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

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Dispositional mindfulness and reward motivated eating:

The role of emotion regulation and mental habit

Abstract

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

Key words: mindfulness; reward motivated eating; automatic; emotion regulation; mental habit.
Introduction

Mindfulness has attracted considerable popular interest (Jha, 2013) and scientific investigation (Chiesa & Serretti, 2010; Davis & Hayes, 2011; Malinowski, 2013) in the past two decades. Although various definitions of mindfulness have been proposed and no clear consensus has been reached (Chiesa, 2012; Shonin, Van Gordon, & Griffiths, 2014) a broad definition often referred to by researchers (Chiesa & Malinowski, 2011; Malinowski, 2008; Zgierska et al., 2009) describes mindfulness as ‘paying attention in a particular way, on purpose, in the present moment, and nonjudgmentally’ (p.4; Kabat-Zinn, 1994). One reason for the popularity of this definition presumably is that a large proportion of research is concerned with mindfulness-based interventions such as mindfulness-based stress reduction (MBSR) or mindfulness-based cognitive therapy (MBCT), both of which are built around the approach to mindfulness introduced by Kabat-Zinn. A recent meta-analytic review of the mechanisms of mindfulness-based interventions has identified strong and consistent evidence for the role of emotional and cognitive reactivity (Gu, Strauss, Bond, & Cavanagh, 2015). Substantial evidence exists to demonstrate that mindfulness training produces beneficial outcomes by promoting effective emotion regulation (Chambers, Gullone, & Allen, 2009; Chiesa, Serretti, & Jakobsen, 2013). The case for developing mindfulness skills to manage unhealthy habitual behaviour rests on the proposition that cultivating mindful awareness of internal experiences (e.g., emotions and physical sensations) facilitates self-acceptance, cognitive flexibility and generally improves the ability to respond adaptively to disturbing emotions (Katterman, Kleinman, Hood, Nackers, & Corsica, 2014). In this respect mindfulness has the potential to moderate the influence of automatic approach-avoidance tendencies evident in maladaptive reward motivated behaviour (Ostafin, Bauer, & Myxter, 2012). Maladaptive eating behaviour provides a potent vehicle to
identify mechanisms of reward motivated behaviour governed by automatic processes (Lowe, Van Steenburgh, Ochner, & Coletta, 2009). For example, laboratory based evidence indicates that brief mindfulness meditation experience attenuates appetitive reaction to rewarding food cues (Fisher, Lattimore, & Malinowski, 2016; Lacaille et al., 2014; Papies, Barsalou, & Custers, 2012).

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

Emotion regulation is a multidimensional construct characterized by flexible modulation strategies, behavioural control, emotional awareness and distress tolerance (Gratz & Roemer, 2004). Difficulties in emotion regulation are evident in disorders where automatic habitual reactivity to reward characterises unhealthy behavioural outcomes, for example binge eating or bulimia type disorders (Svaldi, Tuschen-Caffier, Lackner, Zimmermann, & Naumann, 2012), and addiction (Witkiewitz, Lustyk, & Bowen, 2012). Enhancement of emotion regulation skills can be fostered by cultivating attention to habitual modes of reacting, most notably by use of mindful attention training or meditation (Brown, Ryan, & Cresswell, 2007).
The term dispositional mindfulness describes an inherent human capacity that is experienced to lesser or greater extent by all humans and is not culturally bound (e.g. Bergomi, Tschacher, & Kupper, 2012; Brown & Ryan, 2004; Kabat-Zinn, 2003). Practiced regularly over longer time spans of months and years, the state of mindfulness cultivated in mindfulness meditation is proposed to become a stable, dispositional tendency to be mindful across situations in daily life (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Brown et al., 2007).

As dispositional mindfulness describes both an inherent capacity and the outcome of cultivation through meditation practice, the current study includes analysis that compares those with and without meditation experience, and self-reported mindfulness.

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

The ability fostered by mindfulness practice to disengage from habitual reactions has consequences for behaviour and cognition. For example, Lacaille et al. (2014) showed disengaging from one’s thoughts about food effectively reduces food cravings. On a behavioural level habit can be defined as ‘a recurrent, often unconscious pattern of behaviour
that is acquired through frequent repetition’ (Pinker et al., 2013). On a cognitive level the mental habit concept extends beyond overt behaviour to covert mental events or ‘mental habits’ such as habitual negative self-thinking (Verplanken, 2010). This construct is distinct from other forms of repetitive thought such as rumination, as it relates to the habitual nature of the process rather than the content of cognition (Verplanken, 2010). Verplanken and Tangelder (2011) have proposed that mindfulness mitigates dysfunctional effects of habitual negative thinking through two key processes. Firstly, present-moment awareness may interrupt the automatic quality of the mental habit. Secondly, non-judgmental acceptance may reduce the risks of dysfunctional consequences by diminishing the weight that negative thoughts are given. By consequence they suggest that emotional distress associated with experiencing habitual negative self-thinking is reduced (Verplanken & Tangelder, 2011). This implies that the modulation of mental habit by mindfulness should in turn reduce engagement in emotional eating behaviours that arguably arise from attempts to alleviate aversive internal states (Heatherton & Baumeister, 1991). Prior research indicates that difficulties in emotion regulation and habitual negative self-thinking are associated with an increased vulnerability to experience problematic eating behaviours (Lavender et al., 2015; Lavender et al., 2014; Sim & Zeman, 2004; Verplanken & Tangelder, 2011; Verplanken & Velsvik, 2008; Whiteside et al., 2007).

It is clear from everyday observation that many individuals have difficulty controlling what and how much they eat. This phenomenon is increasingly evident when individuals are motivated to eat when not physically hungry, and is referred to as hedonic hunger or reward motivated eating (Lowe & Butryn, 2007). Although intentional (controlled) processes, for example, dietary restraint (Coelho, Polivy, Herman, & Pliner, 2008), can change overt eating
behaviour by inhibiting automatic appetitive reactions to food cues, under specific conditions
the ability to engage controlled processes is weakened. This is evident when individuals
experience demanding cognitive load (Lattimore & Maxwell, 2004), stress (Wallis &
Hetherington, 2009), and aversive negative affect (Heatherton & Baumeister, 1991; Heatherton,
Polivy, Herman, & Baumeister, 1993), all of which undermine controlled behaviour such as
dietary restraint. Furthermore, individual differences in sensitivity to reward further weaken
intentional effort to control thoughts and emotions associated with reward motivated eating
(Tetley, Brunstrom, & Griffiths, 2010). Relying solely on controlled processes to regulate
automatically reward motivated hedonic eating is not sufficient because self-control resource
capacity is variable and limited (Tice & Bratslavsky, 2000). Recent evidence indicates that
mindfulness based techniques moderate the effect of automatic processes on overt behaviour,
e.g., craving for food and addictive substances (Alberts, Mulkens, Smeet, & Thewissen, 2010;
Alberts, Thewissen, & Raes, 2012; Ostafin et al., 2012; Witkiewitz & Bowen, 2010; Witkiewitz,
Bowen, Douglas, & Hsu, 2013). Furthermore, dispositional mindfulness is negatively associated
with self-reported emotional eating and reward motivated eating (Lattimore, Fisher, &
Malinowski, 2011).

In sum, the recent findings reviewed above highlight emerging support for the beneficial
role of mindfulness in improving maladaptive, reward motivated behaviours which are
characterised by automatic reactivity. Emotion regulation and mental habit have been
identified as two potential mechanisms that may explain how mindfulness is related to reward
motivated eating behaviour. Reward motivated eating behaviour can be measured using the
emotional and uncontrolled eating subscales of the Three Factor Eating Questionnaire
(Cappelleri, Bushmakin, Gerber, Leidy, Sexton, Lowe, et al., 2009) which has proven
associations with dispositional mindfulness and captures tendencies to automatically react to hedonic food cues (Barkeling, King, Naslund, & Blundell, 2006). We expected that dispositional mindfulness would be associated with uncontrolled and emotional eating and that this relationship would be mediated by difficulties in emotion regulation and mental habit (see Figure 1).

Figure 1. Graphical representation of the proposed mediation model.

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

Participants and design

Six-hundred and thirty-two participants (457 female; 88% Caucasian; Age: M = 34yr, SD = 14.2, range 18 to 78) took part in an online cross-sectional survey. The majority of participants were from the UK (413), the USA (126), or Australia (17) and 87% spoke English as their first language. Although self-reported weight and height were requested with the option to give either metric or imperial scales, the provided values were inaccurate and judged unreliable\(^1\) to calculate BMI. In appreciation of participation, respondents were offered the opportunity to be entered into a prize draw to win Amazon shopping vouchers, ranging in value from £20-£100 (or equivalent in US dollars).

Meditation experience

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

\(^1\)Footnote: The ranges of BMI calculated (11-72) suggest that some of the weight values were given in different measurement scales. Data on BMI is not included because it is highly likely that participants gave responses using both imperial and metric values.
The relationship between these measures of meditation experience and psychological and eating measures are shown in Table 3. 82% of meditators said the term mindfulness was used in their meditation practices and 84% agreed that a description based on Kabat-Zinn (1994) described their practice. Those who did not agree stated that it encompassed some but not all of what was practiced. Participants with previous meditation experience who did not maintain a current meditation practice (N=13) or those whose meditation experience was solely through guided relaxation at the end of yoga or tai chi classes or the use of self-hypnosis tapes (N=65) were not included when comparing meditators and non-meditators on psychological measures or eating measures. This strategy resulted in the inclusion of 233 meditators (63% female; Age: M = 44yr, SD =13.2) and 321 non-meditators (76% female; Age: M = 27yr, SD =9.9) in this part of the analysis.

Measures

Mindfulness

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

Eating behaviours

Uncontrolled and emotional eating behaviours were assessed using the two respective scales from the revised 18-item version of the Three-Factor Eating Questionnaire: TFEQ-R18V2
The uncontrolled eating scale (TFEQ-UE) measures the tendency to lose control over eating when feeling hungry or when exposed to food stimuli, while the emotional eating scale (TFEQ-EE) assesses the propensity to overeat in response to negative mood states. All items follow a four-point Likert scale response format (definitely true/mostly true/ mostly false/definitely false). Scores are summed to produce scale scores and the raw scores are transformed to a 0-100 scale. Higher scores are indicative of greater uncontrolled or emotional eating. Internal consistency was satisfactory for the TFEQ-UE and TFEQ-EE subscales (α = 0.85 and 0.90 respectively).

Difficulties in emotion regulation

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

Habitual Negative self-thinking

The habitual quality of negative self-thinking was assessed by the 12-item meta-cognitive Habit Index of Negative Thinking (HINT; Verplanken, 2006). The HINT measures the extent to which negative self-thoughts occur often, are unintended, are initiated without awareness, are difficult to control, and are self-descriptive (Verplanken et al., 2007). In a series of eight studies negative self-thinking habit was shown to be distinct from rumination and mindfulness and to predict anxiety and depressive symptoms 9 months later (Verplanken et al., 2007). In the
current study it assessed the habitual quality of the thoughts that were listed in a preceding thought elicitation task. The instruction was as follows: ‘We now want to know HOW the negative thoughts you wrote down on the previous page usually occur.’ Each question is anchored by the phrase: ‘Having those thoughts is something ...’. Questions are completed by 12 items designed to probe the habitual nature of thoughts (e.g. ‘... I do frequently’, ‘... I find hard not to do’, ‘... I start doing before I realize it’ ... ‘That’s typically “me”). Responses are provided on a 5-point Likert scale (1= strongly disagree to 5= strongly agree) to indicate the extent of the habitual nature of thoughts. Higher scores indicate a strong negative self-thinking habit. Internal consistency for the HINT in the current study was satisfactory (α =0.89).

Procedure

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

Data analysis

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

Descriptive statistics and correlation coefficients are displayed in Table 1. Higher dispositional mindfulness is associated with a reduced tendency to engage in both uncontrolled and emotional eating behaviour, with lower scores on emotion regulation difficulties and with lower frequency of habitual negative self-thinking. Higher scores on the uncontrolled and emotional eating scales were associated with greater difficulties in emotion regulation and with more frequent habitual negative self-thinking.

Table 1. Pearson correlations for psychological and eating measures with Cronbach’s alphas, means and standard deviations (N 632).

<table>
<thead>
<tr>
<th>Scale range</th>
<th>α</th>
<th>M</th>
<th>SD</th>
<th>2.</th>
<th>3.</th>
<th>4.</th>
<th>5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FFMQ</td>
<td>.94</td>
<td>133.1</td>
<td>22.1</td>
<td>-.54**</td>
<td>-.79**</td>
<td>-.45**</td>
<td>-.27**</td>
</tr>
<tr>
<td>2. HINT</td>
<td>.89</td>
<td>40.5</td>
<td>8.9</td>
<td>.56**</td>
<td>.32**</td>
<td>.31**</td>
<td></td>
</tr>
<tr>
<td>3. DERS</td>
<td>.95</td>
<td>81.5</td>
<td>24.1</td>
<td>.41**</td>
<td>.27**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. TFEQ-UE</td>
<td>.85</td>
<td>37.9</td>
<td>19.3</td>
<td></td>
<td>.58**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. TFEQ-EE</td>
<td>.90</td>
<td>36.3</td>
<td>26.7</td>
<td></td>
<td></td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>

Note: **p < 0.01; α = Cronbach’s alphas; M = mean; SD = standard deviation; FFMQ Total = mindfulness; HINT Total = Habitual Negative Self-Thinking; DERS Total = Difficulties in Emotion Regulation; TFEQ-UE = Uncontrolled Eating; TFEQ-EE = Emotional Eating.

Differences between meditators and non-meditators

A series of independent samples t-tests were conducted to examine the differences between meditators and non-meditators on the measured variables (see Table 2). Prior to analysis z-scores were computed for each measure used in t-test comparisons and a total of 29
participants (21 from the non-meditators group) were excluded from analysis because their scores were above or below +/- 2.5 SD. To control for Type 1 errors a Bonferroni adjustment was made to alpha ($\alpha/5 = .01$) for the five t-tests performed. As hypothesised, meditators reported significantly higher levels of dispositional mindfulness, fewer difficulties in emotion regulation, less habitual negative self-thinking and lower levels of uncontrolled eating when compared to non-meditators (all $p < .001$). Although meditators reported lower levels of emotional eating the difference was not significant after Bonferroni adjustment ($p = .014$). For dispositional mindfulness, difficulties in emotion regulation, habitual negative self-thinking and uncontrolled eating effect sizes were medium to large. The effect size for emotional eating was small.

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

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

Note. $^*$ $p < .001$; $d =$ Cohen’s $d$ effect size; FFMQ Total = mindfulness; DERS Total = Difficulties in Emotion Regulation scale; HINT Total = Habitual Negative Self-Thinking; TFEQ-UE = Uncontrolled Eating; TFEQ-EE = Emotional Eating. Adjusted degrees of freedom (Homogeneity of variance not assumed) = $^a$ df = 531.65; $^b$ df = 513.47.
Analyses of correlations between meditation experience and measured constructs

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

Table 3. Relationships between meditation experience and measured constructs

<table>
<thead>
<tr>
<th></th>
<th>Years</th>
<th>Per week</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>FFMQ</td>
<td>.54**</td>
<td>.54**</td>
<td>.48**</td>
</tr>
<tr>
<td>HINT</td>
<td>-.28**</td>
<td>-.29**</td>
<td>-.25</td>
</tr>
<tr>
<td>DERS</td>
<td>-.43**</td>
<td>-.43**</td>
<td>-.11</td>
</tr>
<tr>
<td>TFEQ-UE</td>
<td>-.34*</td>
<td>-.34**</td>
<td>-.30**</td>
</tr>
<tr>
<td>TFEQ-EE</td>
<td>-.08</td>
<td>-.09*</td>
<td>-.06</td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Multiple indirect effects</th>
<th>Product of coefficients</th>
<th>BCa 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>SE</td>
</tr>
<tr>
<td>1. HINT</td>
<td>-.1302*</td>
<td>.0286</td>
</tr>
<tr>
<td>2. DERS</td>
<td>-.0747</td>
<td>.0534</td>
</tr>
<tr>
<td>Total indirect effect</td>
<td>-.2049*</td>
<td>.0540</td>
</tr>
<tr>
<td>Contrasts: 1 vs. 2</td>
<td>-.0555</td>
<td>.0666</td>
</tr>
</tbody>
</table>

Note. * p < .05; HINT = Habit Index of Negative Thinking; DERS = Difficulties in Emotion Regulation Scale Total.
Table 5. Mediation statistics for the effect of dispositional mindfulness on uncontrolled eating through habitual negative self-thinking and difficulties in emotion regulation.

<table>
<thead>
<tr>
<th></th>
<th>Product of coefficients</th>
<th>BCa 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>SE</td>
</tr>
<tr>
<td>Multiple indirect effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. HINT</td>
<td>-.0357</td>
<td>.0207</td>
</tr>
<tr>
<td>2. DERS</td>
<td>-.0911*</td>
<td>.0401</td>
</tr>
<tr>
<td>Total indirect effect</td>
<td>-.2049*</td>
<td>.0540</td>
</tr>
<tr>
<td>Contrasts: 1 vs. 2</td>
<td>.0554</td>
<td>.0497</td>
</tr>
</tbody>
</table>

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

In addition, dispositional mindfulness had a significant direct effect on uncontrolled (B = -.26; SE = 0.05; t = -5.16, p <.001) but not on emotional eating (B = -0.08; SE = 0.07; t = -1.24, p >.05). Examination of the specific indirect effect for emotional eating indicates that only habitual negative self-thinking is a significant mediator, as its 95% confidence intervals do not pass through zero (Table 4). This indicates that difficulties in emotion regulation does not contribute to the indirect effect above and beyond habitual negative self-thinking. By contrast, for uncontrolled eating the specific indirect effects indicate that difficulties in emotion regulation and habitual negative self-thinking are significant mediators, as both 95% confidence intervals do not pass through zero (Table 5). Inclusion of age and gender as covariates on the dependent variables did not substantively alter the total or indirect effects of habitual negative self-thinking in either model. However, for uncontrolled eating the specific
indirect effects of difficulties in emotion regulation is no longer a significant mediator, as its 95% confidence interval passes through zero (LLCI=-.0719, ULCI=.1342).

**Discussion**

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

Regarding the significant negative correlations between dispositional mindfulness and uncontrolled and emotional eating the current findings concur with those identified using a similar methodology in female undergraduate students (Lattimore et al., 2011). By considering emotional and uncontrolled eating as indicators of reward motivated eating behaviour our findings fit well with evidence from clinical studies which show that dispositional mindfulness is negatively associated with aspects of eating pathology including non-acceptance of emotional
experience and binge eating (Butryn et al., 2013; Lattimore et al., 2016; Lavender, Gratz, & Tull, 2011).

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

The mediating role of habitual negative self-thinking in the relation between dispositional mindfulness and the reduced tendency to eat in response to aversive emotions may in part be attributable to decentring from experience that arises from mindfulness practice (e.g. Bieling et al., 2012). Stressful or negative events often trigger derailing negative, self-critical, reactive, and judgmental thoughts; attempts to avoid dealing with these challenging threats to the self reduces goal pursuit (Teasdale, Segal, & Williams, 1995). By allowing negative thoughts and emotions to occur without judgment and reaction, the thoughts and concomitant frustration
dissipate, allowing successful goal pursuit (Brown et al., 2007). Rather than being absorbed in a
dysfunctional cycle of repetitive thinking, mindfulness enhances the ability to maintain
cognitive focus (Chambers et al., 2009; Chambers, Lo, & Allen, 2008).

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

The limitations of this study include the use of self-report measures of mindfulness and physical
characteristics, the latter providing unreliable figures that suggest participants gave information
using a range of scales. The measurement of mindfulness using questionnaires is limited in that
they capture features related to mindfulness rather than measuring mindfulness itself and are
limited by individuals’ awareness of their inner states (Bergomi, Tschacher, & Kupper, 2013;
Grossman & Van Dam, 2011). That is, the ability to accurately measure ‘mindfulness’ is reliant
on participants’ ‘mindfulness’. However, for assessment in general populations the FFMQ has
been suggested to provide the most comprehensive coverage of aspects of current conceptions
of mindfulness (Bergomi et al., 2013). The second limitation is the difficulty in determining what experiences are required to delineate between meditators and non-meditators. Measurements of frequency and duration imply an assumption that a certain amount of meditation is required to see effects on outcomes of interest. However, reviews and meta-analyses of studies that investigate the effect of, primarily mindfulness, meditation show no clear relationship between amount of practice and effects (Carmody & Baer, 2009; Eberth & Sedlmeier, 2012; Vettese, Toneatto, Stea, Nguyen, & Wang, 2009). In the current study measures of meditation experience are provided for description and pragmatic inclusion criteria based on comparable previous research (Lykins & Baer, 2009). An important question for future research is how to determine what is “enough” meditation in a specific context when people come to meditation from different starting point for different reasons (for discussion see Eberth & Sedlmeier, 2012).

Conclusions

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


