Psychology & Health

ISSN: 0887-0446 (Print) 1476-8321 (Online) Journal homepage: https://www.tandfonline.com/loi/gpsh20

Does stress eat away at you or make you eat? EMA measures of stress predict day to day food craving and perceived food intake as a function of trait stress-eating

Julia Reichenberger, Björn Pannicke, Ann-Kathrin Arend, Katja Petrowski & Jens Blechert

To cite this article: Julia Reichenberger, Björn Pannicke, Ann-Kathrin Arend, Katja Petrowski & Jens Blechert (2020): Does stress eat away at you or make you eat? EMA measures of stress predict day to day food craving and perceived food intake as a function of trait stress-eating, Psychology & Health, DOI: 10.1080/08870446.2020.1781122

To link to this article: https://doi.org/10.1080/08870446.2020.1781122

Published online: 24 Jun 2020.

PSYCHOLOGY & HEALTH
https://doi.org/10.1080/08870446.2020.1781122

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Does stress eat away at you or make you eat? EMA measures of stress predict day to day food craving and perceived food intake as a function of trait stress-eating

Julia Reichenberger[a], Björn Pannicke[a], Ann-Kathrin Arend[a], Katja Petrowski[b] and Jens Blechert[a]

[a]Department of Psychology, Centre for Cognitive Neuroscience, Paris-Lodron University of Salzburg, Salzburg, Austria; [b]Department of Medical Psychology and Medical Sociology, University Medicine Center Mainz, Mainz, Germany

ABSTRACT

Eating behaviour can be driven by non-homeostatic factors like stress. Both increased and decreased food intake in response to stress has been documented, but it has remained difficult to identify a trait that predicts who shows either pattern. Thus, we collected naturalistic data from Ecological Momentary Assessment in combination with the trait-level Salzburg Stress Eating Scale (SSES). In study 1, 97 individuals completed the SSES and 6 daily reports about stress, food craving and perceived food intake across 8 days, whereas in study 2, 83 diet-interested participants completed the same measures at 4 daily prompts across 14 days. Consistent across both studies, multilevel modelling revealed that participants with high SSES-scores showed relatively more positive intra-day stress-craving relationships than those with low SSES-scores. On the day level, stress also predicted perceived food intake as a function of SSES-scores. Controlling for negative affect did not alter results. Results support an individual difference model of stress-eating where decrease vs increase of eating depends on SSES-scores. In affected individuals stress influences simultaneous food craving but might exhibit cumulative or delayed effects on food intake. Furthermore, the SSES provides a valid instrument for identifying at risk individuals and for tailoring interventions.

ARTICLE HISTORY
Received 29 January 2020
Accepted 4 June 2020

KEYWORDS
Ecological momentary assessment; eating behaviour; stress; negative affect; food craving

Introduction

Human food intake can be driven by a multitude of factors besides hunger: among others habits, social and situation factors (Cleobury & Tapper, 2014; Renner et al., 2012), or body image concerns that trigger dieting. Among these, the effect of stress on eating behaviour has been particularly intensely researched, mainly because of its high prevalence in the general population and its clinical relevance (Araiza & Lobel,

CONTACT Julia Reichenberger Julia.Reichenberger@sbg.ac.at Department of Psychology, Centre for Cognitive Neuroscience, Paris-Lodron University of Salzburg, Hellbrunnerstrasse 34, Salzburg, 5020, Austria.

2018; Gibson, 2012). Regarding the latter, in extreme forms, stress-eating evolves into binge eating, which is the defining feature of bulimia nervosa and binge eating disorder, and is also observed in subgroups of anorexia nervosa.

Empirically, stress seems to influence various aspects of eating behaviour including overall calories consumed, macro nutritional composition, food choice or food craving (O'Connor & Conner, 2011). Stress can be defined as a state in which environmental demands exceed an individual's resources (incl. coping skills), with reactions on cognitive-emotional (i.e. experiencing negative emotions), behavioural, or physiological levels (Dickerson & Kemeny, 2004). Several physiological and psychological accounts compete in explaining stress-eating relationships. Some physiological accounts suggest a decrease in food intake in response to acute stress (e.g. via activation of the sympathetic nervous systems and a corresponding parasympathetically mediated deactivation of ingestion related activity; e.g. see Torres and Nowson (2007)). Other physiological accounts focus on the metabolic effects of hypothalamic-pituitary-adrenal (HPA) activity via cortisol and hepatic glucose production or via interactions with the insulin system. Yet, several physiological effects of stress might add up or cancel each other out, making it difficult to predict the net effect on eating (Adam & Epel, 2007; Bazhan & Zelena, 2013).

Thus, it is not surprising that empirical results on the stress-eating relationship are markedly mixed and human research has found that experiencing stress can lead to decreased, unchanged or increased food intake across individuals. Indeed, using self-report, stress eaters are almost equally divided between those who perceive themselves as eating more than usual when stressed and those who perceive themselves as eating less than usual when stressed (Gibson, 2006; Oliver & Wardle, 1999). Similarly, while some experimental studies (Gibson, 2012; Oliver & Wardle, 1999; Stone & Brownell, 1994; Zellner et al., 2006) found individuals decrease eating during stressful compared to non-stressful situations, others observed exactly the opposite: increased food consumption during stress (Epel et al., 2001; Gibson, 2012; Oliver & Wardle, 1999; Zellner et al., 2006). Similarly, the relationship between negative emotions and eating behaviour seems complex: Recent laboratory-based reviews contradict each other with Cardi et al. (2015) showing that during negative emotions (including also stressful states) enhanced food consumption is more likely while Evers et al. (2018) found no significant overall emotional eating effect. Nevertheless, both reviews agreed on the important influence of restrained eating promoting the relationship between negative emotions and eating, pointing to marked individual differences and the importance of the investigated sample.

In previous research, stress and negative affect have frequently been used interchangeably. However, their effects on eating behaviour as well as their respective physiological underpinnings likely differ substantially: while stress can overlap with negative affect, there are also non-overlapping states: one might feel stressed (e.g. due to time pressure, task overload) without experiencing negative affect like anxiety or sadness. As a result, recent developments in the respective psychometric instruments have aimed for a stronger separation of stress and emotional eating. Specifically, the Salzburg Stress Eating Scale (SSES; Meule et al., 2018b) assesses changes in eating behaviour in response to stressful situations excluding emotional states. In its validation study (Meule et al., 2018b), the SSES demonstrated not only excellent internal consistency and reliability but also external validity: higher scores were associated with higher BMI, particularly in participants reporting higher current stress.

While informative, the above research has mostly used self-report questionnaires or taken place in the laboratory under standardised, non-social conditions. This brings about several limitations. First, self-awareness during eating in the laboratory inhibits eating as revealed by a comprehensive meta-analysis (Robinson et al., 2015). Second, naturalistic stress elicitation is difficult to simulate in the laboratory (e.g. work pressure). Third, naturalistic stress is likely elicited by a range of different stressors with varying characteristics, duration and intensity, making it difficult, if not impossible, to simulate such stressor variability in the laboratory. In contrast, ecological momentary assessment (EMA) conserves naturalistic conditions by recording information as people engage in their usual activities and thereby seems especially suitable for the study of eating behaviour (Engel et al., 2016; Smyth et al., 2001). EMA research revealed substantial variability in the direction of stress-eating relationships but did so *within* participants and as a function of stressor type: O'Connor et al. (2008) reported that employees increase their snacking when experiencing ego-threatening, interpersonal and work-related stress but the same individuals decrease snacking under physical stress. Zenk et al. (2014) focussed on daily hassles and showed that they go along with more snacking. Targeting not only snacking but any non-hunger related intake, Reichenberger et al. (2018) showed that stress decreases taste-based eating, whereas negative emotions only related to taste-based eating when moderated by emotional eating.

Given the sensitivity of EMA research for between and within participant variability and its high external validity the present study adopted this approach: In two studies, participants responded to several daily prompts (6 in study 1, 4 in study 2) across 8 days in study 1 and 14 days in study 2. Specifically, we aimed to assess stress-related within-participant changes in eating behaviour (food craving and perceived food intake) as a function of between-participant trait-level stress-eating as assessed with the SSES. In this way, the present study mainly aims at a) obtaining a more fine-grained understanding of under- or overeating in response to stress, and as a side aim b) validates the SSES questionnaire in daily life. While it is difficult to predict the direction of the general stress-eating relationship based on inconsistent literature, we expected a relatively more positive relationship between stress and perceived food intake/craving in individuals with high SSES scores. Analyses were done on the level of the within-day prompts and, aggregated, on the day level. Furthermore, due to the so far unclear relationship of stress- with emotional eating, we modelled the effect of negative emotions on eating behaviour as well. To increase replicability and generalizability we analysed these relationships in two separate studies in independent samples. Since dieting might influence the stress-eating relationship (i.e. similar to the influence of restrained eating on emotional eating as reviewed above), due to the disinhibitory role of stress on dietary restraint, study 2 recruited participants with weight reduction/stabilization interest.

Materials and methods – study 1

Participants

Participants were recruited via university mailing lists, flyer as well as word of mouth. Participants were recruited for a study on 'The influence of emotions on eating behaviour' with an EMA part as well as an optional laboratory part. Afterwards, participants completed initial questionnaires and the EMA assessment in daily life. Participants were excluded in case of missing data in the questionnaires or overall low compliance in the EMA assessment (<50%). The resulting 97 individuals, whose data are reported here, ranged from 16 to 35 years with a mean of 22.0 ($SD = 4.01$). Only women were included in the present study, who generally report more stress-eating (Meule et al., 2018b), and they exhibited a mean body-mass index (BMI) of 22.7 kg/m^2 ($SD = 4.19$ kg/m^2; range: 16.2 – 44.3 kg/m^2). Eight participants (8.2%) were underweight (BMI $<$ 18.5 kg/m^2), 74 participants (76.3%) were healthy weight (BMI = 18.5-24.9 kg/m^2), 9 participants (9.3%) were overweight (BMI = 25.0-29.9 kg/m^2), and 6 participants (6.2%) were obese (BMI $\geq$ 30.0 kg/m^2). Additionally, 29 individuals (29.9%) did currently try to restrict their food intake in order to change their shape or weight. All participants signed an informed consent form approved by the ethics committee of the University of Salzburg and were compensated for their participation.

Questionnaires

The *Salzburg Stress Eating Scale* (SSES) is a recently developed measure assessing eating in response to stress (Meule et al., 2018b). The 10 items depict stressful situations, asking individuals how they react to such situations with answers ranging from *1 (= I eat much less than usual)* to *5 (= I eat much more than usual)*. Average scores are calculated and higher values represent eating more when stressed and lower values represent eating less when stressed. Internal consistency was $\alpha = .884$ in study 1.

Procedure

Initially, participants completed several psychometric questionnaires and demographic information on an online survey platform. Measures (not of relevance for the current study) included questionnaires for assessing eating styles (e.g. restrained eating, emotional eating, intuitive eating), eating psychopathology, food craving, emotion regulation, impulsivity, anxiety and depression. Then, participants were introduced to the installation and usage of a smartphone app. In addition, participants received a written app manual explaining relevant variables and smartphone app use. Afterwards, participants completed one practice day (data not included in the present study), followed by eight study days of EMA, with compliance being monitored by staff. At the end of this period, participants completed additional questionnaires via the online survey platform including measures about compliance and reactivity. Additionally, participants had the option to take part at a subsequent laboratory experiment (data partially reported in Georgii et al., 2019, Richard et al., 2019 and Schnepper et al., 2020). At the conclusion of the study, participants were compensated for their participation with compliance dependent remuneration (5-15€ or 1-3 course credits) or individualised feedback on their EMA data.

Signal-contingent sampling was used, with six equidistant prompts at 9a.m., 11.30a.m. 2p.m., 4.30p.m., 7 p.m., and 9.30 p.m. Diary entries could be delayed if safety was a concern (e.g. while driving) or when there was no possibility to reply.

Additionally, participants could delay the required diary entries for one hour with or without reminders every 10 minutes. Later entries for this signal were not allowed and counted as missing values.

EMA measures

At each of six intra-day signals, participants completed questions about their current stress level, negative affect and food craving. Items were assessed on visual-analogue scales consisting of continuous horizontal rating sliders ranging from 0 – 100. Stress was assessed with three items of the *Perceived Stress Scale* (Cohen et al., 1983), adapted for momentary use: 'Do you feel that you can cope with things?', 'Do you feel that you're on top of things?', being rated from 0 (not at all) to 100 (very much), as well as one item asking about feelings of nervousness and stress which was intermingled in the subsequent following affect items because of its similar word stem. Negative affect was assessed with a list of six negative items (presented in random order and interleaved with positive affect items): irritated, bored, troubled, worried, dissatisfied with self, and nervous/stressed, however, nervous/stressed was not used for negative affect but for stress in the current study, to provide more distinctiveness between negative affect and stress. Affect items were also rated from 0 (not at all) to 100 (very much) with participants being asked 'How do you feel right now?'.

Current food craving was assessed at each signal by asking participants 'Do you have a desire to eat something tasty right now?' tapping into 'desire to eat' a subcomponent of food craving measuring the intensity of food craving (Cepeda-Benito et al., 2000). Answers were rated from 0 (not at all) to 100 (very much). In addition, participants indicated if they had eaten anything since the last signal followed by specific questions for this eating occasion. Thereby, perceived food intake was subjectively reported by asking participants 'How much have you eaten?', answered from 0 (eaten too little) to 100 (eaten too much). Participants completed that question for every eating episode that occurred since the last entry (being explicitly defined in the app manual as a distinct episode if longer that 30 minutes apart or contingent on a change of place). After additional questions related to this eating episode (e.g. food classification as snack or main meal, the extent of hunger- and taste-based eating, social situation they were in, and how satisfied they were with that eating episode), participants were asked if they had eaten anything else and repeatedly answered the questions for up to four distinct eating episodes. However, no filler questions were presented in case participants reported no eating episode at a signal to minimise participant burden.

Data analyses

For every signal, stress-level was calculated as the mean of the two reversed PSS-items, as well as the emotion item 'nervous/stressed'. Negative affect was calculated as the mean of all remaining five negative affect items. While stress and emotions were measured momentarily, perceived food intake was assessed retrospectively in the interval since the last signal. Stress at the previous signal (t-1, 2.5 hours before) was used as predictor of perceived food intake (averaged across eating episodes if

Table 1. Descriptive statistics of within day variables assessed in study 1.

Variable	*M*	*SD*
Level 1		
Stress	31.1	20.2
Craving	33.6	30.6
Perceived food intake	52.1	15.0
Negative affect	15.5	14.3
Level 2		
Salzburg Stress Eating Scale (1-5)	2.85	0.71

Note. Level 1 based on 4002 observations, except perceived food intake (2338 observations). Level 2 based on 97 participants.

more than one was reported) reported at signal t within one day to allow for the causality direction (stress > eating) of interest. In addition, for day-level analyses, stress, negative affect, food craving and perceived food intake was averaged across the day.

Hierarchical linear models were applied because of the nested, longitudinal structure of the data, using the software HLM7 (Raudenbush et al., 2011). Signals (Level 1) were nested within participants (Level 2). At Level 1, we modelled stress as predictor of food craving, with the SSES on Level 2 as predictor of the intercept as well as moderator of Level 1 slopes. The same analysis was then repeated with perceived food intake as dependent variable and stress (t-1) as predictor. Additionally, we modelled daily stress as predictor of daily perceived food intake with the SSES as moderator of these relationships on Level 2. Slopes were allowed to vary randomly and significant interactions were followed up with simple slopes analyses. Level 1 predictors were person-mean centred, Level 2 predictors were grand-mean centred. To provide more conceptual clarity for the distinction between stress and negative affect, models were rerun with negative affect instead of stress and with negative affect alongside stress.

The models are expressed by the following equation (exemplified by the prediction of food craving as dependent variable, stress as predictor and stress-eating (SSES scores) as predictor of the intercept and slope):

Level 1 (occasions within individuals):

$$\text{Food Craving}_{tj} = \pi_{0j} + \pi_{1j}\,(\text{Stress}_{tj}) + e_{tj}$$

Level 2 (person):

$$\pi_{0j} = \beta_{00} + \beta_{01}\,(\text{Stress-eating via SSES scores}_j) + r_{0j}$$
$$\pi_{1j} = \beta_{10} + \beta_{11}\,(\text{Stress-eating via SSES scores}_j) + r_{1j}$$

Results – study 1

Descriptives

Table 1 shows descriptives of the variables used in study 1, within day. At 2338 signals (of 4656 possible signals) participants reported any kind of eating. Among those, participants reported in total 1583 main meals (62.7%) and 943 snacks (37.3%)[1]. With regard to the SSES, 56 participants (57.7%) reported to decrease, 28 participants (28.9%) reported to increase their food intake when stressed, whereas 13 participants (13.4%) did not change their eating behaviour when stressed. On average, participants

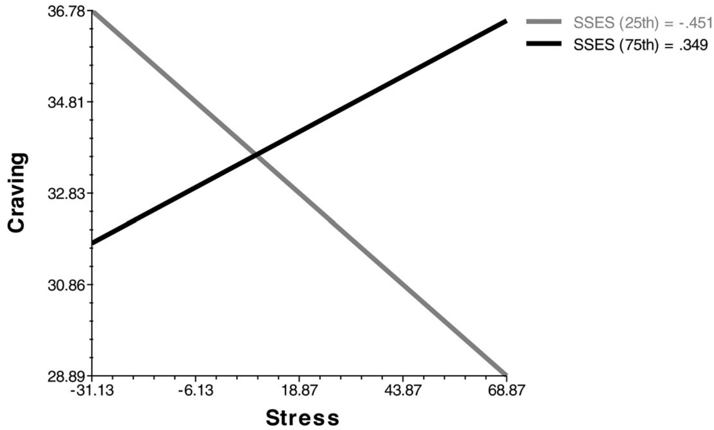

Figure 1. Relationship between stress and food craving moderated by the *Salzburg Stress Eating Scale* (SSES) in study 1.

Table 2. Multilevel models of study 1.

Model	Coefficient β (*SE*)	*p*
intra-day		
Stress – craving relationship		
Stress	$\beta_{10} = -.007$ (.043)	.863
Stress-eating (SSES scores)	$\beta_{01} = -1.34$ (1.80)	.457
Stress*Stress-eating interaction	$\beta_{11} = .159$ (.068)	**.021**
Stress – perceived food intake relationship		
Stress	$\beta_{10} = -.024$ (.035)	.486
Stress-eating (SSES scores)	$\beta_{01} = 2.30$ (1.10)	**.039**
Stress*Stress-eating interaction	$\beta_{11} = .012$ (.034)	.722
day level		
Stress – perceived food intake relationship		
Stress	$\beta_{10} = -.066$ (.047)	.158
Stress-eating (SSES scores)	$\beta_{01} = 2.32$ (.987)	**.021**
Stress*Stress-eating interaction	$\beta_{11} = .117$ (.058)	**.047**

Note: *p*-values $< .050$ are printed in boldface. SSES = Salzburg Stress Eating Questionnaire.

completed 86.0% ($SD = 10.6\%$) of their intra-day signals (range 50.0 – 100%), reflecting overall good compliance.

Stress – craving relationship intra-day

As illustrated in Figure 1 and Table 2, the SSES moderated the relationship between stress and food craving. Individuals with high SSES scores (75th percentile) showed a relative increase of craving with increasing stress while individuals with low SSES scores (below 25th percentile) showed a relative decrease in this relationship (yet slopes were both non-significant when tested individually ($\beta = .048$, $SE = .051$, $t_{(95)} = .950$, $p = .345$; $\beta = -.079$, $SE = .051$, $t_{(95)} = 1.56$, $p = .122$; respectively)). Neither the SSES nor stress exhibited a significant main effect on craving.

Regarding negative affect and its potential distinctiveness from stress, the analysis was rerun with negative affect replacing stress, however, no significant moderation of

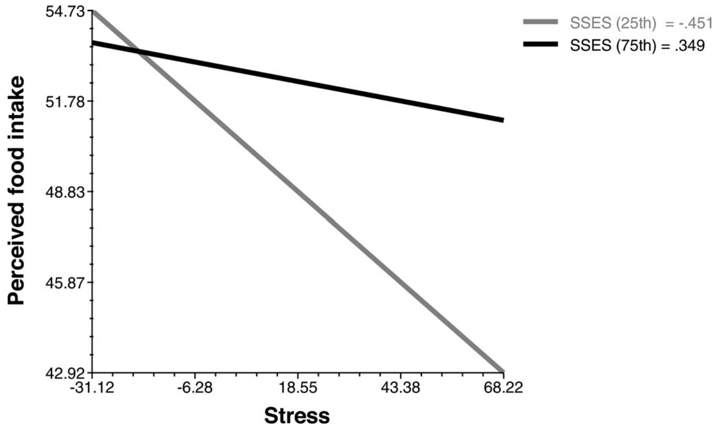

Figure 2. Relationship between stress and food craving moderated by the *Salzburg Stress Eating Scale* (SSES) in study 1.

the SSES on the negative affect – food craving relationship was obtained ($\beta_{11} = .129$, $SE = .084$, $p = .130$). In addition, when including negative affect into the main analysis together with stress, the moderation of the SSES on the stress – food craving relationship remained significant ($\beta_{11} = .146$, $SE = .068$, $p = .034$).

Stress – perceived food intake relationship intra-day

The SSES did not significantly moderate the relationship between stress and perceived food intake (see Table 2). Although the SSES exhibited a significant main effect on perceived food intake in that individuals with higher SSES scores reported higher perceived food intake amounts, stress did not significantly relate to perceived food intake.

Stress – perceived food intake relationship on the day level

In contrast to the intra-day effects, the SSES significantly moderated the relationship between stress and perceived food intake on the day level (see Table 2). As can be seen in Figure 2, on days with higher stress, less perceived food intake was reported by individuals with low SSES scores ($\beta = -.119$, $SE = .049$, $t_{(95)} = -2.43$, $p = .017$), whereas such a negative association is absent in individuals with high SSES scores ($\beta = -.026$, $SE = .054$, $t_{(95)} = .473$, $p = .638$), again representing a *relative increase* in eating behaviour (as for craving in the intra-day level). Similar to the intra-day results, individuals with higher SSES scores reported generally more perceived food intake, whereas stress did not significantly relate to perceived food intake.

To check for the distinct effect of stress, the analysis was rerun with negative affect instead of stress, however, no significant moderation of the SSES on the negative affect – perceived food intake relationship was obtained ($\beta_{11} = .078$, $SE = .067$, $p = .253$). In addition, when including negative affect into the main analysis, the moderation of the SSES on the stress – perceived food intake relationship remained significant ($\beta_{11} = .115$, $SE = .052$, $p = .029$).

Discussion – study 1

To conclude, study 1 revealed marked individual difference in the stress-eating relationship, which would have been obscured without accounting for them e.g. through instruments such as the SSES. In addition, intra-day and day level findings deviated from each other with regard to outcome measures (craving versus perceived food intake). This points to the importance of studying various independent and dependent variables and acknowledging broader timeframes for the stress-eating relationship (day level). Another interesting finding was that stress 'outperformed' negative affect in predicting craving and perceived food intake. To replicate these findings and to extend them to a population with explicit dieting interest, study 2 was conducted. Study 2 extended the EMA period (from 8 to 14 day), assuming that adverse stressful episodes might be rather rare and to increase power for day level analyses, while reducing the number of daily prompts (from 6 to 4) to balance participant burden.

Materials and methods – study 2

Participants

Participants were recruited via student mailing lists at universities in Germany and Austria as well as through word of mouth. Participants were screened for having a dieting interest by answering 'yes' to one of the following two questions: 'Are you currently watching your diet to maintain or reduce your weight?' or 'Are you currently restricting your food intake to maintain or reduce your weight'. Afterwards, a total of 90 participants completed initial questionnaires and the data assessment in daily life. Participants were excluded in case of missing data in the questionnaires or overall low compliance in the EMA assessment (<50%). The resulting 83 individuals, whose data are reported here, ranged from 18 to 38 years with a mean of 22.7 ($SD = 4.14$). Participants were predominantly women (86.7%) with a mean body-mass index (BMI) of 21.9 kg/m^2 ($SD = 2.72$ kg/m^2; range: 17.3 – 33.1 kg/m^2). Five participants (6.0%) were underweight (BMI $<$ 18.5 kg/m^2), 70 participants (84.3%) were healthy weight (BMI $=$ 18.5-24.9 kg/m^2), 7 participants (8.4%) were overweight (BMI $=$ 25.0-29.9 kg/m^2), and 1 participant (1.2%) was obese (BMI $\geq$ 30.0 kg/m^2). All participants signed an informed consent form approved by the ethics committee of the University of Salzburg and were compensated for their participation.

Questionnaire

Similar to study 1, the SSES was used (see study 1 for a detailed description). The internal consistency was $\alpha = .879$ in study 2.

Procedure

The procedure of study 2 was similar to study 1, with the exception that participants were screened for inclusion criteria before participation in the study. Again, participants completed additional questionnaires which are not of relevance for the current study assessing eating styles, food craving, impulsivity, depression, physical activity level, self-control and self-efficacy. Participants received written and oral information about the app installation and EMA items. In addition, after one practice day (data again not included in the present study), participants completed 14 (instead of 8) days of EMA with signal-contingent sampling of four (instead of six) equidistant prompts at 9a.m., 1p.m. 5p.m., and 9p.m. The current study, advertised as a study on 'Physical activity, diet and stress in daily life' consisted of an EMA part only. As the main aim of the study was to examine individuals with a dieting interest, eating behaviour and physical activity was assessed concurrently, however, the physical activity data are not of interest for the current study. At the conclusion of the study, participants were compensated for their participation with an individualised feedback on their EMA data or 4.5 course credits. In addition, the top 20% of participants with the highest compliance rates received an additional remuneration of 20€ to increase motivation and compliance.

EMA measures

EMA measures of stress and negative affect were identical to study 1 with the exception that the list of negative affect items did not include 'dissatisfied with self', thus, contained only five items. Although perceived food intake was measured with the identical item as in study 1, the food craving item was slightly reworded to 'How strong is your desire for specific foods in the current moment?' answered from 0 (not at all) to 100 (very much). This was done to improve similarity to food craving definitions (e.g. Hill, 2007; Meule, 2020) by more directly including the specificity and intensity aspect into the question. Additional questions for each eating episode inquired about were related to food type (classification as snack or main meal), satisfaction (how satisfied they were with that eating episode), amount (how much they have eaten out of several food categories like sweets, carbohydrates, salty snacks, fruits) and how much that eating episode matched to their dieting goal. In study 2, participants had the option to complete questions referring to a distinct eating episode up to three times within one signal.

Data analyses

Again, the affect item nervous/stressed was used for calculating the mean stress level, so that negative affect was calculated as the mean of the remaining four negative affect items. Otherwise, data analysis was identical to study 1.

Results – study 2

Descriptives

Table 3 shows descriptives of the variables used in study 2, within day. At 3074 signals (of 4648 possible signals) participants reported any kind of eating. Among those, participants reported in total 2565 main meals (70.3%) and 1085 snacks (29.7%)[2]. With regard to the SSES, 30 participants (36.1%) reported to decrease, 45

Table 3. Descriptive statistics of within day variables assessed in study 2.

Variable	*M*	*SD*
Level 1		
Stress	33.4	18.2
Craving	21.7	25.2
Perceived food intake	50.0	15.7
Negative affect	13.9	13.3
Level 2		
Salzburg Stress Eating Scale (1-5)	3.11	0.68

Note. Level 1 based on 3954 observations, except perceived food intake (3074 observations). Level 2 based on 83 participants.

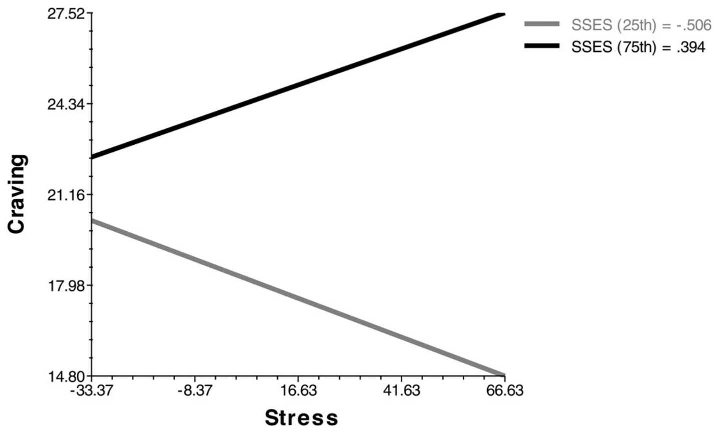

Figure 3. Relationship between stress and food craving moderated by the *Salzburg Stress Eating Scale* in study 2.

Table 4. Multilevel models of study 2.

Model	Coefficient β (*SE*)	*p*
intra-day		
Stress – craving relationship		
Stress	$\beta_{01} = .005$ (.036)	.900
Stress-eating (SSES scores)	$\beta_{01} = 6.36$ (2.10)	**.003**
Stress*Stress-eating interaction	$\beta_{11} = .117$ (.045)	**.011**
Stress – perceived food intake relationship		
Stress	$\beta_{10} = -.014$ (.026)	.580
Stress-eating (SSES scores)	$\beta_{01} = 3.51$ (.971)	**<.001**
Stress*Stress-eating interaction	$\beta_{11} = .031$ (.039)	.418
day level		
Stress – perceived food intake relationship		
Stress	$\beta_{10} = .054$ (.036)	.133
Stress-eating (SSES scores)	$\beta_{01} = 2.95$ (.900)	**.002**
Stress*Stress-eating interaction	$\beta_{11} = .114$ (.041)	**.007**

Note: *p*-values $< .050$ are printed in boldface. SSES = Salzburg Stress Eating Questionnaire.

participants (54.2%) reported to increase their food intake when stressed, whereas 8 participants (9.6%) did not change their eating behaviour when stressed. On average, participants completed 85.1% (*SD* = 12.9%) of their intra-day signals (range 53.6 – 98.2%), reflecting overall good compliance.

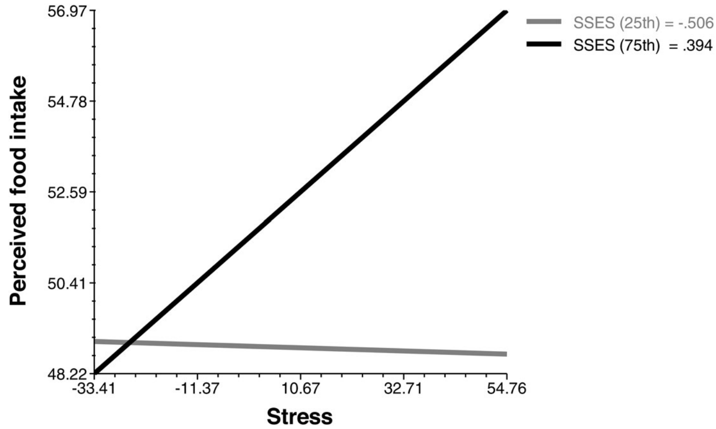

Figure 4. Relationship between stress and food craving moderated by the *Salzburg Stress Eating Scale* (SSES) in study 2.

Stress – craving relationship intra-day

As illustrated in Figure 3 and Table 4, the SSES moderated the relationship between stress and food craving. Individuals with high SSES scores (75th percentile) showed a relative increase of craving with increasing stress while individuals with low SSES scores (below 25th percentile) showed a relative decrease in this relationship (yet slopes were both non-significant when tested individually ($\beta = .051$, $SE = .041$, $t_{(81)} = 1.23$, $p = .223$; $\beta = -.055$, $SE = .041$, $t_{(81)} = -1.32$, $p = .192$; respectively)). Although the SSES exhibited a significant main effect on craving, stress did not.

To check for the distinct effect of stress, the analysis was rerun with negative affect instead of stress, and a significant moderation of the SSES on the negative affect – food craving relationship was obtained ($\beta_{11} = .107$, $SE = .051$, $p = .039$). However, when including negative affect as control variable into the main analysis, the moderation of the SSES on the stress – food craving relationship remained significant ($\beta_{11} = .116$ $SE = .046$, $p = .014$).

Stress – perceived food intake relationship intra-day

Similar to study 1, the SSES did not significantly moderate the relationship between stress and perceived food intake (see Table 4). Also in line with study 1, individuals with higher SSES scores reported more perceived food intake (main effect), whereas stress did not significantly relate to perceived food intake.

Stress – perceived food intake relationship on the day level

In contrast to intra-day effects but in line with study 1, the SSES significantly moderated the relationship between stress and perceived food intake over the day. As can be seen in Figure 4 and Table 4, on days with higher stress, more perceived food intake was reported by individuals with high SSES scores ($\beta = .099$, $SE = .039$, $t_{(81)} = 2.57$, $p = .012$). Individuals with low SSES scores exhibit no significant relationship (β

$= -.004$, $SE = .042$, $t_{(81)} = -.082$, $p = .935$). Similar to intra-day results, the SSES exhibited a significant main effect on perceived food intake, whereas stress did not significantly relate to perceived food intake.

To check for the distinct effect of stress, the analysis was rerun with negative affect instead of stress, and a significant moderation of the SSES on the negative affect – perceived food intake relationship was obtained ($\beta_{11} = .131$, $SE = .046$, $p = .005$). However, when including negative affect as control variable into the main analysis, the moderation of the SSES on the stress – perceived food intake relationship remained significant ($\beta_{11} = .114$, $SE = .041$, $p = .006$).

Overall discussion

The current studies followed the aim of clarifying the direction of stress-eating relationships and the role of individual differences. We also aimed at determining the role of stress relative to negative emotions in this relationship. Therefore, we used smartphone-based EMA in daily life and modelled the effects of momentary stress on momentary food craving and subsequent perceived food intake (within participants) as a function of trait-level stress-eating (between participants) in daily life. Consistently across both studies, a psychometric measure of stress-eating (SSES) moderated the relationships between stress and food craving, as well as stress and perceived food intake. Individuals with higher trait stress-eating scores showed a *relative* increase in these eating behaviours compared to their low trait stress-eating counterparts. Moreover, when controlling for negative affect, the SSES remained significant in moderating the relationship between stress and food craving as well as perceived food intake. Interestingly, the moderation of stress-eating of the stress–perceived food intake relationship was significant on the day level only (intra-day data aggregated), not within days. We will discuss each of these findings in turn.

Notably, neither of the two studies found a significant *main effect* of stress on eating on either dependent variable (food craving, perceived food intake intra-day and day level). This contrast with studies describing such main effects (e.g. Epel et al., 2001; O'Connor et al., 2008; Reichenberger et al., 2018). Instead, trait stress-eating dispositions consistently moderated stress-eating relationships (for craving and day level intake). This supports the *individual difference model* of stress-eating (Greeno & Wing, 1994), pointing to idiosyncratic relationships within participants between stressful experience (and physiology) and their effect on subsequent eating behaviours. Of note, this could support learning accounts that have been elaborated in the emotional eating literature (e.g. Macht, 2008), proposing individual conditioning histories of relieve from stress through the positive reinforcement resulting from eating. However, as introduced above, also the stress physiology varies considerably between individuals pointing to possibilities that eating-facilitative physiological mechanisms dominate suppressive ones in some (those with high SSES scores) but not in other individuals. The present findings do also not exclude the possibility that different stressor types (daily hassles, physical stressors) have different main effects (O'Connor et al., 2008). Crucially though, regardless of underlying theorising, not modelling these interindividual differences (SSES score here) might completely obscure any effect of stress on food craving or perceived food intake (no main effect of stress on eating behaviour) or lead to inconsistent results across studies.

Interestingly, while both studies consistently showed relationships of intra-day stress variation with food craving, relationships with perceived food intake were only seen on the day level (again, consistent in both studies). Hence, stress might exhibit a more prolonged or cumulative influence on food intake that was not captured well with our time window of 2.5 hours in study 1 and 4 hours in study 2 (between stress assessment and perceived food intake report). For example, work stress earlier the day might influence eating behaviour later the day at home. This might be due to factors like availability of food, or the break-down of self-control at the end of the day. In addition, a study by Huh et al. (2015) showed that a relationship between stress and hunger in daily life only started to arise in the afternoon/evening hours. Food intake studies in daily life suggest that rather high-caloric foods are more popular during the afternoon/evening (Haynes et al., 2016; Warde & Yates, 2017). Still, momentary stress related to momentary food craving as a function of stress-eating. This might suggest, that although current stress transfers into current food craving, the subsequent step to actual food intake is not made, supported by research showing that food craving does not always lead to food intake (Hill, 2007; Richard et al., 2017) . Alternatively, on the day level, the causality direction of the stress-eating relationship might have reversed: increased eating at some time of the day might have influenced subsequent stress ratings. Due to the aggregation on the day level such temporal sequencing is absent, so this finding should be interpreted cautiously. The 'emotional about eating' hypothesis (Adriaanse et al., 2011) describes an attribution pattern that justifies overeating with stress. In the same vein, overeating might have increased subsequent stress experience due to body weight or body image concerns and guilt.

Indeed, there is an ongoing debate about ecological validity in the domain of emotional eating because recent reviews failed to show a robust relationship between emotional eating questionnaires and actual emotional eating in the laboratory or in daily life (Adriaanse et al., 2011; Bongers & Jansen, 2016). In contrast, the results of the present studies provide support for the ecological validity for the SSES: it was positively associated with eating behaviours in four of the six tests (three dependent variables in two studies). More specifically, the self-reported trait-level tendency to eat either less or more when stressed by the SSES is also mirrored by EMA data: While the key finding of the present studies is the consistent moderation of the stress-eating relationship in the EMA data by SSES scores, the slopes differed slightly by study. In study 1 more than half of the participants described themselves as 'stress less eaters' in the SSES, paralleled the fact that stress less eaters were the main driver of the moderation effect of the SSES. In contrast, in study 2 more than half of individuals considered themselves as stress more eaters, again also reflected by 'stress more eaters' driving the moderation effect of the SSES. This adds to our earlier validation study showing that higher stress-eating scores (i.e. SSES scores) were associated with higher BMI, and particularly so in participants with higher stress levels (Meule et al., 2018b). The current results might extend this finding in suggesting that the tendency of high stress eaters to increase their food intake *on stressful days* might in the long-term facilitate weight gain and a higher BMI, pointing to a state-trait interaction. Further corroborating this, recent research showed that SSES scores are related to intention-behaviour-gaps with regard to restriction (Reichenberger et al., 2019): Participants with higher SSES scores exhibited higher intention-behaviour gaps in daily life in that they were more prone to report a higher intention to restrict compared to the actual restrictive behaviour. However, pathways towards BMI increase remain speculative unless examined longitudinally. The fact that both studies in unselected (study 1) and diet-interested (study 2) individuals yielded highly similar results points to the generality of stress-eating relationships: these seem independent of current (eating) behaviour change intentions.

Unsurprisingly – due to its close relationship with stress – negative affect showed some relations with perceived food intake across the day (however, only in study 2) as a function of trait-level stress-eating. Previous research suggests that negative affect might be a mediator between stress and pathological eating behaviour (i.e. binge eating) (Goldschmidt et al., 2014). Yet, the stress-eating moderations remained significant when controlling for negative affect. This points to the earlier notion that stress and affect might differ in their effects on eating behaviour and that distinct trait-level assessments of stress-eating and emotional eating are useful (Meule et al., 2018a; 2018b). Since negative emotions and stress share the negative valence, the question arises as to the mediating processes. The effects of the HPA axis on metabolic mediators of appetite might be stronger/different that the effects of negative emotions on autonomic nervous system responses. Alternatively, emotion regulatory processes might be more central for negative emotions relative to stress. Multi-method studies with concurrent modelling of negative emotions, arousal, and stress on eating behaviour is needed to clarify this. At the least, the present finding calls for a clearer separation of the two constructs including consistent naming. We propose to use the terms emotional eating and stress-eating non-interchangeably in future research.

Limitations and implications

Limitations include the subjective assessment of stress and eating behaviour. Although stress might validly be assessed subjectively, eating behaviour and especially retrospective food intake suffers from several biases like a general recall bias (Shiffman et al., 2008), underreporting of actual intake (Johansson et al., 2001; Macdiarmid & Blundell, 1998), or difficulties with regard to over- or underestimating calories (e.g. Carels et al., 2007). Thus, by using the perceived food intake we tried to circumvent complex and time-consuming calorie counting, however introduced a subjective evaluation that might be influenced by sample characteristics (i.e. individuals in the diet-interested sample 2 might be prone to consider objective normal food intake as subjective overeating). Objective assessment is feasible with novel and sophisticated assessments of food intake (e.g. see Blechert et al., 2017 for various assessment protocols) but still insufficiently validated in real life situations. In addition, the assessment of objective indicators of stress like salivary cortisol in daily life is methodologically challenging (Schlotz, 2019). In both studies, stress and negative affect levels were similar, however especially negative affect was rather low. This is common among predominantly student samples (e.g. Barker et al., 2016), and calls for future research in samples with higher stress and negative affect levels as found in clinical populations. Alternatively, EMA assessment could occur during a temporary high stress phase. Moreover, as stated above, the absence of an intra-day prospective effect of stress on perceived food intake might also partially be due to the signal-contingent sampling scheme used in the present studies. Methodological studies varying between event- and signal-contingent sampling or using higher sampling frequency might shed light on the temporal resolution of stress-eating relationships.

Previous research supports the notion that stress-eating contributes to weight gain and obesity as well as other adverse health consequences (Araiza & Lobel, 2018; Torres & Nowson, 2007). Thus, it seems necessary to intervene on the various aspects in the stress-eating relationship described in the present study. O'Connor et al. (2014) applied an intervention by letting participants identify healthy snacks they could consume in certain stressful situations. These participants ate more healthy snacks on subsequent stressful days compared to control participants. Thus, such minimal interventions might support healthy food choices during stressful times. Tackling stress experience per se, coping and emotion regulation training might be helpful in itself and through indirectly improving eating behaviour. Last, identifying people at risk for stress-eating (on the trait level) and pinpointing moments in daily life in which this might be the case paves the way for just-in-time adaptive interventions (e.g. Nahum-Shani et al., 2018).

Overall, the current studies' strengths include the naturalistic EMA design, with time lagged, prospective modelling of stress effects on subsequent eating (intra-day level). The key results were replicated across two independent studies in separate samples with different constitution regarding diet-interest and gender. Findings call for a clearer distinction between emotional and stress eaters, and lend strong support for an individual difference model of stress-eating: individuals seem to be quite accurate in their reports on a trait-level questionnaire about whether their day-to-day stressors are associated with changes in food craving and perceived intake. Thus, tailoring interventions to 'stress more eaters' and 'stress less eaters' is within reach.

Notes

1. Participants reported one main meal at 1554 signals, two main meals at 13 signals and three main meals at one signal. Similarly, participants reported one snack at 889 signals and two snacks at 27 signals.
2. Participants reported one main meal at 2357 signals, two main meals at 101 signals and three main meals at two signals. Similarly, participants reported one snack at 979 signals, two snacks at 50 signals and three snacks at two signals.

Disclosure statement

The authors declare no conflict of interest.

Funding

JB, BP, A-KA, and JR were supported by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation program (ERC-StG-2014 639445 NewEat). This work was supported by the Austrian Science Fund (FWF): [I 02130-B27].

ORCID

Julia Reichenberger http://orcid.org/0000-0003-4982-410X
Katja Petrowski http://orcid.org/0000-0001-7297-2093
Jens Blechert http://orcid.org/0000-0002-3820-109X

References

Adam, T. C., & Epel, E. S. (2007). Stress, eating and the reward system. *Physiology & Behavior*, *91*(4), 449–458. https://doi.org/10.1016/j.physbeh.2007.04.011

Adriaanse, M. A., de Ridder, D. T. D., & Evers, C. (2011). Emotional eating: Eating when emotional or emotional about eating? *Psychology & Health*, *26*(1), 23–39. https://doi.org/10.1080/08870440903207627

Araiza, A. M., & Lobel, M. (2018). Stress and eating: Definitions, findings, explanations, and implications. *Social and Personality Psychology Compass*, *12*(4), e12378. https://doi.org/10.1111/spc3.12378

Barker, E. T., Howard, A. L., Galambos, N. L., & Wrosch, C. (2016). Tracking affect and academic success across university: Happy students benefit from bouts of negative mood. *Developmental Psychology*, *52*(12), 2022–2030. https://doi.org/10.1037/dev0000231

Bazhan, N., & Zelena, D. (2013). Food-intake regulation during stress by the hypothalamo-pituitary-adrenal axis. *Brain Research Bulletin*, *95*, 46–53. https://doi.org/10.1016/j.brainresbull.2013.04.002

Blechert, J., Liedlgruber, M., Lender, A., Reichenberger, J., & Wilhelm, F. H. (2017). Unobtrusive electromyography-based eating detection in daily life: A new tool to address underreporting?. *Appetite*, *118*, 168–173. https://doi.org/10.1016/j.appet.2017.08.008

Bongers, P., & Jansen, A. (2016). Emotional eating is not what you think it is and emotional eating scales do not measure what you think they measure. *Frontiers in Psychology*, *7*(1932), 1–11. https://doi.org/10.3389/fpsyg.2016.01932

Cardi, V., Leppanen, J., & Treasure, J. (2015). The effects of negative and positive mood induction on eating behaviour: A meta-analysis of laboratory studies in the healthy population and eating and weight disorders. *Neuroscience and Biobehavioral Reviews*, *57*, 299–309. https://doi.org/10.1016/j.neubiorev.2015.08.011

Carels, R. A., Konrad, K., & Harper, J. (2007). Individual differences in food perceptions and calorie estimation: an examination of dieting status, weight, and gender. *Appetite*, *49*(2), 450–458. https://doi.org/10.1016/j.appet.2007.02.009

Cepeda-Benito, A., Gleaves, D. H., Williams, T. L., & Erath, S. A. (2000). The development and validation of the state and trait Food-Cravings Questionnaires. *Behavior Therapy*, *31*(1), 151–173. https://doi.org/10.1016/S0005-7894(00)80009-X

Cleobury, L., & Tapper, K. (2014). Reasons for eating 'unhealthy' snacks in overweight and obese males and females. *Journal of Human Nutrition and Dietetics : The Official Journal of the British Dietetic Association*, *27*(4), 333–341. https://doi.org/10.1111/jhn.12169

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, *130*(3), 355–391. https://doi.org/10.1037/0033-2909.130.3.355

Engel, S. G., Crosby, R. D., Thomas, G., Bond, D., Lavender, J. M., Mason, T., Steffen, K. J., Green, D. D., & Wonderlich, S. A. (2016). Ecological momentary assessment in eating disorder and obesity research: A review of the recent literature. *Current Psychiatry Reports*, *18*(4), 1–9. https://doi.org/10.1007/s11920-016-0672-7

Epel, E., Lapidus, R., McEwen, B., & Brownell, K. (2001). Stress may add bite to appetite in women: a laboratory study of stress-induced cortisol and eating behavior. *Psychoneuroendocrinology*, *26*(1), 37–49. https://doi.org/10.1016/s0306-4530(00)00035-4

Evers, C., Dingemans, A., Junghans, A. F., & Boevé, A. (2018). Feeling bad or feeling good, does emotion affect your consumption of food? A meta-analysis of the experimental evidence. *Neuroscience and Biobehavioral Reviews*, *92*, 195–208. https://doi.org/10.1016/j.neubiorev.2018.05.028

Georgii, C., Schulte-Mecklenbeck, M., Richard, A., Van Dyck, Z., & Blechert, J. (2019). The dynamics of self-control: within-participant modeling of binary food choices and underlying decision processes as a function of restrained eating. *Psychological Research*, Advance online publication. https://doi.org/10.1007/s00426-019-01185-3

Gibson, E. L. (2006). Emotional influences on food choice: Sensory, physiological and psychological pathways. *Physiology & Behavior*, *89*(1), 53–61. https://doi.org/10.1016/j.physbeh.2006.01.024

Gibson, E. L. (2012). The psychobiology of comfort eating: implications for neuropharmacological interventions. *Behavioural Pharmacology*, *23*(5-6), 442–460. https://doi.org/10.1097/FBP.0b013e328357bd4e

Goldschmidt, A. B., Wonderlich, S. A., Crosby, R. D., Engel, S. G., Lavender, J. M., Peterson, C. B., Crow, S. J., Cao, L., & Mitchell, J. E. (2014). Ecological momentary assessment of stressful events and negative affect in bulimia nervosa. *Journal of Consulting and Clinical Psychology*, *82*(1), 30–39. https://doi.org/10.1037/a0034974

Greeno, C. G., & Wing, R. R. (1994). Stress-induced eating. *Psychological Bulletin*, *115*(3), 444–464. https://doi.org/10.1037/0033-2909.115.3.444

Haynes, A., Kemps, E., & Moffitt, R. (2016). Is cake more appealing in the afternoon? Time of day is associated with control over automatic positive responses to unhealthy food. *Food Quality and Preference*, *54*, 67–74. https://doi.org/10.1016/j.foodqual.2016.07.004

Hill, A. J. (2007). The psychology of food craving. *Proceedings of the Nutrition Society*, *66*, 277–285.

Huh, J., Shiyko, M., Keller, S., Dunton, G., & Schembre, S. M. (2015). The time-varying association between perceived stress and hunger within and between days. *Appetite*, *89*, 145–151. https://doi.org/10.1016/j.appet.2015.02.001

Johansson, G., Wikman, Å., Åhrén, A.-M., Hallmans, G., & Johansson, I. (2001). Underreporting of energy intake in repeated 24-hour recalls related to gender, age, weight status, day of interview, educational level, reported food intake, smoking habits and area of living. *Public Health Nutrition*, *4*(4), 919–927. https://doi.org/10.1079/phn2001124

Macdiarmid, J., & Blundell, J. (1998). Assessing dietary intake: who, what and why of under-reporting. *Nutrition Research Reviews*, *11*(2), 231–253. https://doi.org/10.1079/NRR19980017

Macht, M. (2008). How emotions affect eating: A five-way model. *Appetite*, *50*(1), 1–11. https://doi.org/10.1016/j.appet.2007.07.002

Meule, A. (2020). Twenty years of the food cravings questionnaires: A comprehensive review. *Current Addiction Reports*, *7*, 30–43.

Meule, A., Reichenberger, J., & Blechert, J. (2018a). Development and preliminary validation of the Salzburg emotional eating scale. *Frontiers in Psychology.*, *9*, 88. https://doi.org/10.3389/fpsyg.2018.00088

Meule, A., Reichenberger, J., & Blechert, J. (2018b). Development and preliminary validation of the Salzburg Stress Eating Scale. *Appetite*, *120*, 442–448. https://doi.org/10.1016/j.appet.2017.10.003

Nahum-Shani, I., Smith, S. N., Spring, B. J., Collins, L. M., Witkiewitz, K., Tewari, A., & Murphy, S. A. (2018). Just-in-Time Adaptive Interventions (JITAIs) in mobile health: Key components and design principles for ongoing health behavior support. *Annals of Behavioral Medicine*, *52*(6), 446–462. https://doi.org/10.1007/s12160-016-9830-8

O'Connor, D. B., Armitage, C. J., & Ferguson, E. (2014). Randomized test of an implementation intention-based tool to reduce stress-induced eating. *Annals of Behavioral Medicine*, *49*(3), 331–343. https://doi.org/10.1007/s12160-014-9668-x

O'Connor, D. B., & Conner, M. (2011). *Effects of stress on eating behavior the handbook of stress science: Biology, psychology, and health* (pp. 275–286). Springer Publishing Company.

O'Connor, D. B., Jones, F., Conner, M., McMillan, B., & Ferguson, E. (2008). Effects of daily hassles and eating style on eating behavior. *Health Psychology: Official Journal of the Division of*

Health Psychology, American Psychological Association, *27*(1 Suppl), S20–S31. https://doi.org/10.1037/0278-6133.27.1.S20
Oliver, G., & Wardle, J. (1999). Perceived effects of stress on food choice. *Physiology & Behavior*, *66*(3), 511–515. https://doi.org/10.1016/S0031-9384(98)00322-9
Raudenbush, S. W., Byrk, A. S., & Congdon, R. (2011). *HLM7 for Windows [Computer software]*. Scientific Software International, Inc.
Reichenberger, J., Kuppens, P., Liedlgruber, M., Wilhelm, F. H., Tiefengrabner, M., Ginzinger, S., & Blechert, J. (2018). No haste, more taste: An EMA study of the effects of stress, negative and positive emotions on eating behavior. *Biological Psychology*, *131*, 54–62. https://doi.org/10.1016/j.biopsycho.2016.09.002
Reichenberger, J., Smyth, J. M., Kuppens, P., Blechert, J. (2019). "I will fast … tomorrow": Intentions to restrict eating and actual restriction in daily life and their person-level predictors. *Appetite*, *140*, 10–18. https://doi.org/10.1016/j.appet.2019.04.019
Renner, B., Sproesser, G., Strohbach, S., & Schupp, H. T. (2012). Why we eat what we eat. The Eating Motivation Survey (TEMS). *Appetite*, *59*(1), 117–128. https://doi.org/10.1016/j.appet.2012.04.004
Richard, A., Meule, A., Reichenberger, J., & Blechert, J. (2017). Food cravings in everyday life: An EMA study on snack-related thoughts, cravings, and consumption. *Appetite*, *113*, 215–223. https://doi.org/10.1016/j.appet.2017.02.037
Richard, A., Meule, A., Georgii, C., Voderholzer, U., Cuntz, U., Wilhelm, F. H., & Blechert, J. (2019). Associations between interoceptive sensitivity, intuitive eating, and body mass index in patients with anorexia nervosa and normal-weight controls. *European eating disorders review : The Journal of the Eating Disorders Association, 27*(5), 571–577. https://doi.org/10.1002/erv.2676
Robinson, E., Hardman, C. A., Halford, J. C., & Jones, A. (2015). Eating under observation: a systematic review and meta-analysis of the effect that heightened awareness of observation has on laboratory measured energy intake. *The American Journal of Clinical Nutrition*, *102*(2), 324–337. https://doi.org/10.3945/ajcn.115.111195
Schlotz, W. (2019). Investigating associations between momentary stress and cortisol in daily life: What have we learned so far?. *Psychoneuroendocrinology*, *105*, 105–116. https://doi.org/10.1016/j.psyneuen.2018.11.038
Schnepper R., Georgii C., Eichin K., Arend A. -K., Wilhelm F. H., Vögele C., Lutz A. P. C., van Dyck Z., & Blechert J. (2020) Fight, Flight, – Or Grab a Bite! Trait Emotional and Restrained Eating Style Predicts Food Cue Responding Under Negative Emotions. *Frontiers in Behavioral Neuroscience, 14*, 91. https://doi.org/10.3389/fnbeh.2020.00091
Shiffman, S., Stone, A. A., & Hufford, M. R. (2008). Ecological momentary assessment. *Annual Review of Clinical Psychology*, *4*, 1–32. https://doi.org/10.1146/annurev.clinpsy.3.022806.091415
Smyth, J., Wonderlich, S., Crosby, R., Miltenberger, R., Mitchell, J., & Rorty, M. (2001). The use of ecological momentary assessment approaches in eating disorder research. *The International Journal of Eating Disorders*, *30*(1), 83–95. https://doi.org/10.1002/eat.1057
Stone, A. A., & Brownell, K. D. (1994). The stress-eating paradox: Multiple daily measurements in adult males and females. *Psychology & Health*, *9*(6), 425–436. https://doi.org/10.1080/08870449408407469
Torres, S. J., & Nowson, C. A. (2007). Relationship between stress, eating behavior, and obesity. *Nutrition*, *23*(11-12), 887–894.
Warde, A., & Yates, L. (2017). Understanding eating events: Snacks and meal patterns in Great Britain. *Food, Culture & Society*, *20*(1), 15–36. https://doi.org/10.1080/15528014.2016.1243763
Zellner, D. A., Loaiza, S., Gonzalez, Z., Pita, J., Morales, J., Pecora, D., & Wolf, A. (2006). Food selection changes under stress. *Physiology & Behavior*, *87*(4), 789–793. https://doi.org/10.1016/j.physbeh.2006.01.014
Zenk, S. N., Horoi, I., McDonald, A., Corte, C., Riley, B., & Odoms-Young, A. M. (2014). Ecological momentary assessment of environmental and personal factors and snack food intake in African American women. *Appetite*, *83*, 333–341. https://doi.org/10.1016/j.appet.2014.09.008