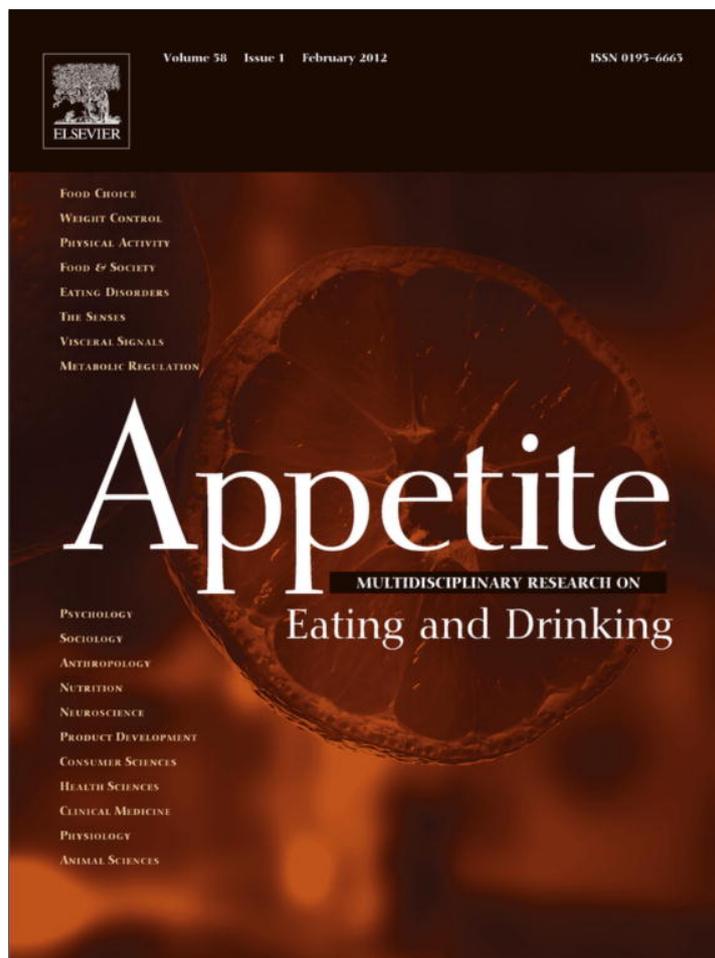


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Research report

High-calorie food-cues impair working memory performance in high and low food cravers

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ABSTRACT

The experience of food craving can lead to cognitive impairments. Experimentally induced chocolate craving exhausts cognitive resources and, therefore, impacts working memory, particularly in trait chocolate cravers. In the current study, we investigated the effects of exposure to food-cues on working memory task performance in a group with frequent and intense (high cravers, $n = 28$) and less pronounced food cravings (low cravers, $n = 28$). Participants performed an *n*-back task that contained either pictures of high-calorie sweets, high-calorie savory foods, or neutral objects. Current subjective food craving was assessed before and after the task. All participants showed slower reaction times and made more omission errors in response to food-cues, particularly savory foods. There were no differences in task performance between groups. State cravings did not differ between groups before the task, but increased more in high cravers compared to low cravers during the task. Results support findings about food cravings impairing visuo-spatial working memory performance independent of trait cravings. They further show that this influence is not restricted to chocolate, but also applies to high-calorie savory foods. Limiting working memory capacity may be especially crucial in persons who are more prone to high-calorie food-cues and experience such cravings habitually.

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Introduction

Craving refers to an urgent desire, longing, or yearning for a particular substance, which includes alcohol, tobacco, addictive drugs, and food (Hormes & Rozin, 2010). Food cravings most often involve an intense desire to eat chocolate (Weingarten & Elston, 1991). It is this intensity and specificity that distinguishes food cravings from ordinary feelings of hunger (Hill, 2007). In both substance use and eating behavior, cravings have been associated with excessive consumption of the craved substance or food, and non-compliance to long-term goals. Drug cravings are associated with relapse in substance abuse (e.g. Allen, Bade, Hatsukami, & Center, 2008) as food cravings are associated with binge eating (Gendall, Sullivan, Joyce, Fear, & Bulik, 1997; Meule, Lutz, Vögele, & Kübler, 2012) or unsuccessful dieting (Meule, Westenhöfer, & Kübler, 2011).

The experience of craving has been found to affect cognitive performance. In simple reaction time tasks, smokers and alcohol-dependent patients displayed a slowing of reactions when craving was induced by either cue-exposure or mental imagery (Baxter & Hinson, 2001; Cepeda-Benito & Tiffany, 1996; Sayette & Hufford, 1994; Sayette et al., 1994). In Tiffany's (1990) cognitive model of

drug urges, attempts to inhibit automatic drug use schemata require non-automatic processing during the experience of craving. This limits available cognitive resources, which negatively affects performance in tasks that require non-automatic processing, such as reaction time tasks.

These findings in substance use have been extended to food cravings. Using different types of cognitive tasks, chronic dieters have been found to slow down reactions after exposure to craving inducing mental imagery (Green, Rogers, & Elliman, 2000) or after consuming a preload (Meule, Lukito, Vögele, & Kübler, 2011). Similarly, trait chocolate cravers exhibited increased reaction times (Kemps, Tiggemann, & Grigg, 2008) or a slower detection of neutral targets among food-related distractors after exposure to cues eliciting chocolate craving (Smeets, Roefs, & Jansen, 2009). It has been further argued that the experience of chocolate craving in trait chocolate cravers leads to distraction by, rather than speeded detection of craving-related cues (i.e. chocolate; Smeets et al., 2009).

Craving leads not only to slowed reactions and distraction, it also affects working memory performance. For instance, smokers performed worse in a working memory task when trials were preceded by smoking-cues (Wilson, Sayette, Fiez, & Brough, 2007). Accordingly, inducing food craving lead to impaired working memory performance in trait chocolate cravers (Kemps et al., 2008) or

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in female students without any moderating role of trait chocolate craving (Tiggemann, Kemps, & Parnell, 2010). Vice versa, concurrent visuo-spatial information processing or mental imagery tasks reduced food cravings (see Kemps & Tiggemann, 2010 for a review), which highlights the role of the visual modality in the experience of craving (Tiggemann & Kemps, 2005). Thus, it has been argued that food cravings selectively impact visuo-spatial aspects of working memory (visuo-spatial sketchpad; Baddeley & Hitch, 1974) which could be confirmed recently (Tiggemann et al., 2010).

While existing studies on food cravings and working memory performance have tended to use imagery to induce craving followed by neutral working memory tasks, there is a plethora of cognitive tasks involving food stimuli that impact performance in people with disordered eating behavior (see Brooks, Prince, Stahl, Campbell, & Treasure, 2011 for a review). One of these measures is the *n*-back paradigm where participants are required to monitor a series of stimuli and to respond when a stimulus matches the one presented *n* trials previously (usually 1-, 2-, or 3-back; cf. Owen, McMillan, Laird, & Bullmore, 2005). This task requires monitoring, updating, and manipulation of information within working memory. To date, there is only one study that used an *n*-back task involving food stimuli (Dickson et al., 2008). In this study, pictorial neutral, aversive and food stimuli presented either subliminally or supraliminally preceded letters in a 1-back or 2-back condition. Although they found differential task performance between anorectic patients and controls, food stimuli did not affect task performance.

Several issues, therefore, remain unresolved in the literature. Firstly, evidence for the influence of food craving on working memory performance is restricted to chocolate craving. Little is known about other food groups that have also been shown to be craved (Hill, 2007). Secondly, the only study that used food stimuli other than chocolate did not find an effect on working memory performance (Dickson et al., 2008). This could be due to methodological reasons because food-cues only preceded targets. Instead, food-cues may have a stronger influence and, therefore, higher external validity, if they directly require a response. Thirdly, no study has investigated the influence of general food craving on working memory performance as a function of both state and trait cravings.

In the current study, we addressed these issues by using an *n*-back (2-back) task that involved pictorial food stimuli as targets and distractors. In addition and rather than restricting stimuli to chocolate, we presented separated blocks containing either pictures of savory foods, sweet foods, or neutral objects. Moreover, groups of either trait food cravers or low cravers were tested and momentary craving was assessed before and after the task. We expected food stimuli to elicit craving which in turn should lead to a decrement in task performance, i.e. prolonged reaction times and more omission and commission errors. Furthermore, we hypothesized that these effects should be particularly pronounced in trait food cravers. Therefore, the current study extends the existing literature by (1) using a newly developed variant of the *n*-back task that (2) not only involved chocolate cues, but also other sweet and savory foods, and (3) investigating effects in both trait high and low cravers with respect to general food cravings instead of specifically chocolate craving.

Methods

The reported data were part of a study investigating the effectiveness of a biofeedback training to reduce food cravings, the results of which are reported elsewhere (Meule, Freund, Skirde, Vögele, & Kübler, in press). The current data were collected at baseline, i.e. before any intervention.

Participants

An online screening was conducted to recruit high and low food cravers. A link of the screening homepage was distributed via a students' mailing list and an advertisement on a local website. The screening homepage included the subscale *lack of control over eating* of the *Food Cravings Questionnaires – Trait* (FCQ-T-LOC). This subscale represents a major feature of food cravings and was chosen to keep the screening succinct. As an incentive for participation, 3 × 10,- Euro were raffled among participants who completed the entire set of questions (*N* = 603).

FCQ-T-LOC scores ranged between the minimum and maximum possible values (*M* = 16.67, *SD* = 5.90, Range: 6–36). The majority of respondents had a body mass index (BMI) within the normal range (*M* = 22.55, *SD* = 3.83, Range: 14.15–48.19) and were in young adulthood (*M* = 23.99, *SD* = 5.54, Range: 16–62). Participants who indicated that they were interested in participating in a further study and whose FCQ-T-LOC scores were in the upper and lower third of the distribution from the initial screening were contacted by e-mail. Volunteers were only included if they had a BMI between 20 and 30 kg/m², and an age between 18 and 40 years, to ensure a homogenous sample without outlying body mass or age. Of all individuals who were contacted, *n* = 56 (high cravers: *n* = 28, four males; low cravers: *n* = 28, five males) met these criteria and agreed to take part in the study. Participants had a mean age of *M* = 24.12 years (*SD* = 3.79) and a mean BMI of *M* = 22.65 kg/m² (*SD* = 3.19). The majority of participants were students (*n* = 40).

Materials

Questionnaires

Habitual food cravings were assessed using the trait version of the Food Cravings Questionnaires (FCQ-T; Cepeda-Benito, Gleaves, Williams, & Erath, 2000; Meule et al., 2012). This 39-item instrument asks participants to indicate on a 6-point Likert scale how frequently they experience food cravings (ranging from *never* to *always*). The FCQ-T consists of nine subscales measuring food cravings in relation to (1) intentions to consume food, (2) anticipation of positive reinforcement, (3) relief from negative states, (4) lack of control over eating, (5) preoccupation with food, (6) hunger, (7) emotions, (8) cues that trigger cravings, and (9) guilt. Subscales are highly inter-correlated and internal consistency of the total FCQ-T is $\alpha > 0.90$ (Cepeda-Benito et al., 2000; Meule et al., 2012). In the current study, we only used total FCQ-T scores in our analyses for the sake of brevity and clarity.

Current food cravings were assessed with the state version of the Food Cravings Questionnaires (FCQ-S; Cepeda-Benito et al., 2000; Meule et al., 2012). This 15-item questionnaire assesses momentary food cravings on the dimensions (1) intense desire to eat, (2) anticipation of positive reinforcement, (3) relief from negative states, (4) lack of control over eating, and (5) hunger. Subscales are highly inter-correlated and internal consistency of the total FCQ-S is $\alpha > 0.90$ (Cepeda-Benito et al., 2000; Meule et al., 2012).

Eating disorder and food addiction symptomatology was assessed with the Eating Disorder Examination – Questionnaire (EDE-Q; Fairburn & Beglin, 1994; Hilbert & Tuschen-Caffier, 2006) and the Yale Food Addiction Scale (YFAS; Gearhardt, Corbin, & Brownell, 2009; Meule, Vögele, & Kübler, in press). The YFAS is a 25-item instrument which contains different scoring options (dichotomous and frequency scoring) to indicate experience of addictive eating behavior. A food addiction symptom count can be calculated which ranges between zero and seven symptoms, according to the diagnostic criteria for substance dependence (Gearhardt et al., 2009). Internal consistency of the YFAS is

$\alpha > 0.80$ (Gearhardt et al., 2009; Meule, Vögele, et al., in press). The EDE-Q is a 28-item instrument which asks about eating disorder symptomatology during the past 28 days. Of these, 22 items assess *restraint*, *eating concern*, *weight concern*, and *shape concern* on a 7-point scale (ranging from *never* to *every day*). Subscales have an internal consistency of $\alpha = 0.85$ – 0.93 (Hilbert, Tuschen-Caffier, Karwautz, Niederhofer, & Munsch, 2007). The remaining six questions assess diagnostically relevant behaviors, e.g. days with binges.

Stimuli

Stimuli were selected from a set of pictures previously used (Blechert, Feige, Hajcak, & Tuschen-Caffier, 2010; Blechert, Feige, Joos, Zeeck, & Tuschen-Caffier, 2011; Meule, Lukito, et al., 2011). All pictures were edited to be homogeneous with respect to background color. In a pilot study, pictures of high-calorie savory foods, high-calorie sweets, and common household items (30 pictures each) were rated on a 5-point scale by 20 individuals with respect to brightness, recognizability, complexity, and pleasantness. For every category, 10 pictures were selected (savory foods: *pasta bake*, *sandwich*, *cheese*, *tortilla chips*, *curry sausage*, *fries*, *cheeseburger*, *lasagna*, *spaghetti*, *pizza*; sweets: *chocolate*, *waffle*, *cookies*, *crêpes*, *croissants*, *doughnut*, *cream gateau*, *strawberry pie*, *chocolate gateau*, *muffins*; neutral objects: *umbrella*, *shoe*, *piggybank*, *beanbags*, *metal can*, *paperclips*, *stapler*, *thumbtacks*, *pencil case*, *phone*). Those did not differ in brightness, recognizability, and complexity, but in pleasantness ($F_{(2,38)} = 16.29$, $p < 0.001$). Post-hoc *t*-tests showed that pictures of sweet ($M = 2.14$, $SD = 0.75$) and savory foods ($M = 2.22$, $SD = 0.58$) were equally pleasant ($t_{(19)} = -0.65$, *ns*) whereas both categories were rated as more pleasant than neutral pictures ($M = 3.01$, $SD = .67$, both p 's ≤ 0.001).

n-back task

An *n*-back task including pictures as targets and distractors was used in this study (Fig. 1). The program was compiled using E-prime 2.0 (Psychology Software Tools Inc., Pittsburgh, PA) and displayed on a LCD TFT 22" screen. Subjects were required to press a button on a response box for every target that matched the picture two trials before (2-back task). The task was separated into three counterbalanced blocks (savory foods, sweets, or neutral objects). Each block consisted of 80 trials including 20 targets. Each picture was presented for 1500 ms or until a response was made.

Inter-trial interval was 1000 ms. A practice block with numbers instead of pictures was presented prior to the experimental blocks. The whole task lasted for approximately 15 min.

Procedure

Participants were tested between 10:00 a.m. and 18:00 p.m. (median of testing time was 14:00 p.m.) and were asked to refrain from eating, smoking and caffeinated drinks at least one hour before the experiment. After providing instructions and signing informed consent, a 15 min baseline heart rate recording was conducted. The physiological data were assessed in order to evaluate the biofeedback procedure and are reported elsewhere (Meule, Freund, et al., in press). Next, participants filled out the FCQ-S and then performed the *n*-back task. Immediately after the task, participants filled out the FCQ-S again. Afterwards, participants completed the rest of the questionnaires and participants' weight and height was measured.

Data analysis

T-tests for independent samples were calculated to compare groups for age, BMI, hours since the last meal, trait food cravings, and food addiction and eating disorder symptomatology. A 2 (group) \times 2 (time) ANOVA for repeated measures was calculated to evaluate state cravings with group (high vs. low cravers) as between-subject factor and time (before vs. after the task) as within-subject factor. Significant interactions were followed up with *t*-tests. In the *n*-back task, trials with a reaction time below 150 ms, reflecting anticipation, were excluded from analyses. Reaction times, omission errors, and commission errors were used as indexes of task performance. A 2 (group) \times 3 (picture type) ANOVA for repeated measures was calculated for each of the dependent variables with group (high vs. low cravers) as between-subject factor and picture type (sweet vs. savory vs. neutral) as within-subject factor. Finally, we explored associations between task performance and change in craving with linear regression analyses. For this purpose, we calculated change scores (craving after the task minus craving before the task) for each FCQ-S subscale and used those as dependent variables. Regression analyses were calculated for each measure of interest (i.e. reaction times, omission errors, commission errors) separately.

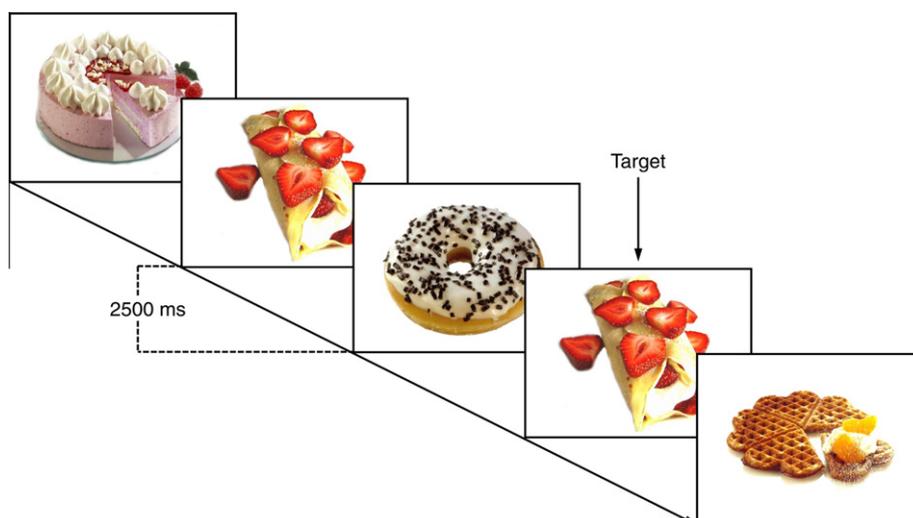


Fig. 1. *n*-back task with representative screen displays from a block with pictures of sweet foods. Participants had to press a button when a picture matched the one which was presented two trials before. Pictures were presented for 1500 ms or until a response was made. A blank screen was presented during the inter-trial interval for 1000 ms.

Results

Participant characteristics

Groups did not differ in age, BMI, or hours since their last meal (Table 1). As expected, high cravers had higher FCQ-T scores than low cravers (Table 1). High cravers also reported higher eating-related psychopathology as indicated by the YFAS and EDE-Q compared to low cravers (Table 1).

State cravings

There were significant main effects for group ($F_{(1,54)} = 5.61, p < 0.05, \eta_p^2 = 0.09$) and time ($F_{(1,54)} = 45.63, p < 0.001, \eta_p^2 = 0.46$), indicating higher state cravings in high cravers compared to low cravers and after the task compared to before. In addition, the interaction group \times time was also significant ($F_{(1,54)} = 8.46, p < 0.01, \eta_p^2 = 0.14$), suggesting differential responses between groups. Post-hoc t -tests revealed that state cravings increased in both low cravers ($t_{(27)} = -2.71, p < 0.05$) and high cravers ($t_{(27)} = -6.86, p < 0.001$). While groups did not differ before the task ($t_{(54)} = 1.65, ns$), high cravers ($M = 42.54, SD = 12.23$) reported stronger state cravings after the task compared to low cravers ($M = 33.36, SD = 11.15, t_{(54)} = 2.94, p < 0.01$; Fig. 2). Comparing changes in FCQ-S-subscores between groups revealed that high cravers showed a steeper increase in FCQ-S-total scores ($t_{(54)} = 2.91, p < 0.01$), intense desire to eat ($t_{(54)} = 1.99, p = 0.05$), anticipation of positive reinforcement ($t_{(54)} = 2.16, p < 0.05$), and lack of control over eating ($t_{(54)} = 2.80, p < 0.01$), but not in relief from negative states ($t_{(54)} = 0.86, ns$) or hunger ($t_{(54)} = 1.84, ns$) as compared to low cravers. Using BMI and gender as covariates did not change interpretation of results.

Task performance

Reaction times

There was a significant main effect for picture type ($F_{(2,108)} = 7.21, p < 0.01, \eta_p^2 = 0.12$). Post-hoc t -tests indicated that participants reacted slower in response to savory foods ($M = 719.41\text{ ms}, SD = 120.05$) compared to sweet foods ($M = 685.29\text{ ms}, SD = 120.89, t_{(55)} = 2.37, p < 0.05$) and neutral objects ($M = 670.22\text{ ms}, SD = 124.67, t_{(55)} = 4.11, p < 0.001$). Reaction times in response to sweet foods did not differ compared to neutral objects ($t_{(55)} = 1.15, ns, \text{Fig. 3a}$). There was no main effect for group ($F_{(1,54)} = 1.97, ns$) and no interaction group \times picture type ($F_{(2,108)} = 0.32, ns$). Using BMI and gender as covariates did not change interpretation of results.

Omission errors

There was a significant main effect for picture type ($F_{(2,108)} = 4.33, p < 0.05, \eta_p^2 = 0.07$). Post-hoc t -tests indicated that

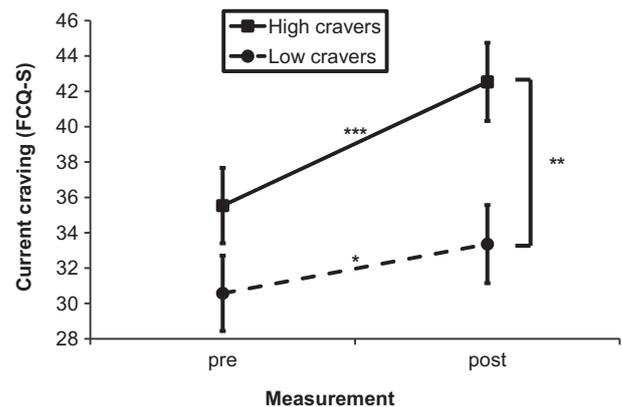


Fig. 2. Mean current food cravings as a function of group (high vs. low cravers) and time (before vs. after the task). FCQ-S = Food Cravings Questionnaires – State Version. Error bars represent the standard error of the mean. Asterisks indicate a p -value $< 0.05^*$, $< 0.01^{**}$, and $< 0.001^{***}$.

participants made more omission errors in response to savory foods ($M = 4.84, SD = 2.83$) compared to neutral objects ($M = 3.86, SD = 2.55, t_{(55)} = 2.85, p < 0.01$). Omission errors in response to sweet foods did not differ compared to savory foods ($t_{(55)} = 1.49, ns$) or neutral objects ($t_{(55)} = 1.49, ns, \text{Fig. 3b}$). There was no main effect for group ($F_{(1,54)} = 1.77, ns$) and no interaction group \times picture type ($F_{(2,108)} = 1.46, ns$). Using BMI and gender as covariates did not change interpretation of results.

Commission errors

There was neither a main effect for group ($F_{(1,54)} = 1.00, ns$) nor a main effect for picture type ($F_{(2,108)} = 0.33, ns$) and no interaction group \times picture type ($F_{(2,108)} = 1.55, ns$). Using BMI and gender as covariates did not change interpretation of results.

Relation between changes in craving and task performance

Reaction times

Neither reaction time predicted any of the change scores (all t 's < 1.78).

Omission errors

Neither omission errors predicted any of the change scores, except for omission errors in response to savory food-cues which predicted increases in relief craving ($\beta = 0.38, t = 2.07, p < 0.05$).

Commission errors

Neither commission errors predicted any of the change scores (all t 's < 1.56).

Table 1
Participant characteristics.

	Low cravers (n = 28) M (SD)	High cravers (n = 28) M (SD)	t	p
Age (in years)	24.46 (3.69)	23.79 (3.93)	0.67	ns
BMI (in kg/m ²)	22.41 (3.34)	22.90 (3.07)	-0.58	ns
Last meal (in hours)	5.84 (4.81)	4.10 (2.53)	1.70	ns
Food Cravings Questionnaire – Trait	83.11 (19.23)	131.43 (23.38)	-8.45	<0.001
Yale Food Addiction Scale (symptom count)	1.11 (0.50)	2.54 (1.35)	-5.27	<0.001
Eating Disorder Examination – Questionnaire				
Restraint	0.57 (0.77)	1.57 (1.37)	-3.36	<0.01
Eating concern	0.12 (0.16)	1.13 (1.06)	-4.99	<0.001
Weight concern	0.66 (0.79)	2.16 (1.64)	-4.37	<0.001
Shape concern	1.17 (1.00)	2.47 (1.77)	-3.39	<0.01
Days with binges	0.18 (0.48)	4.36 (8.76)	-2.52	<0.05

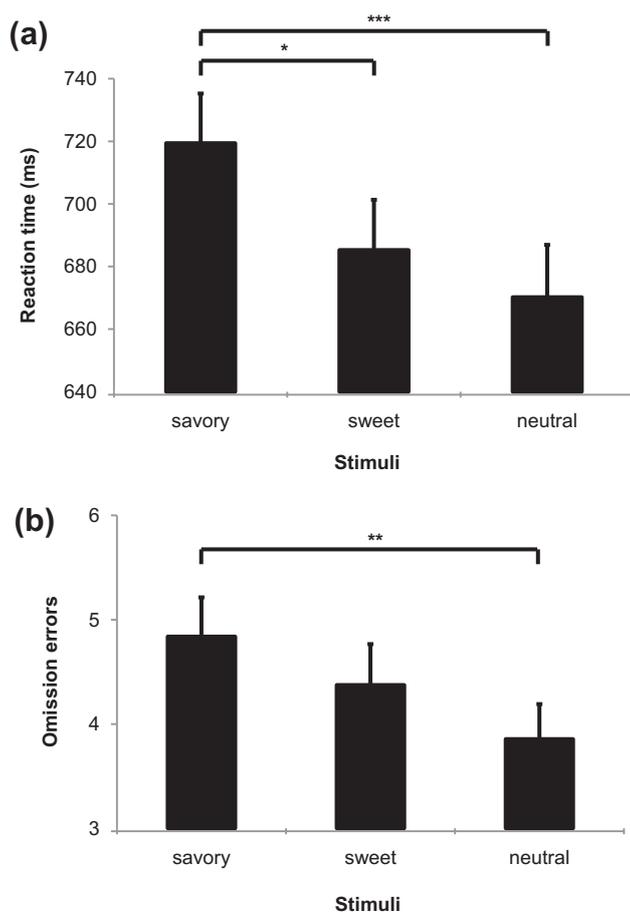


Fig. 3. Mean reaction times (a) and omission errors (b) in the *n*-back task as a function of picture type. Regardless of group, reaction time is slowest and error rate highest in trials with savory food pictures. Error bars represent the standard error of the mean. Asterisks indicate a *p*-value <0.05*, <0.01**, and <0.001***.

Discussion

In the current study, we found that a working memory task involving high-calorie food-cues lead to slower reactions and more omission errors compared to blocks involving pictures of neutral objects. These differences were particularly pronounced for pictures of savory foods. All participants reported more intense food cravings after the task and this increase was significantly more pronounced in participants that frequently and intensely experience food cravings.

As our task required processing of pictorial stimuli in combination with performing a motor response, the current results support findings about food cravings interfering with visuo-spatial working memory task performance (Tiggemann et al., 2010). In contrast to previous studies, we used a novel paradigm where the direct influence of food stimuli on omission errors was measured as opposed to, for example, recalled digit span of neutral stimuli. The observed slowing of reactions is in line with previous findings when craving was experienced or after participants were exposed to foods (Green et al., 2000; Kemps et al., 2008; Meule, Lukito et al., 2011; Smeets et al., 2009). However, changes in craving were not correlated with reaction times in the current study. Instead, increased omission errors predicted increases in relief craving. Hence, it is possible that relief craving in particular is related to decreases in working memory performance but slowing of reaction times may be the result of mere exposure to food-cues without mediating effects of craving. It should also be noted, however, that

relief craving was only one of several subscales of the FCQ-S and associations with this specific subscale might therefore be due to type I error. Nonetheless, the present results extend the current literature in that we included savory food-cues, instead of restricting cues to chocolate, as is usually the case in food craving research (e.g. Kemps & Tiggemann, 2009; Rodríguez, Fernández, Cepeda-Benito, & Vila, 2005). It is important to note that savory food-cues resulted in greater effects compared to sweets in our study. Although reaction times and omission errors in response to sweet foods were higher compared to neutral cues, these differences were not significant.

Although we did not find differences in task performance between high and low food cravers, performing the task induced stronger cravings in high cravers which substantiates that this group is particularly susceptible to experiencing food cravings that can be induced by food-cues in the environment. While Kemps and colleagues (2008) found effects of experimentally induced craving on reaction times and working memory performance only in trait chocolate cravers, they did not find an effect of trait chocolate craving when the task was restricted to visuo-spatial working memory demands (Tiggemann et al., 2010). They interpreted their findings such that most people in western cultures may have acquisition and consumption schemata related to chocolate. Accordingly, this could also apply to savory foods as food-cues like pizza or French fries are omnipresent in our environment. In persons habitually experiencing food cravings, such exposure to food-cues could even more easily elicit craving. This food-cue elicited craving could potentially affect everyday executive functions by consuming cognitive resources, e.g. driving performance in heavy traffic when food advertisements are present.

The current study has several limitations. First, food cravings were only measured subjectively. Additional parameters as e.g. skin conductance, salivary secretion and other cephalic phase responses could contribute to the validity of craving assessment. Second, we measured current food cravings only before and after the task. Therefore, specific changes after each experimental block cannot be disentangled. Third, we found an increase in subjective craving after the task, which was even more pronounced in high food cravers. It cannot be inferred if these increases were due to plain food-cue exposure or if the additional cognitive load during the task contributed to craving developing even stronger. Future studies could investigate if our paradigm triggers stronger craving when compared to similar picture presentation without using a working memory task instruction. Forth, it cannot be inferred from FCQ-S scores which types of foods (i.e. sweets or savory) participants craved after the task and, therefore, if impaired performance in response to savory foods was particularly associated with increased craving for these foods. Finally, we did not find differences in task performance between groups which maybe would have been found if a task with a higher working memory load was used, e.g. a 3-back task.

In conclusion, the paradigm used in the current study successfully induced craving and influenced working memory performance. It contained high-calorie food pictures, which have high external validity because such food-cues are all around us in modern society. Our version of the *n*-back task may be a promising tool that could easily be used in brain imaging studies to further elucidate differences and similarities between food and drug craving and addiction. By using this paradigm, further studies could address if and how the experience of food cravings impact activity of fronto-parietal cortices that have been shown to be activated during *n*-back task performance (Owen et al., 2005). Furthermore, it could be used to investigate the effects of high-calorie food-cues on working memory and the behavioral consequences resulting from this procedure. For instance, even healthy participants who are confronted with food-cues and concomitantly experience a

high working memory load might develop craving and experience a loss of control over eating behavior. This process could be further facilitated in persons who are susceptible to experience craving.

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