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REVIEW

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Mindful eating: what we know so far

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Abstract

Mindful eating is increasingly being used to try to promote healthy eating and weight management. However, the term refers to a diverse set of practices that could have quite different effects on behaviour. This narrative review provides a guide to the concept of mindful eating as well as a comprehensive overview of research in the area. This includes the ways in which mindful eating has been operationalised and measured as well as evidence for effects and potential mechanisms of action. The research reviewed suggests that multi-component mindfulness-based interventions may be beneficial for disordered eating and weight management, but it is unclear whether these benefits exceed those obtained by alternative treatments. Some studies suggest that specific mindful eating strategies may have immediate effects on eating, but more research is needed to reach any definitive conclusions. These studies also suggest that effects may vary depending on the characteristics of the individual and/or the specific eating context. As such, research may ultimately point towards a more personalised approach to the application of mindful eating in order to maximise benefits. Finally, mindful eating interventions for children represent a relatively new area of research and there is currently insufficient evidence to draw any firm conclusions about their value. To advance both our understanding and effective application of mindful eating, more experimental research with high levels of methodological rigour is needed as well as research that explores underpinning mechanisms of action.

KEYWORDS
diet, eating disorders, energy intake, food choice, mindfulness, weight loss

INTRODUCTION

The term 'mindful eating' has been used to refer to a range of different practices. This can lead to confusion over what we mean when we talk about mindful eating as well as a literature that can be difficult to untangle. There is also still much we do not know about mindful eating, especially in relation to its effects on behaviour and the mechanisms of action underpinning any effects. This review starts by examining the concept of mindful eating and the ways in which it has been measured. It goes on to examine evidence for the effects of mindfulness-based interventions (MBIs) and strategies on disordered eating, weight management, energy intake, food choice and diet. It also looks at recent mindful eating interventions for children. Finally, it considers theoretical explanations and possible mechanisms of action and identifies six key research recommendations to help move the field forward.

What is mindfulness?

To understand mindful eating, it is helpful to know a bit about mindfulness. Mindfulness has its origins

in Buddhist teachings, but its use as a therapy or intervention can be traced back to the late 1970s when Kabat-Zinn developed an 8-week programme called mindfulness-based stress reduction (MBSR) to help people cope with physical illness and stress (Kabat-Zinn, 2013). Two decades later, Williams and colleagues adapted this programme into mindfulness-based cognitive therapy (MBCT) for depression and anxiety, a treatment that is now recommended by the UK National Institute for Health and Care Excellence (NICE) (NICE, 2009; Segal et al., 2018). Since then, mindfulness has been increasingly applied to therapeutic and secular contexts, to the extent that the term has become part of our everyday language.

But what do people actually mean when they talk about 'mindfulness'? This can be a difficult question to answer since mindfulness is best viewed as a set of practices (or a process) rather than a unitary construct, and there is no clear consensus on how mindfulness should be defined (Grossman & Van Dam, 2011; Lutz et al., 2015; Van Dam et al., 2018). Indeed, Buddhist scholars have debated the use of the term for centuries (Dunne, 2015; Lutz et al., 2015). Nevertheless, despite these caveats there are certain key features of mindfulness that most experts would agree upon (Bishop et al., 2004; Kabat-Zinn, 2003; Lutz et al., 2015; Shapiro et al., 2006). These include present moment awareness, acceptance and decentering (see Figure 1).

As shown in Figure 1, these three components can be seen to build upon one another. For example, it is quite possible to employ present moment awareness without acceptance or decentering, but the reverse would be tricky since one cannot really accept or decenter from one's experience unless one is aware of it. It has also been argued that repeated practice of present moment awareness tends to naturally lead to acceptance and that decentering will also naturally emerge from repeated practice of both present moment awareness and acceptance (Bishop et al., 2004; Brown & Ryan, 2004; Shapiro et al., 2006). Ultimately, it does seem likely that these three components facilitate one another (Hölzel et al., 2011). Nevertheless, some mindfulness-based therapies employ quite distinct exercises to target each of these different aspects of mindfulness relatively independently (Hayes et al., 2009).

Some MBIs also incorporate teachings and exercises around compassion, self-compassion, gratitude and values (e.g. Hayes et al., 2009). However, since these are not consistently viewed as essential features of mindfulness, they will not be considered in this review. Nevertheless, it is worth noting that there is emerging evidence for the benefits of self-compassion in eating and weight-related interventions (Brenton-Peters et al., 2021).

What is mindful eating?

Mindful eating is essentially the application of mindfulness to eating-related thoughts, emotions, bodily sensations and behaviours. However, given the diverse physiological and cognitive processes involved in eating (such as memory and attention as well as metabolic state, Higgs et al., 2017), a vast array of different practices could, in principle, be described as mindful eating. This has resulted in varied definitions, ranging from the succinct (Winkens et al., 2018) to the lengthy (Peitz et al., 2021). Rather than unpicking these definitions, this review instead attempts to understand mindful eating by looking at the most common ways in which mindfulness has been applied to eating. These are described in Figure 2 and Table 1. Although this list is not exhaustive, and there is overlap between categories, it hopefully serves as a guide to what may be meant by the term 'mindful eating', and also as a useful starting point to understanding the literature.

But is it really mindfulness?

Some would argue that the practices described in Table 1 are not really mindfulness practices. It is certainly true that secular use of the term 'mindfulness' has diverged from its Buddhist origins. Whilst Buddhist mindfulness is aimed at spiritual exploration and involves continuous, extended formal meditation practice, in secular contexts the goal of mindfulness is usually to treat a particular problem and more emphasis may be placed on using brief mindfulness-based exercises throughout the day rather than engaging

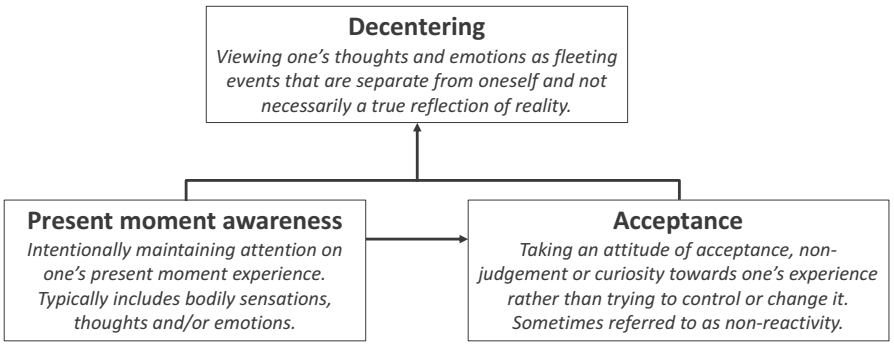

FIGURE 1 Key features of mindfulness

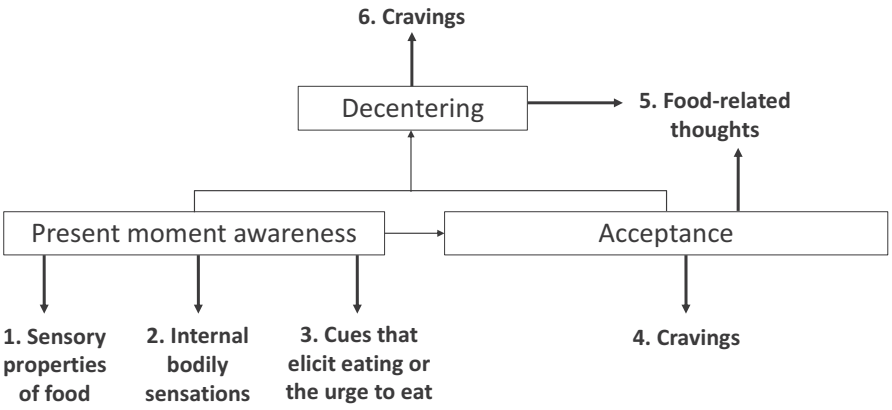

FIGURE 2 Ways in which mindfulness is most often applied to eating-related thoughts, emotions, bodily sensations and behaviours (see Table 1 for further details of these strategies)

TABLE 1 Descriptions of the most common mindful eating practices

Practice	Description	Alternative terms/ related concepts	Example exercises
1. Present moment awareness of the sensory properties of food	Paying attention to the sight, smell, taste, texture and temperature of one's food as one eats	Also referred to as focussed eating or savouring	Raisin exercise (e.g. Arch et al., 2016)
2. Present moment awareness of internal bodily sensations	Paying attention to feelings of hunger and fullness as well as bodily sensations associated with the consumption of different types of foods (such as tiredness following a large meal)	Substantial overlap with the concepts of intuitive eating and internally regulated eating (Linardon et al., 2021; Palascha et al., 2021a)	Body scan (e.g. Palascha et al., 2021b)
3. Present moment awareness of cues that elicit eating or the urge to eat	Noticing cues that prompt one to eat (such as a bowl of crisps within arm's reach) or that elicit feelings of hunger or cravings (such as an advert for ice cream). Cues may also be internal, such as low mood or a particular thought (e.g. 'I really need a sugar boost')	A key component of mindful decision-making (Martin et al., 2017)	Daily self-monitoring (e.g. Martin et al., 2017)
4. Acceptance of cravings	Taking a non-judgemental stance towards cravings; observing and exploring them rather than trying to alleviate or control them	A key component of mindful decision-making (Martin et al., 2017)	Urge surfing (e.g. Jenkins & Tapper, 2014)
5. Acceptance and/or decentering from food-related thoughts	Taking a non-judgemental stance towards food-related thoughts (e.g. 'I may as well eat the whole lot') and/or viewing them as transient mental events that are separate from oneself	–	Mind bus (Tapper & Ahmed, 2018)
6. Decentering from cravings	Viewing cravings as transient mental events that are separate from oneself	–	Leaves on a stream (Wilson et al., 2021)

in long periods of formal meditation practice (Hayes et al., 2009). Additionally, whilst Buddhist teachings state that different aspects of mindfulness cannot be easily extracted and used in isolation, among the scientific community such an approach is increasingly being applied to both the measurement and the study of mindfulness as well as its application (for useful discussion, see Grossman, 2010, 2011; Grossman & Van Dam, 2011). As such, care should be taken to limit research conclusions to the practices that have been studied rather than extending them to mindfulness more generally. Nevertheless, there are several reasons why such adaptations are useful.

First, for a full scientific understanding of mindfulness, we need to know how it works. Given its multifaceted nature, this inevitably means separating it out into different components to understand how they work in isolation and how they interact with one another. A full scientific understanding of mindfulness is important as it will help us know when it is and is not likely to bring

benefits, how it can be modified for greater effects in different contexts, and which components, if any, are less essential.

Second, if the goal is to improve health and wellbeing, it is important to explore briefer, more accessible forms of mindfulness. MBSR recommends 45 minutes of daily mindfulness practice (Kabat-Zinn, 2013), but many will have neither the time, motivation nor mental energy to sustain such practice. Indeed, those with greater health and wellbeing needs are also likely to be those with fewer physical and psychological resources (Devaux & Sassi, 2013; Mani et al., 2013; Shah et al., 2012; Stringhini et al., 2010). Thus labour-intense interventions like MBSR may widen health inequalities, whereas briefer, more accessible forms of mindfulness could help mitigate such effects. Even if briefer practice has much smaller benefits, if it is used by larger numbers of people, population-level benefits could be greater than a more effective intervention with lower uptake.

In summary, although the practices described in Table 1 are arguably quite different from the original Buddhist conception of mindfulness, they all have their roots in mindfulness practice and have the potential to contribute to improved health and wellbeing.

MEASURING MINDFULNESS AND MINDFUL EATING

Being able to measure mindfulness is important for researching its effects. However, measuring mindfulness is difficult since it refers to internal processes rather than physical behaviour, so cannot be directly observed. As such, measurement typically relies on self-report questionnaires, which are subject to a number of biases and inaccuracies. For example, since MBIs usually give people a greater understanding of what it means to be mindful, self-reported mindfulness following an MBI may be susceptible to social desirability bias. Relatedly, self-reports may better reflect the value a person places on a particular practice (such as present moment awareness) rather than their actual engagement with it. Different people may also interpret questionnaire items in different ways, especially those with and without experience of mindfulness practice. Additionally, individual differences in introspection and metacognition may lead to differences in reporting accuracy, potentially introducing confounds into the data. These, plus other limitations, have been discussed at length elsewhere (Grossman, 2011; Grossman & Van Dam, 2011; Lutz et al., 2015; Van Dam et al., 2018; see also Dunning, 2011). Nevertheless, despite their limitations, and perhaps because of a lack of good alternatives, questionnaire measures of mindfulness have been used extensively within the literature (Van Dam et al., 2018). These include the Five Facet Mindfulness Questionnaire (Baer et al., 2006) and the Mindful Attention Awareness Scale (Brown & Ryan, 2003) designed to assess trait mindfulness as well as the State Mindfulness Scale (Tanay & Bernstein, 2013) and Toronto Mindfulness Scale (Lau et al., 2006), aimed at assessing mindfulness as a state.

Building on these generic questionnaires, several more specific questionnaire measures of mindful eating have also been developed. These are considered important since the extent to which a person uses mindfulness in their day-to-day life could, in principle, vary across different domains. These measures are described below.

Mindful eating questionnaire (MEQ)

Developed by Framson et al. (2009), the original version of the MEQ was a 28-item measure with five subscales relating to awareness, distraction, emotional response, external cues and disinhibition. However, given the questionnaire's overlap with other constructs (such as emotional and external eating), Clementi et al. (2017) deleted items to produce a 20-item version with two subscales relating to (a) awareness of the effects of food on the body and senses and (b) tendency to eat in response to hunger and satiety. Nevertheless, the awareness subscale still tends to conflate different components of mindful eating that reflect different practices and/or may have different effects and determinants. Specifically, it includes five items relating to awareness of the sensory properties of food but also items about noticing the emotional and physical effects of food, noticing eating in the absence of hunger and noticing eating in response to external cues. The questionnaire also fails to capture the acceptance facet of mindfulness. In a pilot randomised controlled trial (RCT) of a multi-component nutrition and dietary intervention, the 20-item MEQ failed to show significantly higher scores among intervention participants (Chuang et al., 2020).

Items from the MEQ have also been adapted for use with children and adolescents from 8 years of age (MEQ-C; Hart et al., 2018). This 12-item self-report measure has two factors relating to (a) awareness of the sensory properties of food and (b) mindless eating.

Mindful eating scale (MES)

The MES was developed to try to better align with the subcomponents of generic mindfulness measures as well as tap into the construct of acceptance (Hulbert-Williams et al., 2014). The 28-item questionnaire has six factors relating to acceptance, awareness, non-reactivity, acting with awareness, routine and unstructured eating. However, some have argued that the non-reactivity subscale better reflects the effects of

mindful eating rather than mindful eating per se and that other items, for example relating to snacking when bored or eating between meals, do not assess mindful eating (Winkens et al., 2018). Relative to a control group, two web-based multi-component interventions for women with excess bodyweight resulted in increased scores on the MES (Czepczor-Bernat et al., 2021). An RCT of a mindfulness app for weight, weight-related behaviours and stress also brought about significant increases in MES scores (Lyzwinski et al., 2019).

Mindful eating behaviour scale (MEBS)

The MEBS was developed by Winkens et al. (2018) and focusses on present moment awareness only. The 17-item measure includes subscales relating to focussed eating, awareness of hunger and satiety cues, eating with awareness, and eating without distractions.

Mindful eating inventory (MEI)

Peitz et al. (2021) developed the MEI to incorporate additional facets of mindful eating relating to (a) an awareness of eating motives and (b) a sense of interconnectedness whilst eating. The 30-item scale is made up of seven subscales relating to acceptance of one's own eating experience, awareness of senses whilst eating, eating in response to awareness of fullness, awareness of eating triggers and motives, connectedness, non-reactive stance and focussed attention on eating.

Four facet mindful eating scale (FFaMES)

The FFaMES was developed by Carrière et al. (2022) to incorporate domains of non-judgement and decentering. It comprises 29 items with four factors relating to non-reactance, non-judgement, external awareness and internal awareness.

Conclusions: measuring mindful eating

As illustrated above, there is substantial variation across different measures of mindful eating. As such, it is important to ensure the measure selected sufficiently captures the key feature(s) of interest. Care should also be taken when interpreting findings, given the limitations of questionnaire-based measures of mindfulness (see above). Additionally, although measures of mindful eating tend to show significant associations with, for example, weight status and problematic eating behaviours (e.g. Clementi et al., 2017; Winkens et al., 2018), to date, only the MES has demonstrated significant change following interventions designed to increase mindful eating (Czepczor-Bernat et al., 2021; Lyzwinski et al., 2019). Sensitivity to change (and therefore utility for evaluating mindful eating interventions) has yet to be established for the other measures.

EFFECTS OF MULTI-COMPONENT MINDFULNESS-BASED INTERVENTIONS (MBIs)

One of the keyways in which mindfulness has been applied to eating is via multi-component MBIs designed to target specific outcomes, such as eating disorder symptoms or BMI. These types of interventions typically include mindfulness-based exercises alongside other cognitive and/or behavioural strategies. They may also include educational components and often comprise a series of group-based workshops supplemented with 'homework'. However, they may also be delivered at the individual level and, more recently, through digital means such as smartphone apps (Lyzwinski et al., 2018). Some of these interventions are more focussed on mindfulness, such as MBSR (Kabat-Zinn, 2013; Raja-Khan et al., 2017) and Mindfulness-Based Eating Awareness Training (MB-EAT; Kristeller & Wolever, 2011), whilst others include larger proportions of non-mindfulness content, such as Acceptance and Commitment Therapy (ACT; Hayes et al., 2009) and Dialectical Behaviour Therapy (DBT; Robins & Chapman, 2004). Many interventions that incorporate mindfulness (including MBCT, ACT and DBT) are what are termed third-wave cognitive behavioural therapies. This means that as well as considering the content of a person's thoughts, feelings and behaviours, they also examine the person's relationship with their thoughts, feelings and behaviours, in other words, the context within which these occur. Multi-component MBIs have most commonly been applied to disordered eating and weight management.

Disordered eating

Several meta-analyses have concluded that MBIs may help reduce eating disorder symptoms, binge eating and emotional eating (Godfrey et al., 2015; Katterman et al., 2014; Turgon et al., 2019). However, these were primarily based on within-group comparisons of pre- and post-measures. In other words, studies that did not include a control group but instead looked at change in the group receiving the MBI. Without a control group one cannot rule out the fact that change may have occurred anyway, even in the absence of an intervention. And without an *active* control group, one cannot rule out bias from social desirability and demand characteristics. In a meta-analysis of 13 RCTs (i.e. studies that included a control comparison), Linardon et al. (2017) found that third-wave therapies

for the treatment of eating disorders showed beneficial effects when compared to no treatment, but not when compared to active control groups or to alternative treatments (such as cognitive behaviour therapy). As such, they concluded that these therapies did not meet the criteria for empirically supported treatments for eating disorders. Similar findings were obtained by Grohmann and Laws (2021) in a meta-analysis of 11 RCTs of MBIs for binge eating; significant effects were found in trials with a no treatment control but not in trials with an active control. Significant effects were also not maintained at follow-up. Nevertheless, a recent meta-analysis of three RCTs by Mercado et al. (2021) found that, compared to active control conditions, the MBIs resulted in significant reductions in binge eating disorder symptoms. In contrast to the other meta-analyses, Mercado et al. restricted their analyses to interventions that were predominantly mindfulness-based. This meant they looked at just a small subset of those included in the Grohmann and Laws analysis (specifically, studies using MB-EAT, Mind Your Weight and Mindful Eating and Living) and excluded MBIs where mindfulness represented just one subcomponent of a larger intervention (such as ACT and DBT). Thus, these findings suggest that interventions like MB-EAT, that are predominantly mindfulness-based, may be helpful for disordered eating. However, further RCTs with active control comparisons would be needed to demonstrate this more conclusively.

Weight management

There have been a number of meta-analyses of the effects of MBIs on BMI and weight loss. Some of these have concluded that MBIs can be beneficial for weight management (Carrière et al., 2018; Fuentes Artiles et al., 2019; Lawlor et al., 2020; Roche et al., 2019) whilst others have concluded that there is no evidence for effects (Grider et al., 2021; Mercado et al., 2021; Ruffault et al., 2017; Warren et al., 2017). These inconsistencies are likely due to the fact that these reviews vary in terms of (a) the date they were conducted (with more recent reviews having a greater pool of studies), (b) whether or not they were restricted to RCTs, (c) whether the MBIs were compared with active or non-active control groups, (d) the type of intervention, (e) whether the intervention was aimed at weight loss (or something else, such as healthy eating), (f) the population (e.g. whether they included or excluded trials that recruited participants with a healthy weight), (g) the point at which measures were taken (e.g. immediately post-intervention or at a longer follow-up) and (h) differences in the ways in which effects were computed.

A recent, rigorous meta-analyses was conducted by Lawlor et al. (2020). This examined the effects of third-wave therapies designed specifically for weight loss, conducted with participants with BMIs of over 25 (i.e. those with excess weight) and which included follow-up measures of at least 3 months. Using data from 22 RCTs, they found moderate to high-quality evidence, suggesting that MBIs resulted in slightly greater weight loss than standard behavioural treatment immediately following the intervention and at 12- and 24-month follow-ups (with relatively small differences of approximately 0.6 kg post-intervention and 1.4 kg at 24 months). ACT had the most consistent evidence of effectiveness and was the only treatment with RCT evidence suggesting effectiveness beyond 18 months.

By contrast, a meta-analysis of 11 RCTs by Mercado et al. (2021) concluded that MBIs were no more effective than control comparisons at reducing BMI. Whilst this meta-analysis was also restricted to participants with excess weight, it specifically excluded two third-wave therapies, ACT and DBT, on the grounds that mindfulness was only a sub-component of these therapies. Thus, although the meta-analysis by Lawlor et al. (2020) showed that ACT is helpful for weight management, findings from Mercado et al. (2021) suggest that the non-mindfulness components of ACT may be important for these effects. Nevertheless, weight loss was a specific aim of the MBI in just six of the 11 studies in the Mercado et al. meta-analysis; in the other five studies the MBI was designed to target other aspects of weight and eating such as binge eating, stress eating, weight stigma and quality of life. As such, further analysis would be needed to try to more carefully compare the effects of MBIs with and without substantial non-mindfulness components.

Conclusions: effects of multi-component mindfulness-based interventions (MBIs)

The contrasting results from meta-analyses of multi-component MBIs highlight some of the difficulties in establishing whether mindfulness is helpful when targeting eating-related behaviours since the extent to which any changes are driven by the mindfulness element is difficult to determine. Whilst some have argued that such interventions should incorporate measures of mindfulness, to establish the extent to which this mediates any effects (Olson & Emery, 2015), as described above, obtaining valid measures of mindfulness is problematic.

With this in mind, we now turn to studies that have looked at the effects of more specific mindfulness strategies on eating behaviours. Although multi-component interventions are typically more effective than isolated strategies (NICE, 2006), research on the latter can help identify underlying mechanisms of action, which can then be used to inform and refine larger interventions.

EFFECTS OF SPECIFIC MINDFUL EATING STRATEGIES ON EATING BEHAVIOURS

To the author's knowledge, there are no systematic reviews or meta-analyses examining the effects of specific mindful eating strategies on eating behaviours. The following sections therefore provide a narrative review of individual studies in this area. To identify relevant articles, Web of Science was used to search for the terms 'mind*' and 'eat*'. The search was restricted to articles published in the English language between 2016 and the end of September 2021. The titles, abstracts and/or full texts of these were reviewed and excluded for any of the following reasons: (a) mindfulness was not manipulated, (b) there was no control or comparison group, (c) there was no eating behaviour outcome and (d) the mindfulness manipulation included more than one other non-mindfulness element. These studies were supplemented by studies previously identified in Tapper (2017) or known to the author. They were then divided into studies conducted with children aged 11 years or under or with adults and adolescents aged 12 years or over. The former is described in a later section. The latter were further categorised according to (a) type of outcome and (b) type of mindfulness strategy or strategies employed. These studies are described below. However, with respect to the type of strategy(ies), it is important to note that the precise instructions given to participants was not always provided. In such instances, the studies were categorised according to the information available.

Energy intake

A relatively large number of studies have looked at whether specific mindfulness-based strategies can reduce energy intake, or the amount of food consumed. Most of these have looked at consumption of energy-dense foods within a laboratory setting but a few have also looked at overall energy intake outside the laboratory.

Present moment awareness of the sensory properties of food

Experimental studies examining the effects of attending to the sensory properties of food on energy intake have shown inconsistent results. Whilst some studies have found that this practice significantly reduces subsequent intake of energy-dense foods (Allirot et al., 2018; Arch et al., 2016; Higgs & Donohoe, 2011; Hinton et al., 2021; Mantzios et al., 2020; Robinson et al., 2014b; Seguias & Tapper, 2018; Tapper et al., 2018), others have found no significant effects (Arch et al., 2016; Bellisle & Dalix, 2001; Cavanagh et al., 2014; Long et al., 2011; Seguias & Tapper, 2022; Simonson et al., 2020; Tapper & Seguias, 2020; Whitelock et al., 2018; Whitelock et al., 2019a). Of these studies, only two (Seguias & Tapper, 2022; Tapper & Seguias, 2020) assessed consumption outside the laboratory and both failed to find any effects.

Thus, at this point it would be premature to conclude that this type of mindful eating can be reliably used to reduce energy intake. Nevertheless, the mixed findings suggest there may be certain key moderators that mean this strategy could be helpful for some individuals and/or in specific circumstances. Identifying the mechanisms underpinning the significant laboratory effects could help pinpoint the situations in which this strategy may be helpful. One such possibility is that it works by slowing down the rate of eating (Hinton et al., 2021). This idea is discussed further below under Potential mechanisms of action.

Present moment awareness of internal bodily sensations/feelings of hunger, satiation and satiety

Some experimental studies have examined the effects of attending to internal bodily sensations on energy intake, and again these point to the possibility of complex moderation. Specifically, whilst one study found that a body scan reduced consumption of energy-dense snacks (Jordan et al., 2014), another found a reduction in a sub-group of participants only (those that were hungry; Marchiori & Papies, 2014), another found no significant effects (Van de Veer et al., 2016, Experiment 4), and yet another found a sub-group effect in the opposite direction—in this case participants who were directed to mindfully attend to their body and who consumed a small (as opposed to large) preload, ate *more* of a subsequent snack than those in control conditions (Van de Veer et al., 2016, Experiment 2). Additionally, when this type of mindfulness strategy has been applied outside the laboratory setting (with participants with excess weight), no significant effects on energy intake (or weight loss) have been observed (Martin et al., 2017). Research by Palascha et al. (2021a) hints at potentially complex effects in this area; they found that a brief body scan improved perception of the onset of hunger (assessed outside the laboratory) but not satiation (assessed in the laboratory), raising the possibility that this type of brief mindfulness exercise may be more likely to prompt eating rather than reduce portion sizes. Such an interpretation is in keeping with Lindsay and Creswell (2017, 2019) who state that, when used in isolation, mindfulness-based present moment awareness can increase affective reactivity. They argue that additional training in acceptance is needed to

reduce this affective reactivity (see Mechanisms of action section).

Present moment awareness and acceptance of cues that elicit eating

Martin et al. (2017) looked at the effects of a Mindful Decision-Making intervention on energy intake and weight loss over a 6-week period among participants with excess weight. The Mindful Decision-Making intervention was designed to increase awareness and acceptance of cues that elicit eating. It was compared both to a 'Mindful Eating' intervention, where participants were trained to pay more attention to internal bodily sensations of hunger and satiety, and also to a standard weight loss intervention. However, there were no significant differences between the three groups in either energy intake or weight loss. Nevertheless, the overall sample size was relatively small (n = 79) and there was a medium to large effect size for weight loss (η_p^2 = 0.9, p = 0.08), which was driven by greater weight loss in the Mindful Decision-Making group relative to the Mindful Eating group (d = 0.72, p = 0.07). As such, the authors speculated that mindful decision-making strategies may be more helpful for weight loss compared to mindful attention towards feelings of hunger and satiety, though further research would be needed to establish this.

Decentering from thoughts and reactions to food images

Chang et al. (2018) used a decentering exercise where they asked participants to consider the character of their thoughts and reactions to a series of food images and to imagine these were constructions of the mind that appear and disappear. They compared this with a sensory exercise (where participants were asked to imagine the taste, smell and mouth texture of each food) and a control condition (where participants were simply asked to view the images in a relaxed manner). However, there were no significant effects on subsequent consumption of ('unhealthy') chocolate or ('healthy') almonds. Similarly, Hinojosa-Aguayo and González (2022) used a 3-minute exercise in which they guided participants to decenter from their thoughts, but again this had no effect on the amount of chocolate snack consumed relative to those who had spent 3 minutes listening to an extract from a novel.

Other strategies or combinations of strategies

Several other studies have examined slightly different strategies, or combinations of strategies, that do not readily fit into the above groupings. Specifically, Fisher et al. (2016) looked at the effects of more extended mindfulness practice within a laboratory setting. In their study participants spent 10 minutes being trained to attend to their breath and notice thoughts, emotions and physical sensations without reaction or judgement. After being exposed to four energy-dense foods for 10 minutes, they were later asked to spend a further 10 minutes practicing the mindfulness breathing exercise in their presence. Compared to a control group, these participants subsequently ate fewer of the plate of cookies that were offered to them at the end of the study as a 'token of appreciation'. Masih et al. (2020) also looked at the effects of extended mindful practice. In their study, participants repeatedly practiced a breathing meditation over an 8-week period (alternated with a relaxation exercise in which they repeatedly tensed and relaxed different muscle groups). However, at the end of the 8 weeks there were no effects on energy intake from a meal consumed in the laboratory following a stress induction procedure.

Several other studies have also looked at effects following stress or mood inductions. Following a stress induction procedure, Dutt et al. (2019) asked participants to either listen to a mindfulness-based breathing exercise or a nature audio book. They found that those in the mindfulness group subsequently ate less chocolate and grapes. Similarly, Miller et al. (2021) looked at whether a mindfulness-based focussed-breathing exercise could reduce kilocalories consumed in a meal following a stress induction among adolescents identified as being at risk for obesity. However, although, relative to a control group, the mindfulness exercise reduced state anxiety, it had no effect on energy intake. Finally, following a negative mood induction, Hsu and Forestell (2021) asked participants to either listen to a breath, sound and body mindfulness meditation or a recording of a news article. They then measured snack consumption over a period of 15 min but found no main effects of the mindfulness manipulation on energy intake.

Targeted reduction of specific foods

A range of studies have looked at whether mindfulness-based strategies can reduce the consumption of specific foods (typically energy-dense foods) outside the laboratory over periods ranging from 5 days to 6 months.

Present moment awareness of the sensory properties of food

In a study designed to help reduce the use of sugar in coffee, Lenne and Mann (2020) found that instructing

participants to pay attention to the sensory properties of unsweetened coffee over a 14-day period resulted in greater reported consumption of coffee without sugar at 1- and 6-month follow-ups, compared to those who had simply been asked to drink their coffee unsweetened for a 14-day period.

Acceptance of cravings

Several studies have looked at the influence of acceptance strategies on consumption of chocolate and sweet foods. Forman et al. (2013) gave participants 2 hours of training in an acceptance-based coping strategy for cravings (that also included elements of decentering and a values-based motivational component) and asked participants to apply this strategy to cravings for sweet foods and drinks over a period of 7 days. Similarly, Jenkins and Tapper (2014) gave participants a brief strategy designed to promote acceptance of craving and asked participants to use this strategy over a 5-day period every time they experienced a craving for chocolate. However, compared to control conditions, neither strategy resulted in significant reductions in consumption of the targeted foods. In a similar study conducted by Hulbert-Williams et al. (2019), they found that an acceptance strategy resulted in lower consumption from a bag of chocolates participants had been asked to carry with them, but not lower consumption according to a food diary measure.

Decentering from food-related thoughts and feelings

A number of studies have looked at the effects of decentering-based strategies. Moffitt et al. (2012) provided chocolate cravers with 60 minutes instruction in decentering from food-related thoughts, Hooper et al. (2012) gave participants 5–10 minutes of instruction in decentering from thoughts and feelings related to chocolate craving, Jenkins and Tapper (2014) gave participants 5 minutes of instruction in decentering from food-related thoughts and Hulbert-Williams et al. (2019) gave participants 8 minutes of instruction in decentering from food-related thoughts. When chocolate consumption over the subsequent 5 to 7 days was compared with control conditions, Moffit et al. found significantly greater levels of chocolate abstinence in the decentering condition, both Jenkins and Tapper and Hulbert-Williams et al. found significantly lower levels of chocolate consumption according to an observational measure (chocolates eaten from a bag participants had been asked to carry with them) but not a food diary measure, and Hooper et al. found no significant difference. Both Hulbert-Williams et al. and Hooper et al. also measured chocolate consumption in the laboratory immediately after the end of the intervention period and found significantly lower levels of consumption in the decentering conditions. Similarly, Hinojosa-Aguayo and González (2022) looked at consumption of craved foods over a 2-week period. They asked participants to listen to a 3-minute audio recording every time they experienced a craving; 5 minutes later they were prompted to report whether they had eaten the food they had been craving. The results showed that those who had listened to an audio encouraging them to decentering from their thoughts were less likely to subsequently eat the craved food compared to those who had listened to an extract from a novel.

Present moment awareness of cues that elicit eating

Forman et al. (2016) used a 60-minute group session to train habitual salty snack eaters to become more aware of the sensory, emotional and cognitive processes that influenced their eating. Compared to psychoeducation, this resulted in a significant reduction in the consumption of salty snacks over the following 7 days.

Food choice and diet

Substantial cross-sectional data suggest that higher trait mindfulness is associated with heathier food choices and a healthier diet (e.g. Farrar et al., 2022; Sala et al., 2020). However, only a limited number of experimental studies have examined such effects.

Present moment awareness of the sensory properties of food

Two studies, with measures taken outside the laboratory, found no significant effects of attending to the sensory properties of food on intake of saturated fat, added sugar, fibre or fruit and vegetables over a half-day (Tapper & Seguias, 2020) or 3-day (Seguias & Tapper, 2022) period. Nevertheless, in a laboratory study, Allirot et al. (2018) found that those who had been asked to attend to the sensory properties of their food, subsequently ate fewer high energy-dense sweet and savoury snacks, but not fewer low energy-dense sweet and savoury snacks.

Decentering from reactions to food images and food-related thoughts

Papies et al. (2015) asked participants to apply a decentering strategy whilst viewing a series of food

images and then examined their cafeteria food choices. Where participants were hungrier, the decentering exercise reduced the selection of a more energy-dense meal compared to those who had not viewed any pictures. More specifically, they were less likely to select an 'unhealthy' snack and more likely to choose a salad. However, when Hinojosa-Aguayo and González (2022) used 3 minutes of audio instruction to encourage participants to decenter from their thoughts following a craving induction, this had no effect on their subsequent selection of a 'healthy' versus 'unhealthy' snack to take home as a thank you gift (relative to a control condition who had listened to an extract from a novel).

Other strategies

Masih et al. (2020; see above) found no effect of 8-week practice of a breathing meditation on healthy versus unhealthy foods eaten in the laboratory following a stress induction procedure.

Conclusions: effects of specific mindful eating strategies on eating behaviours

The very varied ways in which mindful eating has been operationalised, combined with relatively limited experimental research, means we are not yet in a position to conclude that specific mindful eating strategies do or do not influence eating. Nevertheless, there is some evidence to suggest that certain strategies, such as decentering and attention towards the sensory properties of food, may be more promising than others, at least when used in isolation, with those with limited mindfulness experience.

MINDFUL EATING IN CHILDREN

In the last few years, mindful eating interventions have also been used with primary and preschool aged children, either to promote consumption of novel or less preferred foods, to reduce consumption of less healthy foods or to influence intake from a selection of both healthy and less healthy foods. The length of these interventions has ranged from one, 1-hour workshop (de Tomas et al., 2020) to 10 sessions delivered over a 5-week period (Dial et al., 2020). The content has typically included exercises aimed at increasing attention towards the sensory properties of food as well as a range of other mindfulness-based exercises such as mindful breathing or a body scan. Of the studies aimed at promoting consumption of novel or less preferred foods, some have shown significant effects with 3-10 year olds (Hong et al., 2018) and 10-12 year olds (Bennett et al., 2020), whilst another with 3-5 year olds found no effects (Dial et al., 2020). One study aimed at reducing candy consumption among 6-9 year olds found no significant effects (though means were in the predicted direction, Savage et al., 2020). Finally, two studies that looked at intake from a selection of healthy and less healthy foods found no significant effects with 8-11 year olds (de Tomas et al., 2020) but reduced total energy intake, and reduced energy intake from less healthy foods, among 8-9 year olds (Gayoso et al., 2021). In the former study, children were presented with all the foods on a tray that was placed in front of them, whilst in the latter they selected foods from a buffet. Thus, in the former study (that found no significant effects) children's behaviour would have been more influenced by unconscious, habitual behaviours whereas in the latter study (that reported reduced energy intake) children's behaviour would have been more influenced by conscious decision-making processes.

Conclusions: mindful eating in children

The relatively limited research in this area, combined with a diverse set of aims, makes it difficult to draw any firm conclusions about the presence or absence of effects. It is also possible that results are affected by social desirability bias, particularly among older children who may quickly infer that they 'ought' to be eating more healthily or trying less preferred foods.

POTENTIAL MECHANISMS OF ACTION

Many of the above studies suggest that any effects of mindfulness on eating are not straightforward. Rather, if they do occur, they tend to occur in certain sub-groups of participants or in specific contexts. Thus, for the field to progress, we really need to understand the mechanisms underlying any effects. This would help us determine when mindful eating strategies are most likely to be helpful, in other words, for what types of individuals and under what circumstances.

Given the multi-faceted nature of mindfulness practice, it seems likely it could exert effects on behaviour via a wide range of different processes. As such, many different theories and mechanisms of action have been proposed. In some cases, general psychological theories and processes have been used to explain specific effects associated with particular mindfulness practices (e.g. Kristeller & Epel, 2014; Papies et al., 2020; Tapper, 2017), whilst in other instances, more comprehensive theories of mindfulness have been developed to account for a broader range of effects across varied circumstances (e.g. Lindsay & Creswell, 2017, 2019;

Ludwig et al., 2020). Whilst it is beyond the scope of this review to consider all these explanations in detail, this section highlights several theories and mechanisms of action that seem particularly relevant for eating behaviours and have implications for mindful eating interventions.

Increased autonomous motivation and self-regulation

Ludwig et al. (2020) propose that present moment awareness, applied to all facets of goal-incongruent behaviours, eventually leads to increased autonomous motivation for goal-*congruent* behaviours, which allows the person to regulate their behaviour without effortful control. They suggest this happens because present moment awareness leads to more accurate assessments of the reward value of specific actions; where actions conflict with a person's goals, the negative affect associated with this conflict becomes encoded in the action, reducing its reward value. Ludwig et al. describe seven steps in this process, from becoming aware of the goal-incongruent behaviour and its consequences, to noticing the results of effortfully controlled behaviour, to the exploration of new, autonomously motivated behaviours and their results. (See also Kristeller & Epel, 2014, who make similar arguments about a shift from 'mindless' eating to effortfully controlled eating to effortless self-regulation.)

However, whilst there are some self-report data showing that anticipated reward value predicts maladaptive eating (Taylor et al., 2021a), this is a relatively new theory that has yet to be rigorously tested. Given the evolved physiological rewards associated with eating (Rogers, 2017), it may be that these cannot always be outweighed by negative affect associated with goal conflict, especially where a person is in a state of energy deficit. As such, this approach may be more effective for reducing maladaptive eating and preventing weight gain rather than aiding weight loss. The theory also predicts that this approach would be more effective among those who are highly motivated to change their behaviour and able to commit to engaging in substantial present moment awareness over an extended period.

Reduced affective reactivity

Monitor and acceptance theory (Lindsay & Creswell, 2017, 2019) emphasises the importance of present moment awareness in combination with acceptance. According to this theory, when used in isolation, present moment awareness increases the vividness of experience which can in turn increase affective reactivity. Acceptance is critical for reducing reactivity, which it does by changing the trajectory of attentional engagement with affective stimuli, enabling earlier engagement and disengagement. Thus, according to this theory, present moment awareness strategies directed towards cues that elicit eating (such as hunger or food in one's environment) could lead to *greater* food consumption if employed in the absence of acceptance. As noted above, this may account for the mixed findings of studies looking at the effects of present moment awareness of internal bodily sensations on food consumption (Marchiori & Papies, 2014; Martin et al., 2017; Palascha et al., 2021a; Van De Veer et al., 2016).

Reduced craving and desire

Food cravings predict both eating and weight gain (Boswell & Kober, 2016). As such, any strategy that reduces cravings could influence eating behaviours. The grounded-cognition theory of desire states that food cravings occur when we mentally simulate eating and enjoying food (Papies et al., 2020). According to this theory, decentering strategies will reduce the believability of these mental simulations and, in doing so, lessen the extent to which they elicit craving and desire. Several studies support this prediction (Keesman et al., 2020; Schumacher et al., 2018; Schnepper et al., 2019; Tapper, 2018; Wilson et al., 2021, though see also Hinojosa-Aguayo & González, 2022; Hulbert-Williams et al., 2019; Mantzios et al., 2020; Masih et al., 2020; Tapper & Turner, 2018). As such, decentering strategies may be helpful for craving management even in the absence of additional mindfulness training. Further qualitative research in this area could help refine the content and delivery of such strategies (e.g. see Tatar et al., 2021).

Increased attention towards hunger, satiation and satiety cues

Interoception refers to the ways in which we sense, interpret and integrate internal bodily signals (Garfinkel et al., 2015; Khalsa et al., 2018). Deficits in interoception have been associated with both eating disorders and a higher BMI (Khalsa et al., 2018; Robinson et al., 2021). Although mindfulness training may not typically improve a person's ability to correctly perceive internal bodily sensations (termed 'interoceptive accuracy'; Khalsa et al., 2020; Parkin et al., 2014), it may help increase attention towards interoceptive information ('interoceptive attention'; e.g. Gawande et al., 2019). For eating behaviour, the most directly relevant interoceptive information will be cues related to hunger, fullness and satiety. As such, increased attention towards these could be an important mechanism via which mindful eating strategies influence eating behaviours. However, such effects might only occur among those with sufficient ability to

accurately detect such cues; in other words, such strategies may have little effect on those with deficits in interoceptive accuracy (e.g. see Llewellyn et al., 2014; Maillard et al., 2016). This could include those with anorexia, and possibly also bulimia, since research suggests these groups may have deficits in hunger and fullness perception, respectively (Herbert, 2020).

The specific nature of effects associated with increased interoceptive attention is also likely to depend on the context; as discussed above, whilst greater attention towards satiation and satiety might help prevent overeating, increased attention towards hunger could be counterproductive for those trying to maintain an energy deficit in order to lose weight.

It is also important to note that much research on interoception has used heartbeat perception tasks and/or general self-reports measures (Robinson et al., 2021). Although there is evidence that interoceptive abilities generalise across modalities (e.g. Herbert et al., 2012), there is still a need for further research looking more specifically at perception of and attention towards hunger, satiation and satiety cues.

Slowed eating and satiation

Research shows that slower eating is associated with lower food intake (Robinson et al., 2014a). This may be because it increases orosensory exposure (i.e. the length of time that food is in the mouth) which promotes the release of gut hormones that reduce appetite (Hawton et al., 2019; Krop et al., 2018). Thus, asking people to attend to the sensory properties of their food as they eat could lead to reduced energy intake due to a slowed rate of eating and increased feelings of satiation. If this were the case, this strategy would be most effective for those who are naturally fast eaters, and/or in situations where people are inclined to eat more quickly, for example when hungry, when eating highly palatable foods or when in a hurry. It would also mean that effects could be maximised by focussing on taste and texture rather than sight and smell. Although other types of interventions have been used to try to slow eating rate (Robinson et al., 2014a), these can be associated with reduced pleasure (Hawton et al., 2019). Given that mindful eating may increase food enjoyment (Seguias & Tapper, 2022), it may therefore represent a more acceptable and sustainable way of promoting slowed eating. However, research in this area is currently too limited to draw any firm conclusions (Hinton et al., 2021; Simonson et al., 2020).

Improved working memory

Jha et al. (2019) emphasise the importance of improvements in working memory. Working memory refers to the brain's ability to retain and manipulate information over short periods of time in order to perform complex tasks such as comprehension and reasoning (Baddeley, 2010; Jha et al., 2019). Working memory has been shown to be important for both emotion regulation and decision-making (Barkus, 2020; Bechara & Martin, 2004; Hinson et al., 2003; Schmeichel & Tang, 2015) but is compromised by factors such stress, emotional arousal, stereotype threat and sleep deprivation (Blasiman & Was, 2018). Several studies have found that mindfulness meditation can help prevent this type of working memory decline (Jha et al., 2010, 2017, 2020; see also Whitfield et al., 2021). As such, mindfulness meditation could influence eating by (a) improving food-related decision-making, (b) helping to regulate food cravings and/or (c) helping with emotion regulation more generally. However, benefits to working memory only seem to emerge after more intensive mindfulness meditation training; for example, Jha (2021) suggests that at least 12 minutes of daily meditation practice over a 4-week period is needed. Thus, daily mindfulness meditation practice might be most suitable for those suffering from or at risk of working memory impairments but who are also able to sustain consistent daily meditation practice. Further research would be needed to explore these possibilities.

Reduced stress and negative affect

Another way in which mindfulness might indirectly influence eating behaviour is through reductions in stress and other types of negative affect, including body dissatisfaction. Stress has been shown to increase consumption of unhealthy foods (Hill et al., 2021) whilst negative affect and body dissatisfaction are risk factors for eating pathology (Stice, 2002). There is also evidence that mindfulness-based strategies and interventions can promote wellbeing and reduce stress, negative affect and body dissatisfaction (Keng & Ang, 2019; Querstret et al., 2020; Taylor et al., 2021b; Wade et al., 2009; Yu et al., 2020). Nevertheless, heterogeneity could dilute effects. For example, it is estimated that whilst 35%–40% of people increase their food intake in response to stress, the remainder show either no change or a reduced intake (Hill et al., 2021; Oliver & Wardle, 1999). Research examining eating in response to negative emotions also shows substantial variability across different types of people (Devonport et al., 2019; Evers et al., 2018). As such, mindfulness-based strategies and interventions aimed at reducing stress and negative affect in order to influence eating, would be best targeted at those identified as being at most risk of overeating in response to these emotions.

Conclusions: potential mechanisms of action

There are a very wide range of different processes via which mindfulness and mindful eating could influence eating behaviours. However, a lack of empirical evidence means that, at present, this literature in primarily speculative. Establishing the ways in which mindfulness influences eating should be a key objective for future research since, as illustrated above, different mechanisms have different implications for how we might develop and tailor mindful eating interventions. In particular, certain practices may be better suited to addressing maladaptive eating and overeating rather than aiding weight loss. Indeed, over the short-term, certain types of mindfulness practice could actually be counterproductive for those trying to limit their food intake. As such, care should be taken when designing briefer, more accessible mindful eating interventions, or for longer interventions where there is likely to be substantial drop out at an early stage.

SIX RECOMMENDATIONS FOR FUTURE RESEARCH

It is clear from the above review that the existing body of research on mindful eating (and mindfulness more generally) is limited by both methodological weaknesses and gaps in the evidence. The following would help address these limitations and advance the field at a more rapid pace.

1. *Invest in research that experimentally manipulates mindfulness*. There is already much cross-sectional research showing correlations between mindfulness, mindful eating and eating-related behaviours and outcomes (e.g. Sala et al., 2020). Whilst such research provides a useful first step in exploring potential links between these variables, the conclusions that can be drawn are limited due to (a) problems associated with self-report measures of mindfulness (see above) and (b) the fact that one cannot make inferences about causality. As such, the field now needs to move beyond correlational evidence and focus efforts on experimental research that provides clearer evidence of causality.
2. *Control for demand characteristics, social desirability bias and any other elements that are not specific to mindfulness but may affect outcomes*. Much existing research fails to adequately control for such variables, making it difficult to conclude that any effects are brought about by mindfulness per se. Research could be strengthened through the use of participant blinding and active control conditions that are matched, as far as possible, to the intervention (e.g. through the use of sham meditation, visualisation or relaxation; Jenkins & Tapper, 2014; Wilson et al., 2021; Zeidan et al., 2010).
3. *Pre-register studies*. This would help build confidence in the findings. It is especially important where there are sub-group analyses or more than one outcome measure since multiple comparisons increase the chances of spurious results. Websites such as osf.io make it easy to pre-register hypotheses and analyses plans prior to data collection.
4. *Provide full details of the mindfulness strategies employed*. These are often lacking in research publications which makes it difficult for reviews to differentiate between different types of strategies and for other researchers to replicate or compare findings. Complete details, for example in the form of scripts, could be made available in publication appendices or supplemental material.
5. *Conduct more research into the effects of repeated mindfulness practice over a sustained period*. There is a lack of carefully controlled experimental research in this area. However, such work could be informative given that some facets and outcomes of mindfulness (such as acceptance and benefits to working memory) may only emerge over longer periods of time (Jha, 2021; Rogge & Daks, 2021).
6. *Conduct more research into potential mechanisms of action*. This would help build theory and understanding that could translate into more tailored and effective application of mindfulness-based strategies and interventions. Potential mechanisms of action can be explored by examining possible mediators (e.g. see Preacher, 2015) as well as through the use of comparison conditions that control for different aspects of a manipulation (e.g. Hinton et al., 2021; Wilson et al., 2021).

CONCLUSIONS

The term ‘mindful eating’ has been used to refer to a very diverse set of practices. Multi-component interventions that incorporate these practices may be helpful for the treatment of disordered eating and weight management. However, such interventions are not necessarily more effective than other types of treatment. In terms of specific mindful eating strategies, there is currently insufficient evidence to confidently conclude that they influence eating. However, most experimental research in this area has examined effects over short periods of time only. The results also point to complex moderation by both individual and situational factors, suggesting that a personalised approach to the use of mindful eating strategies may be most appropriate. At this stage, in the absence of clear evidence, this could translate into an n-of-1 style method of treatment, in which different strategies are introduced at different points in time and their effects closely monitored (Kazdin, 2011). In future,

as the field advances, we may be able to identify in advance, which individuals are most likely to benefit from which strategies.

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CONFLICT OF INTEREST

The author has no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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