Effect of a brief single mindfulness exercise on response conflict about unhealthy food and its mediating effects

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Abstract

People are constantly triggered by tempting, unhealthy food, which makes them easily come into cognitive conflict when making food choices and therefore require self-control to choose the healthier option. The lower the response conflict the less self-control is needed and the happier and healthier people are. Practicing mindfulness has beneficial effects on reducing response conflict. However, in modern, fast-paced lives, time is precious and people do not have time for extended mindfulness exercises. Therefore, this study examined if a brief, single mindfulness exercise would be an effective tool to avoid making unhealthy food choices and, if so, which components of mindfulness – present-moment awareness, acceptance and decentering – would contribute to the effect. The study is an experimental cross-sectional design offered online. It included 86 participants, who were randomly assigned to either a 10-minute mindfulness or history audio. After the audio, participants were shown unhealthy food images and were asked to rate their conflicts towards them. In contrast to expectations, no direct or mediating effects were found between a mindfulness exercise and response conflict about unhealthy food. The small sample size and, therefore also, the lenient exclusion criteria could explain the lack of significant results in the study. Moreover, the strong correlation found between present-moment awareness and acceptance, provokes further investigation about the use of components. This study suggests that the state mindfulness components relevant for response conflict are not obvious, and that further research with a larger sample size is needed to draw more concrete conclusions.

Keywords: response conflict, self-control, unhealthy food, state mindfulness, present-moment awareness, acceptance, decentering, food craving

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Healthy food choices are sometimes difficult to make as the "obesogenic" environment – an environment that encourages unhealthy eating behaviour and stimulates obesity in society – constantly triggers desires to make unhealthy food choices (Keesman et al., 2017). Unhealthy food is tempting to us because it is advertised everywhere, accessible and often cheaper than healthier food. This makes a healthy food choice more effortful than an unhealthier one (Oude Groeniger et al., 2019).

Giving in to your immediate desires (e.g., eating chocolate) can come into cognitive conflict with longer-term goals (e.g., losing weight) (Gillebaart et al., 2020). To not indulge in your short-term desires and, thus, to overcome a conflict, self-control is needed to choose the option that serves an individual's longer-term goal (Gillebaart et al., 2020).

Response conflict is a mental discrepancy between two or more competing behavioral tendencies and is a central element of self-control (Gillebaart et al., 2020). The magnitude of the response conflict indicates how much self-control is needed (Hofmann et al., 2012). Lower response conflict facilitates performing self-control successfully and thus the lower the response conflict the less self-control is needed and the easier it is to resolve the conflict (Rosenthal & Dietl, 2022). Individuals who are better at resolving their response conflicts are happier and healthier in life (Schneider et al., 2019). Also, they present better at work and school and have more pleasant relationships (Gillebaart et al., 2020).

Self-control and mindfulness

In recent decades research has paid attention to the effects of mindfulness within psychology and health, and since the 21st century, the influence of mindfulness on self-control has been studied.

Participants who had experiences with practicing mindfulness meditation showed higher efficiency in controlling response conflicts (Jo et al., 2017). Besides, high in mindfulness has been associated with fewer negative affect around the response conflict experienced (Elkins-Brown et al., 2017).

Kabat-Zinn (2003, p. 145) conceptualizes mindfulness as "*the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment"*.

Two types of mindfulness exist: state mindfulness and trait mindfulness. State mindfulness indicates mindfulness in the present-moment and is often during or immediately after a mindfulness exercise (Tang et al., 2015). Trait mindfulness indicates the insistent change in a person's perception, feelings and self-awareness (Zhang & Zhang, 2021). An individual who is trait mindful has the aptitude to be mindful in everyday life (Kiken et al., 2015). Trait mindfulness increases by repeating mindfulness exercises and develops slowly over some time. Thus, those who score higher on state mindfulness also score higher on trait mindfulness. Without mindfulness-based exercises, one's trait mindfulness remains steady over time (Kiken et al., 2015).

Most studies that investigated the effect of mindfulness on self-control are focused on trait mindfulness (e.g., Elkins-Brown et al., 2017; Jo et al., 2017). To activate trait mindfulness among participants, researchers often provide mindfulness trainings consisting of a few sessions spread over several days or weeks for various hours (Alberts et al., 2010; Tapper, 2017). For most individuals, this is unfeasible to apply in a real-life setting because people feel they do not have time to follow a long mindfulness training in modern, fast-paced lives.

Contrary, it takes less time to achieve state mindfulness. Luberto and McLeish (2018) showed this by studying the effect of a 10-minute mindfulness practice on state mindfulness and cigarette cravings among smokers. Compared to a control exercise, the 10-minute mindfulness exercise led to higher state mindfulness among participants. Also, Mahmood and Randsley De Moura (2016) examined if an online 5-minute mindfulness exercise – a body scan – is sufficient to induce state mindfulness. Participants' state mindfulness was measured before and right after the intervention. Compared to a control group who had a similar exercise, the online mindfulness practice of 5 minutes was sufficient to increase levels of state mindfulness.

As a state mindfulness exercise only requires a single mindfulness exercise and thus less time and effort, it would be a more applicable method than trait mindfulness training that requires repeating exercises. For that reason, this current study focuses on the effect of state mindfulness on self-control.

Although limited studies focus on state mindfulness and its effect on self-control, evidence exists that state mindfulness positively influences an individual's self-control in the context of eating behavior. Jordan et al. (2014) concluded that trait mindfulness as well as state mindfulness predicted healthier eating behavior. Participants in the experimental group,

inducing state mindfulness, were more able to regulate themselves in consuming calories in an eating task than people in the control group.

Additionally, Papies et al. (2011) examined whether performing a brief mindfulness exercise, paying mindful attention to external stimuli, positively affect responses to attractive food. Responses were tested with an approach-avoidance task. The study concluded that a mindfulness exercise limits an individual's desire for attractive food, and therefore a mindfulness practice could act as an effective aid to self-regulation. Although a more extensive mindfulness program could have additional favorable effects, a mindfulness exercise does not necessarily have to be repeated in order to have beneficial effects.

State mindfulness and its components

State mindfulness consists of different components that explain how mindfulness works.

Elkins-Brown et al. (2017) claimed that the positive influence of mindfulness on self-control can be explained by the underlying mechanisms of present-moment awareness and acceptance and that combining those two mechanisms strengthens the positive effect on self-control. Also, Inzlicht and Legault (2013) stated that to react to your emotions efficiently, not only present-moment awareness is needed, but also a non-judgmental attitude (i.e., acceptance) towards those emotions.

Tapper (2018) argued that awareness and acceptance are closely related but can be studied independently on the effect of food cravings. This is confirmed by Cardaciotto et al. (2008). They stated that one should highlight the difference between these two components and study them separately as a higher present-moment awareness does not always occur with enhanced acceptance and the other way around (Cardaciotto et al., 2008).

Whereas Elkins-Brown et al. (2017) explained how mindfulness in general influences self-control and Inzlicht and Legault (2013) studied the influence of mindfulness on self-control in the context of physical and social pain, Tapper (2018) reviewed 30 experimental studies that examined the effect of a mindfulness exercise specifically in the context of food cravings. As the current study is about food cravings, Tapper (2018) was considered the most related and the consideration to study the components separately was followed.

In addition, Tapper (2017, p. 124) adds the decentering component of mindfulness: *"the practice of viewing one's thoughts and feelings as temporary events that are separate from oneself and not necessarily a true reflection of reality"*.

All three components, present-moment awareness, acceptance and decentering, could explain the effect of mindfulness on self-control in a food context differently (Tapper, 2017). The review by Tapper (2017) compared several studies on the effects of different mindfulness strategies (i.e., present-moment awareness, acceptance and decentering) on different weight-management-related eating behaviors (i.e., weight loss, calories consumed, consumption of high-calorie foods, food choice). Decentering strategies resulted in an increased capacity to resist food cravings, and present-moment awareness strategies diminished future food intake. However, acceptance strategies showed no apparent effect on immediate food intake. For all three components, further research is needed to get more clarification.

Below, the components will be further illustrated independently, based on existing literature.

Self-control and present-moment awareness

The first component that could explain the relationship between a mindfulness exercise and self-control is present-moment awareness.

By bringing your attention to the present-moment, someone can become aware of their inner emotional state and subsequently evolve the ability to become aware of sensations going on in their everyday lives outside the mindfulness exercise (Elkins-Brown et al., 2017). By being aware of your current sensations, an individual can draw attention to the negative emotions arising from the experienced conflict and subsequently strengthen the ability to respond more adaptively and in a more controlled manner to the negative feeling (Elkins-Brown et al., 2017).

Moreover, Ludwig et al. (2020) stated that the more conscious and informed an individual is about their feelings, thoughts, and surroundings, the more value-consistent their behavior would be. Therefore, they choose the intrinsically more valuable and enjoyable option. So, by engaging in a mindfulness exercise, inducing awareness, someone becomes aware of the reward value of healthy eating and diminishes the reward value for habitual unhealthy eating behaviors. Subsequently, when healthy eating becomes more rewarding, it takes less effort to engage in that behavior, which facilitates controlling unhealthy eating behavior (Ludwig et al., 2020).

Besides, with present-moment awareness, an individual becomes aware of the triggers of eating unhealthy food. For instance, by being mindful, someone realizes that the trigger is

not only the availability of the candy but also, for example, not having eaten lunch or his or her mood (Kristeller, 2015). This decreases the reactivity to unhealthy food.

Self-control and acceptance

The second component that could explain the effect of a mindfulness exercise on self-control is acceptance. Tapper (2017) suggested that the effect of acceptance on response conflict should be examined further, as there is little proof yet of the effect of acceptance in the context of food and self-control.

Existing studies indicated that acceptance could lead to less response conflict.

According to Alberts et al. (2012), more self-control resources would come available by accepting uncomfortable feelings that arise with the response conflict. Subsequently, those resources can be used to control their cravings. This can be explained by the fact that self-control resources can deplete (Muravan et al., 1998) and by resisting uncomfortable thoughts and feelings, one should already use those limited self-control resources (Alberts et al., 2012). The study showed that participants who accepted their feelings while watching a sad video scored better on the following self-control task (Alberts et al., 2012).

In addition, Inzlicht et al. (2014) stated that acceptance reinforces monitoring goal conflicts and enhances an individual's self-control. The acceptance component allows an individual to let thoughts and feelings come and go without judging or restraining them Instead, an individual looks at those thoughts and feelings with curiosity, acceptance and respect (Inzlicht et al., 2014). This, again, reduces the demand on self-control resources and, in turn, make them more disposable. Also, by accepting the thoughts and feelings that arise, someone can understand the meaning of those emotions and cognitions and is more likely to adaptively and effectively react to them (Inzlicht et al., 2014).

Further, Alberts et al. (2010) showed that participants, who followed an acceptance-based intervention training, experienced fewer food cravings and obsessive thoughts about food than participants who did not get the intervention. More precisely, participants in the acceptance-based intervention had less loss of control when exposed to palatable food images.

Friese and Hofmann (2016) also argued that the more accepting and non-judging an individual is about their desires, the less likely it is that an individual experience an inner conflict. However, in contrast to the studies described above, Friese and Hofmann (2016) stated that this could lead to less use of self-control resources. Subsequently, acceptance

could make individuals indulge their desires more instead of controlling them. Participants who were in an acceptance-based mindfulness condition ate the following week more chocolate than the control condition (Friese & Hofmann, 2016).

The contradicting results about the consequences of a lower response conflict on healthy eating behavior, confirms Tapper (2017), who suggested that more research is needed.

The present study follows Alberts et al. (2012) and Inzlicht et al. (2014), who stated that acceptance would increase the accessibility to self-control resources and, therefore, positively influence healthy eating behavior, as it is only Friese and Hofmann (2016) that do not confirm.

Self-control and decentering

Unlike the research mentioned above, Keesman et al. (2017) stated that the awareness and acceptance components of mindfulness did not positively affect reactivity to food cues. Instead, decentering is crucial in diminishing the response to food cues. Keesman et al. (2017) argued that the decentering component of mindfulness could reduce reactivity to food cues because it reduces negative affect and cravings for unhealthy food. By decentering, one can perceive the thoughts about the taste and smell of food and the gratification of eating the food, just as transient subjective events, which makes it easier to detach from the imagery of consuming the food (Keesman et al., 2017). Therefore, food images become less vivid and powerful and thus, the desire and craving for the food are diminished, enabling individuals to experience less conflict towards the food (Keesman et al., 2017). Even though someone does not have a clear health goal, decentering could still be a helpful tool to limit cravings for food and unhealthy food intake (Keesman et al., 2017).

This was supported by an experiment by Papies et al. (2011), who measured the response to a tempting food cue with an approach-avoidance task. The study showed that experiencing the stimuli as a transient mental occurrence interrupted spontaneous responses and facilitated controlling impulsive responses to the food cue.

Likewise, Tapper and Ahmed (2018) indicated that decentering from thoughts and emotions while looking at an image of a chocolate bar, could disturb automatic responses to habitual snacking and subsequently allow an individual to respond in a more controlled manner towards the food stimuli.

Research aims and hypotheses

The research described above shows that mindfulness is an effective self-control strategy. However, the mindfulness-based interventions used in prior studies often lasted for several weeks and are focused on trait mindfulness. Less is known about the effect of a single brief mindfulness exercise, inducing state mindfulness. A brief mindfulness exercise is simple and can be easily performed at home, which makes it an accessible method for most people. Therefore, this present study aims to investigate if a brief mindfulness exercise could be a helpful strategy for reducing response conflict about unhealthy food.

Moreover, there is little understanding of how a mindfulness-based intervention works on response conflict. Looking at existing literature, it is likely that the present-moment awareness and decentering component would positively influence an individual's response conflict. The effect of the acceptance components is still unsure. Also, existing studies rarely untangle the different components of mindfulness or compare them with each other (Keesman et al., 2020). Understanding which mindfulness components are specifically beneficial for self-control in a food context helps strengthen the efficiency of mindful-based interventions (Jenkins & Tapper, 2013). Thus, the second aim of the present study is to explore which components of mindfulness might facilitate reduced response conflict about unhealthy food.

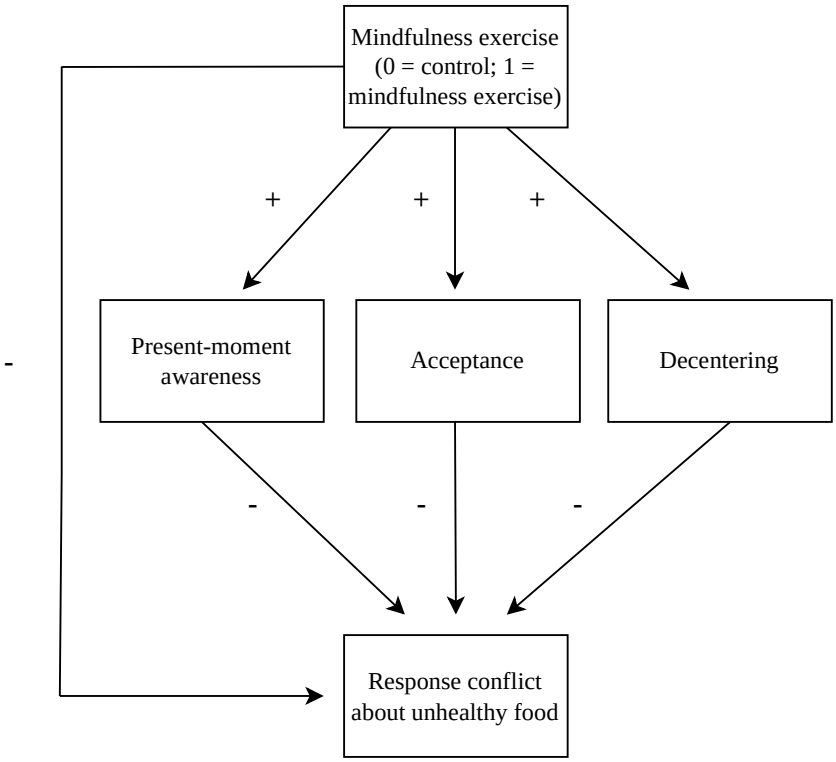
This results in the following research question: *Does a brief, single mindfulness exercise reduces response conflict about unhealthy food, and how can this effect be explained?*

The following hypotheses will be tested (Figure 1):

1. The brief mindfulness exercise (0 = control; 1 = mindfulness exercise) diminishes response conflict about unhealthy food.
2. Present-moment awareness mediates the relationship between the brief mindfulness exercise and response conflict about unhealthy food.
3. Acceptance mediates the relationship between the brief mindfulness exercise and response conflict about unhealthy food.
4. Decentering mediates the relationship between the brief mindfulness exercise and response conflict about unhealthy food.

Figure 1

The expected relations between a brief mindfulness exercise and response conflict about unhealthy food with present-moment awareness, acceptance and decentering as mediators



Method

Design

To measure the effects of the independent variable, the brief mindfulness exercise, on the dependent variable, response conflict about unhealthy food, the present study used an experimental, cross-sectional, and quantitative design. The variables present-moment awareness, acceptance and decentering were analysed as mediators. Goal strength, meditation skills, hungriness and demographics were measured as separate variables.

Participants

Beforehand, a power analysis was performed to calculate the minimum required sample size for the study. The power analysis indicated 385. The data was collected for one month, but after one month of recruiting data, the power analysis was not met.

After collecting data, the research population consisted of 101 participants. Fifteen participants (N = 15) were excluded because they did not meet the criteria: they did not start the audio fragment (N = 7) or did not complete the entire questionnaire (N = 8). Eventually, 86 participants were included in this study, equally spread across the experimental condition (N = 43) and the control condition (N = 43).

The age range of participants was 49, and the mean age was 33.310 (SD = 14.305). The sample included 52 women and 34 men. In total, 67 participants were Dutch, and 19 were from other nationalities. Additionally, 54.7% of the participants (N = 47) had completed their bachelor's degree, and 26.7% had their master's degree (N = 23). Other levels of education completed were high school (N = 10), doctorate degree (N = 3), intermediate vocational education (N = 2) and professional degree (N = 1). Besides, the majority of the participants, 59.3%, was employed (N = 51), 32.6% was student (N = 28) and the remaining 8.1% was unemployed (N = 4), retired (N =2), or other (N =1).

Materials and measurements

The independent variable was manipulated, and several variables were measured for this study. The entire questionnaire can be found in Appendix[1].

Brief mindfulness exercise manipulation

Participants were informed that they would listen to an audio with a mindfulness body scan (experimental condition) or a history audio (control condition) that would last for 10 minutes (Cropley et al., 2007). The mindfulness audio was a guided body scan in which the participant was instructed to focus on breathing by bringing their attention to their abdominal area. Later, participants were guided to bring attention to other body areas.

The control audio was a neutral natural history story about Selbourne, a village in England.

Participants in both conditions were asked to listen to the entire audio and adopt a relaxed and upright seated position with closed eyes.

An invisible timer was set on the audio page to check if participants listened to the entire audio.

[1] Since the data collection is a cooperation between two students, the questionnaire consisted of (sub)scales that were not used in the present study, including the Brief Self-Control scale and the subscale curiosity of the Toronto Mindfulness Scale (TMS). However, the subscale decentering of the TMS is used for this study.

Goal strength

Goal strength items were used to assess the dietary aims of participants (Rosenthal & Dietl, 2022). The questionnaire included the following three items: *"I am currently trying to eat a healthy diet"*, *"Maintaining a healthy diet is very important to me"*, and *"Eating a healthy diet is one of my main goals".* The items were scored on a Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*), and the three items were averaged to measure the total score of goal strength.

Cronbach's alpha (α) indicated an acceptable internal reliability of the items for the experimental condition (α = .713) and good internal reliability for the control condition (α = .839).

Meditation skills

Participants were asked about their meditation skills with the single question "*How skilled do you find yourself in terms of applying meditation techniques?"* (Keesman et al., 2020), measured on a 0 to 10 Visual Analogue Scale (VAS).

Hungriness

The hungriness scale assessed how hungry participants felt when participating, with the question *"How hungry are you at the moment?".* It was measured on a VAS from 0 to 10.

Response conflict about unhealthy food

To measure response conflict about unhealthy food, seven images of unhealthy food by Rosenthal and Dietl (2022) were shown. The images were presented randomly and included a cheeseburger, pizza, brownie, chocolate, fries, pancakes and bonbons. Participants were asked how conflicted they felt towards the images on a 5-point Likert scale, ranging from 1 (*no conflict*) to 5 (*maximum conflict*). The seven items of food images read *"Towards the pictured food, I feel…".*

All items were averaged and had a good internal reliability for the experimental (α = .819) and control condition (α = 8.23).

Present-moment awareness

The Mindful Attention Awareness Scale (MAAS) – State was used to measure present-moment awareness (Brown & Ryan, 2003). The measure consists of five items on a

7-point Likert scale, ranging from 0 (*not at all*) to 6 (*very much*). A sample item was *"While listening to the audio… I was finding it difficult to stay focused on what was happening."*. All items were negatively formulated, so they were reverse coded and then the total score of all items was averaged.

The internal reliability of the items was good for the experimental condition (α = .833) and acceptable for the control condition (α = .755).

Acceptance

The subscale non-judging of inner experience from the Five Facet Mindfulness Questionnaire (FFMQ) was used to measure the acceptance component (Baer et al., 2011). The subscale consisted of eight items, all reverse coded, with answer options ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*). The total score of the items was calculated by averaging the items. As the statements in the FFMQ initially concerned trait mindfulness, the statements were modified to refer to state mindfulness by adding *"While listening to the audio…"* and rewriting the sentence in the past tense. For example, *"I tell myself that I shouldn't be thinking the way I'm thinking"* was changed to *"While listening to the audio… I told myself that I shouldn't be thinking the way I'm thinking"*.

The internal reliability of the subscale was excellent for both the experimental (α = .929) and control (α = .903) condition.

Decentering

The Toronto Mindfulness Scale (TMS) consists of two subscales that capture two components of mindfulness: decentering and curiosity (Lau et al., 2006). The seven items of the subscale decentering were used to measure decentering and were summed to calculate the total score. They were measured on a 5-point Likert scale, from 0 (*not at all*) to 4 (*very much*). An example of the items was: *"While listening to the audio… I experienced myself as separate from my changing thoughts and feelings"*.

The internal reliability of the subscale was acceptable for both the experimental (α = .741) and control condition (α = .780).

Dempographics

At the end of the survey, five demographic questions were asked. First, they were asked about their age. Next, participants were asked about their nationality, choosing between

Dutch and *Other*. Besides, their gender was asked with the response options: *Male, Female, Non-binary /third gender*, *Prefer to self-describe* and *Prefer not to say*. Furthermore, they were asked about their highest level of education completed: *No schooling completed, High school, Bachelor's degree, Master's degree, Professional degree, Doctorate degree, Prefer not to say* or *Other*. Lastly, their employment status was asked, and they could select *Working full-time, Working part-time, Unemployment and looking for work, A home-maker or stay-at-home parent, Student, Retired*, or *Other*.

Procedure

This study has been approved by the Ethical Review Board of the Faculty of Social and Behavioural Sciences of Utrecht University filed under number 22-1133.

Participants were recruited via convenience and snowball sampling, as they were approached through Whatsapp and Facebook and were asked to forward the survey. The survey was also posted on different Facebook groups with as subject mindfulness or meditation.

The survey was created on the Qualtrics platform, and the experiment took place online, with participants using their computers or mobile phones.

Before participants could continue the study, they were provided with a short introduction to the study. They were asked to participate in a quiet environment where they could not be disturbed. Besides, they had to provide informed consent to continue the study.

The study started with questions about goal strength, hungriness and meditation skills. Then the participants needed to listen to a 10-minute audio fragment. Participants were randomly assigned to the experimental condition (mindfulness audio) or control condition (history audio). After that, they were exposed to attractive yet unhealthy food images and were asked to rate the conflict they felt towards the food. Then, the study continued with questions about present-moment awareness, decentering and acceptance and ended with questions about demographic data. Apart from the audio, the questionnaire was the same for both conditions. The experiment took around 20 to 25 minutes in total.

Data analysis

For the data analysis, IBM Statistical Program for Social Sciences (SPSS) version 28.01.0 was used. A parallel mediation analysis was conducted to evaluate the extracted data, using the PROCESS macro for SPSS of Andrew Hayes (Kane & Ashbaugh, 2017). In

addition, independent samples *t*-tests and Pearson correlations were performed to determine differences between groups and associations between variables. A significance level of $p < .050$ is set for all analyses, and significance values between .050 and .100 were considered trends.

Results

Descriptive statistics

Table 1 illustrates that participants in the control condition scored on average higher on the covariates meditation skills, hungriness and goal strength. Contrary, age scored higher in the experimental condition than in the control condition. Participants scored relatively low on hungriness and goal strength, both in the control and experimental condition.

On all main variables (i.e., response conflict, acceptance, present-moment awareness, and decentering), the experimental condition scored on average higher than the control condition. Both conditions scored on average between low and some response conflict.

Table 1

Means and standard deviations (SD) of main variables and covariates for both conditions together (N = 86), as well as the control condition (N = 43) and experimental condition (N =43) separately. Test statistics (t) and significance values (p; two-tailed) of comparisons between the conditions

	Total		Control condition		Experimental condition		*t*	*p*
	M	*SD*	*M*	*SD*	*M*	*SD*		
Covariates								
Meditation skills	4.300	2.197	4.600	2.311	4.000	2.059	1.281	.204
Hungriness	3.970	2.485	4.510	2.453	3.420	2.422	2.079	.041
Goal strength	3.760	.759	3.780	.752	3.730	.774	.330	.742
Age	33.310	14.305	32.260	14.050	34.370	14.637	-.684	.496

Main variables								
Response conflict	2.470	.846	2.450	.843	2.490	.857	-.236	.814
Present-moment awareness	3.260	1.301	2.980	1.256	3.530	1.302	-1.989	.050
Acceptance	3.900	.863	3.880	.806	3.920	.927	-.217	.828
Decentering	12.870	5.500	11.400	5.482	14.350	5.168	-2.571	.012

Exploratory analysis

To detect if there were univariate and multivariate outliers, the *z*-scores and the Mahalanobis distances were inspected. The absolute scores of the *z*-scores were < 3.290, so there were no univariate outliers. Also, there were no multivariate outliers, as all *p*-values of Mahanolobis distance were > .010. Therefore, no items had to be deleted.

Moreover, it was checked whether the scores on the covariates were equal for the two conditions and genders through independent samples *t*-tests.

A shown in Table 1, the covariate hungriness differed between the two conditions, $t(84) = 2.079$, $p = .041$. Participants in the control condition were hungrier than participants in the experimental condition. There were no significant differences between conditions on the other covariates.

In addition, there were no significant differences between men and women on any of the covariates (meditation skills: $t(84) = .372$, $p = .711$, hungriness: $t(84) = -.072$, $p = .943$, goal strength: $t(84) = -.394$, $p = .694$ and age: $t(84) = 1.464$, $p = .168$).

Furthermore, Pearson correlation analyses were performed to explore whether covariates were correlated with the variables of interest (see Table 2). There was a positive, moderate correlation between meditation skills and decentering. No other correlations between covariates and variables of interest were significant. Also, correlations were found between the main variables. Negative, moderate correlations were found between present-moment awareness and response conflict and between acceptance and response conflict. Moreover, there was a strong, positive correlation between acceptance and present-moment awareness ($r(84) = .521$, $p < .001$).

Table 2

Pearson correlations between the variables

Variable	1	2	3	4	5	6	7	8
1. Meditation skills	-							
2. Hungriness	-.024	-						
3. Goal strength	.066	.049	-					
4. Age	.277**	-.151	-.061	-				
5. Response conflict	-.024	-.157	.047	.028	-			
6. Present-moment awareness	.168	-.085	.077	.148	-.322*	-		
7. Acceptance	.140	-.042	-.008	.125	-.365**	.521**	-	
8. Decentering	.305**	-.082	.084	.157	.037	.163	.048	-

Note. *$p < .050$, **$p < .010$ (two-tailed).

Inferential analysis

Before performing the analysis, the assumptions were checked. First, a linear regression was conducted to check the assumption of linearity through scatterplots of the residuals against predicted values. All scatterplots showed a linear relationship. Second, the assumption of homoscedasticity was tested, by looking at how the estimation errors were spread in the scatterplots of the linear regression. The errors were equally and consistently spread. Third, Q-Q plots of the main variables were created and showed that the residuals of

the linear regression analysis were normally distributed. With this, the assumption of linearity, homoscedasticity and normality of estimation error were met.

To examine the hypotheses, a parallel mediation analysis was conducted, using PROCESS.

First, the direct effect of a mindfulness exercise on response conflict about unhealthy food was tested. Figure 2 shows that no significant, direct effect is found between a brief mindfulness exercise (0 = control, 1 = mindfulness exercise) and response conflict about unhealthy food ($F(1,84) = .055$, $R^2 = .001$, b (SE) = .043 (.183), $\beta = .098$; $p = .590$).

Next, mediating effects, first the effects of the mindfulness exercise on the mediators and then the effects of the mediators on response conflict about unhealthy food, were considered.

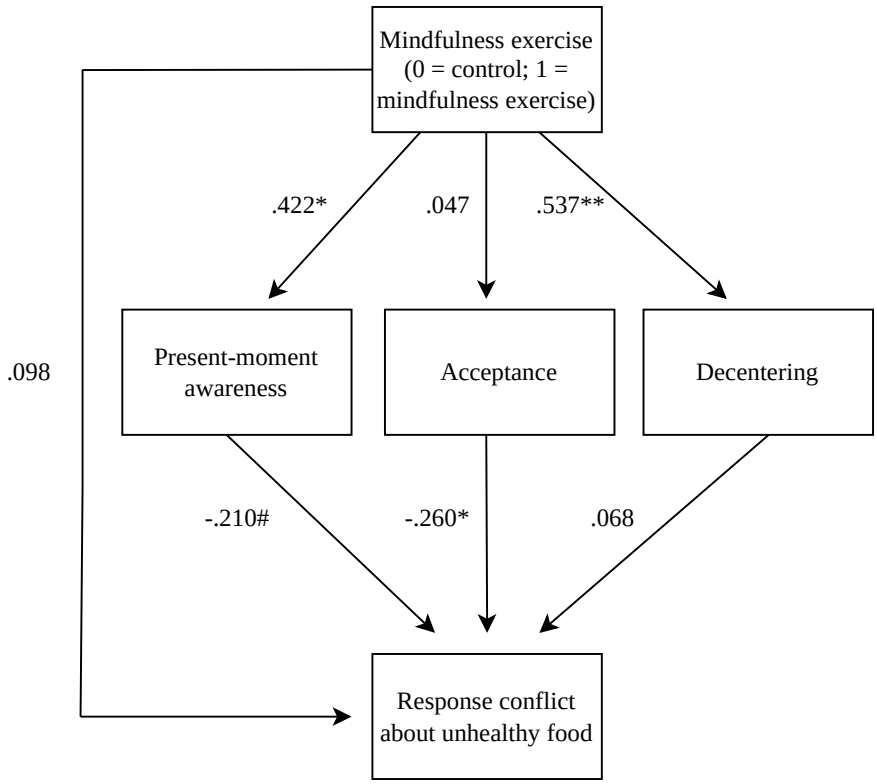
The mindfulness exercise increased present-moment awareness, which was just significant ($F(1,84) = 3.957$, $R^2 = .045$, b (SE) = .549 (.276), $\beta = .422$; $p = .050$), and decentering ($F(1,84) = 6.608$, $R^2 = .073$, b (SE) = 2.953 (1.149), $\beta = .537$; $p = .012$). However, the mindfulness exercise did not affect acceptance ($F(1,84) = .047$, $R^2 = .001$, b (SE) = .041 (.187), $\beta = .047$; $p = .829$).

Looking at the effects of the mediators on response conflict about unhealthy food, acceptance reduced response conflict about unhealthy food, $F(4,84) = 4.047$, $R^2 = .167$, b (SE) = -.255 (.117), $\beta = -.260$; $p = .032$. Present-moment awareness ($F(4,84) = 4.047$, $R^2 = .167$, b (SE) = -.136 (.080), $\beta = -.210$; $p = .091$) and decentering ($F(4,84) = 4.047$, $R^2 = .167$, b (SE) = .010 (.016), $\beta = .068$; $p = .525$) did not affect response conflict about unhealthy food significantly, even though , the negative effect of present-moment awareness on response conflict about unhealthy food could be regarded as a trend ($p < .100$).

The analysis was performed again, first with hungriness as a covariate as it differed between the two conditions, then with meditation skills as a covariate as it was correlated with the main variable decentering and lastly, with both hungriness and meditation skills as covariates. However, neither of these covariates, changed the pattern of the results, so they were not taken into further account in the main analysis.

Figure 2

The relationship between a mindfulness exercise and response conflict about unhealthy food mediated by present-moment awareness, acceptance and decentering. All presented effects are standardized (ß)



Note. *$p < .050$, **$p < .010$, #$p < .100$.

Discussion

This study aimed to investigate if a brief single mindfulness exercise could be an effective strategy for reducing response conflict in food cravings and, if effective, how this effect could be explained. It was hypothesized that present-moment awareness, acceptance and decentering would mediate the effect of a mindfulness exercise on response conflict about unhealthy food.

No direct effect was found between the mindfulness exercise and response conflict about unhealthy food. The mindfulness exercise increased present-moment awareness and decentering but did not affect acceptance. Moreover, while acceptance resulted in a lower

response conflict about unhealthy food, present-moment awareness and decentering did not affect response conflict about unhealthy food. Though, present-moment awareness did show a trend effect on response conflict about unhealthy food. In short, contrary to the hypotheses, no direct and no mediating effects were found between a mindfulness exercise and response conflict about unhealthy food.

A possible explanation for this could be that the conditions of experiencing a conflict have not been mapped out well enough. This, in turn, might have threatened the results of the outcome response conflict and, therefore, the mediators as well. A response conflict exists when an individual's goal conflicts with an individual's desire, and the amount of response conflict depends on the initial desire, and the goal a participant has (Rosenthal & Dietl, 2022). However, both conditions, desire and goal strength, essential for experiencing a conflict, were not appropriately considered.

Firstly, the desire for unhealthy food images was not measured. Strong desires have higher response conflicts than weaker desires. If there is initially no temptation, no dilemma arises, and thereby no self-regulation is needed (Gillebaart et al., 2020). Participants likely differed in desires for the food. The food images were universal but might not be equally attractive for everyone because of, for instance, personal preferences (e.g., vegetarian participants will look at a cheeseburger differently than meat-eaters).

Secondly, participants who scored lower than neutral (i.e., < 3) on goal strength were included in the study. Those participants do not intend to eat healthily and thus may have a lower chance of perceiving a response conflict (Rosenthal & Dietl, 2022). For that reason, contrary to the present study, Rosenthal and Dietl (2022) only included participants who scored on average at least 'neutral' (i.e., ≥ 3) on goal strength.

Also, the non-mediating effects of present-moment awareness and acceptance do not correspond with what was predicted based on existing literature (Alberts et al., 2012; Inzlicht et al., 2014; Kristeller, 2015; Ludwig et al., 2020). Unexpectedly, the non-mediating effect of acceptance is in line with Friese and Hofmann (2016), who stated that acceptance makes individuals indulge more. Also, it is consistent with Tapper (2017), in which acceptance does not show a clear effect on food intake.

An explanation for the non-significant mediation is, as described above, partly the insufficient identification of the variable response conflict. In addition, another explanation could be the use of components of mindfulness. This study used present-moment awareness and acceptance as separate components. However, the strong correlation that was found

indicates that when present-moment awareness increases, acceptance increases, and the other way around. Therefore, considering the components as one component instead of two separate ones may strengthen the effect and would have more impact on the outcome variable.

Yet, this is not in line with Cardaciotto et al. (2008), who stated that one should study the different mechanisms of mindfulness separately because an increased present-moment awareness does not necessarily go hand in hand with increased acceptance and vice versa. Tapper (2018) also argued that the components could be studied separately in a food context.

However, it is more consistent with Elkins-Brown et al. (2017) and Inzlicht and Legault (2013), who argued that both components are needed and that combining present-moment awareness and acceptance reinforces the effect of a mindfulness exercise on response conflict.

Doing a mindfulness exercise does significantly increase present-moment awareness and decentering, but not acceptance. Therefore, the results are not entirely consistent with previous literature that a brief mindfulness exercise could bring you to a state of mindfulness (Mahmood & Randsley De Moura, 2016; Luberto & McLeish, 2018). A possible explanation could be that existing literature used different components to indicate state mindfulness. Whereas in the current study, state mindfulness is measured by the separate components present-moment awareness, acceptance and decentering, Mahmood and Randsley De Moura (2016) measured state mindfulness with the TMS and Luberto and McLeish (2018) with the State Mindfulness Scale (SMS).

Limitations and strengths

Several limitations of the present study should be considered because they could affect the reliability and validity of the study.

A first shortcoming of the study is the potential inaccuracy of the answers, reducing the validity of the data. Firstly, due to convenience, response conflict relies on a self-reported measure. The measure may be inaccurate in real life, and therefore a mouse tracking task, similarly to the study by Schneider et al. (2019) and Gillebaart et al. (2020), would be more valid to measure response conflict. Secondly, the questionnaire and the audio were in English in order to be able to reach a large and diverse group of participants. However, English was not the mother tongue of the majority of the respondents, and thus respondents could have misinterpreted the questions or misunderstood what to do. As the statements used to measure

the components were detailed and sometimes subtly differed from one another, it was important that participants would have understood them well to be able to have answered them correctly.

Furthermore, the lack of significance may be attributed to a power problem. The required sample size was 385, at a power of .800, and with 86 respondents participating in this study, the power was insufficient for the analysis. This could partly be due to the length of the study. The experiment took around 20 to 25 minutes, including the audio fragment lasting 10 minutes. Therefore, even though the study was made accessible by offering it online, the time needed to participate could be a barrier to start the study and lead to drop out. In addition, because the study was offered online, it could not be checked if participants actually listened to the audio and participated in the exercise, which also lead to dropouts. The small sample reduces the chance that the test will reflect actual existing effects and impacts the internal and external validity of the results (Faber & Fonseca, 2014).

Another limitation that comes with it is the mild exclusion criteria of the study. Because of the small sample and to not reduce it even more, not everyone who would have potentially been excluded was removed from the study. Therefore, participants who stayed on the audio page for fewer than 5 minutes were included in the study. This risks the results because a 5-minute mindfulness exercise can bring an individual into a mindful state (Mahmood & Randsley De Moura, 2016) but, as far as it is known, it is unclear if a mindfulness practice of fewer than 5 minutes will do the same. Also, to not threaten the power, participants who had problems while playing the audio were included.

A strength of the study is that it is a randomized experiment, which is an accurate instrument to measure a cause-effect relation between the mindfulness exercise and response conflict about unhealthy food. Also, it ensures that two comparable groups are created, increasing the research's internal validity.

Another strength is that this study appears to be the first to investigate the three different components separately and compare them in the same model. Therefore, this study gives important insights into which components of mindfulness are relevant to study in the context of self-control and which mediators should be considered for further research.

Implications

The current study gives a fresh perspective on state mindfulness. It does not only look at the effect of state mindfulness on response conflict but also critically looks at what state

mindfulness entails, instead of using standardized measurements for state mindfulness, such as the TMS and SMS. With that, the study shows that state mindfulness is comprehensive, indicating the importance of the choice of the components of state mindfulness. The study gives insight into reconsidering which components should be used and if present-moment awareness and acceptance should be studied as unrelated components.

This study does not support that a brief mindfulness exercise decreases response conflict about unhealthy food. Therewith, the study highlights the complexity of the construction of the model and clarifies that more research is needed to explore the effect of state mindfulness on self-control. For future research, it is relevant to continue on this because, by understanding which components of mindfulness are relevant to reduce a response conflict about unhealthy food, the efficiency of a mindfulness exercise could be increased. Also, the study is practically relevant as it used a potentially beneficial method for everyone, an exercise one could practice at home when one craves unhealthy food.

Recommendations

Future research should use a larger sample so that the exclusion criteria could be more stringently applied. Therefore, only including participants who listened to the audio fragment for the minimum amount of time needed to reach state mindfulness, participants who did not have any problems while listening to the audio fragment and participants who scored a certain minimum amount of goal strength and desire. For that, desire for the food must also be measured to get an adequate idea of a respondent's likelihood of experiencing a conflict towards unhealthy food.

Besides, to prevent dropouts, an audio of 5 minutes should be used as 5 minutes is already enough to bring participants into a mindful state, or further research should determine if a shorter exercise would also bring participants into a mindful state. The shorter the exercise, the more applicable it is for people in their daily lives to use it for controlling their cravings. In addition, to prevent dropouts and ensure participants listen to the entire audio, participants should conduct the study in a more controlled setting, for instance, a laboratory. Also, as a manipulation check, a question related to the content of the audio should be added.

Lastly, acceptance and present-moment awareness should be further investigated in a food context to examine if the components should be studied related to each other and, if not, which components would be the best to use when testing a mediating effect between a mindfulness exercise and response conflict about unhealthy food.

Conclusion

Although no direct and no mediation effects were found between a brief single mindfulness exercise and response conflict about unhealthy food, the study adds to limited previous studies about the effect of a single mindfulness exercise – inducing state mindfulness – on self-control. By having a closer look at state mindfulness and disentangling the components of state mindfulness, the study is critical and shows the complexity of state mindfulness. The strong correlation between present-moment awareness and acceptance prompts further investigation into which components should be considered to understand the effects on response conflict about unhealthy food. Also, a larger sample size is needed to draw more concrete conclusions.

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Appendix: Online questionnaire

Informed consent

Dear participant,

We are Mieke and Renske, two master's students from Utrecht University. For our master's thesis, we are conducting an online experiment in which we are interested in the effect of a short mindfulness exercise on the response of seeing unhealthy food images.

When participating in this study, it is important to take place in a quiet environment where you cannot be distracted or disturbed and that you are able to listen to an audio fragment. The study will start with a short questionnaire. You will then listen to a 10-minute audio fragment. Thereafter, you will be shown images of food and we will ask you to rate these images. The study ends with a final questionnaire.

Participation in the study will take approximately 25 minutes. The results of this study will only be used for scientific purposes and will not be shared with third parties. By deciding to start this study, you confirm that you are at least 18 years of age and that you are aware that your participation in this study is voluntary and that you can stop with the study at any time for no reason.

If you have any further questions, please contact us by sending an email to m.a.priesman@students.uu.nl.

Best regards,

Renske ten Bokkel Huinink and Mieke Priesman, Students Social, Health and Organizational Psychology (Utrecht University)

Questions

1. Meditation skills (0 – 10)
   How skilled do you find yourself in terms of applying meditation techniques?

2. Hungriness (0 – 10)

   How hungry are you at the moment?

3. Goal strength (strongly disagree – strongly agree)
   a. I am currently trying to eat a healthy diet.
   b. Maintaining a healthy diet is very important to me.
   c. Eating a healthy diet is one of my main goals.

4. Trait self-control (not at all like me – very much like me)
   a. I am good at resisting temptation.
   b. I have a hard time breaking bad habits.
   c. I am lazy.
   d. I say inappropriate things.
   e. I do certain things that are bad for me, if they are fun.
   f. I refuse things that are bad for me.
   g. I wish I had more self-discipline.
   h. People would say that I have iron self-discipline.
   i. Pleasure and fun sometimes keep me from getting work done.
   j. I have trouble concentrating.
   k. I am able to work effectively toward long-term goals.
   l. Sometimes I can't stop myself from doing something, even if I know it is wrong.
   m. I often act without thinking through all the alternatives.

[Experimental condition] *You are now going to listen to an audio with a mindfulness body scan. The audio lasts 10 minutes. Please listen to it entirely and take a relaxed and upright sit with your eyes closed for listening to this audio fragment.*
[Control condition] *You are now going to listen to an audio of a history story. The audio lasts 10 minutes. Please listen to it entirely and take a relaxed and upright sit with your eyes*

closed for listening to this audio fragment.

5. Control question

   Were you able to play the audio without any problems?

   - Yes
   - No

6. Response conflict about unhealthy food (no conflict – maximum conflict)

Now you will see seven pictures of food. Some people may feel conflicted feelings when they see these pictures of food. They may experience a conflict between a current goal (e.g., to eat healthily) and competing desires (e.g., to eat unhealthy food). Please indicate for each picture how conflicted you feel towards the food pictures from no conflict to maximum conflict.

Towards the pictured food, I feel...

a.

b.

c.

d.

e.

f.

g.

The following questions are about your experience while listening to the audio.

7. Decentering (TMS) (not at all – very much)
   (Only the statements with * are about decentering and used for this study)

   While listening to the audio...

   a. I experienced myself as separate from my changing thoughts and feelings.*
   b. I was more concerned with being open to my experiences than controlling or changing them.*
   c. I was curious about what I might learn about myself by taking notice of how I react to certain thoughts, feelings, or sensations.
   d. I experienced my thoughts more as events in my mind than as a necessarily accurate reflection of the way things 'really' are.*
   e. I was curious to see what my mind was up to from moment to moment.
   f. I was curious about each of the thoughts and feelings that I was having.

g. I was receptive to observing unpleasant thoughts and feelings without interfering with them.*
h. I was more invested in just watching my experiences as they arose, than in figuring out what they could mean.*
i. I approached each experience by trying to accept it, not matter whether it was pleasant or unpleasant.*
j. I remained curious about the nature of each experience as it arose.
k. I was aware of my thoughts and feelings without overidentifying.*
l. I was curious about my reactions about things.
m. I was curious about what I might learn about myself by just taking notice of what my attention gets drawn to.

8. Present-moment awareness (MAAS – State) (not at all – very much)

While listening to the audio...

a. I was finding it difficult to stay focused on what was happening.
b. I was doing something without paying attention.
c. I was preoccupied with the future or the past.
d. I was doing something automatically, without being aware of what I was doing.
e. I was rushing through something without being really attentive to it.

9. Acceptance (FFMQ) (never or very rarely true – very often or always true)

While listening to the audio...

a. I criticized myself for having irrational or inappropriate emotions.
b. I told myself I shouldn't be feeling the way I'm feeling.
c. I believed some of my thoughts were abnormal or bad and I shouldn't think that way.
d. I made judgments about whether my thoughts were good or bad.
e. I told myself that I shouldn't be thinking the way I'm thinking.
f. I thought some of my emotions were bad or inappropriate and I shouldn't feel them.

g. When I had distressing thoughts or images, I judged myself as good or bad depending what the thought or image was about.
h. I disapproved of myself when I had irrational ideas.

10. Age

What is your age?

_____

11. Nationality

What is your nationality?

- Dutch
- Other _____

12. Gender

How do you describe yourself?

- Male
- Female
- Non-binary / third gender
- Prefer to self-describe _____
- Prefer not to say

13. Educational level

What is the highest level of education you have completed?

- No schooling completed
- High school
- Bachelor's degree
- Master's degree
- Professional degree
- Doctorate degree
- Prefer not to say
- Other _____

14. Work status

    What best describes your employment status over the last three months?

    - Working full-time
    - Working part-time
    - Unemployed and looking for work
    - A homemaker or stay-at-home parent
    - Student
    - Retired
    - Other _____