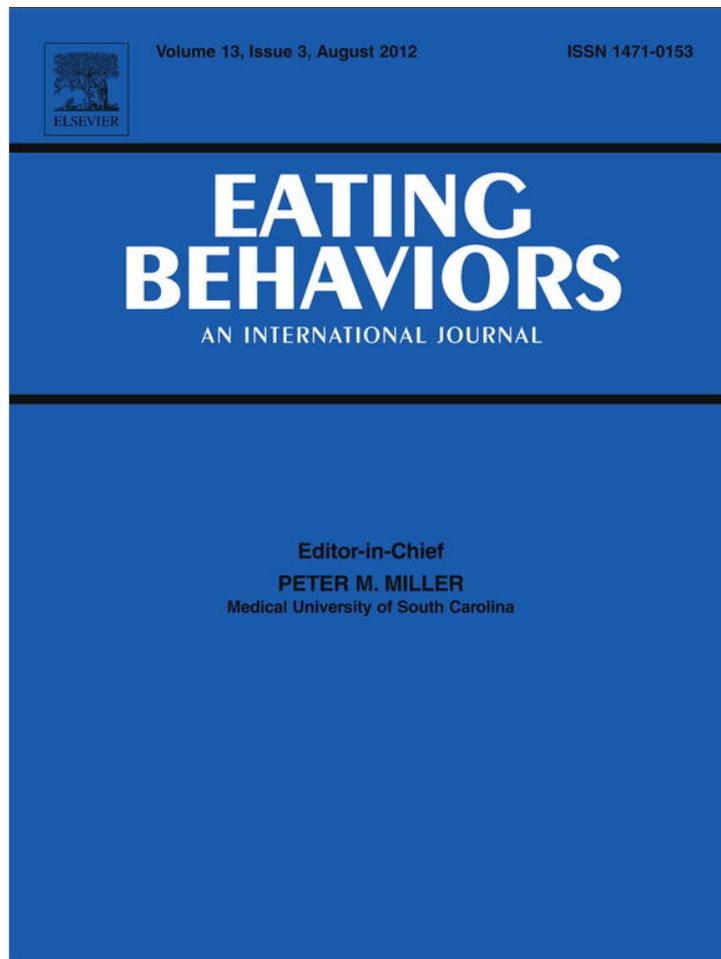


Provided for non-commercial research and education use.
Not for reproduction, distribution or commercial use.



This article appeared in a journal published by Elsevier. The attached copy is furnished to the author for internal non-commercial research and education use, including for instruction at the authors institution and sharing with colleagues.

Other uses, including reproduction and distribution, or selling or licensing copies, or posting to personal, institutional or third party websites are prohibited.

In most cases authors are permitted to post their version of the article (e.g. in Word or Tex form) to their personal website or institutional repository. Authors requiring further information regarding Elsevier's archiving and manuscript policies are encouraged to visit:

<http://www.elsevier.com/copyright>



Food cravings in food addiction: The distinct role of positive reinforcement

Adrian Meule^{a,*}, Andrea Kübler^{a,b}

^a Department of Psychology I, University of Würzburg, Marcusstr. 9-11, 97070 Würzburg, Germany

^b Institute of Medical Psychology and Behavioural Neurobiology, University of Tübingen, Gartenstr. 29, 72074 Tübingen, Germany

ARTICLE INFO

Article history:

Received 2 October 2011

Received in revised form 4 January 2012

Accepted 2 February 2012

Available online 10 February 2012

Keywords:

Substance-related disorders

Feeding behavior

Reinforcement

Guilt

Pleasure

ABSTRACT

Craving for a particular substance is an essential characteristic of addictive behavior. Increasing evidence suggests that food cravings and excessive food consumption could similarly be due to addictive processes. Recently, the *Yale Food Addiction Scale* (YFAS) was introduced for identifying individuals with addictive eating patterns. We conducted an online study ($n = 616$, 75.8% female) in which participants filled out the YFAS and the *Food Cravings Questionnaire-Trait* (FCQ-T). Participants diagnosed as being addicted to food using the YFAS had higher scores on all food craving subscales except for anticipation of positive reinforcement that may result from eating. In a subsequent regression analysis, all food craving subscales positively predicted food addiction symptoms while positive reinforcement negatively predicted food addiction symptoms. Similar to other addictive behaviors, results indicate that individuals with addictive eating patterns experience more food cravings, but concurrently do not expect a positive reinforcement through eating.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Craving refers to an urgent desire, longing, or yearning for a particular substance, which includes alcohol, tobacco, drugs, and food (Hormes & Rozin, 2010). In relation to food cravings, it is this intensity and specificity that distinguishes such 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, and non-compliance to long-term goals that include refraining from consumption. Drug cravings are associated with relapse in substance abuse (e.g. Allen, Bade, Hatsukami, & Center, 2008) and 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). Furthermore, food cravings have been found to be positively correlated with body-mass-index (BMI; Franken & Muris, 2005). Morbidly obese patients reported more food cravings than control participants on the *Food Cravings Questionnaire-Trait* (FCQ-T), except for positive reinforcement as a result from eating (Abilés et al., 2010).

In the past decade, a plethora of studies has been published that relate excessive food consumption, like in obesity or binge eating disorder, to addictive behavior (e.g. Davis & Carter, 2009; Gearhardt, Corbin,

& Brownell, 2009a; Pelchat, 2009; Volkow, Wang, Fowler, & Telang, 2008), albeit critical remarks regarding the clinical validity or utility of the food addiction model have also been noted (e.g. Wilson, 2010). Recently, Gearhardt, Corbin, and Brownell (2009b) presented a questionnaire for identifying addictive eating patterns (*Yale Food Addiction Scale*, YFAS) which assesses symptoms of food addiction according to the diagnostic criteria for substance dependence.

One of the most compelling similarities between food and drug addiction is the experience of craving which is often accompanied by a loss of control and subsequent ingestion of the craved substance or food. Overlapping neural structures were identified to be involved in the experience of food or drug craving. For instance, activation of the insula was found during food craving (Pelchat, Johnson, Chan, Valdez, & Ragland, 2004). This area has also been recognized as a crucial part in urges to take drugs (Naqvi & Bechara, 2009). Using the YFAS, Gearhardt et al. (2011) found food addiction symptoms to correlate with elevated activation in reward circuitry (e.g. anterior cingulate, orbitofrontal cortex, and amygdala) during anticipation of food intake. Similar activation patterns could consistently be found in cue-induced craving paradigms across studies with nicotine, alcohol or cocaine users (Kühn & Gallinat, 2011). Moreover, food addiction symptoms were highly correlated with habitual experiences of food craving (Meule et al., 2012). In the current study, we investigated the relationship between food craving and food addiction in greater detail. Specifically, we explored relationships between symptom count and diagnosis of the YFAS with the subscales of the FCQ-T. We hypothesized that food addicted participants would score higher on food craving subscales as

* Corresponding author. Tel.: +49 931 31 808 34; fax: +49 931 31 8 24 24.
E-mail addresses: adrian.meule@uni-wuerzburg.de (A. Meule),
andrea.kuebler@uni-wuerzburg.de (A. Kübler).

compared to non-addicted participants. Furthermore, we expected food craving subscales to positively predict the amount of food addiction symptoms, and that this relationship should be independent of current body mass.

2. Method

2.1. Participants

Data were collected as part of an online study that included a range of questionnaires related to eating behavior, but also questionnaires related to other constructs (e.g. impulsivity). Details of this study are reported elsewhere (Meule et al., 2012). Student councils of several German universities were contacted by e-mail and asked to distribute the internet address of the online study using their mailing lists. As an incentive, five × 50 Euro were raffled among participants who completed the entire set of questions ($N=617$ participants). Questionnaire completion took approximately 25 min. The majority of participants were women (75.8%, $n=467$). Almost all participants were students (80.9%) and had German citizenship (95.5%). Data from one participant were excluded from further analyses because of implausible statements. Participants reported their age (in years), weight (in kilogram), and height (in meters). BMI was calculated as weight divided by height squared. Mean BMI was 22.3 kg/m² ($SD \pm 3.3$). Participants had a mean age of 24.5 years ($SD \pm 4.0$).

2.2. Measures

2.2.1. Food Cravings Questionnaire-Trait

Food cravings were assessed using the trait version of the Food Cravings Questionnaires (FCQ-T; Cepeda-Benito, Gleaves, Williams, & Erath, 2000). This 39-item instrument asks participants to indicate on a 6-point scale how frequently they experience food cravings (ranging from *never to always*). The FCQ-T consists of the subscales intentions and plans to consume food (*intentions*), anticipation of positive reinforcement that may result from eating (*positive reinforcement*), anticipation of relief from negative states and feelings as a result of eating (*relief*), lack of control over eating (*lack of control*), thoughts or preoccupation with food (*preoccupation*), craving as a physiological state (*hunger*), emotions that may be experienced before or during food cravings or eating (*emotions*), cues that may trigger food cravings (*cues*), and guilt from cravings and/or giving into them (*guilt*). Validity of the FCQ-T has been shown by strong associations with disinhibited eating or eating disorder symptoms in healthy participants and eating disorder patients (Cepeda-Benito, Fernandez, & Moreno, 2003; Cepeda-Benito et al., 2000; Moreno, Rodríguez, Fernandez, Tamez, & Cepeda-Benito, 2008). Moreover, FCQ-T-subcales have been found to discriminate between successful and unsuccessful dieters (Meule et al., 2012) or anorexia and bulimia nervosa subtypes (Moreno, Warren, Rodríguez, Fernández, & Cepeda-Benito, 2009). Internal consistency of the English version is $\alpha = .97$ for the total score and ranges between $\alpha = .81-.94$ for the subscales (Cepeda-Benito et al., 2000). In the present study, internal consistency was $\alpha = .96$ for the total score and ranged between $\alpha = .72-.92$ for the subscales (Table 1).

2.2.2. Yale Food Addiction Scale

Food addiction symptoms were assessed using the Yale Food Addiction Scale (YFAS; Gearhardt et al., 2009b). This 25-item instrument contains different scoring options (dichotomous and frequency scoring) to indicate experience of addictive eating behavior. A symptom count can be calculated which can range between zero to seven food addiction symptoms. Moreover, a diagnosis of food addiction can be made if at least three symptoms and a clinically significant impairment are present. The YFAS has been found to highly correlate with scores on the Eating Attitudes Test and emotional and external eating behavior and to predict binge eating (Gearhardt et al., 2009b;

Table 1
Group differences on the Food Cravings Questionnaire-Trait.

	Food addiction ($n=48$) M (SD)	No food addiction ($n=568$) M (SD)	$K-S-Z$	p
Intentions ($\alpha = .79$)	12.19 (3.43)	8.33 (2.90)	3.49	<.001
Positive reinforcement ($\alpha = .81$)	15.25 (4.99)	13.83 (4.48)	.91	<i>ns</i>
Relief ($\alpha = .77$)	9.46 (3.33)	7.14 (2.92)	2.02	<.01
Lack of control ($\alpha = .90$)	25.25 (7.21)	14.84 (5.72)	3.48	<.001
Preoccupation ($\alpha = .92$)	25.81 (8.18)	12.94 (5.54)	4.06	<.001
Hunger ($\alpha = .72$)	13.71 (4.32)	11.67 (3.29)	1.53	<.02
Emotions ($\alpha = .88$)	15.63 (5.65)	10.00 (4.38)	3.08	<.001
Cues ($\alpha = .78$)	16.23 (3.94)	13.06 (3.92)	1.92	<.01
Guilt ($\alpha = .88$)	13.56 (3.94)	6.48 (3.11)	4.30	<.001
Total ($\alpha = .96$)	147.08 (34.54)	98.29 (27.69)	3.88	<.001

Meule, Vögele, & Kübler, in press). Only a weak correlation was found with BMI, but food addiction diagnoses increased remarkably in obese participants (Meule et al., in press). Internal consistency of the English version is $\alpha = .86$ (Gearhardt et al., 2009b) and was $\alpha = .83$ in the present study.

2.3. Statistical analyses

Participants who received a food addiction diagnosis ($n=48$) were compared to non-addicted participants ($n=568$) on the subscales and the total score of the FCQ-T. A non-parametric test (two-sample Kolmogorov-Smirnov-Z) was chosen because of unequal sample sizes and deviation from normal distribution. Subsequently, FCQ-T subscales were used as predictors in a linear regression analysis with the YFAS symptom count as dependent variable. Here, we combined all subscales but positive reinforcement into one predictor in order to reduce the number of possible interaction terms. Thus, we calculated a regression analysis with three z-standardized predictors: positive reinforcement, food craving without positive reinforcement, and the interaction positive reinforcement × food craving without positive reinforcement.¹

3. Results

3.1. Group differences

Groups did not differ in age ($K-S-Z = .83$, *ns*) or BMI ($K-S-Z = 1.00$, *ns*). Individuals with a food addiction diagnosis had a higher FCQ-T total score and higher scores on all FCQ-T-subcales, except for positive reinforcement (Table 1).

3.2. Food craving subscales and food addiction symptoms

The overall model was significant ($F_{(3,612)} = 173.55$, $p < .001$). Also, all three predictors in this model were significant. Positive reinforcement negatively predicted food addiction symptoms ($\beta = -.22$, $p < .001$) while these were positively predicted by other FCQ-T-subcales ($\beta = .74$, $p < .001$). A significant interaction indicated that food addiction symptoms were predicted by increasing experience of food craving and concomitantly decreasing anticipation of positive reinforcement ($\beta = .11$, $p < .001$). Inclusion of BMI as control variable was not significant ($\beta = -.01$, *ns*) and did not alter beta-weights of the other predictors.

¹ All three predictors were intercorrelated ($r = .14-.58$, all p 's < .01). However, inspection of tolerance (range: .63–.94) and variance inflation factor (range: 1.07–1.58) did not indicate a problem of collinearity (cf. O'Brien, 2007).

4. Discussion

In the current study, we found that individuals who present with signs of addictive eating behavior report more experiences of a variety of food craving dimensions such as intentions to consume food, anticipation of relief from negative states as a result of eating, lack of control over eating, preoccupation with food, hunger, emotions before or during eating, cue-elicited craving, and guilt. However, food cravings related to an anticipation of positive reinforcement as a result from eating were not elevated. Moreover, food addiction symptoms were positively predicted by experiences of food cravings, but concurrently were negatively predicted by food cravings in relation to positive reinforcement.

These results correspond to the study by *Abilés et al. (2010)*, who also found that morbidly obese patients reported more food cravings except for positive reinforcement when compared to normal-weight controls. In our study, food addicted and non-addicted participants did not differ in BMI, which may be due to our predominantly normal-weight and non-clinical sample. However, these results suggest that differences in craving can be predicted by other variables than BMI and, therefore, elevated levels of craving in morbidly obese patients might be associated with an increased prevalence of food addiction.

While participants who scored high on the YFAS experienced elevated food cravings, they did not anticipate to be positively reinforced by eating. This might suggest an increased food wanting with decreased food liking in people with food addiction symptoms. However, inspection of the questionnaire items reveals that the positive reinforcement subscale rather refers to anticipated positive effects *after* eating. People with food addiction symptoms may *want* craved foods and even *like* their taste, but they already know it will not make them feel better. Similarly, they experience feelings of guilt after giving in to cravings. Hence, our results further demonstrate the ambivalent nature of food craving experiences (*Cartwright & Stritzke, 2008*) and this ambivalence seems to be even more pronounced in individuals with addictive eating behaviors. Furthermore, results also correspond to the finding that food intake can lead to negative mood rather than positive mood in eating disorders (e.g. *Alpers & Tuschen-Caffier, 2001*).

Interpretations of our results are limited by our sample that consisted predominantly of normal-weight women. A replication of our results in a sample of obese persons is warranted. Moreover, we investigated a cross-sectional sample which precludes conclusions about causal directions or longitudinal changes in craving and addictive eating behavior. Furthermore, we only used self-report measures of food craving and food addiction. Interviews to make diagnoses of food addiction may be a more valid approach (cf. *Cassin & von Ranson, 2007*). With regard to food cravings, however, it has been recognized that “subjective self-report seems the only viable assessment modality” (*Shiffman, 2000, p. S172*).

In sum, food cravings are a substantial part of eating behavior that highly resembles addiction. Similarly to chronic drug addiction, food addicted individuals do not expect positive reinforcement after the consumption of food. All other dimensions of food craving positively predict symptoms of food addiction. Thus, our results contribute to rising evidence of the concept of food addiction. Future investigations may explore the relationships between addictive eating, food cravings and body mass in more detail. For instance, neither did BMI differ between groups nor did it influence the relationship between food cravings and food addiction symptoms in our study. However, both food addiction diagnoses and food cravings are increased in obese samples as compared to normal-weight samples, but do not differ between obese classes (*Abilés et al., 2010; Meule, 2011*) which might suggest a non-linear relationship between those constructs and BMI. Furthermore, restrictive diets and weight loss have been found to reduce food cravings (*Martin, O’Neil, & Pawlow, 2006; Martin et al., 2011*). Accordingly, longitudinal studies may investigate the effects of

weight loss on addictive eating and the role of food cravings in this relationship.

Role of funding sources

Funding for this study was provided by a grant of the research training group 1253/1 which is supported by the German Research Foundation (DFG) by federal and Länder funds. DFG had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Contributors

Adrian Meule designed this study, performed data analyses, and wrote the first draft of the manuscript. Andrea Kübler aided in study design and manuscript preparation. Both authors contributed to and have approved the final manuscript.

Conflict of interest

Neither author has any conflicts of interest.

References

- Abilés, V., Rodríguez-Ruiz, S., Abilés, J., Mellado, C., García, A., Pérez de la Cruz, A., et al. (2010). Psychological characteristics of morbidly obese candidates for bariatric surgery. *Obesity Surgery, 20*, 161–167.
- Allen, S. S., Bade, T., Hatsukami, D., & Center, B. (2008). Craving, withdrawal, and smoking urges on days immediately prior to smoking relapse. *Nicotine & Tobacco Research, 10*, 35–45.
- Alpers, G. W., & Tuschen-Caffier, B. (2001). Negative feelings and the desire to eat in bulimia nervosa. *Eating Behaviors, 2*, 339–352.
- Cartwright, F., & Stritzke, W. G. (2008). A multidimensional ambivalence model of chocolate craving: construct validity and associations with chocolate consumption and disordered eating. *Eating Behaviors, 9*, 1–12.
- Cassin, S. E., & von Ranson, K. M. (2007). Is binge eating experienced as an addiction? *Appetite, 49*, 687–690.
- 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*, 151–173.
- Cepeda-Benito, A., Fernandez, M. C., & Moreno, S. (2003). Relationship of gender and eating disorder symptoms to reported cravings for food: Construct validation of state and trait craving questionnaires in Spanish. *Appetite, 40*, 47–54.
- Davis, C., & Carter, J. C. (2009). Compulsive overeating as an addiction disorder. A review of theory and evidence. *Appetite, 53*, 1–8.
- Franken, I. H. A., & Muris, P. (2005). Individual differences in reward sensitivity are related to food craving and relative body weight in healthy women. *Appetite, 45*, 198–201.
- Gearhardt, A. N., Corbin, W. R., & Brownell, K. D. (2009). Food addiction – An examination of the diagnostic criteria for dependence. *Journal of Addiction Medicine, 3*, 1–7.
- Gearhardt, A. N., Corbin, W. R., & Brownell, K. D. (2009). Preliminary validation of the Yale Food Addiction Scale. *Appetite, 52*, 430–436.
- Gearhardt, A. N., Yokum, S., Orr, P. T., Stice, E., Corbin, W. R., & Brownell, K. D. (2011). Neural correlates of food addiction. *Archives of General Psychiatry, 68*, 808–816.
- Gendall, K. A., Sullivan, P. F., Joyce, P. R., Fear, J. L., & Bulik, C. M. (1997). Psychopathology and personality of young women who experience food cravings. *Addictive Behaviors, 22*, 545–555.
- Hill, A. J. (2007). The psychology of food craving. *Proceedings of the Nutrition Society, 66*, 277–285.
- Hormes, J. M., & Rozin, P. (2010). Does “craving” carve nature at the joints? Absence of a synonym for craving in many languages. *Addictive Behaviors, 35*, 459–463.
- Kühn, S., & Gallinat, J. (2011). Common biology of craving across legal and illegal drugs – A quantitative meta-analysis of cue-reactivity brain response. *European Journal of Neuroscience, 33*, 1318–1326.
- Martin, C. K., O’Neil, P. M., & Pawlow, L. (2006). Changes in food cravings during low-calorie and very-low-calorie diets. *Obesity, 14*, 115–121.
- Martin, C. K., Rosenbaum, D., Han, H. M., Geiselman, P. J., Wyatt, H. R., Hill, J. O., et al. (2011). Change in food cravings, food preferences, and appetite during a low-carbohydrate and low-fat diet. *Obesity, 19*, 1963–1970.
- Meule, A. (2011). How prevalent is “food addiction”? *Frontiers in Psychiatry, 2*(61), 1–4.
- Meule, A., Lutz, A., Vögele, C., & Kübler, A. (2012). Food cravings discriminate differentially between successful and unsuccessful dieters and non-dieters. Validation of the Food Cravings Questionnaires in German. *Appetite, 58*, 88–97.
- Meule, A., Vögele, C., & Kübler, A. (in press). Deutsche Übersetzung und Validierung der Yale Food Addiction Scale [German translation and validation of the Yale Food Addiction Scale]. *Diagnostica, 58*, xx–xx.
- Meule, A., Westenhöfer, J., & Kübler, A. (2011). Food cravings mediate the relationship between rigid, but not flexible control of eating behavior and dieting success. *Appetite, 57*, 582–584.
- Moreno, S., Rodríguez, S., Fernandez, M. C., Tamez, J., & Cepeda-Benito, A. (2008). Clinical validation of the trait and state versions of the food craving questionnaire. *Assessment, 15*, 375–387.
- Moreno, S., Warren, C. S., Rodríguez, S., Fernández, M. C., & Cepeda-Benito, A. (2009). Food cravings discriminate between anorexia and bulimia nervosa. Implications for “success” versus “failure” in dietary restriction. *Appetite, 52*, 588–594.
- Naqvi, N. H., & Bechara, A. (2009). The hidden island of addiction: The insula. *Trends in Neurosciences, 32*, 56–67.

- O'Brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Quality and Quantity*, 41, 673–690.
- Pelchat, M. L. (2009). Food addiction in humans. *The Journal of Nutrition*, 139, 620–622.
- Pelchat, M. L., Johnson, A., Chan, R., Valdez, J., & Ragland, J. D. (2004). Images of desire: Food-craving activation during fMRI. *NeuroImage*, 23, 1486–1493.
- Shiffman, S. (2000). Comments on craving. *Addiction*, 95, S171–S175.
- Volkow, N. D., Wang, G. -J., Fowler, J. S., & Telang, F. (2008). Overlapping neuronal circuits in addiction and obesity: evidence of systems pathology. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 363, 3191–3200.
- Wilson, G. T. (2010). Eating disorders, obesity and addiction. *European Eating Disorders Review*, 18, 341–351.