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Fisher, N, Mead, BR, Lattimore, P and Malinowski, P (2017) Dispositional mindfulness and reward motivated eating: The role of emotion regulation and mental habit. *Appetite*, 118. pp. 41-48. ISSN 0195-6663

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1 **Dispositional mindfulness and reward motivated eating:**

2 **The role of emotion regulation and mental habit**

3 **Abstract**

4 Evidence regarding the effectiveness of mindfulness based interventions (MBIs) for eating
5 disorders, weight management and food craving is emerging and further studies are required to
6 understand the underlying mechanisms of MBIs in these domains. The current study was
7 designed to establish the role of specific mechanisms underlying the putative relationship
8 between mindfulness and reward motivated eating. We predicted that mindfulness would be
9 negatively related to features of reward motivated eating and that this association would be
10 mediated by emotion regulation and habitual negative self-thinking. A cross-sectional survey
11 measuring uncontrolled and emotional eating, mindfulness, emotion regulation and habitual
12 negative self-thinking was completed by female and male meditators and non-meditators (N =
13 632). Lower levels of dispositional mindfulness were associated with difficulties in emotion
14 regulation, habitual negative self-thinking and both emotional and uncontrolled eating.
15 Difficulties in emotion regulation significantly mediated the mindfulness-uncontrolled eating
16 relationship. Habitual negative self-thinking significantly mediated the mindfulness-emotional
17 eating relationship. Participants with meditation experience reported greater levels of
18 dispositional mindfulness, fewer difficulties with emotion regulation and habitual negative self-
19 thinking and reduced uncontrolled eating tendencies, compared to non-meditators. The
20 findings suggest that MBIs designed to change reward motivated eating and weight control
21 should focus on emotion regulation and mental habits as underlying mechanisms.

22 **Key words:** mindfulness; reward motivated eating; automatic; emotion regulation; mental
23 habit.

25 Mindfulness has attracted considerable popular interest (Jha, 2013) and scientific
26 investigation (Chiesa & Serretti, 2010; Davis & Hayes, 2011; Malinowski, 2013) in the past two
27 decades. Although various definitions of mindfulness have been proposed and no clear
28 consensus has been reached (Chiesa, 2012; Shonin, Van Gordon, & Griffiths, 2014) a broad
29 definition often referred to by researchers (Chiesa & Malinowski, 2011; Malinowski, 2008;
30 Zgierska et al., 2009) describes mindfulness as ‘paying attention in a particular way, on purpose,
31 in the present moment, and nonjudgmentally’ (p.4; Kabat-Zinn, 1994). One reason for the
32 popularity of this definition presumably is that a large proportion of research is concerned with
33 mindfulness-based interventions such as mindfulness-based stress reduction (MBSR) or
34 mindfulness-based cognitive therapy (MBCT), both of which are built around the approach to
35 mindfulness introduced by Kabat-Zinn. A recent meta-analytic review of the mechanisms of
36 mindfulness-based interventions has identified strong and consistent evidence for the role of
37 emotional and cognitive reactivity (Gu, Strauss, Bond, & Cavanagh, 2015). Substantial evidence
38 exists to demonstrate that mindfulness training produces beneficial outcomes by promoting
39 effective emotion regulation (Chambers, Gullone, & Allen, 2009; Chiesa, Serretti, & Jakobsen,
40 2013). The case for developing mindfulness skills to manage unhealthy habitual behaviour rests
41 on the proposition that cultivating mindful awareness of internal experiences (e.g., emotions
42 and physical sensations) facilitates self-acceptance, cognitive flexibility and generally improves
43 the ability to respond adaptively to disturbing emotions (Katterman, Kleinman, Hood, Nackers,
44 & Corsica, 2014). In this respect mindfulness has the potential to moderate the influence of
45 automatic approach-avoidance tendencies evident in maladaptive reward motivated behaviour
46 (Ostafin, Bauer, & Myxter, 2012). Maladaptive eating behaviour provides a potent vehicle to

47 identify mechanisms of reward motivated behaviour governed by automatic processes (Lowe,
48 Van Steenburgh, Ochner, & Coletta, 2009). For example, laboratory based evidence indicates
49 that brief mindfulness meditation experience attenuates appetitive reaction to rewarding food
50 cues (Fisher, Lattimore, & Malinowski, 2016; Lacaille et al., 2014; Papies, Barsalou, & Custers,
51 2012).

52 The current study was designed to identify the role of emotion regulation and mental
53 habit in the putative relationship between mindfulness and reward driven eating behaviour.
54 The construct of 'mental habit' describes *how* we think (the process) rather than *what* we think
55 (the content) that is characterised by automaticity, lack of awareness, mental efficiency, lack of
56 control and lack of conscious intent (Verplanken, Friberg, Wang, Trafimow, & Woolf, 2007). The
57 focus on *how* phenomena are experienced rather than changing the *content* of these
58 experiences per se is consistent with how positive outcomes of mindfulness practices can be
59 understood (Bishop et al., 2004; Chiesa & Malinowski, 2011; Shapiro, Carlson, Astin, &
60 Freedman, 2006).

61 Emotion regulation is a multidimensional construct characterized by flexible modulation
62 strategies, behavioural control, emotional awareness and distress tolerance (Gratz & Roemer,
63 2004). Difficulties in emotion regulation are evident in disorders where automatic habitual
64 reactivity to reward characterises unhealthy behavioural outcomes, for example binge eating or
65 bulimia type disorders (Svaldi, Tuschen-Caffier, Lackner, Zimmermann, & Naumann, 2012), and
66 addiction (Witkiewitz, Lustyk, & Bowen, 2012). Enhancement of emotion regulation skills can be
67 fostered by cultivating attention to habitual modes of reacting, most notably by use of mindful
68 attention training or meditation (Brown, Ryan, & Cresswell, 2007).

69 The term dispositional mindfulness describes an inherent human capacity that is
70 experienced to lesser or greater extent by all humans and is not culturally bound (e.g. Bergomi,
71 Tschacher, & Kupper, 2012; Brown & Ryan, 2004; Kabat-Zinn, 2003). Practiced regularly over
72 longer time spans of months and years, the state of mindfulness cultivated in mindfulness
73 meditation is proposed to become a stable, dispositional tendency to be mindful across
74 situations in daily life (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Brown et al., 2007).
75 As dispositional mindfulness describes both an inherent capacity and the outcome of
76 cultivation through meditation practice, the current study includes analysis that compares
77 those with and without meditation experience, and self-reported mindfulness.

78 Several psychological processes have been proposed to underpin the positive
79 associations between mindfulness practice and adaptive emotion regulation. Firstly, increasing
80 non-judgemental awareness facilitates healthy engagement with thoughts and emotions
81 (Hayes & Feldman, 2004). Secondly, mindfulness training of attention may result in an
82 improved capacity to disengage from aversive emotional stimuli, thereby enabling greater
83 emotional flexibility (Lutz, Slagter, Dunne, & Davidson, 2008). Finally, mindfulness practice
84 promotes meta-cognitive awareness (Malinowski, 2013), an ability to decentre from thoughts
85 and emotions and re-perceive them as transient rather than taking them as reality. Decentring
86 in this way allows disengagement from overt and covert habitual reactions (Shapiro et al., 2006;
87 Williams, 2008).

88 The ability fostered by mindfulness practice to disengage from habitual reactions has
89 consequences for behaviour and cognition. For example, Lacaille et al. (2014) showed
90 disengaging from one's thoughts about food effectively reduces food cravings. On a
91 behavioural level habit can be defined as 'a recurrent, often unconscious pattern of behaviour

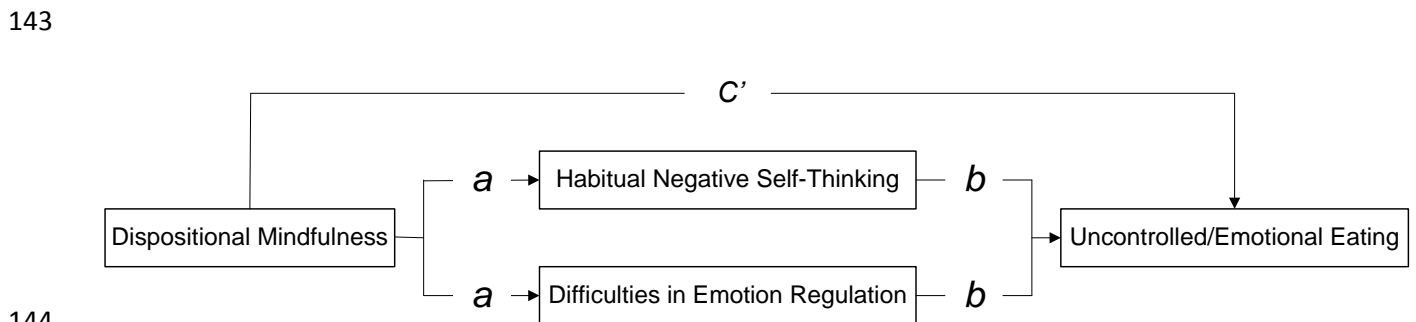
92 that is acquired through frequent repetition' (Pinker et al., 2013). On a cognitive level the
93 mental habit concept extends beyond overt behaviour to covert mental events or 'mental
94 habits' such as habitual negative self-thinking (Verplanken, 2010). This construct is distinct from
95 other forms of repetitive thought such as rumination, as it relates to the habitual nature of the
96 process rather than the content of cognition (Verplanken, 2010). Verplanken and Tangelder
97 (2011) have proposed that mindfulness mitigates dysfunctional effects of habitual negative
98 thinking through two key processes. Firstly, present-moment awareness may interrupt the
99 automatic quality of the mental habit. Secondly, non-judgmental acceptance may reduce the
100 risks of dysfunctional consequences by diminishing the weight that negative thoughts are given.
101 By consequence they suggest that emotional distress associated with experiencing habitual
102 negative self-thinking is reduced (Verplanken & Tangelder, 2011). This implies that the
103 modulation of mental habit by mindfulness should in turn reduce engagement in emotional
104 eating behaviours that arguably arise from attempts to alleviate aversive internal states
105 (Heatherton & Baumeister, 1991). Prior research indicates that difficulties in emotion
106 regulation and habitual negative self-thinking are associated with an increased vulnerability to
107 experience problematic eating behaviours (Lavender et al., 2015; Lavender et al., 2014; Sim &
108 Zeman, 2004; Verplanken & Tangelder, 2011; Verplanken & Velsvik, 2008; Whiteside et al.,
109 2007).

110 It is clear from everyday observation that many individuals have difficulty controlling
111 what and how much they eat. This phenomenon is increasingly evident when individuals are
112 motivated to eat when not physically hungry, and is referred to as hedonic hunger or reward
113 motivated eating (Lowe & Butryn, 2007). Although intentional (controlled) processes, for
114 example, dietary restraint (Coelho, Polivy, Herman, & Pliner, 2008), can change overt eating

115 behaviour by inhibiting automatic appetitive reactions to food cues, under specific conditions
116 the ability to engage controlled processes is weakened. This is evident when individuals
117 experience demanding cognitive load (Lattimore & Maxwell, 2004), stress (Wallis &
118 Hetherington, 2009), and aversive negative affect (Heatherton & Baumeister, 1991; Heatherton,
119 Polivy, Herman, & Baumeister, 1993), all of which undermine controlled behaviour such as
120 dietary restraint. Furthermore, individual differences in sensitivity to reward further weaken
121 intentional effort to control thoughts and emotions associated with reward motivated eating
122 (Tetley, Brunstrom, & Griffiths, 2010). Relying solely on controlled processes to regulate
123 automatically reward motivated hedonic eating is not sufficient because self-control resource
124 capacity is variable and limited (Tice & Bratslavsky, 2000). Recent evidence indicates that
125 mindfulness based techniques moderate the effect of automatic processes on overt behaviour,
126 e.g., craving for food and addictive substances (Alberts, Mulkens, Smeets, & Thewissen, 2010;
127 Alberts, Thewissen, & Raes, 2012; Ostafin et al., 2012; Witkiewitz & Bowen, 2010; Witkiewitz,
128 Bowen, Douglas, & Hsu, 2013). Furthermore, dispositional mindfulness is negatively associated
129 with self-reported emotional eating and reward motivated eating (Lattimore, Fisher, &
130 Malinowski, 2011).

131 In sum, the recent findings reviewed above highlight emerging support for the beneficial
132 role of mindfulness in improving maladaptive, reward motivated behaviours which are
133 characterised by automatic reactivity. Emotion regulation and mental habit have been
134 identified as two potential mechanisms that may explain how mindfulness is related to reward
135 motivated eating behaviour. Reward motivated eating behaviour can be measured using the
136 emotional and uncontrolled eating subscales of the Three Factor Eating Questionnaire
137 (Cappelleri, Bushmakin, Gerber, Leidy, Sexton, Lowe, et al., 2009) which has proven

138 associations with dispositional mindfulness and captures tendencies to automatically react to
139 hedonic food cues (Barkeling, King, Naslund, & Blundell, 2006). We expected that dispositional
140 mindfulness would be associated with uncontrolled and emotional eating and that this
141 relationship would be mediated by difficulties in emotion regulation and mental habit (see
142 Figure 1).



144
145

146 Figure 1. Graphical representation of the proposed mediation model.

147

148 To ensure a wide variation of dispositional mindfulness scores and to gain an indication of the
149 possible role of mindfulness meditation, both meditators and non-meditators were recruited.
150 Practicing mindfulness meditation has been shown to increase awareness of sensations (body,
151 thoughts and emotions), thereby improving discrimination between physiological hunger and
152 hedonic hunger (Gilbert & Waltz, 2010). In this respect, mindfulness practice permits
153 ‘connection’ with internal experiences (e.g., hunger) and consequently reduces likelihood of
154 reacting to external and emotional cues to eat (Kristeller & Wolever, 2011). Therefore, we
155 expected that experienced meditators would report significantly higher levels of dispositional
156 mindfulness, fewer difficulties in emotion regulation, less habitual negative self-thinking and
157 lower levels of both uncontrolled and emotional eating compared to non-meditators.

158

159

Method

160 *Participants and design*

161 Six-hundred and thirty-two participants (457 female; 88% Caucasian; Age: $M = 34\text{yr}$, $SD = 14.2$,
162 range 18 to 78) took part in an online cross-sectional survey. The majority of participants were
163 from the UK (413), the USA (126), or Australia (17) and 87% spoke English as their first language.
164 Although self-reported weight and height were requested with the option to give either metric
165 or imperial scales, the provided values were inaccurate and judged unreliable¹ to calculate BMI.
166 In appreciation of participation, respondents were offered the opportunity to be entered into a
167 prize draw to win Amazon shopping vouchers, ranging in value from £20-£100 (or equivalent in
168 US dollars).

169 *Meditation experience*

170 Determining how much experience of meditation is enough for a group to be described as
171 meditators and therefore sufficiently different from non-meditators presents significant
172 challenges in research. Lykins and Baer (2009) classed participants as regular meditation
173 practitioners if they engaged in at least one meditation session per week. The current study
174 also uses this cut off however, based on the variation in reported experiences this group is
175 described as “meditators” rather than “regular meditators”. Meditators reported between <1
176 and 53 years of meditation experience ($M=11.80$, $SD=10.05$), practicing between 1 and 28 times
177 per week ($M=5.45$, $SD=3.80$) and between 5 and 120 minutes ($M=32.47$, $SD=17.00$) each time.

178 ¹Footnote: The ranges of BMI calculated (11-72) suggest that some of the weight values were given in different measurement
179 scales. Data on BMI is not included because it is highly likely that participants gave responses using both imperial and metric
180 values.

181 The relationship between these measures of meditation experience and psychological and
182 eating measures are shown in Table 3. 82% of meditators said the term mindfulness was used
183 in their meditation practices and 84% agreed that a description based on Kabat-Zinn (1994)
184 described their practice. Those who did not agree stated that it encompassed some but not all
185 of what was practiced. Participants with previous meditation experience who did not maintain
186 a current meditation practice (N=13) or those whose meditation experience was solely through
187 guided relaxation at the end of yoga or tai chi classes or the use of self-hypnosis tapes (N=65)
188 were not included when comparing meditators and non-meditators on psychological measures
189 or eating measures. This strategy resulted in the inclusion of 233 meditators (63% female; Age:
190 M = 44yr, SD =13.2) and 321 non-meditators (76% female; Age: M = 27yr, SD =9.9) in this part
191 of the analysis.

192 Measures

193 *Mindfulness*

194 Dispositional mindfulness was assessed using the 39-item Five Facet Mindfulness Questionnaire
195 (FFMQ) (Baer et al., 2006). The response format comprises a five-point Likert scale (1 = never or
196 very rarely true; 5 = very often or always true). Higher scores are indicative of greater
197 mindfulness in daily life. The analysis included in this study used the total score, representing the
198 higher-order factor of mindfulness, rather than the different mindfulness facets. Internal
199 consistency was satisfactory ($\alpha = 0.88$).

200 *Eating behaviours*

201 Uncontrolled and emotional eating behaviours were assessed using the two respective scales
202 from the revised 18-item version of the Three-Factor Eating Questionnaire: TFEQ-R18V2

203 (Cappelleri, Bushmakin, Gerber, Leidy, Sexton, Karlsson, et al., 2009). The uncontrolled eating
204 scale (TFEQ-UE) measures the tendency to lose control over eating when feeling hungry or
205 when exposed to food stimuli, while the emotional eating scale (TFEQ-EE) assesses the
206 propensity to overeat in response to negative mood states. All items follow a four-point Likert
207 scale response format (definitely true/mostly true/ mostly false/definitely false). Scores are
208 summed to produce scale scores and the raw scores are transformed to a 0-100 scale. Higher
209 scores are indicative of greater uncontrolled or emotional eating. Internal consistency was
210 satisfactory for the TFEQ-UE and TFEQ-EE subscales ($\alpha = 0.85$ and 0.90 respectively).

211 *Difficulties in emotion regulation*

212 The 36-item Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) measures
213 awareness and understanding of emotions, acceptance of emotions, the ability to maintain goal
214 directed behaviour and ability to access emotion regulation strategies when experiencing
215 negative emotions (Gratz & Roemer, 2004). All items follow a five-point Likert scale response
216 format (Almost never/Sometimes/About half the time/Most of the time/Almost always)
217 Higher scores are indicative of greater difficulties in emotion regulation. Internal consistency in
218 the current study for the total score was satisfactory ($\alpha = 0.95$).

219 *Habitual Negative self-thinking*

220 The habitual quality of negative self-thinking was assessed by the 12-item meta-cognitive Habit
221 Index of Negative Thinking (HINT; Verplanken, 2006). The HINT measures the extent to which
222 negative self-thoughts occur often, are unintended, are initiated without awareness, are
223 difficult to control, and are self-descriptive (Verplanken et al., 2007). In a series of eight studies
224 negative self-thinking habit was shown to be distinct from rumination and mindfulness and to
225 predict anxiety and depressive symptoms 9 months later (Verplanken et al., 2007). In the

226 current study it assessed the habitual quality of the thoughts that were listed in a preceding
227 thought elicitation task. The instruction was as follows: 'We now want to know HOW the
228 negative thoughts you wrote down on the previous page usually occur.' Each question is
229 anchored by the phrase: 'Having those thoughts is something ...'. Questions are completed by
230 12 items designed to probe the habitual nature of thoughts (e.g. '... I do frequently', '... I find
231 hard not to do', '... I start doing before I realize it' ... 'That's typically "me"'). Responses are
232 provided on a 5-point Likert scale (1= strongly disagree to 5= strongly agree) to indicate the
233 extent of the habitual nature of thoughts. Higher scores indicate a strong negative self-thinking
234 habit. Internal consistency for the HINT in the current study was satisfactory ($\alpha = 0.89$).

235 *Procedure*

236 Participants were recruited through advertisements on a mindfulness research webpage and
237 emailed invitations to meditation groups and university mailing lists to primarily recruit people
238 with and without meditation experience, respectively. Ethical approval for the study was
239 obtained from the University Research Ethics Committee. The survey was delivered via Bristol
240 Online Survey (<https://www.onlinesurveys.ac.uk>) and took approximately 20 minutes to
241 complete.

242 *Data analysis*

243 Pearson correlations were performed and bootstrapping techniques used for regression
244 analysis of mediation effects (Preacher & Hayes, 2008). Independent t-tests were used to
245 compare meditators and non-meditators. Bias corrected and accelerated bootstrap percentile
246 confidence intervals (5000 resamples) are presented for total and indirect effects. 95%
247 confidence intervals that do not contain zero between upper and lower bounds indicated
248 significant mediation. Regression diagnostics were all within acceptable ranges.

249

Results

250

Descriptive statistics and correlation coefficients are displayed in Table 1. Higher

251

dispositional mindfulness is associated with a reduced tendency to engage in both uncontrolled

252

and emotional eating behaviour, with lower scores on emotion regulation difficulties and with

253

lower frequency of habitual negative self-thinking. Higher scores on the uncontrolled and

254

emotional eating scales were associated with greater difficulties in emotion regulation and with

255

more frequent habitual negative self-thinking.

256

257 Table 1. Pearson correlations for psychological and eating measures with Cronbach's alphas,

258 means and standard deviations (N 632).

	Scale range	α	M	SD	2.	3.	4.	5.
1. FFMQ	39-195	.94	133.1	22.1	-.54**	-.79**	-.45**	-.27**
2. HINT	12-60	.89	40.5	8.9		.56**	.32**	.31**
3. DERS	36-180	.95	81.5	24.1			.41**	.27**
4. TFEQ-UE	0-100	.85	37.9	19.3				.58**
5. TFEQ-EE	0-100	.90	36.3	26.7				---

259

Note: ** $p < 0.01$; α = Cronbach's alphas; M = mean; SD = standard deviation; FFMQ Total=

260

mindfulness; HINT Total = Habitual Negative Self-Thinking; DERS Total = Difficulties in Emotion

261

Regulation; TFEQ-UE = Uncontrolled Eating; TFEQ-EE = Emotional Eating.

262

Differences between meditators and non-meditators

263

A series of independent samples t-tests were conducted to examine the differences

264

between meditators and non-meditators on the measured variables (see Table 2). Prior to

265

analysis z-scores were computed for each measure used in t-test comparisons and a total of 29

266 participants (21 from the non-meditators group) were excluded from analysis because their
 267 scores were above or below +/- 2.5 SD. To control for Type 1 errors a Bonferroni adjustment
 268 was made to alpha ($\alpha/5 = .01$) for the five t-tests performed. As hypothesised, meditators
 269 reported significantly higher levels of dispositional mindfulness, fewer difficulties in emotion
 270 regulation, less habitual negative self-thinking and lower levels of uncontrolled eating when
 271 compared to non-meditators (all $p < .001$). Although meditators reported lower levels of
 272 emotional eating the difference was not significant after Bonferroni adjustment ($p = .014$). For
 273 dispositional mindfulness, difficulties in emotion regulation, habitual negative self-thinking and
 274 uncontrolled eating effect sizes were medium to large. The effect size for emotional eating was
 275 small.

276 Table 2. Differences between meditators and non-meditators on psychological measures.

	Meditation Experience							
	None (N = 321)		Meditators (N = 229)		<i>t</i> (548)	<i>d</i>	Effect size 95% CI	
	M	SD	M	SD			Lower	Upper
FFMQ	124.2	17.6	149.2	17.6	16.13*	1.40	1.21	1.58
DERS ^a	89.7	24.4	65.9	12.6	13.54*	-1.17	-1.35	-0.99
HINT ^b	42.9	8.3	37.9	7.2	7.38*	-0.64	-0.81	-0.47
TFEQ-UE	42.7	18.3	28.6	15.8	9.57*	-0.83	-1.00	-0.65
TFEQ-EE	36.5	23.4	31.4	22.2	2.47	-0.21	-0.38	-0.04

277 Note. * $p < .001$; *d* = Cohen's *d* effect size; FFMQ Total = mindfulness; DERS Total = Difficulties in
 278 Emotion Regulation scale; HINT Total = Habitual Negative Self-Thinking; TFEQ-UE =
 279 Uncontrolled Eating; TFEQ-EE = Emotional Eating. Adjusted degrees of freedom (Homogeneity
 280 of variance not assumed) = ^a *df* = 531.65; ^b *df* = 513.47.

281

282 *Analyses of correlations between meditation experience and measured constructs*

283 The distributions of meditation experience (time spent meditating and frequency) were skewed
 284 (z-scores ranging between 2.02 and 12.24) due to variation in what is considered meditation
 285 practice, for example, formal sitting practices or practicing mindfulness in all of life’s activities.
 286 The scores for individuals who report that they are always meditating are therefore not true
 287 outliers as they reflect the wide variation in meditation practice. Instead of removing “apparent”
 288 outliers, non-parametric correlations (Spearman’s Rho) were computed between meditation
 289 experience and other measures shown in Table 3.

290 Table 3. Relationships between meditation experience and measured constructs

	Meditation experience		
	Years	Per week	Length
FFMQ	.54**	.54**	.48**
HINT	-.28**	-.29**	-.25
DERS	-.43**	-.43**	-.11
TFEQ-UE	-.34*	-.34**	-.30**
TFEQ-EE	-.08	-.09*	-.06

291 Note: * $p < 0.05$, ** $p < 0.01$; Years= number of years practicing meditation; Per week = Average
 292 number of meditation practices per week; Length = Average duration (minutes) of each
 293 meditation practice. FFMQ Total= mindfulness; HINT Total = Habitual Negative Self-Thinking;
 294 DERS Total = Difficulties in Emotion Regulation; TFEQ-UE = Uncontrolled Eating; TFEQ-EE =
 295 Emotional Eating.

296

297

298

299 *Mediation analyses: Indirect effects and direct effects*

300 We proposed that the relations between dispositional mindfulness and eating measures
 301 would be mediated by difficulties in emotion regulation and habitual negative self-thinking (see
 302 Figure 1). Prior to analysis z-scores were computed for each measure and eight participants
 303 were excluded from analysis because their scores were above or below +/- 2.5 SD on the
 304 difficulties in emotion regulation scale. Mediation tests were run with and without the inclusion
 305 of these participants. As there were no substantive differences on any of the tests of mediation
 306 (point estimates, confidence intervals or path weights of direct, indirect and total effects)
 307 outcomes of the mediation analyses are reported for the complete sample. Overall, the results
 308 of the multiple mediation analysis presented in Tables 4 and 5 indicate that habitual negative
 309 self-thinking and difficulties in emotion regulation are significant mediators of the mindfulness-
 310 eating relationship.

311 Table 4. Mediation statistics for the effect of dispositional mindfulness on emotional eating
 312 through habitual negative self-thinking and difficulties in emotion regulation.

	Product of coefficients			BCa 95% CI	
	Estimate	SE	Z	Lower	Upper
Multiple indirect effects					
1. HINT	-.1302*	.0286	-4.5484	-.1915	-.0710
2. DERS	-.0747	.0534	-1.3995	-.1806	-.0371
Total indirect effect	-.2049*	.0540	-3.7980	-.3135	-.0889
Contrasts: 1 vs. 2	-.0555	.0666	.8330	-.1957	-.0739

313 Note. * $p < .05$; HINT = Habit Index of Negative Thinking; DERS = Difficulties in Emotion
 314 Regulation Scale Total.

315 Table 5. Mediation statistics for the effect of dispositional mindfulness on uncontrolled eating
 316 through habitual negative self-thinking and difficulties in emotion regulation.

Multiple indirect effects	Product of coefficients			BCa 95% CI	
	Estimate	SE	Z	Lower	Upper
1. HINT	-.0357	.0207	-1.7270	-.0765	-.0057
2. DERS	-.0911*	.0401	-2.2720	-.1728	-.0053
Total indirect effect	-.2049*	.0540	-3.7980	-.2085	-.0446
Contrasts: 1 vs. 2	.0554	.0497	1.1153	-.0496	.1564

317 Note. * $p < .05$; HINT = Habit Index of Negative Thinking; DERS = Difficulties in Emotion
 318 Regulation Scale Total.

319

320 In addition, dispositional mindfulness had a significant direct effect on uncontrolled (B =
 321 -0.26; SE = 0.05; $t = -5.16$, $p < .001$) but not on emotional eating (B = -0.08; SE = 0.07; $t = -1.24$,
 322 $p > .05$). Examination of the specific indirect effect for emotional eating indicates that only
 323 habitual negative self-thinking is a significant mediator, as its 95% confidence intervals do not
 324 pass through zero (Table 4). This indicates that difficulties in emotion regulation does not
 325 contribute to the indirect effect above and beyond habitual negative self-thinking. By contrast,
 326 for uncontrolled eating the specific indirect effects indicate that difficulties in emotion
 327 regulation and habitual negative self- thinking are significant mediators, as both 95%
 328 confidence intervals do not pass through zero (Table 5). Inclusion of age and gender as
 329 covariates on the dependent variables did not substantively alter the total or indirect effects of
 330 habitual negative self-thinking in either model. However, for uncontrolled eating the specific

331 indirect effects of difficulties in emotion regulation is no longer a significant mediator, as its 95%
332 confidence interval passes through zero (LLCI=-.0719, ULCI=.1342).

333 **Discussion**

334 The present study tested the hypotheses that greater dispositional mindfulness would be
335 negatively associated with indicators of reward motivated eating and that this relationship
336 would be mediated by difficulties in emotion regulation and habitual negative self-thinking. The
337 findings support these hypotheses as lower dispositional mindfulness was significantly
338 associated with greater difficulties in emotion regulation, stronger negative self-thinking habits,
339 and uncontrolled and emotional eating. Further analysis revealed emotion regulation
340 difficulties and habitual negative self-thinking as mechanisms by which dispositional
341 mindfulness influences uncontrolled eating and emotional eating, respectively. In relation to
342 the proposed differences between meditators and non-meditators, meditators scored
343 significantly lower on difficulties in emotion regulation, habitual negative self-thinking, and
344 uncontrolled eating compared to non-meditators, providing some indication that meditation
345 practice might be a useful way of influencing emotional and uncontrolled eating via the
346 mechanisms discovered here.

347 Regarding the significant negative correlations between dispositional mindfulness and
348 uncontrolled and emotional eating the current findings concur with those identified using a
349 similar methodology in female undergraduate students (Lattimore et al., 2011). By considering
350 emotional and uncontrolled eating as indicators of reward motivated eating behaviour our
351 findings fit well with evidence from clinical studies which show that dispositional mindfulness is
352 negatively associated with aspects of eating pathology including non-acceptance of emotional

353 experience and binge eating (Butryn et al., 2013; Lattimore et al., 2016; Lavender, Gratz, & Tull,
354 2011).

355 Taken together, the observed association between dispositional mindfulness and reward
356 motivated eating and the finding that meditators reported higher mindfulness and lower DERS
357 and HINT scores suggests that mindfulness training may alter tendencies to automatically react
358 to rewarding food cues. Through a process of acceptance of and non-reactivity to affective
359 states that typically engage overt habits sustained mindfulness training cultivates greater
360 awareness and inhibitory control of disruptive emotions (Chambers et al., 2009; Chiesa,
361 Brambilla, & Serratti, 2010; Chiesa et al., 2013). The correlations identified in the current study
362 suggest that difficulties in emotion regulation and mental habit may underpin the relation
363 between mindfulness and unhealthy behaviours as indicated in prior research (Ostafin et al.,
364 2012; Svaldi et al., 2012; Witkiewitz et al., 2012). The results from parallel tests of multiple
365 mediation indicate that these mediators had differential influence on aspects of reward
366 motivated eating. Difficulties in emotion regulation significantly mediated the mindfulness-
367 uncontrolled eating relationship whereas habitual negative self-thinking significantly mediated
368 the mindfulness-emotional eating relationship.

369 The mediating role of habitual negative self-thinking in the relation between dispositional
370 mindfulness and the reduced tendency to eat in response to aversive emotions may in part be
371 attributable to decentring from experience that arises from mindfulness practice (e.g. Bieling et
372 al., 2012). Stressful or negative events often trigger derailing negative, self-critical, reactive, and
373 judgmental thoughts; attempts to avoid dealing with these challenging threats to the self
374 reduces goal pursuit (Teasdale, Segal, & Williams, 1995). By allowing negative thoughts and
375 emotions to occur without judgment and reaction, the thoughts and concomitant frustration

376 dissipate, allowing successful goal pursuit (Brown et al., 2007). Rather than being absorbed in a
377 dysfunctional cycle of repetitive thinking, mindfulness enhances the ability to maintain
378 cognitive focus (Chambers et al., 2009; Chambers, Lo, & Allen, 2008).

379 In addition to the influence of mindfulness on indicators of reward motivated eating
380 through potential mediators, its direct effect on uncontrolled eating indicates that mindfulness
381 may directly influence the tendency to engage in uncontrolled eating by altering reactivity to
382 internal sensations or environmental cues. This evidence is in agreement with recent research
383 indicating that MBIs can reduce reactivity to factors that cause problematic eating behaviour
384 (Alberts et al., 2010; Alberts et al., 2012). An additional benefit of mindfulness practice is the
385 potential to develop capacity to reduce identification with dysfunctional thoughts about food,
386 weight and body shape (Albers, 2011; Godfrey, Gallo, & Afari, 2015; Rogers, Ferrari, Mosely,
387 Lang, & Brennan, 2017) and to bolster self-regulation in the face of negative affect associated
388 with impulsive reactivity (Fetterman, Robinson, Ode, & Gordon, 2010). The differences we
389 observed between meditators and non-meditators support the emerging evidence that
390 mindfulness practice can influence responses to phenomena including thoughts and emotions.

391 The limitations of this study include the use of self-report measures of mindfulness and physical
392 characteristics, the latter providing unreliable figures that suggest participants gave information
393 using a range of scales. The measurement of mindfulness using questionnaires is limited in that
394 they capture features related to mindfulness rather than measuring mindfulness itself and are
395 limited by individuals' awareness of their inner states (Bergomi, Tschacher, & Kupper, 2013;
396 Grossman & Van Dam, 2011). That is, the ability to accurately measure 'mindfulness' is reliant
397 on participants' 'mindfulness'. However, for assessment in general populations the FFMQ has
398 been suggested to provide the most comprehensive coverage of aspects of current conceptions

399 of mindfulness (Bergomi et al., 2013). The second limitation is the difficulty in determining what
400 experiences are required to delineate between meditators and non-meditators. Measurements
401 of frequency and duration imply an assumption that a certain amount of meditation is required
402 to see effects on outcomes of interest. However, reviews and meta-analyses of studies that
403 investigate the effect of, primarily mindfulness, meditation show no clear relationship between
404 amount of practice and effects (Carmody & Baer, 2009; Eberth & Sedlmeier, 2012; Vettese,
405 Toneatto, Stea, Nguyen, & Wang, 2009). In the current study measures of meditation
406 experience are provided for description and pragmatic inclusion criteria based on comparable
407 previous research (Lykins & Baer, 2009). An important question for future research is how to
408 determine what is “enough” meditation in a specific context when people come to meditation
409 from different starting point for different reasons (for discussion see Eberth & Sedlmeier, 2012).

410 *Conclusions*

411 Our study set out to examine potential mechanisms by which mindfulness influences reward
412 motivated behaviour typically characterised as habitual or automatic in nature. Although the
413 design of the study was cross sectional and causality cannot be inferred, in conjunction with the
414 reviewed evidence our mediation analyses suggest plausible relations between mindfulness,
415 emotion regulation, habitual negative self-thinking and uncontrolled and emotional eating as
416 indicators of reward motivated eating. Future investigations involving the design and evaluation
417 of MBIs for reward motivated behaviours could verify whether emotion regulation and mental
418 habit underpin outcomes. We believe the strength and originality of the findings provide a basis
419 from which to design mindfulness-based interventions to test the effect of directly targeting
420 difficulties in emotion regulation and habitual negative self-thinking to reduce reward
421 motivated dysfunctional behaviour.

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