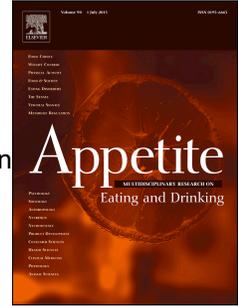# Accepted Manuscript

Dispositional mindfulness and reward motivated eating: The role of emotion regulation and mental habit

Naomi R. Fisher, Bethan R. Mead, Paul Lattimore, Peter Malinowski

Title page

Dispositional mindfulness and reward motivated eating:
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Authors: Naomi R. Fisher, PhD[1]; Bethan R. Mead, MSc[2]; Paul Lattimore, PhD[3]; Peter Malinowski, PhD[3].

School of Natural Sciences and Psychology, Liverpool John Moores University, Tom Reilly Building, Byrom Street, Liverpool, L3 3AF

[1]Division of Health Research, Faculty of Health and Medicine, Lancaster University, United Kingdom, LA1 4YG

[2]Department of Psychological Sciences, Institute of Psychology, Health and Society, University of Liverpool

[3]School of Natural Sciences and Psychology, Liverpool John Moores University

Corresponding author:

Naomi Ruth Fisher, PhD
Division of Health Research
Faculty of Health and Medicine
Lancaster University
United Kingdom
LA1 4YG

Email: N.R.Fisher@lancaster.ac.uk

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.

Introduction

24

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, Friborg, 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).

3

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

4

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, Smeet, & 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).

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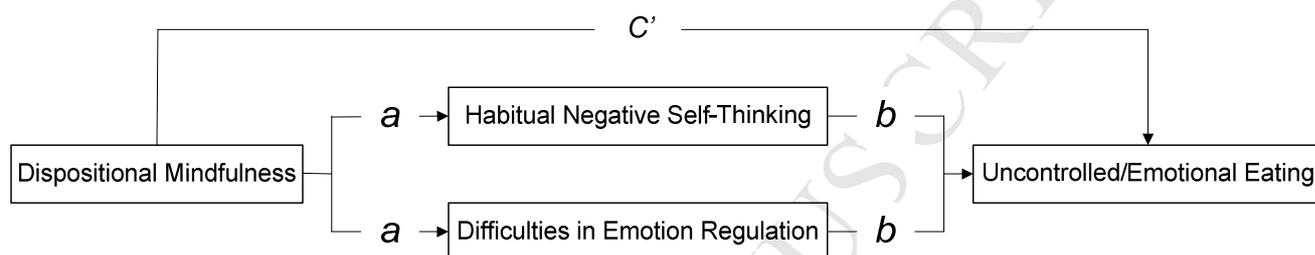
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146 Figure 1. Graphical representation of the proposed mediation model.

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 = 34yr, *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 unreliable[1] 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 [1]Footnote: 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 (α = 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 (α = 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 (α =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 (α =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-mediators*

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 (α/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)				Effect size 95% CI	
	M	SD	M	SD	t(548)	d	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*

13

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.

Multiple indirect effects	Product of coefficients			BCa 95% CI	
	Estimate	SE	Z	Lower	Upper
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.

	Product of coefficients			BCa 95% CI	
Multiple indirect effects	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

16

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

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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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