food intake. This is consistent with previous research in
437 which providing self-serving attributions for eating (i.e. emotional eating) was related to
438 increased dietary-related concerns, rather than to an actual tendency to engage in emotionally
439 driven eating (Adriaanse, de Ridder, & Evers, 2011). However, as there was no effect of
440 condition on the rank assigned to the ‘addictiveness’ attribution, we are unable to conclude
441 that eating-related guilt and dietary concern have *causal* effects on food addiction
442 attributions.

443 A secondary aim was to examine the *consequences* of perceived overeating and food
444 addiction attributions on subsequent snack selection. Based on previous findings (e.g. Allard
445 & White, 2015; Ruddock, Christiansen, et al., 2016), it was predicted that individuals who
446 were led to believe they had overeaten, would select less tempting snacks to take home with
447 them, compared to those in undereating and control conditions, and that this would be
448 mediated by higher levels of dietary concern and guilt. As hypothesised, we found an effect
449 of condition on snack selection, and this was due to those in the undereating condition
450 choosing *more* tempting snacks than those in overeating conditions. Snack selection did not
451 differ significantly between those in the control and undereating conditions (though there was

452 a non-significant trend for those in the undereating condition to select more tempting snacks),
453 or between the control and overeating conditions. However, contrary to prediction, the effect
454 of condition on snack choice was not mediated by subjective levels of guilt and/or dietary
455 concern. Snack selection was also *not* associated with self-perceived food addiction or self-
456 control ratings.

457 These findings are inconsistent with our previous findings, in which we found that
458 increased levels of dietary concern (due to manipulating food addiction beliefs) led
459 participants to decrease the amount of time they spent exposed to tempting foods, (Ruddock,
460 Christiansen et al., 2016). Thus in the current study, the effect of condition on snack
461 selection appears to have been driven by an alternative mechanism. One possible explanation
462 is that perceptions of lower calorie intake in the undereating condition may have given
463 participants a ‘license to over-eat’, thus leading to more tempting snack selection. This idea is
464 consistent with recent findings in which participants who were led to believe they had
465 expended more calories during exercise consumed more food during a subsequent *ad libitum*
466 test meal, than those who were told they had expended fewer calories (McCaig, Hawkins, &
467 Rogers, 2016).

468 It is also possible that participants’ levels of satiety may have masked any influence of
469 dietary concern, guilt, or self-perceived food addiction, on snack choice. Specifically, in the
470 current study, participants selected a snack to take home with them after consuming a buffet
471 lunch (i.e. when they were satiated). In contrast, in our previous study (Ruddock,
472 Christiansen, et al. 2016) participants were exposed to foods when they were hungry. Known
473 as the ‘cold-to-hot empathy gap’ (Loewenstein, 1996), previous research has demonstrated
474 that individuals who are satiated (i.e. in a ‘cold’ state) tend to overestimate their ability for
475 self-control compared to when they are hungry (i.e. in a ‘hot’ state) (Nordgren et al., 2009).
476 As such, one possibility is that satiated participants in the current study may have felt

477 particularly confident about their ability to refrain from eating the snack during the week, and
478 this may have exerted greater influence over snack choice than dietary concern, guilt, or food
479 addiction beliefs.

480 The current study yields a number of limitations which should be addressed in future
481 research. Firstly, it is important to consider that participants in the current study were
482 informed that they had consumed an amount that was relative to their estimated calorie
483 intake. As such, the bogus calorie feedback may have generated between-*subject*, as well as
484 between-*condition*, differences. Specifically, it is possible that feelings of guilt and dietary
485 concern may have varied substantially between participants in the same condition as a result
486 of receiving different calorie feedback. Nonetheless, the decision to provide participants with
487 tailored (rather than universal) calorie feedback, was taken to ensure that it was always less
488 than (in the undereating condition), more than (in the overeating condition), or equal to (in
489 the control condition) the amount of calories participants *believed* they had eaten. This may
490 not have been achieved had we provided participants with universal calorie feedback. As
491 such, providing participants with tailored calorie feedback likely maximized the effectiveness
492 of the manipulation on feelings of guilt. Importantly, no between-group differences were
493 observed with regard to actual or estimated (pre-manipulation) calorie intake, suggesting that
494 the observations made in the current study were due to the manipulation.

495 Secondly, the current study did not take into account participants' dieting goals. This
496 may have been an important factor in the current study, as previous findings suggest that
497 individuals are most likely to provide self-serving attributions for behaviours which are
498 perceived to violate their own personal standards (Eiser & Sutton, 1957; Jellinek, 1960). As
499 such, future research should investigate the possibility that individuals with strict dietary
500 goals may be most likely to provide food addiction attributions following an eating-related
501 guilt induction. Finally, the all-female sample used in the current study limits the

502 generalisability of the findings to other populations. Future research is required to examine
503 the effect of perceived overeating on food addiction attributions and snack choice in male
504 participants.

505 Despite the aforementioned limitations, to our knowledge the current study is the first
506 to investigate whether the concept of food addiction may be used as a self-serving attribution
507 for eating. In doing so, our results suggest that a single episode of perceived overeating is
508 unlikely to alter self-perceived food addiction. Nonetheless, it remains plausible that the
509 concept of food addiction may be used as a self-serving attribution following more regular
510 and repeated patterns of disinhibited or 'binge' eating. Indeed, evidence suggests that binge
511 eating is a highly stigmatized behaviour (Bannon, Hunter-Reel, Wilson, & Karlin, 2009), and
512 thus individuals who regularly engage in disinhibited patterns of eating may be particularly
513 inclined to use the concept of 'food addiction' as a means of minimizing perceptions of
514 blame. Future research should investigate this possibility by examining the effects of
515 perceived overeating, dietary concern, and guilt, on food addiction attributions in those with a
516 propensity for trait overeating, such as in obese or binge eating samples.

517 Overall, the current study provides a novel methodological approach for
518 manipulating eating-related guilt and dietary concern that may be useful for future research.
519 While our findings do not fully support the concept of food addiction as an 'attribution'
520 (Rogers & Smit, 2000), we provide correlational evidence to suggest that beliefs about the
521 addictive potential of foods are related to feelings of eating-related guilt and dietary concern.
522 Future research should aim to clarify the direction of this relationship (i.e. whether eating-
523 related guilt/dietary concern *causes* attributions about the addictiveness of foods, or
524 alternatively whether eating foods that are perceived as addictive causes guilt/dietary
525 concern), and to investigate the possibility that food addiction may be used as a self-serving

526 attribution for those who experience repeated episodes of eating-related guilt and dietary
527 concern.

528

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627 Tables

628 **Table 1.** Participant characteristics, appetite ratings, and estimated and actual calorie intake, in each
 629 condition. Values are means with standard deviations in parentheses.

	Undereating (n=30)	Control (n=30)	Overeating (n=27)
Age (years)	22.30(7.31)	22.73(9.28)	20.70(5.90)
BMI (kg/m ²)	23.10(2.73)	22.53(1.69)	23.59(2.67)
TFEQ-R	7.33(4.40)	8.59(4.58)	7.70(3.96)
TFEQ-D	7.53(3.09)	5.93(3.21)	7.11(3.53)
YFAS-symptoms	1.97(1.16)	2.00(1.44)	1.41(0.93)
Estimated intake (Kcal)*	566.17(268.11)	500.00(282.36)	622.78(413.97)
Bogus intake	267.63(141.29)	536.00(146.38)	950.99(218.16)
Actual intake (Kcal)	810.51(259.69)	792.95(303.79)	838.51(354.09)
Hunger VAS (pre meal) (mm)	64.30(18.11)	68.93(22.66)	71.56(14.25)
Fullness VAS (pre meal) (mm)	19.27(19.24)	14.97(16.99)	17.56(18.28)
Hunger VAS (post meal) (mm)	8.07(9.15)	10.33(17.64)	13.15(19.02)
Fullness VAS (post meal) (mm)	77.70(19.00)	78.60(22.03)	70.33(27.56)

630 *i.e. the number of calories participants estimated they had consumed during the buffet lunch, prior to the
 631 manipulation. N.B. All hunger and fullness ratings were taken before the guilt manipulation.

632

633 **Table 2.** Mean (standard deviations) self-perceived food addiction rating, and rank assigned to the 'foods were
 634 addictive' attribution, in each of the three conditions.

	Undereating	Control	Overeating
Self-perceived food addiction (Likert rating 1-5) ¹	2.70(1.06)	2.63(1.19)	2.78(.93)
"Foods were addictive" attribution (rank, 1-10) ²	6.50(2.45)	6.33(2.32)	6.51(2.38) ⁶³⁵

640 ¹ Responses to the assessment of self-perceived food addiction (i.e. 'Please indicate the extent to which you
 641 agree with the following statement: "I believe myself to be a food addict"') were provided on a 5-point Likert
 642 scale ranging from 1='Strongly Disagree' to 5='Strongly Agree'.

643 ² Lower rank indicates more importance

644

645 Figure legends

646 **Figure 1.** Overview of study procedure in sessions 1 and 2.

647 **Figure 2.** Schematic representation of the hypothesised effect of condition on self-perceived food
 648 addiction, addictiveness ranking, and snack selection, via dietary concern and guilt. It was predicted
 649 that those in the overeating condition would have greater self-perceived food addiction beliefs (hyp
 650 1), would assign a lower rank (indicating more importance) to the addictiveness attribution (hyp 2),
 651 and would select less tempting snacks (hyp 3), relative to those in the undereating and control
 652 conditions. These effects were expected to be mediated by increased levels of dietary concern and
 653 guilt in the overeating condition.

654 **Figure 3.** Mean dietary concern and guilt ratings by condition. *significant at $p<.01$, **significant at
655 $p<.001$.

656 **Figure 4.** Mean temptingness rank (1=most tempting, 6=least tempting) of snack taken in each of the
657 three conditions. Median (mdn) and range values are also provided for each condition. * $p<.01$.

ACCEPTED MANUSCRIPT

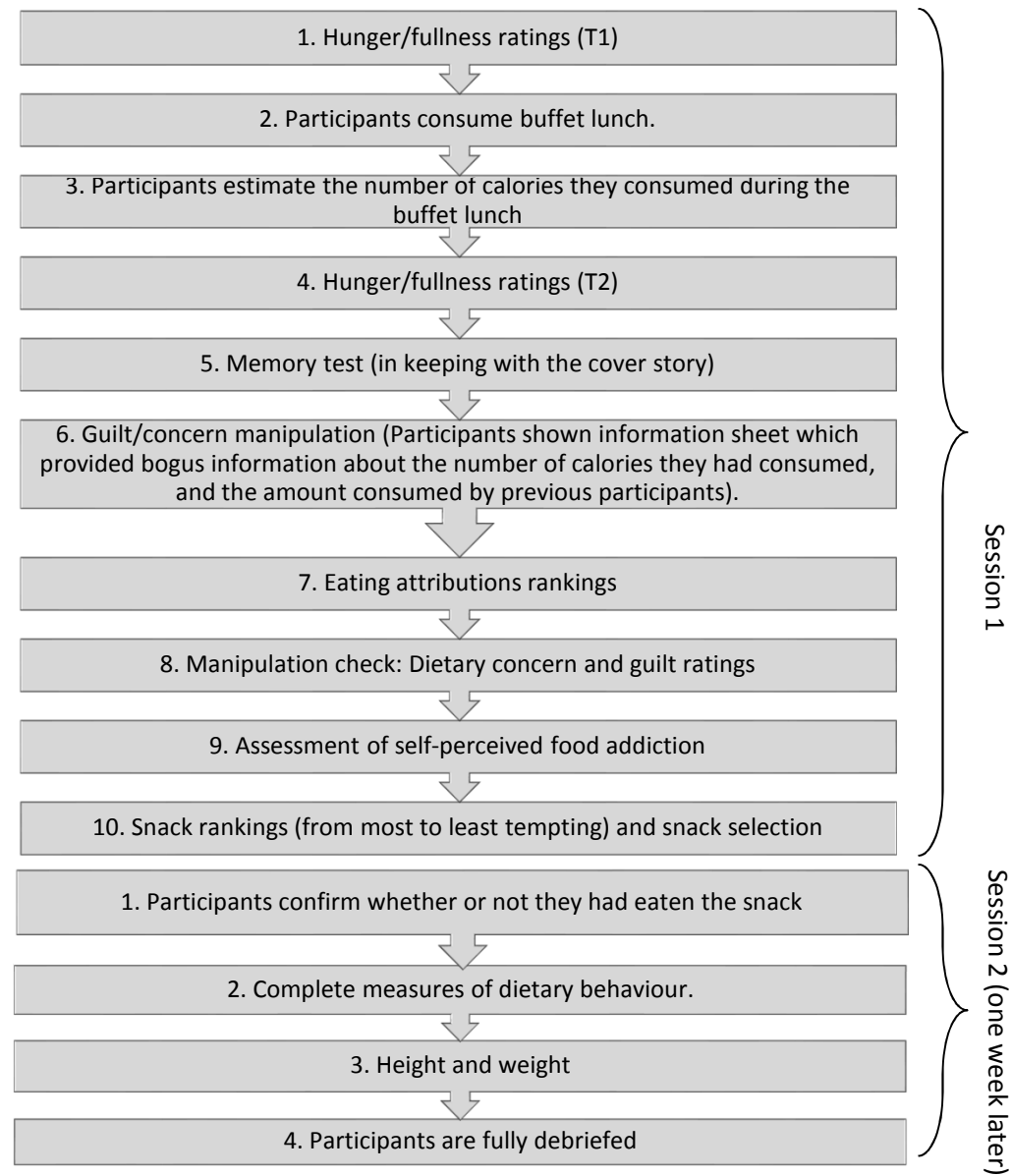


Figure 1. Overview of study procedure in sessions 1 and 2.

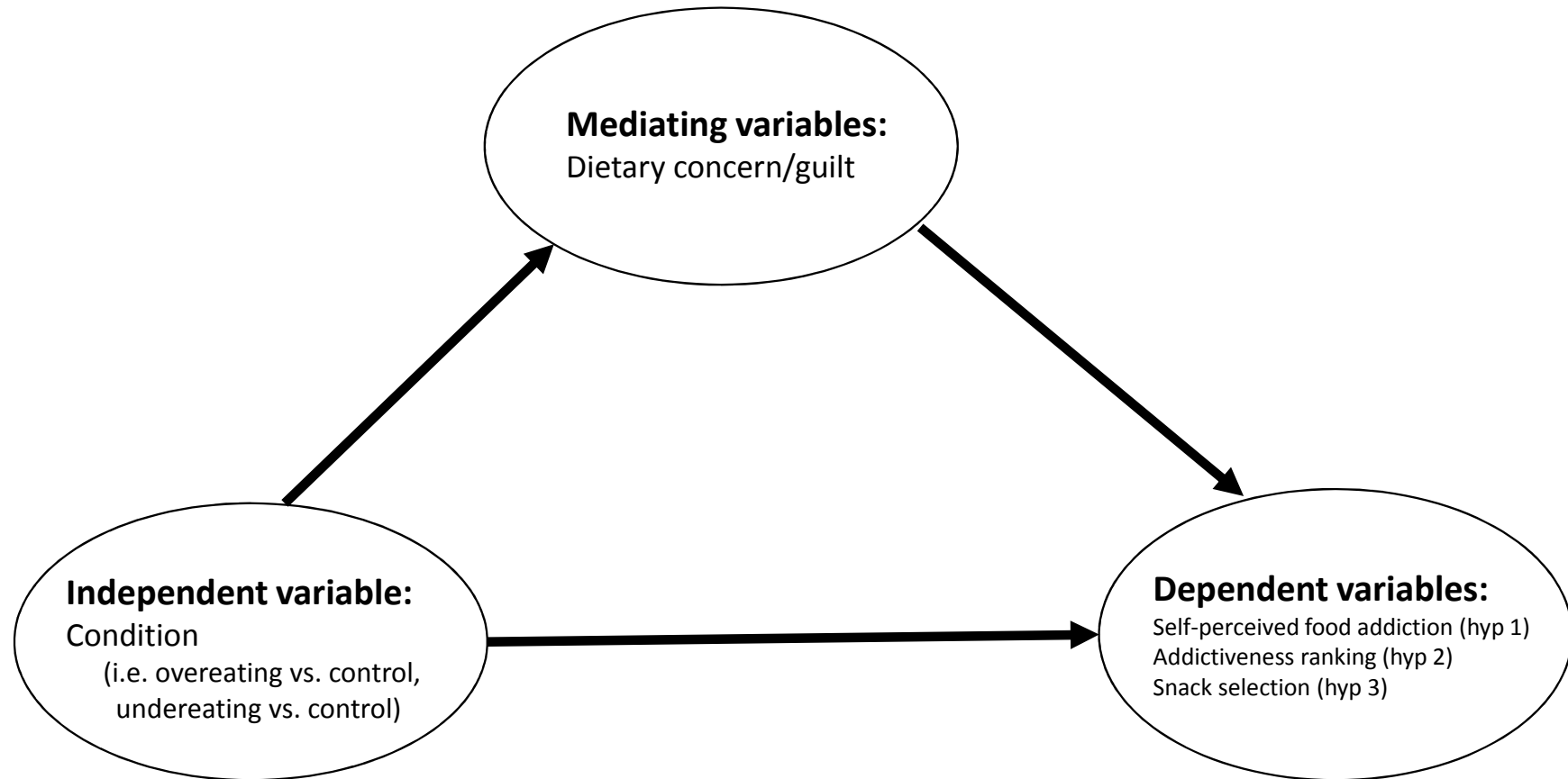


Figure 2. Schematic representation of the hypothesised effect of condition on self-perceived food addiction, addictiveness ranking, and snack selection, via dietary concern and guilt. It was predicted that those in the overeating condition would have greater self-perceived food addiction beliefs (hyp 1), would assign a lower rank (indicating more importance) to the addictiveness attribution (hyp 2), and would select less tempting snacks (hyp 3), relative to those in the undereating and control conditions. These effects were expected to be mediated by increased levels of dietary concern and guilt in the overeating condition.

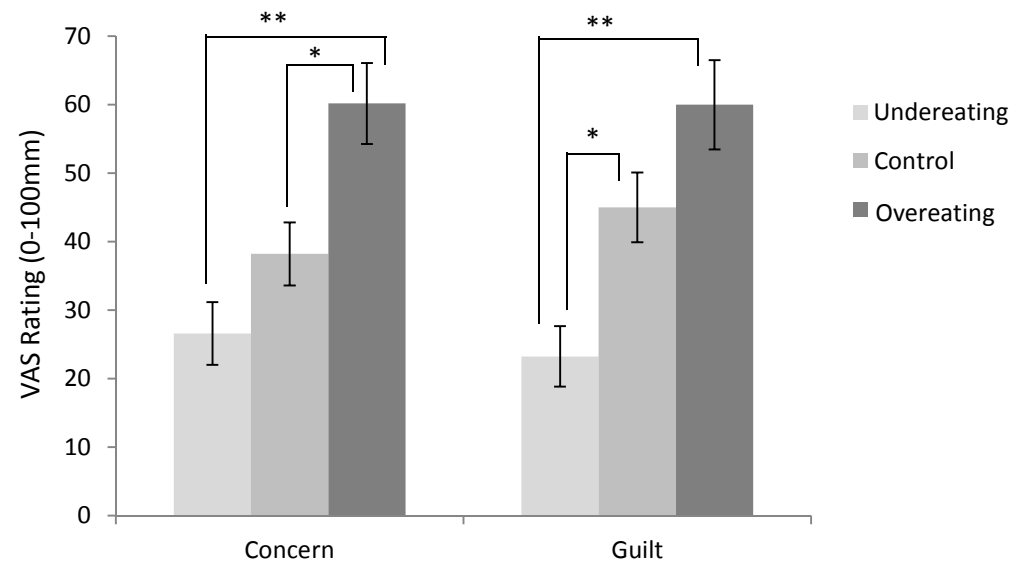


Figure 3. Mean dietary concern and guilt ratings by condition. *significant at $p < .01$, **significant at $p < .001$.

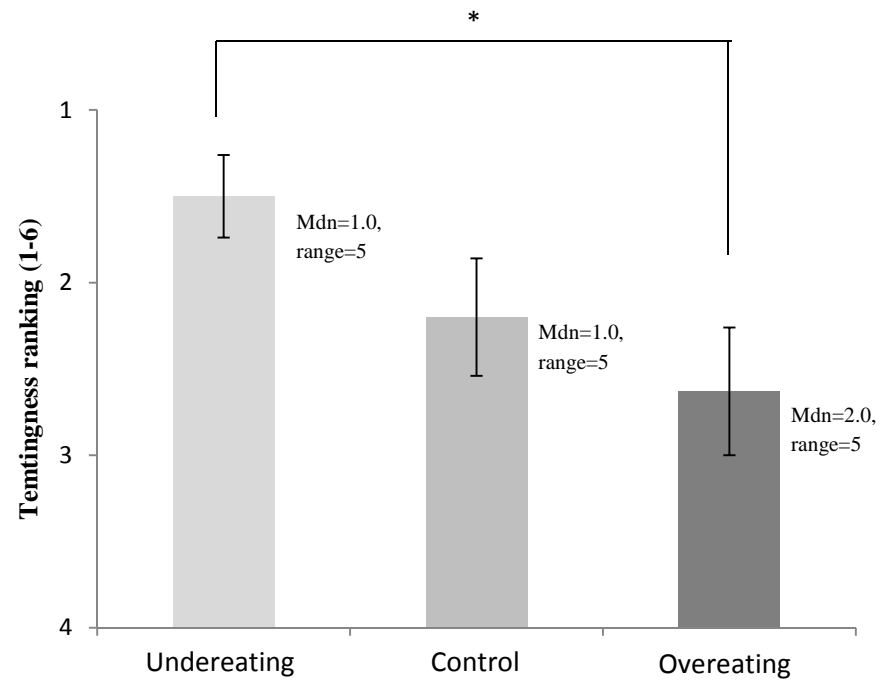


Figure 4. Mean temptingness rank (1=most tempting, 6=least tempting) of snack taken in each of the three conditions. Median (mdn) and range values are also provided for each condition. * $p < .01$.