The Psychology of Desire

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CHAPTER 16

Desire for Food and the Power of Mind

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In the Western world, overweight and obesity rates are high and continue to rise. Globally, 35% of adults are overweight, and 11% are obese (World Health Organization, 2013). Obesity is related to many detrimental health consequences and a reduced quality of life (Jia & Lubetkin, 2005, 2010; Kolotkin, Meter, & Williams, 2001). Examples include cardiovascular diseases, diabetes, and psychological problems such as depression (e.g., Blaine, 2008; Luppino et al., 2010). Ultimately, the cause of obesity is an energy imbalance, that is, more calories are consumed than are expended (Westerterp, 2010). This energy imbalance seems mainly due to the overconsumption of high-caloric palatable foods (Swinburn, Jolley, Kremer, Salbe, & Ravussin, 2006; Swinburn et al., 2009; Westerterp, 2010). A more interesting question is *why* so many people have an unfavorable energy balance, which has led them to be overweight, or even obese. Why do so many people overconsume high-caloric palatable foods when it is common knowledge that these foods are detrimental for your health and waistline?

An obvious possibility seems to be that people's control of homeostasis is disturbed (Gale, Castracane, & Mantzoros, 2004). However, at the very least, this homeostatic explanation is not sufficient, and nonhomeostatic factors have been shown to play an important role (Shin, Zheng, & Berthoud, 2009). That is, people consume foods because of the expected experience of reward. Homeostatic and nonhomeostatic factors may interact, as foods may, for example, become more attractive when one is hungry (e.g., Siep et al., 2009; Uher, Treasure, Heining, Brammer, & Campbell, 2006). So an important contribution to the obesity epidemic likely is so-called hedonic hunger (Lowe & Butryn, 2007). That is, "some individuals experience frequent thoughts, feelings and urges about food in the absence of any short- or long-term energy deficit" (Lowe & Butryn, p. 432).

Desire for food is thought to be reflected in the brain as food-cue-elicited activity in brain regions involved in reward processing (Berthoud, Lenard, & Shin, 2011; Kringelbach, 2009; van der Laan, de Ridder, Viergever, & Smeets, 2011; see also Lopez, Wagner, & Heatherton, Chapter 7, this volume). These brain regions are listed as follows in Frankort et al. (2012): "the amygdala, hippocampus, ventral pallidum, nucleus accumbens and striatum, the ventral tegmental area and substantia nigra, as well as the anterior cingulate, orbitofrontal, insular, posterior fusiform, dorsolateral prefrontal and medial prefrontal cortices" (p. 627).

With regard to the experience of desire, a highly relevant finding is that activity elicited by visual food stimuli in the insular cortex, the left operculum, and the right putamen was modulated positively by the subjective feeling of appetite in lean healthy participants (Porubská, Veit, Preissl, Fritsche, & Birbaumer, 2006). Moreover, in a study in which participants were put on a monotonous diet and asked during scanning to imagine sensory properties of a favorite food, craving-specific brain activity was found in the hippocampus, insula, and caudate (Pelchat, Johnson, Chan, Valdez, & Ragland, 2004).

With our Western environment being full of food temptations (e.g., Wadden, Brownell, & Foster, 2002), the experience of desire for food is always lurking. So it has become a challenge to attain or retain a healthy weight. However, the food-replete environment is not a problem for everyone, as an approximately equally large number of people have a healthy weight. Therefore, a reasonable hypothesis is that high-caloric foods in the environment may be more attractive for certain people, making it harder for them to resist these foods, thereby possibly leading to overconsumption and ultimately to overweight or obesity.

From a cognitive perspective, this increased attractiveness is thought to be reflected in *biased* cognitive processing of food stimuli in people with overeating problems, such as overweight and obese people and high-restrained eaters. In other words, their desire for food may influence their cognitive processing of food stimuli, making it harder to resist these desires. Moreover, a biased cognitive processing of food stimuli may also maintain and/or further increase food desires. More specifically, their attention may be drawn preferentially to (high-caloric) food cues (e.g., Werthmann et al., 2011), they may have more positive associations with (high-caloric) foods (e.g., Roefs et al., 2011), and (high-caloric) food cues may trigger more activity in the reward centers of their brains (e.g., Frankort et al., 2012). These cognitive processes all may contribute to the degree of experienced craving, desire, and thereby to food consumption (see also Hofmann, Kotabe, Vohs, & Baumeister, Chapter 3, this volume).

Further adding to the potential power of high-caloric food cues in the environment is the hypothesized *automaticity* of the increased cognitive hedonic reactivity to these food cues, while simultaneously assuming that cognitive resources are needed to activate the longer-term goal of a healthy weight (e.g., Hofmann, Friese, & Strack, 2009). As argued recently (Hofmann & Van Dillen, 2012), these initial automatic responses can lead to habitual or impulsive eating behavior, but they may also enter into working memory and can become a conscious desire, which may grow increasingly stronger (see also Kavanagh, Andrade, & May, 2005; Andrade, May, Van Dillen, & Kavanagh, Chapter 1, this volume). If this desire escalates, conscious pursuit of the desire may follow, resulting in the consumption of the desired foods.

Taken together, the idea is that attention, associations, and food-reward processing in the brain are all *automatically* biased toward a *hedonic* response to food in susceptible people. This implies that people with overeating problems will show evidence of all three types of biased cognitive processing. But what is the current status of empirical evidence for this idea? Attention bias for food, implicit measures of associations with food, and brain reward activity in response to food cues will be considered successively in this chapter. The chapter focuses on research done with people with overeating problems, that is, overweight people and restrained eaters. Restrained eaters have a chronic intention of losing weight but are frequently unsuccessful, and then indulge in the high-caloric foods they attempt to avoid (Herman & Polivy, 1980, 2004). The frequent alternations between restraint and disinhibited eating may increase the attractiveness of the high-caloric foods that they actually consider as forbidden (e.g., Gendall & Joyce, 2001).

Biased Attention Toward Foods

A large number of studies have addressed biased attention toward food in various groups of people with eating problems: obesity and overweight, eating disorders, and restrained eating (for meta-analyses, see Brooks, Prince, Stahl, Campbell, & Treasure, 2011; Dobson & Dozois, 2004). The hypothesized increased attractiveness of high-caloric foods to overweight people and high-restrained eaters is thought to be reflected in biased attention toward high-caloric foods.

How Is Attention Bias Measured?

Attention bias for food is frequently assessed using either a food variant of the emotional Stroop task (Williams, Mathews, & MacLeod, 1996) or with the visual probe paradigm (MacLeod, Mathews, & Tata, 1986) measuring response latencies and/or eye movements. In the food Stroop task, participants name the color of (different types of) food words and neutral words. If participants are slower on the food word trials, it is concluded that the food words produce more interference, and this interference is often taken as evidence for an attention bias *toward* food. However, the interpretation of the emotional Stroop effect is not straightforward, as attentional *avoidance* of the stimulus altogether would also cause a slowdown in response latency (e.g., Field & Cox, 2008). Generally, the exact cognitive mechanism underlying the emotional Stroop effect is unclear (see Williams et al., 1996), which complicates the interpretation of interference scores.

The visual probe paradigm (e.g., MacLeod et al., 1986) is an improvement in that sense, as it can be clearly determined whether the participant shows relative attentional approach or avoidance as compared to a contrast category of stimuli. Typically, in this paradigm a pair of cues (e.g., one food and one neutral picture) is presented on screen, and after a certain interstimulus interval (ISI) (e.g., 1,000 msec), a dot replaces one of these pictures. The participant has to decide as quickly as possible in what location (typically left vs. right side of the screen) the dot appeared. If participants are on average faster on trials in which the dot replaces the food picture as compared to the neutral pictures, it is concluded that they have an attention bias toward food. A reverse effect is taken as evidence for attentional avoidance of food. If eye movements are measured, conclusions are reached in a similar way. It is tested whether a first eye movement more often goes to either the food or the control picture, and the gaze duration on both pictures is determined and compared.

Attention Bias for High-Caloric Foods in Obesity and Restrained Eating

There is indeed some evidence for the idea that obese people preferentially attend to (high-caloric) foods as compared to healthy-weight people. Using a visual probe task with eye tracking, Castellanos and colleagues (2009) found that sated obese participants, as compared to sated healthy-weight participants, preferentially attended to food as compared to neutral items, as apparent both in initial orientation and gaze duration. No group differences were observed in the hungry state. Another study using the dot-probe task reported similar results: on a response-latency-based measure, obese people, but not healthy-weight controls, showed a bias toward food pictures, with the effect being primarily due to high-caloric foods (Kemps, Tiggemann, & Hollitt, 2014).

Partly converging evidence was found using event-related potentials (ERPs; Nijs, Franken, & Muris, 2010). Obese people showed evidence of an increased early attention bias for high-caloric food (reflected in the P200 component), but no difference between obese and healthy-weight participants was seen on a later component (P300; see also Nijs, Franken, & Muris, 2008), or on a behavioral measure (response latency in the food Stroop paradigm). This pattern of results was partly observed in

eye-tracking data (Werthmann et al., 2011) as well: Obese people more frequently oriented toward a high-caloric food picture than a neutral picture as compared to healthy-weight people, but their fixation duration on these food stimuli was shorter than that in healthy-weight people, suggesting an approach–avoidance response in obese people. Taken together, the three studies described above all found evidence for a relatively early attention bias toward food specifically in overweight or obese people, but diverged in their findings regarding later components of this attention bias (approach, no difference, or even avoid).

Partly in keeping with the previously discussed studies are the results from Nijs, Muris, Euser, and Franken (2010). They measured multiple indices of attention bias for high-caloric food—eye tracking (initial orientation and gaze duration), response latency in a dot-probe task with 100 and 500 msec presentation of cue pair, and P300. They found a difference between obese and healthy-weight participants only on their response latency data in the visual probe task with 100 msec cue-pair presentation, with obese people showing increased attention bias toward high-caloric foods. This partly fits with the above findings that the only difference between obese and healthy-weight participants was observed in an early component of attention bias. However, it is surprising that no differences were found in Nijs et al.'s (2010) eye-tracking data (cf. Werthmann et al., 2011, in which effects were found in eye-tracking data but not in response latency data).

Finally, on a food Stroop task, clear differences were observed between obese and healthy-weight children. That is, obese children specifically showed greater interference by food words than did healthy-weight children (Braet & Crombez, 2003). Note, however, that it is unclear exactly how to interpret the results from this paradigm (see above). One cannot be certain whether increased interference actually reflects more or less attention toward the word itself.

So far it seems there is some evidence for an increased attention bias toward food in overweight and obese people, albeit most convincingly in relatively early attention processes. However, quite a few studies, using various types of methodology, reported no relationship between body mass index (BMI) and attention bias for food: dot-probe tasks comparing attention to healthy and unhealthy food words (Pothos, Tapper, & Calitri, 2009), attention to food and neutral words with a very brief cue-pair presentation of 50 msec (Loeber et al., 2012), or attention to high-caloric foods and neutral control stimuli in obese versus healthy-weight children (Werthmann, Jansen, Vreugdenhil, Nederkoorn, Schyns, et al., in press); an emotional Stroop task with healthy and unhealthy food words (Phelan et al., 2011; Pothos et al., 2009); and gaze time at high- and low-calorie foods in a free-viewing paradigm (Graham, Hoover, Ceballos, & Komogortsev, 2011). Finally, some studies even reported a reverse association between BMI and attention bias toward high-caloric foods. That is, they found a reduced attention bias for these foods with increasing

BMI. More specifically, Graham et al. (2011) found that their healthy-weight group oriented more frequently toward high-caloric sweet foods than low-caloric foods, while they did not find differences in frequency of initial orientation between food types in their overweight group. In addition, in a visual search paradigm, participants showed increasingly faster detection of food compared to nonfood items with lower BMIs (Nummenmaa, Hietanen, Calvo, & Hyönä, 2011). So, it is evidently too simplistic to conclude that obese people are characterized by an exceptionally strong attention bias toward high-caloric foods.

Another group of people who are hypothesized to be especially vulnerable to the tempting foods in our environment are the restrained eaters. Whether this increased vulnerability to tempting food cues is reflected in biased attention toward food cues has been the topic of many studies, but again, it is hard to draw a general conclusion. In particular, the food Stroop task has been employed frequently. Two meta-analyses (Brooks et al., 2011; Dobson & Dozois, 2004) conclude that there is a small food interference effect specifically in restrained eaters, but one meta-analysis (Johansson, Ghaderi, & Andersson, 2005) concludes that there are no differences between restrained and unrestrained eaters in this regard. Bear in mind the interpretation problems with the emotional Stroop task as well.

Using a visual probe paradigm, most studies found no evidence for a stronger attention bias toward food in restrained than unrestrained eaters (Ahern, Field, Yokum, Bohon, & Stice, 2010; Boon, Vogelzang, & Jansen, 2000; Brignell, Griffiths, Bradley, & Mogg, 2009; Werthmann et al., 2013b), whereas Hepworth, Mogg, Brignell, and Bradley (2010) did. Notably, when using a free-viewing paradigm combined with eye-tracking, a reverse effect was found. More specifically, restraint was associated with a reduced frequency of orientation to high-calorie sweet foods in an overweight group (Graham et al., 2011).

So, taken together, there is no clear evidence for either attentional approach or attentional avoidance of high-caloric foods in either overweight people or restrained eaters. Reaching a general conclusion about these studies is complicated by the great diversity in paradigms, timing parameters, stimulus details, and comparison categories (e.g., high-caloric vs. low-caloric foods or foods vs. neutral items). Though the between-group approach did not prove to be particularly elucidating, what about studies that actually assessed craving for food and consumption of food?

Relationship between Attention Bias and Craving and Consumption

Another highly relevant question is obviously whether an attention bias toward food is actually (causally) related to craving and food intake, as this is frequently assumed in studies assessing attention bias for food. However, it may also be argued that the attention bias toward food is

caused by worry or anxiety about food. It is relevant in this respect that attention bias for food has also been frequently studied in patients with anorexia nervosa (AN). Clinically, one could expect both worry/anxiety about food and craving for food in this group of patients.

There have been a number of studies with the food Stroop task in patients with AN, but a meta-analysis (Dobson & Dozois, 2004) concluded that the food interference effect was not consistently observed in these patients. In a study using the visual probe paradigm, an attention bias toward high-caloric foods was observed (Shafran, Lee, Cooper, Palmer, & Fairburn, 2007), and in another study, increased distraction by high-caloric and low-caloric foods was observed in patients with AN (Smeets, Roefs, van Furth, & Jansen, 2008). Note that exactly the reverse—that is, reduced attention for food stimuli in patients with AN—was observed in a recent eye-tracking study (Giel et al., 2011). So, again, research focusing on group differences is not particularly elucidating, and the overall picture is not very consistent. Therefore, research that actually measures craving, or studies in which either craving or attention bias is manipulated, may help us further.

Correlations have been observed between attention bias toward food and momentary craving in an overweight group but not in a healthy-weight group (Werthmann et al., 2011), and between attention bias toward chocolate and chronic chocolate craving (Kemps & Tiggeman, 2009; Smeets, Roefs, & Jansen, 2009; Werthmann, Roefs, Nederkoorn, & Jansen, 2013a). Supporting the association between attentional processing and the control of craving, a recent ERP study (Harris, Hare, & Rangel, 2013) found evidence for early attentional modulation by successful versus unsuccessful self-control, but only when weight loss was made relevant for the participants by monetary incentive. More specifically, in trials in which participants made a food choice indicative of unsuccessful self-control (e.g., chose an unhealthy liked food), the N1 amplitude was more negative (reflecting more attentive processing) than on trials in which participants made a food choice indicative of successful self-control (e.g., chose a healthy but disliked food). So successful self-control in the context of food choice was associated with attention suppression.

In addition, there is also evidence for a causal relationship, that is, evidence that induced craving for chocolate leads to an attention bias for chocolate in chocolate likers (Kemps & Tiggeman, 2009) and high-trait chocolate cravers (Smeets et al., 2009). Relatedly, it was observed that attention bias toward a food decreased from premeasure (before the food was eaten to satiety) to postmeasure (after the food was eaten to satiety) (Di Pellegrino, Magarelli, & Mengarelli, 2011).

Interestingly, there is also evidence for a causal relation in the other direction, with manipulated attention for food affecting craving and/or food intake. More specifically, in two experiments (Kemps, Tiggemann, Orr, & Grear, 2014a) it was shown that participants who were trained to attend to chocolate cues consumed more chocolate in a so-called taste test afterwards as compared to participants who were trained to avoid chocolate cues. Moreover, in one of these experiments (but not the other), the attend-chocolate training was associated with an increase in craving, whereas the avoid-chocolate training was associated with a decrease in craving. Similar results were obtained in a study in which participants were either trained to attend to healthy or to unhealthy foods. It was found that participants who were trained to attend to healthy foods consumed relatively more healthy than unhealthy foods afterwards as compared to the participants who were trained to attend to unhealthy foods (Kakoschke, Kemps, & Tiggeman, 2013). Note that in both Kemps, Tiggemann, Orr, and Grear (2014b) and in Kakoschke et al. (2013), the training procedure also successfully altered the attention bias for the targeted food. This was corroborated in a later study in which it was also found that an attentional training procedure changed the attentional bias, both on the dot-probe task and on a word-stem completion task (Kemps et al., 2014a).

Using a novel attention bias modification procedure based on the anti-saccade task (e.g., Hallett, 1978), converging evidence was obtained (Werthmann, Field, Roefs, Nederkoorn, & Jansen, 2014). Here it was found that participants who were trained to avoid looking at chocolate and who performed highly accurately during the training showed a reduced chocolate intake as compared to a group of participants who were trained to look toward chocolate. No effects of the training on craving were observed, though. In stark contrast to these three studies are results from a study that manipulated attention bias toward cake. Only weak evidence was found for a change in the attention bias itself, and no effects on hunger or food intake were found (Hardman, Rogers, Etchells, Houstoun, & Munafò, 2013).

Taken together, there is a substantial amount of evidence for an association between biased attention for food and craving for food, and even some evidence in support of a causal relationship between these two variables. This conclusion is in line with the results from a meta-analysis on the association between attention bias and craving for addictive substances (Field, Munafò, & Franken, 2009; see also Franken, Chapter 19, this volume). In this meta-analysis, the association between attention bias and craving was small but significant, with some indications for a larger correlation when the measure that was used reflected attentional disengagement. Importantly, the correlation was substantially higher for studies employing a direct measure of attention bias (i.e., eye movement monitoring and ERP measurements) as compared to indirect response-latency-based measures.

Top-Down Influences on Attention Bias

As partially reviewed above, there is quite a large literature on group differences in attention bias toward high-caloric foods, the hypothesis under investigation being that overweight/obese people and chronically

restrained eaters show attentional approach toward these foods. The findings have been disappointingly inconsistent. Part of the problem, of course, is the huge diversity in employed paradigms, stimuli, and timing parameters, compromising comparability across studies.

A more general problem is the double-faceted nature of high-caloric foods. In daily life the investigated groups typically fluctuate frequently between a momentary focus on taste versus a focus on health/weight consequences, reflecting this double-faceted nature of high-caloric foods. These fluctuations may be especially pronounced for people with weight problems. The possibility that attention focus (i.e., focus on taste vs. healthiness of food) is an overlooked factor with the potential to explain the divergence of findings in the field has received relatively little attention. It may be the case that such a momentary focus is a stronger determinant of attention bias for food than are more stable differences in weight and restraint status.

One hint that this may be the case is provided by studies that induced craving for food or an addictive substance. The inducement of craving may have led to a strong focus on taste or reward at the cost of health considerations. Indeed, inducing craving for chocolate led to an attention bias toward chocolate in two studies (Kemps & Tiggeman, 2009; Smeets et al., 2009). In a related finding, Werthmann et al. (2013c) discovered an association between self-endorsed eating permission (i.e., whether participants reported that they allowed themselves to consume chocolate in a taste test of the experiment) and a relatively long dwell time on chocolate. Similarly, using eye-tracking methodology as well, it was found that an attention bias for rewarding stimuli was enlarged when participants expected to receive these rewards (Jones et al., 2012). It is relevant here as well that an attentional bias for food was completely eliminated by providing participants with a concurrent high cognitive load, suggesting that some resources are necessary to recognize temptations (Van Dillen, Papies, & Hofmann, 2013).

In addition, from the meta-analysis by Field and colleagues (2009), it became apparent that the correlation between attention bias toward addictive substances and craving for these substances was particularly large when craving was induced in participants as compared to no-craving-induction control conditions. The craving induction possibly had the effect of focusing all the participants on the same aspect of the addictive substance, the positive rewarding aspect. Thus, the participants may have alternated less between focusing on positive versus negative consequences of the addictive substance, leading to a higher correlation between attention bias and craving.

Also supporting the relevance of attention focus is an ERP study (Meule, Kübler, & Blechert, 2013) in which participants were asked to focus either on the immediate or on the long-term consequences of consuming high-caloric and low-caloric foods. The late positive potential (LPP), which is thought to be driven by arousal (Olofsson, Nordin,