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http://researchonline.ljmu.ac.uk/id/eprint/4823/

Article

'I can't accept that feeling': Relationships between interoceptive awareness, mindfulness and eating disorder symptoms in females with, and at-risk of an eating disorder.

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Abstract

Mindfulness based therapies (MBTs) for eating disorders show potential benefit for outcomes yet evidence is scarce regarding the mechanisms by which they influence remission from symptoms. One way that mindfulness approaches create positive outcomes is through enhancement of emotion regulation skills. Maladaptive emotion regulation is a key psychological feature of all eating disorders. The aim of the current study was to identify facets of emotion regulation involved in the relationship between mindfulness and maladaptive eating behaviours. In three cross-sectional studies, clinical (*n*=39) and non-clinical (*n*=137 & 119) female participants completed: 1) the Eating Disorder Inventory (EDI) eating specific scales (drive-for-thinness and bulimia) and the EDI psychological symptom scales (emotion dysregulation and interoceptive deficits); and 2) mindfulness, impulsivity, and emotion regulation questionnaires. In all samples mindfulness was significantly and inversely associated with EDI eating and psychological symptom scales, and impulsivity. In non-clinical samples interoceptive deficits mediated the relationship between mindfulness and EDI eating specific scales. Non-acceptance of emotional experience, a facet of interoceptive awareness, mediated the relationship between mindfulness and eating specific EDI scores. Further investigations could verify relationships identified so that mindfulness based approaches can be optimised to enhance emotion regulation skills in sufferers, and those at-risk, of eating disorders.

1. Introduction

Emotion dysregulation is considered a key psychological characteristic of many psychiatric disorders whereby difficulties experiencing and differentiating emotions, and modulating or attenuating their intensity, underpins psychopathology (Sheppes, Suri, & Gross, 2015). Indeed, the emotion dysregulation concept has received increasing support as a 'transdiagnostic' indicator of mental ill-health (Aldao, Nolen-Hoeksema, & Schweizer, 2010; Kring & Sloan, 2010). Emotion regulation as a multidimensional construct is characterized by flexible modulation strategies, behavioural control, emotional awareness and distress tolerance (Gratz & Roemer, 2004). Similar conceptualisations highlight awareness, goals and strategies as features of adaptive emotion regulation (Gross & Jazaieri, 2014). Maladaptive emotion regulation, widely referred to as *emotion dysregulation*, is a key psychological characteristic of all eating disorders and is increasingly viewed as a transdiagnostic risk and/or maintenance factor rather than being disorder specific (Brockmeyer et al., 2014; Lavender et al., 2014; Merwin, 2011; Merwin et al., 2011; Svaldi, Griepenstroh, Tuschen-Caffier, & Ehring, 2012).

Considerable attention has been directed towards emotion regulation as a mediator of the putative benefits of mindfulness based therapies (MBTs) (Chambers, Gullone, & Allen, 2009; Chiesa, Anselmi, & Serretti, 2014; Chiesa, Serretti, & Jakobsen, 2013) whereby MBTs may affect symptom outcome by promoting more effective emotion regulation and greater flexibility responding to mental and external events (Brown, Ryan, & Creswell, 2007; Moore & Malinowski, 2009; Roemer, Williston, & Rollins, 2015). Evidence is accumulating regarding

the specific nature of emotion regulation difficulties in eating disorders (Brockmeyer et al., 2014; Butryn et al., 2013; Garner, 2004; Haynos & Fruzzetti, 2011; Lavender et al., 2014; Merwin, 2011; Racine & Wildes, 2013) and the potential therapeutic benefits of MBTs for eating related disorders has received increased empirical support (DeSole, 2013; Godsey, 2013; Katterman, Kleinman, Hood, Nackers, & Corsica, 2014; Kristeller & Epel, 2014; O'Reilly, Cook, Spruijt-Metz, & Black, 2014; Wanden-Berghe, Sanz-Valero, & Wanden-Berghe, 2011). The nature of MBT is grounded in the development and wider application of Mindfulness Based Stress Reduction programmes (Kabat-Zinn, 2003), for example, its incorporation into Acceptance and Commitment Therapy (S. C. Hayes, 2011). In this context, mindfulness is frequently defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p. 145). Although the emerging use of MBTs shows promise in terms of improving eating disorder outcomes, evidence is scarce regarding the mechanisms by which MBTs may influence improvement in eating disorder symptoms such as drive-for-thinness and bulimic cognitions and behaviours. The present study addresses this gap in understanding by examining facets of emotion regulation through which dispositional mindfulness may operate to influence symptoms in those with an eating disorder and in university students who a are recognised to be a population at greater risk of developing eating disorders than the general population (Berg, Frazier, & Sherr, 2009; Eisenberg, Nicklett, Roeder, & Kirz, 2011; Sepulveda, Carrobles, & Gandarillas, 2008; Wilfley, Agras, & Taylor, 2013).

The rationale for cultivating mindfulness skills as a component of therapy for eating disorders rests on the proposition that by cultivating mindful awareness of internal experiences (e.g, emotions, physical sensations) this facilitates self-acceptance, cognitive flexibility, compassion for self and others, and generally improves ability to respond adaptively to disturbing emotions (Katterman et al., 2014). Preliminary evidence regarding the benefits of MBTs for eating disorders illustrates that in addition to positive outcomes for eating specific symptoms (e.g., binge eating), key psychological characteristics are also amenable to change in clinical cases (Merwin et al., 2011), namely, *'interoceptive awareness'* and *'emotion regulation difficulties'* (Clausen, Rosenvinge, Friborg, & Rokkedal, 2011; Gustafsson, Edlund, Kjellin, & Norring, 2010; Nevonen, Clinton, & Norring, 2006). Early in the conceptualisation of eating disorders it was proposed that 'deficits' in interoceptive awareness were central to understanding the aetiology and maintenance of symptoms (Bruch, 1962; Skarderud, 2009).

The putative deficit in interoceptive awareness relates to on-going confusion and difficulty recognizing, being aware of, and accepting internal bodily signals, especially hunger, often confusing such signals with emotions (Cameron, 2001). Interoceptive awareness abilities appear to be essential prerequisites for adaptive emotion regulation (Fustos, Gramann, Herbert, & Pollatos, 2013). Deficits in interoceptive awareness, for example being unable to distinguish hunger from anxiety, stand out as a common feature across anorexia and bulimia nervosa (Lavender et al., 2015; Lavender et al., 2014; Merwin, 2011; Merwin et al., 2013; Merwin et al., 2011; Merwin, Zucker, Lacy, & Elliott, 2010; Milos, Spindler, & Schnyder, 2004). By contrast, the diagnostic conceptualisation of *'emotion*

regulation difficulties' as a key psychological problem in eating disorders relates to a tendency toward mood instability, impulsivity, recklessness, anger and self-destructiveness (Garner, 2004).

Both interoceptive awareness and emotion regulation difficulties have consistently been assessed in outcome studies using specific subscales of the Eating Disorders Inventory (EDI) (Garner, 2004). The EDI refers directly to 'deficits' whereby the interoceptive deficits scale reliably predicts symptoms across all eating disorder types compared to healthy controls (Clausen et al., 2011), and discriminates between eating disorder patients and controls (Nevonen et al., 2006). Risk of developing eating disorders is jointly predicted by the interoceptive deficits and emotion dysregulation scales (Gustafsson et al., 2010). A limitation of the assessment of interoceptive deficits using the EDI has been highlighted (Merwin et al., 2010) such that the EDI scale does not clearly differentiate between the two dimensions of the putative interoceptive deficit, namely, *lack of clarity* and *non-acceptance* of affective arousal. Each dimension may implicate separate mechanisms underlying symptom appearance and by consequence target of intervention. For example, non-acceptance of affective arousal may lead to avoidance-based coping associated with dietary restriction and binge-purge behaviour (Merwin et al., 2010).

Merwin et al. (2010) suggest that the non-acceptance component of the interoceptive deficit is more important than the lack of clarity component, and present evidence to support that distinction in predicting eating disorder symptoms. By consequence they propose that mindfulness and acceptance based interventions "are well

suited to address this core ED symptom [non-acceptance of affective arousal]" (p.899) (Merwin et al., 2010). However it may be premature to conclude that lack of clarity of affective arousal is not so important in eating disorders. In a non-clinical study that used the heartbeat detection method of assessing interoceptive awareness EEG analysis shows that adaptive emotion regulation depends upon how clearly one is aware of interoceptive bodily signals (Fustos et al., 2013). Mindfulness meditation promotes adaptive emotion regulation by enhancing awareness of internal states (Menezes, Pereira, & Bizarro, 2012) but also by enabling non-judgemental acceptance of internal states as passing phenomena. Therefore, it is not yet certain whether one or both aspects of interoceptive awareness examined by Merwin et al. (2010) should be considered as "targets" of MBTs. Despite the claims that MBTs can improve outcomes for eating disorder sufferers, perhaps by addressing key psychological characteristics such as interceptive awareness deficits, empirical evidence to support relationships between mindfulness, interoceptive awareness and eating disorder symptoms is needed to support on-going therapy development.

Despite accumulating evidence regarding emotion regulation and interoceptive awareness difficulties as transdiagnostic factors in eating disorder aetiology, a subcomponent of the emotion regulation construct, namely impulse control, may prove useful in differentiating eating disorder subtypes. Gratz & Roemer (2004) aligned their view of emotion regulation with theoretical positions (Linehan, 1993; Thompson, 1994) that postulate adaptive emotion regulation to be "the ability to inhibit inappropriate or impulsive behaviours, and behave in accordance with desired goals when experiencing negative emotions" (p.42, Gratz & Roemer, 2004). Impulse control falls under the broader

multidimensional construct of impulsivity, that also encompasses urgency, response inhibition and delayed gratification (Bari & Robbins, 2013). Impulsivity differentiates between individuals with eating disorders and controls and is implicated as a either a causal or moderating factor in eating disorder symptom expression (Waxman, 2009). Recent reviews and empirical studies highlight how impulsivity, especially impulse control, as defined in the multidimensional emotion regulation model (Gratz & Roemer, 2004) is expressed differentially in clinical samples across eating disorders (Brockmeyer et al., 2014; Lavender et al., 2015). Additionally in non-clinical individuals lower dispositional mindfulness is related to greater emotional eating associated with eating disorders yet this relationship is mediated by impulsivity (Lattimore, Fisher, & Malinowski, 2011), and is strongly related to different facets of impulsivity after controlling for negative affect and psychological distress (Peters, Shannon, Upton, Baer, & Roemer, 2011).

Beyond the behavioural manifestation of disordered eating (e.g., purging, bingeing, restriction), key psychological problems including difficulties in emotion regulation, interoceptive awareness and impulse control often persist in clinical cases beyond remission from behavioural symptoms (Holland, Bodell, & Keel, 2013; Slane, Klump, Donnellan, McGue, & Iacono, 2013; Wagner et al., 2006) and thus therapies should be focussing on these key psychological problems implied in the etiology and maintenance of eating disorders to prevent reoccurrence of eating specific symptoms. MBTs show promise for effectively treating eating disorders (Godsey, 2013; Katterman et al., 2014; Wanden-Berghe et al., 2011) possibly by fostering increased emotion acceptance and decreased emotion avoidance which may break connections between eating disorder symptoms and maladaptive emotion

regulation (Wildes, Ringham, & Marcus, 2010). Given the available evidence a plausible assumption is that MBTs improve awareness and acceptance of on-going emotion (Butryn et al., 2013; Chapman, Gratz, & Brown, 2006; Juarascio et al., 2013), thereby limiting impulsive tendencies, and by consequence create more effective and adaptable behavioural options for dealing with negative or challenging emotional reactions. Although recent findings indicate that mindfulness moderates the relationship between eating disorder cognitions and eating specific symptoms in non-clinical university students (Masuda, Boone, & Timko, 2011; Masuda, Price, & Latzman, 2012) there is a lack of knowledge regarding the impact mindfulness may have on the relationship between key psychological problems and eating specific symptoms such as excessive calorie restriction and binge eating. However, in a recent study of eating disorder patients at admission to treatment, facets of mindfulness similar to those measured by the Five Facet Mindfulness Questionnaire (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006), namely present moment awareness and non-judgmental acceptance, were negatively correlated with the EDI eating specific scales of drive-for-thinness and bulimia(Butryn et al., 2013). Furthermore, improvements in awareness and non-judgmental acceptance were associated with improvement in eating specific symptoms post-treatment (Butryn et al., 2013). Although Butryn et al. (2013) identified a relationship between two core features of dispositional mindfulness that reflect the widely used definition (Kabatt-Zinn, 2003) and the EDI eating specific symptoms, their study did not address a path through which mindfulness is related to potential improvement in eating disorder symptoms.

To develop understanding of potential causal pathways there is a need to identify whether mindfulness alters key psychological problems (emotion dysregulation, interoceptive deficits, and impulse control) to affect outcomes (e.g., reduction in drive-for-thinness and bulimic behaviours). Such relationships can be modelled statistically using cross-sectional methodology. This approach was adopted in the current study to examine how dispositional mindfulness is associated with eating disorder symptoms through a potential influence on emotion dysregulation, interoceptive awareness deficits and impulse control. Three studies were conducted, one in a sample of outpatients from an eating disorder service, and the other two in university student samples where the risk of developing eating disorders is greater than in the general population (Berg et al., 2009; Eisenberg et al., 2011; Wilfley et al., 2013). Prospective evidence from a non-clinical population indicates that emotion regulation problems amplify the influence maladaptive beliefs and cognitions have on the risk for developing eating disorders (Stice, Marti, & Durant, 2011). Considering these links between emotion regulation and eating disorder development, and the prevalence of eating disorder symptoms in community samples, the inclusion of non-clinical samples in the current study afforded an opportunity to determine whether the suggested associations between mindfulness, key psychological problems and eating specific symptoms exist outside of clinical settings.

In view of the widespread use of the EDI in outcome studies we utilised this measure in all three studies. In our first study we predicted that lower dispositional mindfulness would be associated with higher scores on the EDI-3 scales of drive-for-thinness, bulimia, emotion dysregulation and interoceptive deficits, and with higher scores on an impulsivity

measure. According to our propositions outlined above we expected that the relationship between mindfulness and eating specific symptoms would be mediated jointly or independently by emotion dysregulation, interoceptive deficits and impulsivity. We tested these propositions again in study two to determine whether similar associations and mediation effects would be present in university students who are at greater risk of developing eating disorder than the general populationan. In view of the evidence regarding the nature of interoceptive deficits in eating disorder patients (Merwin et al., 2010) our final study tested the predictions Merwin et al. (2010) they made regarding the relation between eating disorder symptoms and both dimensions of the putative interoceptive deficit, namely that symptoms of bulimia and anorexia nervosa would be associated with non-acceptance of affective arousal rather than lack of clarity of arousal. The novel aspect of our replication of Merwin's work (Merwin et al., 2010) is an additional prediction regarding the role of dispositional mindfulness. We predicted that non-acceptance of affective arousal would mediate the relation between dispositional mindfulness and eating disorder symptoms of anorexia and bulimia nervosa.

2. Methods

2.1. Study 1

2.1.1. Participants

Thirty-nine Caucasian female participants from an outpatient eating disorder service self-selected to take part in the study (age M= 29yr; range 18-50yr, SEM = 1.5). The primary diagnostic characteristics (DSM-IV) obtained from medical records were: Anorexia Nervosa

(*n* = 7), Binge Eating Disorder (*n* = 4), Bulimia Nervosa (*n* = 16), Eating Disorder Not

Otherwise Specified (*n* = 12). Participants attended assessments at a National Health Service

Eating Disorder Therapy Service (UK, North West). Ethical approval was granted by the NHS

National Research Ethics Service (Protocol reference: 09/H1001/79). Informed consent was

obtained prior to enrolment; eligibility was assessed by review of patients' medical records;

and questionnaires completed in the presence of a research assistant or clinician from the

therapy service. All participants in were at different points in their treatment plan, some

were awaiting therapy following assessment and diagnosis, and others had started therapy.

2.1.2. Measures

The Eating Disorder Inventory - EDI-3 (Garner, 2004) was used to assess eating

disorder symptoms because it performs well as prognostic indicator in outcome studies

(Bulik, Sullivan, Joyce, Carter, & McIntosh, 1998), as a measure of symptom change during

treatment (Milos et al., 2004), and that risk of developing eating disorders is jointly

predicted by two key psychological symptom scales, namely 'interoceptive deficits' and

'emotion dysregulation' (Gustafsson et al., 2010). In the current studies these two scales

were used: the Emotional Dysregulation (EDI-ED) scale assesses tendency toward mood

instability, recklessness, anger and self-destructiveness; the Interoceptive Deficits (EDI-ID)

scale assesses confusion related to accurately recognising and responding to emotional and

bodily states, including hunger. Anorexic and bulimic symptoms were assessed using the

Drive-for-Thinness (EDI-DFT) and Bulimia scales (EDI-BUL), respectively. The 6-option

response format on each scale is subsequently transformed to a 0-4 format whereby zero

values are treated as non-symptomatic responses. Higher scores on each scale indicate greater frequency of symptom like behaviour. The reliability and validity of the EDI-3 (and its earlier version EDI-2) is well documented (Brewin, Baggott, Dugard, & Arcelus, 2014; Clausen et al., 2011; Garner, 2004; Nevonen et al., 2006; Nyman-Carlsson, Engstrom, Norring, & Nevonen, 2015). The current sample size (39) to item ratio (7-9 items) is marginally acceptable for internal reliability analysis. The Cronbach alphas for the EDI-DFT, EDI-B, EDI-ED, and EDI-ID scales are acceptable: 0.79, 0.90, 0.79, 0.85, respectively.

Dispositional mindfulness was assessed using the 24-item short-form of the Five Facet Mindfulness Questionnaire - FFMQ (Bohlmeijer, ten Klooster, Fledderus, Veehof, & Baer, 2011) which was derived from the 39-item version (Baer et al., 2006). Both versions comprise five subscales of which three are closely aligned with the widely used definition of mindfulness as "*Paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally* (Kabat-Zinn, 2003). In the current study we used only three of these subscales: 1) Non-reactivity to inner experience (FFMQ-NR), e.g., "I watch my feelings without getting lost in them"; 2) Acting with awareness (FFMQ-A), e.g., "It seems I am running on automatic without much awareness of what I'm doing"; and 3) Non-judging of inner experience (FFMQ-NJ, refraining from value judgements or self-criticism) "I tend to evaluate whether my perceptions are right or wrong". The response format comprises a 5-point Likert scale (1 = never or very rarely true, rarely true, sometimes true, often true and 5 = very often or always true). Scores between 1 and 5 are summed to produce totals for each subscale and a total scale score. Higher scores indicate higher levels of dispositional mindfulness. A composite of the three subscales was derived by summing their scores. The

FFMQ short form has been shown to have good internal consistency and significant relationships in the predicted directions with a variety of constructs related to mindfulness (Bohlmeijer et al., 2011). However, research shows that there are limitations to the predictive and face validity of the observing and describing scales of the FFMQ, thus for this reason we excluded them (Bergomi, Tschacher, & Kupper, 2013; Christopher, Neuser, Michael, & Baitmangalkar, 2012; Lilja, Lundh, Josefsson, & Falkenstrom, 2013). The sample size to item ratio did not justify analysis of item reliability in this sample.

The Barratt Impulsiveness Scale (BIS-11) (Patton, Stanford, & Barratt, 1995) was used to assess impulsivity. The BIS-11 is a self-rating questionnaire with 30 questions concerning control of thoughts and behaviour and comprises three second order factors or subscales and a total score. The total score was used for analysis. Responses are given using a 4-point Likert scale (1 = rarely/never; 2 = occasionally; 3 = often; 4 = almost always/always) with higher scores indicating greater impulsivity. The sample size to item ratio did not justify analysis of item reliability in this sample.

2.2. Study 2

2.2.1. Participants

The sample comprised 137 female university students who had no prior diagnosis of an eating disorder (age M = 21yr; range: 18-45yr, SEM = 0.5). Participants were recruited opportunistically through the university's undergraduate research participation scheme. Ethical approval for the study protocol was granted by the University Research Ethics Committee. Participants completed questionnaire items on-line using Bristol Online Survey

service in return for course credit. Informed consent was obtained online prior to completing survey questions. The participant information sheet stipulated that participants should not take part if they were in treatment for an eating disorder or had been in the past.

2.2.2. Measures

The same measures as in Study one were used. Internal consistency coefficients for study measures are displayed in Table 3.

2.3. Study 3

2.3.1. Participants

The sample comprised 119 female university students who had no prior diagnosis of an eating disorder (age M = 20yr; range: 18-27yr; SEM = 0.2). Recruitment, survey administration and ethical approval procedures were the same as Study 2. Participants were recruited from the same university population as study 2 but from a different cohort. The participant information sheet stipulated that participants should not take part if they were in treatment for an eating disorder or had been in the past.

2.3.2. Measures

The same measures of mindfulness (FFMQ) and eating disorder symptoms (EDI-3) as in Study one and two were used. In addition three subscales of the 36-item Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) were administered. In accord with the approach used by Merwin et al. (2010) we employed the lack of emotional clarity (DERS-LEC) and non-acceptance of emotional responses (DERS-NA) scales. In addition we used

impulse control difficulties scale (DERS-IMP) as a substitute for the BIS-11 that was used in study two. Items on the DERS impulse control difficulties subscale are prefaced by the phrase, "*When I'm upset …*", which reflects an approach focussing on emotional context that is distinct from a broader assessment of impulsiveness captured by the BIS-11. In the development of the DERS, Gratz & Roemer (2004) aligned their view of emotion regulation with theoretical positions (Linehan, 1993; Thompson, 1994) that postulate adaptive emotion regulation to be "the ability to inhibit inappropriate or impulsive behaviours, and behave in accordance with desired goals when experiencing negative emotions" (p.42, Gratz & Roemer, 2004). In the current study we used the DERS impulse control difficulties scale in place of the BIS-11 scale used in Study 2 to more precisely examine the role of impulse control related to emotional context in the relationship between mindfulness and eating disorder core symptoms. Although there is ample evidence of the relationship between impulsivity as measured by the BIS-11 and symptoms of anorexia and bulimia nervosa (Farstad, McGeown, & von Ranson, 2016; Meule, 2013) this evidence pertains to impulsivity as a broader personality construct and not as a facet of emotion regulation as conceived by Gratz & Roemer (2004). By using the DERS-IMP in place of the BIS-11 in study 3 we created the opportunity to examine impulse control as a facet of emotion regulation in accord with recent conceptualisations of its presentation in eating disorders (Brockmeyer et al., 2014; Lavender & Anderson, 2010; Lavender & Mitchell, 2015). The internal consistency of all study measures were found to be in the acceptable range (see Table 4).

2.4. Statistical analysis strategy

The statistical approach used in each of the three studies involved computation of Pearson coefficients to examine associations between study variables. Where conditions for mediation were met regression analysis was performed using the PROCESS 4 dialog add-in for SPSS V.21 (A. F. Hayes, 2013). Parallel multiple mediator models were tested using PROCESS to conduct all regressions using OLS regression estimation. Direct and indirect effect estimates are produced and 95% bias adjusted bootstrap confidence intervals estimated (5000 resamples) to determine if mediation is present or not (see Hayes, 2013, p. 125-143).

3. Results

3.1. Comparative scores on EDI-3 across all samples

Information regarding scores on the anorexia and bulimia scales of EDI-3 (drive-for-thinness and bulimia) are presented in Table 1 for comparative purposes across all three samples. In addition to mean (SD) raw scores, information is provided regarding percentage of participants scoring in clinical ranges according to published normative data (Garner, 2004). Comparison of averages indicates that the clinical sample scores substantially higher than those in study 2 and study 3, especially when averages are calculated for the non-clinical samples having excluded cases scoring in the elevated clinical range. Regarding drive-for-thinness scores, the percentages in the elevated and typical clinical ranges for non-clinical samples (Study 2 & 3) is cause for concern as the normative reference data published in 2004 (Garner, 2004) suggests that only 2% of non-clinical adults would score in the elevated, and 18% in the typical clinical ranges; in study three 25% scored in the typical clinical range. Similarly, the percentages scoring in the elevated and typical clinical ranges

for the bulimia scale are cause for concern in the non-clinical samples. According to

normative data reference values (Garner, 2004) the estimated occurrence of bulimia

symptoms in the elevated range would be 2%, and in the typical clinical range, 30%; in both

study 2 and 3 the percentages are higher than this reference estimate.

3.2. Study 1

The relationships between EDI-3 scales, mindfulness and impulsivity are displayed in

Table 2. Drive-for-thinness was the only eating specific scale associated with dispositional

mindfulness such that higher scores on the drive-for-thinness scale were associated with

lower scores on the mindfulness subscales and composite. The bulimia scale was only

significantly associated with greater impulsivity. Emotion dysregulation was significantly

associated with lower scores on mindfulness composite and the act-with-awareness scale,

and greater interoceptive deficits and impulsivity. Interoceptive deficits was significantly

associated with lower mindfulness composite, act-with-awareness and non-reactivity scores,

and with greater impulsivity. Impulsivity was significantly inversely associated with the

mindfulness composite and act-with-awareness scale. The conditions required to test

whether impulsivity, interoceptive deficits and emotion dysregulation mediate the relation

between mindfulness and eating specific symptoms are not met because drive-for-thinness

is not significantly associated with the proposed mediators, and bulimia is not significantly

associated with the predictor (mindfulness). The lack of significant, and even sizable

correlations between the bulimia and drive-for-thinness and predictor and proposed

mediators could be a function of limited range or variance or mixed diagnoses or that the

proposed relations do not exist in clinical samples.

3.3. Study 2

The correlations between study variables are displayed in Table 3. Higher scores on EDI-DFT were significantly associated with lower mindfulness composite, non-judging and non-reactivity scales. EDI-DFT was significantly associated with bulimia scores, emotion dysregulation and interoceptive deficits, but not with impulsivity. The bulimia scale was significantly associated with lower mindfulness on all FFMQ facets and was significantly associated with emotion dysregulation, interoceptive deficits and impulsivity. Emotion dysregulation, interoceptive deficits and impulsivity were each significantly inversely associated with lower mindfulness on all FFMQ facets. Emotion dysregulation and interoceptive deficits were associated with greater impulsivity.

In terms of the bulimia scale the conditions are met to test whether emotion dysregulation, interoceptive deficits and impulsivity act as mediators between mindfulness and bulimia symptom scores. The regression model accounted for 48% of variance in bulimia scores (R^2 = .48, $F(4, 131)$ = 30.3, $p < .001$). The direct effect of mindfulness on bulimia was significant (R^2 = .16, $F(1,134)$ = 25.1, $p < .01$; B = -.34 ± .07, t = 5.02, $p < .01$, 95%CI: -0.47 to -0.21). The indirect effect of mindfulness on bulimia indicated mediation was present (Effect = -.40, SE = .07, 95% CI: -0.55 to -0.27). However, when broken down by specific mediators only interoceptive deficits mediated the relation between mindfulness and bulimia scores (Effect = -.42, SE = .07, 95% CI: -0.57 to -0.30) which is also confirmed by contrast with emotion dysregulation (EDI-ED minus EDI-ID 95%CI: 0.30 to 0.66) and impulsivity (BIS-11 minus EDI-ID 95%CI: 0.26 to 0.55). Variance inflation factors (VIF) and Tolerance values were within acceptable ranges: 1.2 to 2.9, and .34 to .77, respectively.

In terms of the drive-for-thinness scale the conditions are met to test whether emotion dysregulation and interoceptive deficits, but not impulsivity, act as mediators between mindfulness and drive-for-thinness scores. The regression model accounted for 27% of variance in drive-for-thinness scores (R^2 = .27, F(3, 132) = 16.6, p < .01). The direct effect of mindfulness on drive-for-thinness was significant (R^2 = .10, F(1,134) = 15.0, p < .01; B = -.29 ± .07, t = 3.8, p < .01, 95%CI: -0.43 to -0.14). The indirect effect of mindfulness on drive-for-thinness indicated mediation was present (Effect = -.27, SE = .05, 95% CI: -0.38 to -0.16). However, when broken down by specific mediators only interoceptive deficits mediated the relation between mindfulness and drive-for-thinness scores (Effect = -.37, SE = .07, 95% CI: -0.52 to -0.23) which is also confirmed by contrast with emotion dysregulation (EDI-ED minus EDI-ID 95%CI: 0.25 to 0.71). Variance inflation factors (VIF) and Tolerance values were within acceptable ranges: 1.6 to 2.8, and .34 to .60, respectively.

3.4. Study 3

The correlations between study variables are displayed in Table 4. Initially we sought to test the mediation models examined in study two where conditions were met to do so. Additionally we sought to replicate the findings of Merwin et al. (2010) in terms of their proposition that the interoceptive deficits scale of the EDI-3 can be parsed into two elements; namely lack of emotional clarity and non-acceptance of emotional responses (as measured by the DERS). In terms of correlations between study variables, all EDI-3 and DERS scales were significantly and inversely correlated with FFMQ subscales (range: r = -.19 to -.64) indicating that lower dispositional mindfulness is related to higher endorsement of

eating disorder symptoms and emotion regulation difficulties. Henceforth, the FFMQ composite of the three subscales is reported in analyses. Lower dispositional mindfulness was significantly associated with each EDI-3 scale and each DERS scale. Both drive-for-thinness and bulimia were significantly associated with greater interoceptive deficits, emotion dysregulation, lack of emotional clarity and non-acceptance of emotional responses, and poorer impulse control. Interoceptive deficits and emotion dysregulation were strongly associated with DERS scales: lack of emotional clarity, non-acceptance of emotional responses and impulse control.

In terms of both drive-for-thinness and the bulimia scale the conditions are met to assess the outcomes reported in Study 2, that is, whether the EDI-3 scales emotion dysregulation and interoceptive deficits, and the DERS impulse control scale (DERS-IMP) act as mediators between mindfulness and the EDI anorexia and bulimia symptom scores.

In terms of drive-for-thinness, the regression model accounted for 24% of variance in drive-for-thinness (R^2 = .24, $F(4, 113)$ = 9.03, p < .001). The direct effect of mindfulness on drive-for-thinness was significant (R^2 = .12, $F(1,116)$ = 15.5, p < .001; B = -.33 ± .08, t = 3.9, p < .001, 95%CI: -0.49 to -0.16). The indirect effect of mindfulness on drive-for-thinness indicated mediation was present (Effect = -.26, SE = .09, 95% CI: -0.45 to -0.08). However, when broken down by specific mediators only interoceptive deficits mediated the relation between mindfulness and drive-for-thinness scores (Effect = -.30, SE = .09, 95% CI: -0.49 to -0.13) which is also confirmed by contrast with emotion dysregulation (EDI-ED minus EDI-ID 95%CI: -0.63 to -0.09) and impulsivity (DERS-IMP minus EDI-ID 95%CI: -0.64 to -0.01).

Variance inflation factors (VIF) and Tolerance values were within acceptable ranges: 2.2 to 2.3, and .42 to .45, respectively.

In terms of bulimia the model the model accounted for 38% of variance in bulimia (R^2 = .38, $F(4, 113)$ = 17.4, $p < .001$). The direct effect of mindfulness on bulimia was significant (R^2 = .08, $F(1,116)$ = 9.86, $p < .01$; B = -.23 ± .07, t = 3.1, $p < .01$, 95%CI: -0.38 to -0.08). The indirect effect of mindfulness on bulimia indicated mediation was present (Effect = -.39, SE = .08, 95% CI: -0.58 to -0.25). However, when broken down by specific mediators only interoceptive deficits mediated the relation between mindfulness and bulimia scores (Effect = -.33, SE = .08, 95% CI: -0.50 to -0.18) which is also confirmed by contrast with emotion dysregulation (EDI-ED minus EDI-ID 95%CI: -0.45 to -0.02) and impulsivity (DERS-IMP minus EDI-ID 95%CI: -0.64 to -0.11). These outcomes of mediation analysis for bulimia and drive-for-thinness scores concur with the outcomes of study two. Variance inflation factors (VIF) and Tolerance values were within acceptable ranges: 2.2 to 2.3, and .42 to .45, respectively.

Given that we consistently observed that interoceptive deficits as measured on the EDI-3 mediates relations between mindfulness and eating disorder symptom scores (Study 1 & Study 2), and in line with Merwin's suggestions (2010), we performed further mediation modelling using the two DERS scales of *non-acceptance* and *lack of clarity of emotion* as mediators in place of the EDI-3 interoceptive deficits scale. This allows us to more precisely determine the nature of the putative interoceptive deficit and to determine if the findings of Merwin et al. (2010) are replicable in a non-clinical at-risk sample. Impulse control (DERS)

and emotion dysregulation (EDI-3) were not included as mediators. When EDI-3 bulimia scores were used as the outcome the regression model accounted for 11% of variance in bulimia scores (R^2 = .11, F(3, 115) = 4.6, p < .01). The direct effect of mindfulness on bulimia scores was significant (R^2 = .07, F(1,117) = 10.80, p < .01; B = -.23 ± .07, t = 3.1, p < .01, 95%CI: -0.38 to -0.08). The indirect effect of mindfulness on bulimia indicated mediation was *not* present (Effect = -.15, SE = .08, 95% CI: -0.31 to 0.01). Variance inflation factors (VIF) and Tolerance values were within acceptable ranges: 1.7 to 2.2, and .44 to .57, respectively. When EDI-3 drive-for-thinness scores were used as the outcome the model accounted for 15% of variance in drive-for-thinness scores (R^2 = .15, F(3, 115) = 7.1, p < .001). The direct effect of mindfulness on drive-for-thinness scores was significant (R^2 = .11, F(1,117) = 14.7, p < .01; B = -.32 ± .08, t = 3.8, p < .001, 95%CI: -0.48 to -0.15). The indirect effect of mindfulness on drive-for-thinness was present but only for the *non-acceptance of arousal* facet of interoceptive awareness deficit (Effect = -.19, SE = .11, 95% CI: -0.33 to -0.04). Variance inflation factors (VIF) and Tolerance values were within acceptable ranges: 1.7 to 2.2, and .44 to .57, respectively.

4. Discussion

The purpose of the studies presented was to examine the relationship between mindfulness and eating disorder symptoms as measured by the EDI-3 and how interoceptive awareness deficits, impulsivity and emotion dysregulation may play a part in this relationship. The reason for examining these relationships was to identify possible targets that mindfulness-based therapies may focus on to improve outcomes. By examining these

issues in a clinical sample and in samples at-risk of developing eating disorders we provide unique evidence of the relationship between dispositional mindfulness and key psychological problems associated with development and maintenance of anorexia and bulimia nervosa. Additionally, our evidence corroborates and extends upon previously reported findings (Merwin et al., 2010) regarding the link between interoceptive awareness deficits and eating specific symptoms, by demonstrating specifically in non-clinical samples that: 1) interoceptive deficits mediate the relationship between mindfulness and indicators of bulimia and anorexia; and 2) that non-acceptance of emotional arousal is the key element of interoceptive awareness that mediates the mindfulness-eating symptom relationship.

The EDI-3 scales of drive-for-thinness and bulimia have been found to correlate with facets of mindfulness, most notably, present moment awareness and non-judgemental acceptance (Butryn et al., 2013). The results from analysis of the clinical sample (Study 1) demonstrated as predicted that lower mindfulness was moderately associated with drive-for-thinness, and strongly with emotion dysregulation and interoceptive deficits. The bulimia scale was not significantly associated with mindfulness. Additionally, high impulsivity was related to lower dispositional mindfulness, bulimia, emotion dysregulation and interoceptive deficits, but not with drive-for-thinness. This outcome is in accord with well-established evidence that impulse control is a feature of bulimia (Brockmeyer et al., 2014; Lavender & Mitchell, 2015; Waxman, 2009). We found support for similar relations in our clinical and non-clinical samples. In all samples stronger drive-for-thinness was associated with lower overall mindfulness.

Unlike Butryn's (2013) study, the EDI-3 bulimia scale did not correlate with any measure of mindfulness in eating disorder participants, yet in our non-clinical samples higher scores on the bulimia scale were associated with lower dispositional mindfulness. In the non-clinical samples lower mindfulness was associated with interoceptive deficits, emotion dysregulation and impulsivity. In the clinical sample the lack of significant, and even sizable correlations between the bulimia and drive-for-thinness and predictor and proposed mediators limits the conclusions that can be drawn about the mediation models. We cannot rule out alternative explanations such as limited variance due to restricted sample size or mixed diagnoses, or possibly that the models identified in the non-clinical samples are different to what might be identifiable in the clinical sample. However, it is notable that although we required participants to exclude themselves from Studies 2 & 3 if they had a current or past diagnosis of an eating disorder, a sizeable proportion scored in the elevated clinical symptom ranges on the EDI-3, especially on the Bulimia scale. Therefore we are confident that at least our models identify meaningful relations in the at-risk population we studied. It is possible that some individuals who do have an eating disorder included themselves in the non-clinical samples, however the high proportions at-risk are similar to those reported in other studies of the university students presumed to be at-risk of eating disorders (Berg et al., 2009; Eisenberg et al., 2011; Sepulveda et al., 2008; Wilfley et al., 2013). It remains to be seen whether the relationships we identified in the non-clinical samples would be evident in clinical samples or even specific to disorder type.

The evidence from all samples suggests that emotion dysregulation, interoceptive awareness deficits and impulsivity are important to consider in understanding the

relationship between mindfulness and eating specific symptoms. It was not possible to model causal relationships between variables in Study 1 because the conditions for mediation were not satisfied. Despite this limitation and the small sample size, the evidence regarding the relation between mindfulness and key psychological problems is unique and points toward the possibility that MBTs should focus on interoceptive awareness and emotion regulation as processes that can be altered to effect positive outcomes in eating specific symptoms. As such it can be hypothesised that an association between mindfulness and eating specific symptoms depends upon key psychological problems, especially interoceptive awareness deficits. Given that the evidence suggests key psychological problems may precede diagnosis (Clausen et al., 2011; Gustafsson et al., 2010; Nevonen et al., 2006) a test of the mediation hypothesis in Studies 2 & 3 afforded the opportunity to address that issue in a sample known to be at-risk for developing eating disorders (Berg et al., 2009; Eisenberg et al., 2011; Wilfley et al., 2013).

The outcome of Study 2 & 3 demonstrated that that interoceptive awareness deficits mediates the relation between mindfulness and the EDI drive for thinness and bulimia scales, above and beyond emotion dysregulation and impulsivity. We cannot rule out that emotion dysregulation and impulse control are not important, just that they do not stand out as the primary mediators. In Study 3 we replicated the mediation effects observed in Study 2 and then tested the hypotheses presented by Merwin et al. (2010) regarding the precise nature of interoceptive awareness deficits. We identified that a specific aspect of interoceptive awareness, non-acceptance of emotional arousal, is implicated in the relationship between mindfulness and drive-for-thinness. This pattern of relationship was

not observed in the case of bulimia. Although cross-sectional methods were employed, our findings document that in an at-risk population interoceptive deficits, emotion regulation and impulse control difficulties are associated with symptom indicators of anorexia nervosa and bulimia, suggesting that such difficulties may exist prior to diagnosis and even contribute to eating disorder development as recent conceptualisations would indicate (Lavender & Anderson, 2010; Merwin, 2011; Merwin et al., 2011).

We appropriately acknowledge that regression modelling is not a replacement for prospective cohort studies and that the suggested relationships identified in our samples would require corroboration using prospective designs. Nonetheless, we expect our findings would inform future development of MBTs in the treatment of eating disorders given existing evidence of their potential to improve eating specific symptoms and general psychological functioning, regardless of diagnosis (Godsey, 2013; Katterman et al., 2014; Kristeller & Epel, 2014; Merwin et al., 2011). The theoretical rationale for using MBTs to treat eating disorders hinges on the proposition that cultivation of mindful awareness of internal experiences (e.g, emotions, physical sensations) facilitates self-acceptance, cognitive flexibility, compassion for self and others, and generally improves ability to respond adaptively to disturbing emotions and establish more broadly effective emotion regulation skills (Katterman, 2014); skills that are viewed as a central feature in recent conceptualisations of eating disorders (Chambers et al., 2009; Haynos & Fruzzetti, 2011; Lavender & Anderson, 2010; Merwin, 2011). Our evidence points to the importance of cultivating awareness of internal experiences or more specifically interoceptive abilities. Increasingly, neuroscientific research points towards the importance of interoception as an

enhancing agent for effective emotion regulation (Fustos et al., 2013; Menezes et al., 2012).

In particular evidence is accumulating to indicate that mindfulness training enhances

executive control by increasing awareness of emotional perturbations in everyday

experience which signal need for a proactive response which would in turn improve

emotion regulation skills (Manuello, Vercelli, Nani, Costa, & Cauda, 2016; Teper & Inzlicht,

2013; Teper, Segal, & Inzlicht, 2013). The fact that interoceptive awareness consistently

emerged as the stronger mediator in the present study accords with the view it is a

'prerequisite' for effective emotion regulation (Fustos, et al., 2013; Menezes et al., 2012). A

prospective investigation could assess the sequential connection between interoceptive

awareness on emotion regulation and by consequence symptom change in eating disorders.

Current conceptualisation of mindfulness based approaches for eating disorders

such as ACT partly focus on enhancing acceptance and tolerance of difficult emotions

related to "normalisation" of eating behaviour (Godfrey, Gallo, & Afari, 2015; Godsey, 2013;

Juarascio et al., 2013; Manlick, Cochran, & Koon, 2013; Merwin, 2011). These approaches

use to varying extent the standardized mindfulness exercises common to MBSR that require

attending to breath and body sensations(increasing interoceptive awareness).

Neuroscientific studies of mindfulness provide an explanation of how such mindfulness

practices create positive outcomes (Kerr, Sacchet, Lazar, Moore, & Jones, 2013): "localized

attention to body sensations enables subsequent gains in emotional and cognitive

regulation by enhancing sensory information processing in the brain" (Kerr et al., p12).

Additionally there is ample evidence to indicate how cultivation of interoceptive awareness

directly influences emotion regulation ability (Fustos et al., 2013; Holzel et al., 2011; Kerr et

al., 2013; Menezes et al., 2012). In addition to practices that increase interoceptive awareness, cultivation of intention to accept what arises in awareness without judging or engaging with it is central to producing gains from mindfulness practices(Teper & Inzlicht, 2013). The current study suggests that acceptance, or non-acceptance, of arousal is an important marker of the relationship between mindfulness and eating disorder symptoms. Future investigations involving the design and evaluation of MBTs for eating disorders could verify whether interoceptive awareness with acceptance underpins outcomes. Emotion focused treatments (Sala, Heard, & Black, 2016) could incorporate more clearly mindfulness practices and be optimised to focus on enhancement of emotion regulation through improved interoceptive awareness skills. Researchers could use such an approach to evaluate a range of emotion regulation factors, especially acceptance of emotional arousal, as mediators of outcome.

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Table 1. Raw scores (M/SD) and percentages scoring in risk ranges for anorexia and bulimia scales of the EDI-3 for Studies 1, 2 and 3.

| | Study 1 (n=39) | | Study 2 (n=137) | | Study 3 (n=119) | |
	DFT	BUL	DFT	BUL	DFT	BUL
M (SD)	22.7	16.5	9.6	7.4	12.1	8.4
	(5.7)	(9.6)	(7.2)	(6.8)	(8.3)	(7.2)
M (SD) exc. elevated cases[a]	---	---	9.2	5.9	11.1	6.7
			(6.8)	(4.9)	(7.6)	(5.1)
Range	2-28	2-32	0-27	0-31	0-27	0-32
% Elevated clinical	44.0	44.0	3.0	8.0	7.0	9.0
% Typical clinical	48.0	46.0	18.0	46.0	25.0	51.0
% Low clinical	8.0	10.0	79.0	46.0	68.0	40.0

Note. Drive-for-thinness (DFT): Elevated clinical raw score range 25-28; Typical clinical raw score range 17-24; Low clinical raw score range 0-16. Bulimia (BUL): Elevated clinical raw score range 19-32; Typical clinical raw score range 5-18; Low clinical raw score range 0-4 (Garner, 2004, p. 54-57). [a]mean (SD) recalculated after excluding cases scoring in elevated range.

Table 2. Study one: Pearson correlation coefficients indicating association between EDI-3 scales, mindfulness (FFMQ) and impulsivity (BIS-11) for clinical sample (n = 39).

	M	SD	Drive for Thinness	Bulimia	Emotion Dysregulation	Interoceptive Deficits	Impulsivity
Act-with-awareness[a]	12.8	3.7	-.35*	-.19	-.61**	-.56**	-.57**
Non-judging[a]	13.1	3.7	-.36**	-.18	-.28	-.19	-.16
Non-reactivity[a]	12.5	2.6	-.35*	-.01	-.17	-.33*	-.25
Mindfulness[b]	38.4	7.9	-.45**	-.17	-.48**	-.46**	-.43**
Drive-for-thinness	22.7	5.7		.26	.21	.13	.13
Bulimia	16.5	9.6			.25	.19	.42**
Emotion Dysregulation	8.9	6.4				.66**	.57**
Interoceptive Deficits	16.0	8.1					.44**
Impulsivity	73.5	9.6					---

Note. * p < .05; ** p < .01; [a] Subscales of the FFMQ; [b] composite of the three FFMQ subscales.

Table 3. Study two: Pearson correlation coefficients indicating association between eating disorder, mindfulness and impulsivity scales for non-clinical sample (n = 137).

	M	SD	Cronbach Alpha	Drive-for-thinness	Bulimia	Emotion Dysregulation	Interoceptive Deficits	Impulsivity
Act-with-awareness[a]	12.8	2.5	0.81	-.15	-.24**	-.30**	-.35**	-.42**
Non-judging[a]	17.9	4.4	0.78	-.30**	-.35**	-.49**	-.63**	-.20*
Non-reactivity[a]	12.2	2.8	0.73	-.24**	-.26**	-.38**	-.41**	-.27**
Mindfulness[b]	43.1	7.9	0.80	-.32**	-.40**	-.54**	-.63**	-.42**
Drive-for-thinness	9.6	7.2	0.89		.71**	.31**	.51**	.11
Bulimia	7.4	6.8	0.76			.50**	.67**	.23**
Emotion Dysregulation	6.0	5.9	0.82				.77**	.38**
Interoceptive Deficits	7.9	7.1	0.86					.29**
Impulsivity	68.2	10.4	0.82					---

Note. * $p < 0.05$; ** $p < 0.01$. [a] Subscales of the FFMQ; [b] composite of the three FFMQ subscales.

Table 4. Study three: Pearson correlation coefficients indicating association between eating disorder, mindfulness and difficulties in emotion regulation scales ($n = 119$).

	M	SD	Cronbach Alpha	Drive-for-thinness	Bulimia	Emotion Dysregulation	Interoceptive Deficits	DERS-LEC	DERS-NA	DERS-IMP
Mindfulness[b]	41.3	8.7	0.79	-.33**	-.28**	-.59**	-.64**	-.63**	-.67**	-.69**
Drive-for-thinness	12.1	8.3	0.91		.54**	.30**	.49**	.23*	.38**	.29**
Bulimia	8.4	7.2	0.86			.47**	.59**	.27**	.29**	.33**
Emotion Dysregulation	7.3	6.9	0.87				.68**	.53**	.47**	.67**
Interoceptive Deficits	10.1	8.2	0.89					.74**	.62**	.62**
DERS-LEC	12.3	4.4	0.87						.54**	.66**
DERS-NA	15.4	6.3	0.91							.67**
DERS-IMP	13.9	6.1	0.93							---

Note: * $p < 0.05$; ** $p < 0.01$. DERS = difficulties in emotion regulation scale; DERS-LEC =Lack of emotional clarity; DERS-NA = non-acceptance of emotional responses; DERS-IMP = impulse control. [a] composite of the three FFMQ subscales.