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Indulgent thinking? Ecological momentary assessment of overweight and healthy-weight participants' cognitions and emotions

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A B S T R A C T

Cognitions and emotions are considered important determinants of eating behaviour in cognitive behavioural models of obesity. Ecological data on these determinants is still limited. The present study investigated cognitions and emotions of overweight ($n = 57$) and healthy-weight ($n = 43$) participants via Ecological Momentary Assessment.

It was found that eating-related cognitions mainly focused on desire and taste. Unexpectedly, dysfunctional cognitions (i.e., thoughts that may promote overeating) did not occur more often for overweight participants in almost all cases. So, the present EMA study provides no evidence for a role of dysfunctional cognitions in obesity-promoting eating behaviour when assessing eating-related cognitions immediately prior to eating events using a free-text format assessment.

Right before eating events, participants mostly reported feeling calm/relaxed and cheerful/happy. Overweight participants scored higher on negative emotions, both at eating events and non-eating moments, than did healthy-weight participants. In addition, scores on standard questionnaires assessing emotional eating were positively associated with negative emotions reported at both eating and non-eating moments. As such, negative emotions, as assessed in the present study, do not seem to be *specific* triggers for food consumption.

The increased availability of high caloric palatable foods and drinks has been accompanied by a surge in obesity rates (Swinburn et al., 2011). Results of most weight loss trials have been marginal at best, with most or all weight-losses regained over a span of 5 years (Anderson, Konz, Frederich, & Wood, 2001; Dansinger, Tatsioni, Wong, Chung, & Balk, 2007; Douketis, Macie, Thabane, & Williamson, 2005; Gudzune et al., 2015). One important reason for these disappointing results may be an insufficient focus on psychological factors, such as dysfunctional cognitions (i.e., thoughts that may promote overeating) and emotions, which may moderate the association between availability of food and eating behaviour (Carter & Jansen, 2012; Faith, Fontaine, Baskin, & Allison, 2007; Karhunen et al., 2012). The goal of the present study was to investigate cognitions and emotions as they occur when not eating, and prior to eating events in overweight and healthy-weight participants.

The cognitive model for obesity states that inadequate weight loss is the result of dysfunctional cognitions and emotions about eating, weight and shape (e.g., "when I eat, I have to empty my plate"; Werrij, 2005). Such cognitions can cause dietary disinhibition, and the resulting overeating in turn reinforces dysfunctional cognitions and beliefs (e.g., "I may as well continue eating"). Previous research has shown that obese participants had more dysfunctional food- and weight-related cognitions concerning catastrophizing, body image and self-control, than healthy-weight participants (Nauta, Hospers, Jansen, & Kok, 2000; O'Connor & Dowrick, 1987; Vreugdenburg, Bryan, & Kemps, 2003). So far, the effectiveness of changing eating-related dysfunctional cognitions to promote weight loss has been investigated in several clinical trials. Studies comparing Cognitive (Behavioural) Therapy (C(B)T) for obesity with a diet and exercise control group (Werrij et al.,

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2009), behavioural therapy (Sbrocco, Nedegaard, Stone, & Lewis, 1999), a wait-list control group (Stahre & Hällström, 2005) and treatment-as-usual (Stahre, Tärnell, Håkanson, & Hällström, 2007) found that the CBT group achieved modest weight loss that was maintained at a 12-month follow-up, whereas the other groups regained the lost weight. Cooper et al. (2010), however, found that weight lost after CBT was regained at 3-year follow-up. So, the evidence so far suggests CT/CBT might be relatively effective for the long-term treatment of obesity.

Another central cognitive-behavioural determinant of (over) eating for overweight people is emotions (Beck, 2011; Carter & Jansen, 2012). Both positive and negative emotions have been associated with food intake (Cardi, Leppanen, & Treasure, 2015; Oliver, Wardle, & Gibson, 2000; van Strien, Herman, Anschutz, Engels, & de Weerth, 2012). To improve CBT for obesity, more knowledge should be gained on the contents of dysfunctional cognitions and the nature of emotions prior to eating in overweight versus healthy-weight people (Carter & Jansen, 2012). Therefore, the present study investigated cognitions and emotions as they occur when not eating, and prior to eating, using Ecological Momentary Assessment (EMA).

EMA is an increasingly popular research method in which people's everyday lives are put under a magnifying lens (Mehl & Connor, 2012). EMA forms an important adjunct to experimental research in laboratory settings, because it increases ecological validity (Shiffman, Stone, & Hufford, 2008). EMA data can provide different insights from retrospective measures. For example, EMA may detect binge eating in cases where diagnostic interviews may not (Goldschmidt, Crosby, Cao, et al., 2014). EMA can also provide greater construct validity due to directly measuring relevant events (Shiffman et al., 2008). Given these advantages, EMA seems especially suitable for the investigation of cognitive and emotional associations with (problematic) eating behaviour.

So far, some studies have investigated eating- and obesity-related cognitions using EMA. It was found that all participants, but in particular those high on eating pathology, had increased exercise and diet-related cognitions after social comparisons (Leahey, Crowther, & Ciesla, 2011; Rancourt, Leahey, Larose, & Crowther, 2015). In addition, eating disordered participants had more negative emotion-related cognitions before and after binge eating events (Hilbert & Tuschen-Caffier, 2007), and reported greater negative affect following self-reported loss of control after an eating event (Goldschmidt, Crosby, Cao, et al., 2014; Goldschmidt, Crosby, Engel, et al., 2014). Lastly, after a dietary lapse, women in a weight loss program reported more dieting and health-related cognitions than when merely tempted to eat (Carels, Douglass, Cacciapaglia, & O'Brien, 2004). In short, so far, most EMA studies have covered a wide range of eating-related cognitions, mainly in samples with eating pathology.

For emotions, both negative and positive emotions coincided with eating events in healthy-weight participants (Macht, Haupt, & Salewsky, 2004), and increases in these emotions were associated with more dietary lapses (Carels et al., 2001; McKee, Ntoumanis, & Taylor, 2014). In adolescents, self-reported minor daily stressors predicted desire to eat high-caloric foods (Kubiak, Vögele, Siering, Schiel, & Weber, 2008), and eating unhealthy snacks was associated with feeling more bored or lonely (Grenard et al., 2013). These data fit with laboratory studies showing that both negative and positive emotions can induce (over)eating in overweight (Chua, Touyz, & Hill, 2004; Jansen et al., 2008) and healthy-weight participants (Bongers, Jansen, Havermans, Roefs, & Nederkoorn, 2013; Oliver et al., 2000).

Previous EMA research on (over)eating behaviour mostly did not include comparisons between overweight and healthy-weight participants. In addition, most EMA research on eating-related cognitions has focused on eating disorders, and on BED in particular. However, the prevalence of BED is only around 30% for individuals seeking weight loss treatment (De Zwaan, 2001). So, more insights into eating-related cognitions from a non-BED sample are needed. The present study examines cognitions and emotions in the context of eating events and non-eating moments in daily life, and compares overweight and healthy-weight participants. Cognitions and emotions were assessed over the course of a two-week period. Emotions and cognitions were rated immediately prior to self-reported eating events, and in the case of emotions, at random times throughout the waking day (non-eating moments). It was expected that overweight participants would report more dysfunctional cognitions and negative emotions prior to eating and would believe more strongly in such cognitions than healthy-weight participants.

A secondary aim was to investigate whether emotional eating questionnaire scores reflect actual emotional eating, or a dysfunctional belief about eating behaviour. Much research on emotional eating – defined as eating in response to experienced negative emotions – has relied on retrospective questionnaire measures, such as the Emotional Eating subscale of the Dutch Eating Behaviour Questionnaire (EE-DEBQ; van Strien, Frijters, Bergers, & Defares, 1986). Several studies shed doubt on the validity of these self-report questionnaires. Self-reported emotional eaters did not eat more after negative emotions (Bongers, Jansen, Havermans, et al., 2013; O'Connor & O'Connor, 2004). In addition, scores on the EE-DEBQ did not predict (snack) intake (Adriaanse, de Ridder, & Evers, 2011; Bongers, de Graaff, & Jansen, 2016; Bongers, Jansen, Houben, Roefs, 2013; Evers, de Ridder, & Adriaanse, 2009; Jansen et al., 2011; Lluch, Herbeth, Méjean, & Siest, 2000; Werthmann et al., 2014). To further investigate the validity of emotional eating questionnaires, measurements of emotions and eating behaviour as they occur in daily life could be beneficial. This way, the issues of memory recall bias that are associated with retrospective questionnaire assessment (Bradburn, Rips, & Shevell, 1987; Schwarz, 2007), especially for events with a high emotional impact (Fredrickson, 2000), are avoided. By comparing EMA and questionnaire data, it can then be established whether emotional eating is an actual eating style, or a dysfunctional belief about the association between emotions and eating (Adriaanse et al., 2011; Evers et al., 2009). Based on previous work (Adriaanse et al., 2011; Bongers, Jansen, Havermans, et al., 2013; Bongers, Jansen, Houben, et al., 2013; Evers et al., 2009), we did not expect a specific positive association between emotional eating questionnaire scores and high-caloric eating events, when experiencing negative emotions or reporting emotion-related cognitions. Instead, it was expected that such a positive association would occur at eating events *and* non-eating moments (i.e., at all assessments).

1. Method

1.1. Participants and recruitment

Participants were recruited via flyers that were spread throughout a university building, an academic hospital, health centres, local supermarkets, household fairs, and Facebook. Advertisements were also placed in local newspapers and on several websites. The study was approved by the Ethical Committee of the Faculty of Psychology and Neuroscience of Maastricht University. All participants signed an informed consent form.

Inclusion criteria for participation in the study were: (1) self-reported Body Mass Index (BMI) between 18.5 and 40, (2) in possession of an iPhone, (3) not on a professionally supervised diet, (4) no medical conditions that affect (regular) eating behaviour, and

(5) not pregnant. Participants were matched on age, level of education and gender. Two participants provided self-report measures of BMI that were below 40, but turned out to have a BMI of 40.8 and 45.7 after obtaining supervised measurements. It was decided to leave these participants in the study, because of power considerations. The final sample consisted of 100 participants (see Table 1 for demographic data), with 57 overweight and 43 healthy-weight participants. Of the 57 overweight participants, 34 were considered 'overweight' (BMI between 25 and 30), 21 were considered 'obese' (BMI between 30 and 40), and 2 were considered 'morbidly obese' (BMI higher than 40). For the remainder of the article, all participants with BMI >25 will be referred to as 'overweight'. See Fig. 1 for a flowchart of participation throughout the study.

Table 1
Demographics of the overweight (n = 57) and healthy-weight participants (n = 43) and relevant statistics.

Demographic	Overweight	Healthy-weight	Comparison	
	n	*n*	χ^2	*p*
Gender			0.000	0.99
Male	7	5		
Female	50	38		
Employment			2.3	0.31
Unemployed	10	4		
Student	18	19		
Working	29	20		
Education			1.7	0.65
No degree	0	0		
Lower	10	5		
Intermediate	19	12		
Higher	17	14		
University	11	12		
Age	*M(SD)*	*M(SD)*	*t*(98)	*p*
	31.2(10.0)	32.1(10.6)	0.43	0.67
BMI at measurement 1	30.3(4.3)	22.1(1.5)	13.4	<0.0001*
BMI at measurement 2	30.2(4.2)	22.2(1.5)	13.2	<0.0001*

Note. M = Mean, SD = Standard Deviation, n = Number of participants, χ^2 = Chi Square. Neither the overweight participant group ($t(56) = 1.22$, $p = 0.23$) nor the healthy-weight participant group ($t(42) = 1.07$, $p = 0.29$) showed significant weight change between BMI measurement 1 and measurement 2.
* = $p \le 0.05$.

1.2. Design of the EMA protocol

The data presented in this paper are part of a larger EMA study on psychological factors related to eating behaviour. For the purpose of the overall study protocol of this larger study, an EMA app was developed for iPhone. The EMA protocol consisted of two parts: event sampling (assessment just before eating events) and signal-contingent sampling (assessments based around the time of day). Additionally, each day of sampling included a morning and evening questionnaire. The morning questionnaire assessed sleep quality and sleep duration. The evening questionnaire always occurred shortly before bedtime and assessed the intake of beverages. All self-report measures were provided in the Dutch language.

For the signal-contingent sampling, a waking day was, per default, divided into 8 time windows of two hours each. Time windows would be automatically added or removed depending on participants' sleep and waking times (as entered in the app). A signal-contingent sample occurred at a random time point within

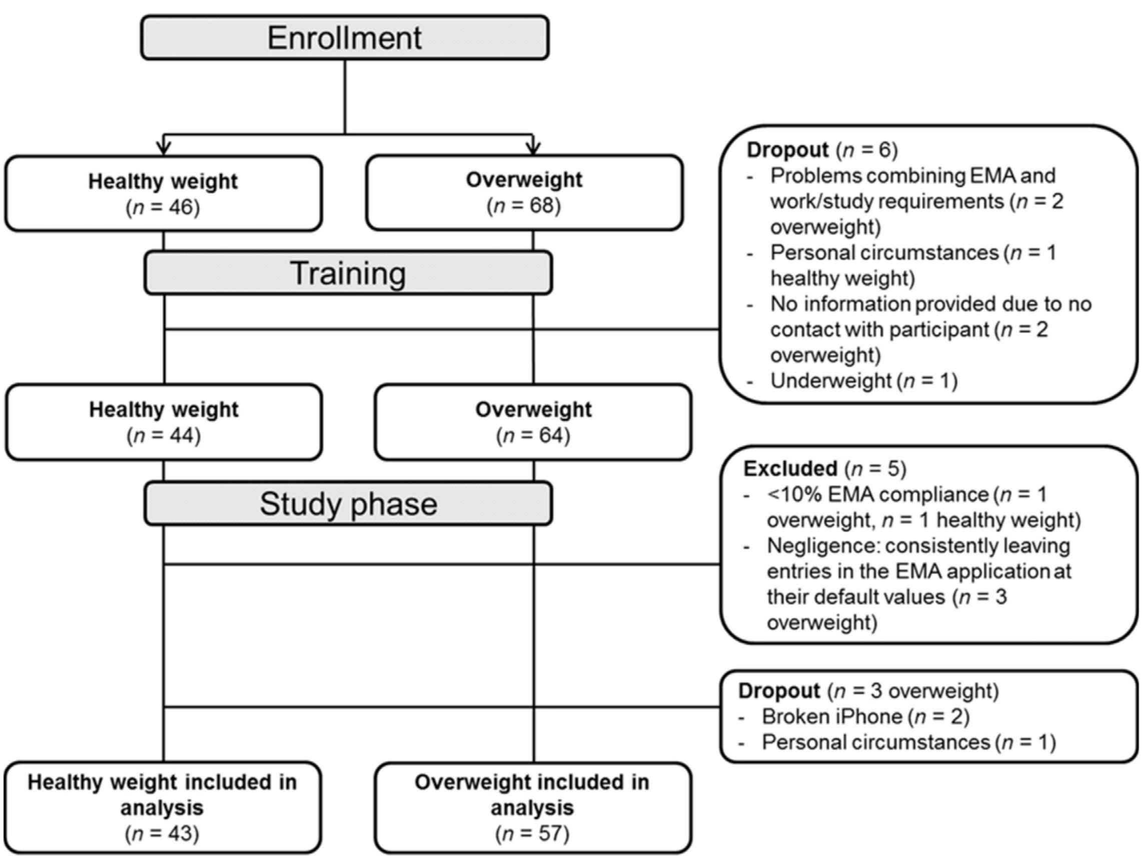


Fig. 1. Flowchart of participants.

each time window (Hektner, Schmidt, & Csikszentmihalyi, 2006), and was triggered by a notification sent to the participant's iPhone. For eating event sampling, the participant was instructed to take his/her iPhone and press a button to initiate a brief EMA questionnaire whenever (s)he was about to eat something. At each assessment, the participant was asked to provide input on level of desire, specificity of desire, experienced emotions and physical location and circumstances. Completing an assessment took around 90 s. The eating event EMA questionnaire additionally assessed eating-related cognitions and the food that was about to be consumed. The EMA protocol lasted for two weeks in total.

To investigate the hypotheses of the present paper, only the emotion and cognition EMA questions of the signal-contingent and eating event-related samples were included in the analysis, along with the food consumption measure. Included emotion items were adapted from an earlier EMA study (Macht et al., 2004), and included the following: 'angry/annoyed', 'anxious/scared', 'calm/relaxed', 'cheerful/happy', 'sad/gloomy' and 'tense/stressed'. Additionally, the item 'bored' was included in this list because it was found to be an important determinant of eating in earlier research (Koball, Meers, Storfer-Isser, Domoff, & Musher-Eizenman, 2012). Emotion items were presented to the participant as a list, led by the question "How do you feel?", and were individually scored on Visual Analogue Scales (VAS) ranging from 0 (not at all) to 100 (extremely). All emotion VAS items started by default at a score of zero. The participant was not required to fill in all VAS items one by one; instead (s)he had to choose *at least one* item that corresponded best to how (s)he felt at the time of assessment and then fill in the corresponding VAS. As such, the participant was allowed, but not obligated, to fill in multiple VAS items. The emotion VAS items that were not filled in by participants were considered to be equal to zero, also for the purposes of analysis. Note that this method, therefore, provides insight into the strongest experienced emotion(s) at the time of assessment.

Cognitions were assessed via a free-input text area in the app, in which the participant could write one current cognition, with the instruction to answer the question "What are you thinking regarding why you are going to eat right now?". The participant was instructed on how to answer this question prior to starting the EMA period in three ways. First, (s)he was provided with a printed EMA instruction that contained examples. Second, an instructional video series also contained an example of how to report cognitions. Finally, (s)he was asked over the phone if (s)he understood the instructions and any remaining questions were resolved. Examples of relevant cognitions include: "Everyone is eating cake, I might as well join in"/"I am stuffed, but my mom cooked so I eat because it is respectful"/"Got some great news! I am celebrating!"/"I am just hungry and want to eat my lunch". The participant was explicitly instructed to give the cognition question careful consideration. Additionally, below the free text area, a separate question was asked: "How strongly do you believe in this thought?". The participant was instructed to specify his/her degree of belief on a VAS, ranging from 0 (not at all) to 10 (very much).

In addition to these questions, the participant ended the overall eating event EMA questionnaire by indicating what (s)he was about to eat. This was done by selecting out of a matrix of icons representing a wide selection of foods the icon(s) most closely resembling the food(s) that the participant was about to eat. Also, the participant took a picture of his/her food, which was used to verify that an actual eating event was about to take place. Once an EMA questionnaire had been completed, it appeared in an overview list and could be reviewed as a brief summary. To minimize reactivity to the protocol, this review option contained only minimal information.

1.3. Questionnaires

1.3.1. Screening questionnaire

Interested candidates were sent a screening questionnaire that included questions about age, sex, dieting status, current employment, education level, weight and height, pregnancy, menopause, current medical and psychological treatment, dietary requirements, experience with monitoring eating behaviour, and the possession of an iPhone.

1.3.2. Post-EMA period questionnaire battery

After the EMA period ended, the participant filled in a battery of questionnaires included the emotional eating subscale of the Dutch Eating Behaviour Questionnaire (EE-DEBQ; van Strien et al., 1986), the Emotional Eating Questionnaire (EES; Arnow, Kenardy, & Agras, 1995), the Problematic Eating Behaviour Questionnaire (Carter & Jansen, 2012), the Belief in Dysfunctional Thoughts Scale (Werrij et al., 2009), and a brief feedback questionnaire on the use of the app. The participant completed these questionnaires in the week following the EMA period. Questionnaires were administered after the EMA-period to avoid the influence of questionnaire-assessment on the EMA data. For the analyses reported in the present paper, only data from the EE-DEBQ and the EES are discussed.

The DEBQ (van Strien et al., 1986) is a 33-item questionnaire that assesses different types of eating styles (subscales of the questionnaire): emotional eating, restrained eating, and external eating. Items are rated on a 5-point Likert scale ranging from 'never' to 'very often'. The EE-DEBQ subscale consists of 13 items. The item-total correlations of the subscale were previously found to be > 0.65 (van Strien et al., 1986). The subscale also had a high internal consistency in the current sample ($\alpha = 0.94$).

The EES (Arnow et al., 1995) is a questionnaire that consists of 25 items that describe emotional states, with 5-point Likert-scale options going from "no desire to eat" to "an overwhelming urge to eat". People are requested to indicate the extent to which the 25 items apply to their own food desire experiences. The test-retest reliability for this questionnaire was previously found to be sufficient; $r = 0.79$, $p < 0.001$ (Arnow et al., 1995). The questionnaire was translated to Dutch by the authors of the present study and had a high internal consistency in the current sample ($\alpha = 0.95$).

1.4. Weight and height measurement

A first measurement of height and weight was conducted in the week prior to the start of the training. The second measurement was conducted during the week after the EMA period, and included only weight). Participants were instructed to undergo supervised measurements, either externally (conducted by health care professionals such as general practitioners and physiotherapists) or at the university (conducted by the researcher or research assistants), both times under identical conditions (same scale and supervisor). Eighteen participants underwent both measurements at the university, whereas 71 participants went to a healthcare professional. The remaining 11 participants ($n = 7$ overweight, $n = 4$ healthy-weight) reported being unable to obtain one or both supervised measurements (e.g., due to busy work schedules, or private circumstances). These participants were allowed to provide self-report measurements to avoid study drop-out.

1.5. Procedure

All e-mail and phone correspondence was standardized. Interested candidates were sent a link to an online screening questionnaire (X_0) via e-mail ($@_0$). Those eligible for inclusion were contacted via e-mail ($@_1$) to plan a suitable two-week period of participation. After inclusion, the participant was contacted by phone (☎$_1$) and instructed to complete a brief questionnaire (X_1) and obtain a first measurement of BMI (BMI1). Additionally, an instruction guide for the study and app was sent via postal mail (✉). The participant was also provided with a username and identification code to ensure confidentiality. Participants were clearly instructed that their assessments were kept confidential.

Next, the participant was contacted via e-mail (@$_3$) and telephone (☎$_2$) to schedule a one-day training with the app and EMA protocol. After completing the training, the participant was contacted via phone to discuss his/her performance (☎$_3$). The training was repeated ($n = 4$) if the participant (1) did not report any eating events, (2) did not report any signal-contingent samples, or (3) misunderstood the instructions and thought that prompts to complete signal-contingent samples were prompts to eat something. The two-week EMA period started at the Monday of the subsequent week to ensure that the number of weekend and weekdays was equal across participants. The participant was then sent an e-mail (@$_4$) with this information.

During the two-week EMA period, the participant used the app and was allowed to contact experimenters in case of technical difficulties or interfering personal circumstances. At day 3 or 4, the participant was briefly contacted via phone (☎$_4$) for a check-up. At day 8, a brief motivational e-mail (@$_5$) was sent. At the end of the EMA period, the participant was asked via phone (☎$_5$) to undergo a second measurement (BMI2) and fill out the post-EMA questionnaire (X_2). The participant was also debriefed about the study goals. Upon handing over the results of the second measurement of weight and completing the post-EMA questionnaire, the participant received a gift certificate of €50,-, and was sent a final e-mail (@$_7$).

1.6. Data analysis

The main focus of the present paper was on a comparison between overweight and healthy-weight participant groups, so change over time within individuals was not considered in the analyses. Instead, the EMA methodology provided the benefit of repeatedly assessing cognitions and emotions immediately prior to eating events and non-eating moments in daily life. As suggested by Shiffman (2014), data were collapsed across all assessment points, and the aggregated or averaged values were entered in between-subjects analyses. This increased the reliability of the cognition and emotion measurements (Shiffman, 2014). Note that time-lagged analyses were reported in a different paper on this dataset (Spanakis, Weiss, Boh, & Roefs, 2016), which focused on predicting eating behaviour at time-point *t* from data gathered at time-point *t*-1.

As a first step in the analyses, assessments were divided into three types. One assessment type consisted of eating events that included the selection of at least one high-caloric food, such as snack foods and dishes with a side of French fries. The second type consisted of the remainder of foods, which were lower in caloric content and relatively healthier options, such as fruits and vegetables and dishes with a side of rice or potatoes (healthier option foods). The last type consisted of all the signal-contingent samples (non-eating moments). Table 2 contains an overview of food products included in the high-caloric and healthier option assessment types.

As a second step in the analyses, cognitions were assigned to categories according to theme. To this end, a subset of 700 cognitions (350 of overweight participants and 350 of healthy-weight participants) was randomly selected from the total dataset. Then, three of the researchers (AJ, AR and BB) determined appropriate categories that could apply to all 700 cognitions in the subset. This resulted in three main categories: ‘functional’, ‘neutral’ and ‘dysfunctional’. These categories were each further split into several subcategories. The exact categories and subcategories can be found in Table 3. Next, two blinded independent raters (a CBT therapist (LL) and a researcher who was not involved in the present study) and one of the researchers (BB) used the proposed list of categories to categorize another randomly generated subset of 700 cognitions. In clearly ambiguous cases of multiple subcategories being applicable (for example: “I am hungry, because I feel bad”), raters were instructed to prioritize the category of dysfunctional cognitions over the category of neutral cognitions.

Next, an interrater reliability analysis was performed using Fleiss's *Kappa* to determine the consistency among the three raters, with $Kappa = 0.76$ ($p < 0.001$), 95% CI [0.73, 0.79] for healthier option foods, and $Kappa = 0.71$ ($p < 0.001$), 95% CI [0.68, 0.74] for high-caloric foods. A Fleiss's *Kappa* value between 0.61 and 0.80 reflects ‘substantial agreement’ (Landis & Koch, 1977). Finally, one of the researchers (BB) blindly categorized all 5521 cognitions using these categories. This final categorization was then applied to subsequent data analyses.

2. Results

2.1. Compliance ratings for the EMA entries

The percentage of completed non-eating moment (signal-contingent) assessments relative to the total number of signal-contingent assessments participants received during the 14-day EMA period was calculated. Overweight participants completed 80.91% ($SD = 9.96\%$) of the assessments, and healthy-weight participants completed 79.73% ($SD = 9.73\%$) of the assessments. Compliance did not differ between both participant groups, $t(98) = 0.59$, $p = 0.55$. Furthermore, overweight participants reported $M = 3.77$ ($SD = 1.05$) eating events on average per day, whereas healthy-weight participants reported $M = 4.17$ ($SD = 1.50$) eating events on average per day.

2.2. Cognitions preceding eating events

During the two weeks of EMA, 5521 unique cognitions were obtained. There was no difference in the number of reported cognitions, averaged over participants, between overweight and healthy-weight participants, $t(98) = 1.59$, $p = 0.12$ (overweight: $M = 52.77$, $SD = 14.71$; healthy-weight: $M = 58.44$, $SD = 21.03$). Note that this also means there were no group differences in the average number of reported eating events, because only one cognition entry was provided by participants per assessment.

In total, 4007 cognitions were allocated to the healthier option

Table 2
Overview of food products assigned to the high-caloric and to the healthier option eating event assessment types. Note that participants were instructed to select one or multiple food products most closely resembling what they were about to eat.

Food products	Included in eating event type
Hamburger, Muffin, Cookies, Candy Bar, Chips, Cake, Ice-cream, Pizza, Dish with a side of fries	High-caloric
Sandwich, Yoghurt, Cornflakes, Salad, Fruit, Soup, Pasta dish, Rice dish, Dish with a side of potatoes	Healthier option

Table 3
Categories of cognitions immediately preceding an eating event and their averaged frequencies of occurrence, presented as percentages.

		Subcategory	Example	Averaged % of occurrence				Comparisons			
				High-caloric		Healthier option		High-caloric		Healthier option	
				OW	NW	OW	NW				
				M(SD)	M(SD)	M(SD)	M(SD)	t(98)	p	t(98)	p
Neutral	1.1	Unrelated	I don't have any thoughts.	9.0(21.6)	0.7(2.3)	8.4(18.6)	3.7(5.8)	2.82(57.7)	0.006*~	1.78(69.6)	0.08^
	1.2	Description of an eating event	Time for breakfast.	6.5(14.4)	5.6(8.2)	21.7(19.8)	18.2(15.6)	0.3	0.76	0.94	0.35
	1.3	Hunger related	I am so hungry! Time to eat.	8.5(12.6)	11.6(19.8)	19.5(24.3)	19.8(25.8)	0.95	0.35	0.04	0.97
	1.4	Desire for food and tastes	I am looking forward to this chocolate bar.	42.8(27.4)	46.2(27.8)	24.2(18.2)	33.0(24.1)	0.74	0.46	2.0(75.4)	0.049*
	1.5	Energy necessity	I won't have much time to eat later.	2.5(5.7)	3.8(7.1)	6.3(6.2)	8.7(9.4)	1.06	0.29	1.45(68.4)	0.15
Functional	2.1	Healthy intention	Oranges are a healthy choice.	0.6(1.9)	0.1(0.5)	6.4(9.5)	4.0(5.0)	1.86(68.1)	0.07^	1.5(88.6)	0.14
	2.2	Control success	Everyone's taking cake, but I went for a pear.	1.1(2.9)	0.1(0.5)	3.5(5.2)	2.2(3.4)	2.71(60.4)	0.009*	1.6(96.4)	0.11
Dysfunctional	3.1	Negative emotions	Feel terrible, maybe this will comfort me.	1.7(3.9)	2.1(5.8)	0.4(1.2)	0.7(2.0)	0.44	0.66	0.7	0.49
	3.2	Positive emotions	I feel great, so I got myself some ice cream!	0.3(1.3)	1.2(5.7)	0.1(0.5)	0.1(0.5)	1.12(45.4)	0.27	0.42	0.67
	3.3	Social activity and pressure	Everyone's eating cake, so I took a piece.	11.5(19.5)	12.3(17.2)	4.2(6.9)	5.4(8.1)	0.28	0.78	0.81	0.42
	3.4	Food as a reward	I think I deserved this after all the hard work.	1.2(3.3)	1.2(3.8)	0.7(2.2)	0.6(1.7)	0.01(82.4)	0.99	0.21	0.83
	3.5	Other dysfunctional cognitions	Coffee should go together with cookies.	7.9(10.6)	9.4(13.4)	2.2(3.1)	2.7(3.9)	0.71	0.48	0.66	0.51
	3.6	Control failure	I know it's not healthy, but I just can't resist.	6.3(10.4)	5.7(9.8)	2.3(4.2)	1.0(2.0)	0.26	0.8	1.98(84.8)	0.05^
Total %				100	100	100	100				

Note. Percentage of occurrence was calculated by first determining percentages for each participant and then averaging over all participants per group for the high-caloric, low-nutrient-dense foods and healthier option foods. Also shown are comparisons between the overweight and normal-weight groups for these percentages.
OW = overweight participants ($n = 57$). NW = normal-weight participants ($n = 43$). M = mean percentage of cognitions labelled with a certain category relative to the total number of cognitions for either the high-caloric or healthier option foods. SD = standard deviations of means (also in percentages). In case of a violation of the assumption of equal variances, corrected degrees of freedom (*df*) values are presented in parentheses next to the relevant t-values.
^ = $0.05 \leq p < 0.1$; * = $p < 0.05$.
~ = p values that remained significant after applying a Bonferroni-Holm correction for multiple comparisons (within the dysfunctional and neutral cognition categories, separately for high-caloric and healthier option foods).

foods assessment type, and 1514 cognitions were allocated to the high-caloric foods assessment type. Healthy-weight participants on average reported significantly more healthier option eating events than did overweight participants, $t(98) = 2.26$, $p = 0.03$ (healthy-weight: $M = 43.4$, $SD = 14.9$; overweight: $M = 37.6$, $SD = 10.8$), whereas no group difference was found for the high-caloric foods, $t(98) = 0.06$, $p = 0.95$ (healthy-weight: $M = 15.1$, $SD = 10.8$; overweight: $M = 15.2$, $SD = 10.0$).

2.3. Differences for cognitions between overweight and healthy-weight participants

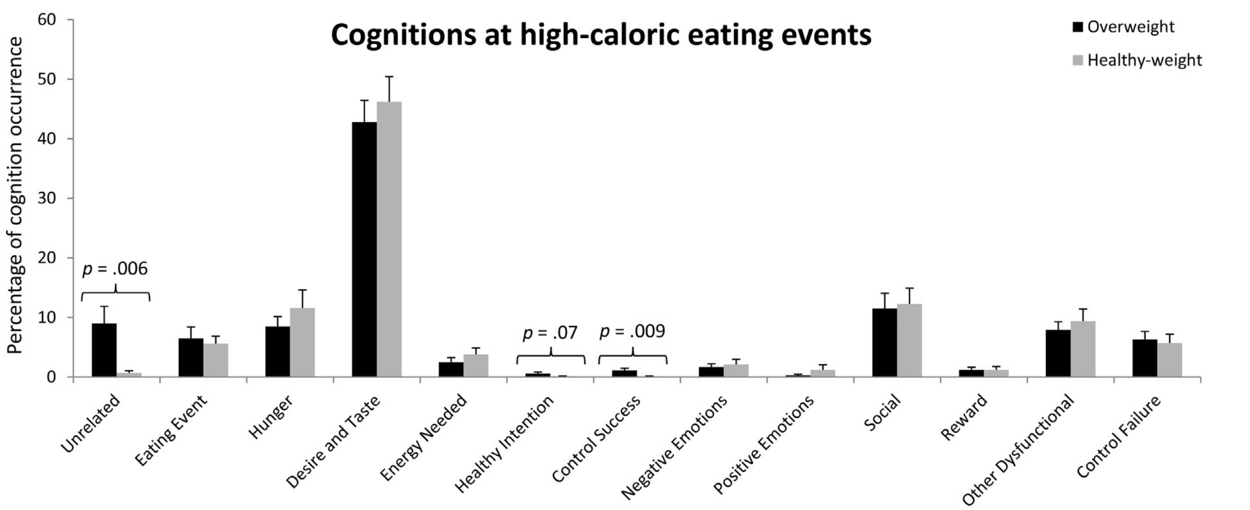
Frequency of occurrence of cognitions was compared between overweight and healthy-weight participants for all the cognition subcategories, separately for the high-caloric and healthier option foods. Considering that the number of high-caloric and healthier option eating event types differed over participants, the frequency of occurrence of each subcategory of cognitions was expressed as a percentage of the total number of cognitions per eating event assessment type[1] (high-caloric and healthier option foods) per participant. These percentages were then averaged over participants, separately for the overweight and healthy-weight groups. Table 3 and Fig. 2 contain an overview of the obtained results.

For the neutral cognitions, overweight participants reported more eating-unrelated cognitions for high-caloric foods than healthy-weight participants, with a trend-significant group-difference for healthier option foods. Healthy-weight participants reported more desire and taste cognitions for healthier option foods than overweight participants. For the functional cognitions, overweight participants reported more successful control cognitions and trend-significantly more healthy intention cognitions for the high-caloric foods when compared to healthy-weight participants. However, the number of these cognitions was relatively low. For the dysfunctional cognition category, only control failure cognitions were reported significantly more by overweight participants relative to healthy-weight participants for healthier option foods. Importantly, obtained p-values for the neutral and dysfunctional cognition categories were adjusted for multiple comparisons via a stepwise rejective Bonferroni-Holm correction (Holm, 1979), separately for high-caloric and healthier option foods. Only the difference between overweight and healthy-weight participants of the occurrence of eating-unrelated cognitions for high-caloric foods remained significant after these corrections.

In addition to frequency of occurrence, belief in reported dysfunctional cognitions was investigated. Because many of the dysfunctional cognition subcategories did not occur for the majority of participants, it was decided to investigate belief in all dysfunctional cognition subcategories taken together (i.e., belief scores for dysfunctional cognitions were summed and then averaged irrespective of subcategory), separately for the high-caloric

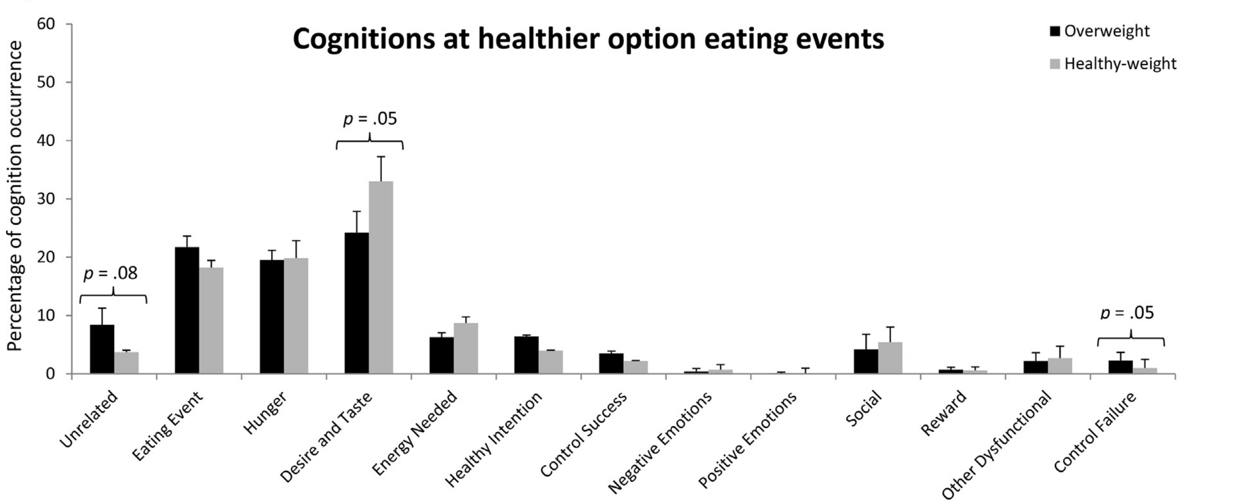
[1] Analyses of differences between overweight and healthy-weight participants using raw frequency totals per food type per participant group did not lead to a different pattern of results.

a



Note. The y-axis represents percentages of frequency of occurrence of cognition subcategories for high-caloric foods, relative to the total number of cognitions for these foods. Error bars represent standard errors.

b



Note. The y-axis represents percentages of frequency of occurrence of cognition subcategories for healthier option foods, relative to the total number of cognitions for these foods. Error bars represent standard errors.

Fig. 2. a) Bar plots of overweight and healthy-weight participants' cognitions related to the high-caloric foods. Note. The y-axis represents percentages of frequency of occurrence of cognition subcategories for high-caloric foods, relative to the total number of cognitions for these foods. Error bars represent standard errors. **b)** Bar plots of overweight and healthy-weight participants' cognitions related to the healthier option foods.

and healthier option food types. Results showed that overweight participants did not differ from healthy-weight participants in their belief of dysfunctional cognitions for the high-caloric foods (healthy-weight $M = 6.74$, $SD = 1.49$; overweight $M = 6.77$, $SD = 1.58$), $t(49) = 0.06$, $p = 0.95$, nor for the healthier option foods (healthy-weight $M = 6.71$, $SD = 1.54$; overweight $M = 6.72$, $SD = 1.39$), $t(49) = 0.03$, $p = 0.98$.

2.4. Emotions preceding eating events and non-eating moments

By far the highest overall scores were found for the ‘cheerful/happy’ and ‘calm/relaxed’ emotions, irrespective of assessment type. 2 (group: overweight vs. healthy-weight) By 3 (assessment type: high-caloric foods, healthier option foods, non-eating moments) mixed ANOVAs were performed for each of the seven emotions separately. Greenhouse-Geisser corrected F-values are reported, and statistics relating to main effects can be found in Table 4. If there was a main effect of assessment type, three pairwise comparisons were performed pooling over participant group. Only for ‘sad/gloomy’, a trend-significant participant group x assessment type interaction emerged. Contrary to expectations, Separate 1-way ANOVAs for overweight and healthy-weight participants revealed a significant effect of assessment type for healthy-weight participants, $F = 5.88$, $p = 0.01$, but not for overweight participants, $F = 0.43$, $p = 0.57$. Pairwise comparisons of assessment type for the healthy-weight group indicated that

Table 4
Results of mixed ANOVA for each of the emotions, with group (overweight and healthy-weight) as between-subjects variable and assessment type (high-caloric foods, healthier option foods and non-eating) as within-subjects variable.

Category	OW $M(SD)$			HW $M(SD)$			Main effect: Group		Main effect: Assessment type		Interaction: Group x assessment type		Pairwise comparisons for main effect of assessment type
	High-caloric	Healthier option	Non-eating	High-caloric	Healthier option	Non-eating	F	p	F	p	F	p	
Cheerful/Happy	3.67(2.5)	3.32(2.18)	3.27(2.21)	3.92(2.2)	3.54(2.06)	3.23(1.94)	0.1	0.75	15.46	<0.0001***~	1.33	0.26	$HC^c > HO^b > NE^a$
Calm/Relaxed	4.09(2.58)	3.95(2.4)	4.06(2.32)	3.67(2.5)	3.33(2.33)	3.62(2.26)	1.11	0.3	3.62	0.047*	0.59	0.49	$HC^b > HO^a < NE^b$
Bored	0.63(1.11)	0.5(1.05)	0.55(0.95)	0.66(1.11)	0.6(0.92)	0.66(0.95)	0.17	0.68	3.34	0.050^	0.54	0.54	$HC^b > HO^a < NE^b$
Tense/Stressed	0.9(1.03)	1.13(1.16)	0.97(0.92)	0.54(0.97)	0.74(0.86)	0.7(0.72)	3.54	0.06^	5.47	0.01**~	0.48	0.55	$HC^a < HO^b > NE^a$
Anxious/Scared	0.09(0.37)	0.08(0.34)	0.08(0.31)	0.02(0.08)	0.03(0.08)	0.04(0.11)	1.14	0.29	0.15	0.78	0.81	0.4	
Angry/Annoyed	0.41(1.36)	0.3(0.41)	0.3(0.38)	0.15(0.24)	0.19(0.25)	0.18(0.2)	2.85	0.1	0.14	0.72	0.53	0.48	
Sad/Gloomy	0.4(0.72)	0.37(0.57)	0.37(0.53)	0.12(0.23)	0.21(0.31)	0.21(0.32)	4.36	0.04*	0.64	0.47	3.18	0.07^	

Note. Emotions were rated on VAS items that ranged from 0 to 10. At each assessment (eating event or non-eating moment), emotions that were not rated by participants were considered to have a score of '0'. Pairwise comparisons are denoted with 'a' and 'b' in superscript. Means that do not share a superscript differ significantly from each other (LSD, $p < 0.05$). The directions of the pairwise comparisons for the significant main effect effects of assessment type are indicated with > and < in the pairwise comparisons column.
OW = Overweight; HW = Healthy-weight; M = Mean; SD = Standard deviation; HC = High-caloric food category; HO = Healthier option food category; NE = Non-eating category.
^ = $0.05 \leq p < 0.1$; * = $p < 0.05$; ** = $p \leq 0.01$; *** = $p \leq 0.0001$.
~ = p values that remained significant after applying a Bonferroni-Holm correction for multiple comparisons (separately for main effects and interaction) over all emotions.

healthy-weight participants were trend-significantly more 'sad/gloomy' at healthier option eating events ($p = 0.06$) and significantly more 'sad/gloomy' at non-eating moments ($p = 0.02$) compared to high-caloric eating events.

Looking at the pattern of results in Table 4 (main effects), it appeared that overweight participants were always more 'sad/gloomy' and (as a trend) more 'tense/stressed' than healthy-weight participants, independent of assessment type. Furthermore, pairwise comparisons between each of the assessment types revealed that overall participants were most cheerful when about to eat, especially if the food was high-caloric. Participants were least 'calm/relaxed' and 'bored' and, contrary to expectations, most 'tense/stressed' at healthier option eating events compared to high-caloric eating events and non-eating moments. Scores for high-caloric eating events and non-eating moments did not differ for these three emotions.

2.5. EE-DEBQ and EES scores in comparison with emotion-related cognitions and emotions

Overweight participants scored trend-significantly higher than did healthy-weight participants on the EE-DEBQ, $t(98) = 1.82$, $p = 0.07$ (healthy-weight: $M = 2.17$, $SD = 0.79$; overweight: $M = 2.5$, $SD = 0.99$), but there was no group-difference for the EES, $t(98) = 1.31$, $p = 0.19$ (healthy-weight: $M = 47.56$, $SD = 16.14$; overweight: $M = 52.68$, $SD = 21.49$). The EE-DEBQ and EES correlated significantly, $r\,(98) = 0.84$, $p < 0.001$.

Next, EE-DEBQ and EES scores were correlated with the frequencies of occurrence of the negative and positive emotion cognition subcategory and emotion scores, for the high-caloric and healthier option food categories separately, and for non-eating moments. See Table 5 for an overview of the correlation results. For emotion *cognitions*, both negative and positive emotion cognitions, irrespective of food type (high-caloric or healthier option), correlated positively with the EE-DEBQ and EES. Furthermore, negative emotion *scores* (except 'scared/anxious' and 'bored'), irrespective of type of eating event, also correlated positively with the EE-DEBQ and EES. For positive emotion scores, there was a trend-significant negative correlation of 'calm/relaxed' with the EE-DEBQ for healthier option foods. Interestingly, for non-eating moments, negative emotions ('sad/gloomy' and 'tense/stressed') also correlated positively with the EE-DEBQ and EES, whereas the

Table 5
Correlations of the emotional eating subscale of the Dutch Eating Behaviour Questionnaire (EE-DEBQ) and the Emotional Eating Scale (EES) with emotion-related cognitions and emotion scores, both for eating events (high-caloric and healthier option) and non-eating moments.

Category	Correlations with the EE-DEBQ ($n = 99$)						Correlations with the EES ($n = 99$)					
	High-caloric		Healthier option		Non-eating		High-caloric		Healthier option		Non-eating	
	r	p	r	p	r	p	r	p	r	p	r	p
Cognitions												
Negative emotions	0.27	0.007*	0.17	0.13			0.34	0.001*	0.22	0.03*		
Positive emotions	0.19	0.06^	0.19	0.07^			0.21	0.04*	0.1	0.32		
Emotions												
Anxious/Scared	0.14	0.18	0.14	0.15	0.15	0.14	0.16	0.11	0.16	0.12	0.16	0.11
Angry/Annoyed	0.19	0.07^	0.2	0.050^	0.14	0.17	0.24	0.016*~	0.15	0.15	0.08	0.42
Sad/Gloomy	0.24	0.02*	0.22	0.03*	0.26	0.01*	0.25	0.01*~	0.2	0.050^	0.26	0.01*
Tense/Stressed	0.22	0.03*	0.15	0.14	0.16	0.13	0.3	0.002*~	0.25	0.045*	0.22	0.03*
Cheerful/Happy	−0.14	0.17	−0.1	0.3	−0.06	0.58	−0.05	0.64	0.01	0.95	0.04	0.7
Calm/Relaxed	−0.16	0.12	−0.18	0.07^	−0.17	0.09^	−0.16	0.1	−0.16	0.11	−0.17	0.12
Bored	0.03	0.78	−0.01	0.95	−0.02	0.84	0.07	0.49	0.05	0.63	0.01	0.94

Note. Emotion scores ranged between 0 and 10. The presented emotion categories are translated from Dutch.
^ = $0.05 \leq p < 0.1$; * = $p < 0.05$.
~ = p values that remained significant after applying a Bonferroni-Holm correction for multiple comparisons (separately for high-caloric eating events, healthier option eating events and non-eating moments) over all emotions.

positive emotion ‘calm/relaxed’ correlated trend-significantly negatively with the EE-DEBQ only. So, overall, participants scoring high on the EE-DEBQ or the EES also scored higher on scores for several mainly negative emotions at both eating events and non-eating moments and on the occurrence of emotion-related cognitions at eating events than participants scoring low on these questionnaires.

3. Discussion

The present study investigated how cognitions and emotions experienced in daily life relate to eating behavior in overweight and healthy-weight participants. Contrary to expectations, overweight and healthy-weight participants were largely comparable in terms of frequencies of, and belief in, cognitions at eating events. The most important differences were that overweight participants reported more eating-unrelated cognitions at high-caloric eating events, whereas healthy-weight participants reported more desire and taste cognitions at healthier option eating events. As for emotions, during eating events and non-eating moments, both participant groups mainly reported feeling neutral to positive, with overweight participants and self-reported emotional eaters being more negative irrespective of whether they were eating or not. That is, contrary to our hypotheses, emotions did not specifically predict eating events for overweight participants and self-reported emotional eaters.

Participants indicated mostly that they ate because of a desire to experience taste and give in to desire for food. The number of dysfunctional cognitions was relatively low in comparison with the number of neutral/functional cognitions and barely differed between overweight and healthy-weight participants. Belief in dysfunctional cognitions also did not differ for overweight and healthy-weight participants. So, dysfunctional cognitions did not appear to play a large role in overweight participants’ eating behavior. This is not in line with cognitive (behavioral) models for obesity (Beck, 2007; Cooper & Fairburn, 2001; Werrij, 2005), which state that in particular dysfunctional cognitions are important determinants of overeating behavior.

Importantly, the number of reported dysfunctional cognitions may have been underrepresented in the present study. Firstly, the present study only assessed eating-related cognitions immediately prior to eating events, with the foods being in front of the participant. However, deciding to eat is the result of many separate decisions (Wansink & Cashman, 2007) that do not just take place immediately prior to eating. It may be that dysfunctional cognitions play a more important role at earlier stages in the decision-making process. Secondly, being about to eat, and being able to see and smell the food, may have promoted desire and taste-related cognitions to such a degree that these would take precedence over dysfunctional cognitions. It might therefore be interesting to investigate dysfunctional cognitions that occur during moments of dietary weakness (Carels et al., 2001; McKee et al., 2014) and by giving participants the option to report multiple cognitions at an assessment. Thirdly, the low occurrence of dysfunctional cognitions could be due to the set-up of the study. In therapy settings, clients are first trained to identify (automatic) cognitions. This may be an essential prerequisite for effective reporting of cognitions. So, overall, the assessment of eating-related cognitions could be expanded by measuring at different time points and by training participants in recognizing their cognitions beforehand.

For the differences between overweight and healthy-weight participants related to specific cognitions, only the difference for the eating-unrelated cognitions subcategory remained significant after a multiple comparisons correction. This cannot plausibly be explained by a difference in cognitive abilities between participant groups, as participants were matched on level of education. Instead, it may be that overweight participants (1) were less willing to be confronted with their actual cognitions about eating, (2) were less likely to commit the effort to report cognitions, or (3) actually had fewer eating-related cognitions than healthy-weight participants. This third interpretation is in line with the idea that eating is often an automated, habitual, behavior (Cohen & Farley, 2008). Another finding that is important because of the prevalence of desire and taste-related cognitions, is that healthy-weight participants reported more of such cognitions at healthier option eating events. Overweight participants are more sensitive to the rewarding properties of foods (Davis, Strachan, & Berkson, 2004). Thus, it might be that healthy-weight participants appreciated the taste of these healthier option foods more than overweight participants.

The present study also investigated the association between emotions and eating behavior. For the majority of assessments, healthy-weight and overweight participants reported feeling neutral to positive. Both participant groups were most positive when about to eat high-caloric foods, followed by healthier option foods and then non-eating moments. Relatedly, for both participant groups, low-arousing emotions (‘calm/relaxed’, ‘bored’) were most strongly associated with high-caloric foods and non-eating moments, whereas highly-arousing emotions (‘tense/stressed’) were most strongly associated with healthier option foods. These findings provide further evidence for the concept of ‘happy eating’ (Bongers, Jansen, Havermans, et al., 2013; Bongers, Jansen, Houben, et al., 2013; Evers, Adriaanse, de Ridder, & de Witt Huberts, 2013), which states that experiencing more positive emotions is associated with increased caloric intake. In addition, it seems that low-arousing emotions are also important antecedents of snacking.

Most strikingly, overweight participants scored higher on negative emotions than did healthy-weight participants on all three assessment types (high-caloric foods, healthier option foods and non-eating moments). This suggests that overweight participants were *generally* more emotionally negative than healthy-weight participants. So, negative emotions do not appear to be specifically associated with the intake of high caloric foods in overweight people. Instead, overweight people reported more negative emotions in general than did healthy-weight people. This is contrary to what some studies have reported (Oliver et al., 2000; van Strien et al., 2012). However, those studies relied on retrospective questionnaires to assess the association between emotions and eating. In line with the hypothesis of the present study's secondary aim, emotional eating questionnaire scores were associated with negative emotions at all assessments, irrespective of eating. This provides further evidence for the argument that people may hold a dysfunctional *belief* about the presence of such an association, which is not supported by actual eating behavior (Adriaanse et al., 2011; Bongers, Jansen, Havermans, et al., 2013; Bongers, Jansen, Houben, et al., 2013; Evers et al., 2009).

The present results are complementary to an analysis of the time-lagged (with lag t - 1) network structure of these data (Spanakis et al., 2016). In these time-lagged analyses, it was found that the interplay between emotions and eating events was more complex and dense in overweight participants, than in healthy-weight participants. In addition, negative emotions, high-caloric food desires and eating events played a more central role in the time-lagged networks for overweight participants than for healthy-weight participants. Furthermore, for all participants, positive emotions at time $t - 1$ promoted eating something high-caloric at time t. Interestingly, only for overweight participants, negative emotions at time $t - 1$ specifically promoted high-caloric eating events, and inhibited healthier option eating events, at time t. This pattern was not observed for healthy-weight participants. These findings differ from the cross-sectional analyses presented in the present paper, in which overweight participants seemed to be more emotionally negative in general as compared to healthy-weight participants. So, a negative emotion experienced some time before an eating event seems to be more relevant for predicting specific eating behavior than a concurrently experienced emotion.

A potential limitation of the present study is the selective influence of repeated assessments of eating events on (determinants of) eating behavior of overweight participants. It is possible that being repeatedly asked to report eating events may have made overweight participants more weight-conscious. Note that most studies investigating this issue did not find any influence of reactivity on data quality (Cruise, Broderick, Porter, Kaell, & Stone, 1996; Heron & Smyth, 2013; Stone et al., 2003), although one study did (Fuller-Tyszkiewicz et al., 2013). In the present study, to minimize assessment reactivity, the duration of completing an assessment was deliberately kept short, at around 90 s.

Another potential limitation of the current study is that socially desirable answering tendencies may have influenced the results. Being overweight is met with social stigma (Puhl & Brownell, 2003). So, overweight participants may not have been willing to report all high-caloric eating events, or dysfunctional cognitions. For eating events, this issue can only be overcome by using covert monitoring, instead of relying on self-report measures. However, there is no easy, and ethical, solution to achieve this. For the assessment of internal constructs, such as cognitions and emotions, one has no other option than to rely on introspection (McNally, 2001).

In conclusion, in the present study, no support was found for the importance of dysfunctional cognitions as determinants of overeating behavior (Carter & Jansen, 2012). Instead, cognitions were mainly related to desire and taste. Moreover, the experience of negative emotions does not seem to be specifically related to the consumption of high-caloric foods in overweight participants. Instead, overweight participants reported more negative emotions, independent of whether it was an eating event (high-caloric or healthier option) or not, than healthy-weight participants. Similarly, participants scoring high on questionnaires (EE-DEBQ/EES), reported more negative emotions regardless of whether they were eating or not. Note that these conclusions are limited by the assessment of emotions and cognitions immediately preceding an eating event. Future research should focus on exploring cognitions at earlier time points in the decision making process about whether or not to eat (i.e., during moments of dietary weakness).

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