The Psychology of Food Cravings: the Role of Food Deprivation

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Abstract

Purpose of Review Dieting is often blamed for causing food cravings. Such diet-induced cravings may be mediated by physiological (e.g., nutritional deprivation) or psychological (e.g., ironic effects of food thought suppression) mechanisms. However, this notion is often based on cross-sectional findings and, thus, the causal role of food deprivation on food cravings is unclear.

Recent Findings Experimental studies suggest that a short-term, selective food deprivation seems to indeed increase cravings for the avoided foods. However, experimental studies also show that food craving can be understood as a conditioned response that, therefore, can also be unlearned. This is supported by intervention studies which indicate that long-term energy restriction results in a reduction of food cravings in overweight adults.

Summary Dieting’s bad reputation for increasing food cravings is only partially true as the relationship between food restriction and craving is more complex. While short-term, selective food deprivation may indeed increase food cravings, long-term energy restriction seems to decrease food cravings, suggesting that food deprivation can also facilitate extinction of conditioned food craving responses.

Keywords Food craving - Dieting - Food deprivation - Caloric restriction - Pavlovian conditioning - Extinction

Introduction

A food craving is an intense desire to eat a particular type of food [1]. Humans typically crave energy-dense foods: chocolate and other chocolate-containing foods are the most frequently craved foods, followed by other high-caloric sweet and savory foods [2–6]. Cultural differences have been found, for example, with rice being the most frequently craved food in Japan [7]. Among low-caloric foods, cravings for fruits are also reported quite commonly [3, 5, 8]. Food cravings typically occur in the late afternoon and evening [9]. Interestingly, only the desire to eat high-calorie foods increases throughout the day, while craving for fruits decreases [8].

Hunger refers to the absence of fullness, that is, feelings of hunger are brought about by an empty stomach [10]. Food craving can be differentiated from feelings of hunger through its specificity and intensity. That is, while a food craving can usually only be satisfied by consumption of a particular food, hunger can be alleviated by consumption of any type of food [11]. Moreover, while hunger and food craving often co-occur, being hungry is not a prerequisite for experiencing a food craving. In a laboratory study on chocolate craving, for example, current chocolate craving intensity was positively correlated with current hunger, but unrelated to the length of food deprivation. Moreover, only current chocolate craving intensity—but not current hunger—related to higher salivary flow during a chocolate exposure and to higher chocolate consumption [12].

The experience of a food craving is multidimensional. Physiologically, it is associated with several processes that prepare the body for ingestion and motivates food seeking and consumption such as increased salivary flow [12, 13] and activation of reward-related brain areas such as the striatum [14–16]. It also includes cognitive (i.e., thinking about the food) and emotional (e.g., desire to eat or changes in mood) components. Finally, it often also includes a behavioral component of seeking and consuming the food. Yet, while experiencing a food craving often leads to consumption of the craved food, the craving–consumption relationship also depends on interindividual differences and situational factors [3, 17].
Theories of Food Craving

It seems obvious to assume that the emergence of a food craving might be driven by some nutrient deficiency. However, evidence for this is relatively poor. For example, when participants had to consume a nutritionally balanced, yet monotonous, liquid diet, they reported more food cravings than during a baseline period [18], and food craving could be induced by imagining their favorite food although participants were sated [16]. During pregnancy—a time during which the body needs more energy and certain nutrients than usual—it seems that the types of craved foods do not differ from usually craved foods [19, 20], and even if women crave unusual, potentially harmful, foods or other substances, it seems that this is rather driven by social factors than by physiological needs [21]. Similar interpretations have been derived from perimenstrual (chocolate) cravings which, for example, do not disappear after menopause, making hormonal mechanisms unlikely [11].

Hence, although simple associations between nutrient deficiency and food cravings seem compelling, they appear to account for a small fraction of food cravings at most. Instead, several psychological explanations for why and how food cravings emerge have been developed. Prominent models are based on (Pavlovian) conditioning [22]. Here, a cue or context that has been repeatedly paired with food intake can itself elicit a conditioned response (e.g., food craving) that promotes food intake. Theoretically, any cue can become a conditioned stimulus that elicits food craving and, indeed, appetitive conditioning studies in the laboratory have shown that neutral stimuli such as geometric figures or objects can increase eating desires when they have previously been associated with food intake [23•]. In real life, relevant cues are typically internal states such as hunger [24], external states or contexts such as time of day [25], and many more [23•].

There are also several cognitive models which, however, often include reference to conditioning processes but additionally assume higher-order cognitive processes that play a role in the craving response (see [26•] for an overview of different theories). For example, an important part of the Elaborated Intrusion Theory of Desire [27–29] is that while cues can unconsciously trigger intrusive images or thoughts, these thoughts are then consciously elaborated by retrieving cognitive associations and creating mental imagery of the target. Others emphasize the ambivalent nature of food cravings, which are often marked by both approach and avoidance inclinations that can be partially attributed to socio-cultural norms [20, 30, 31].

Dieting and Food Craving

There has been a considerable interest in the question of whether food restriction induces food cravings. Research on this topic was started off as early as the 1970s and heavily influenced by a now classic study by Herman and Mack [32]. They found that so-called restrained eaters showed a disinhibited eating behavior (higher ice cream consumption) after consumption of a preload (milkshake), whereas so-called unrestrained (“normal”) eaters decreased their ice cream consumption after consumption of a milkshake. This effect was later assumed to stem from the fact that restrained eaters had violated their dietary rules (exceeded their dietary boundary) by consumption of the milkshake, which led to a “what-the-hell-effect” [33]. Later research showed that there are many other factors (e.g., distraction, emotions) that can disinhibit food intake in restrained eaters [34, 35].

Self-report measures of restrained eating are positively correlated with self-report measures of food craving. That is, restrained eaters experience more intense and more frequent food cravings than unrestrained eaters [36]. Yet, it has also been demonstrated that measures of restrained eating do not relate to actual caloric restriction [37–39]. Thus, it appears that restrained eaters should rather be regarded as eating- and weight-concerned persons who may or may not be actually dieting [40, 41].

Although restrained eating and dieting are not synonymous, studies that differentiated more clearly between current dieters and non-dieters seem to show similar results to the restrained eating literature. In a study by Massey and Hill [42], for example, food cravings were measured with daily diaries across 7 days and it was found that current dieters reported more food cravings than non-dieters. However, a causal influence of dieting on the likelihood of experiencing food cravings can still not be inferred from such studies as dieters may have a higher predisposition for experiencing cravings in the first place. In other words, the susceptibility for experiencing cravings and giving in to them may lead to weight gain and subsequent dieting attempts (and not the other way around).

Effects of a Selective Food Deprivation

As cross-sectional research based on self-reported restrained eating or dieting cannot clearly answer the question of whether food restriction causes food cravings, experimental studies have been conducted. One type of such studies investigated a selective food deprivation during which participants were instructed to refrain from eating certain types of food. This type of experimental manipulation is sometimes also called a “hedonic deprivation” [43] as only specific foods are avoided, while consumption of all other foods are unrestricted and, thus, total energy consumption is assumed to be unaffected.

Table 1 lists the specifications and results of such studies. Some studies included a deprivation of chocolate-containing foods but single studies on other food types are also available.
The deprivation periods ranged between 1 day and 14 days, and all studies investigated university students. Almost all studies found that the deprivation increased cravings for the avoided foods. An exception is the study by Polivy and colleagues [49] who did not find deprivation-induced effects on craving. However, they found that chocolate-deprived restrained eaters ate the largest amount of chocolate in a laboratory taste test. These results are partially in line with the findings by Richard and colleagues [50] who found deprivation effects only in trait chocolate cravers. Thus, it seems that deprivation-induced increases in food craving can primarily be found in a subgroup of susceptible individuals such as restrained eaters or trait food cravers.

In sum, these studies support psychological mechanisms in the emergence of food cravings as the selective food deprivation instructions are unlikely to have created a nutrient deficiency. An exception may be the study by Beauchamp and colleagues [44] during which a very low sodium diet was complemented by the administration of diuretics to achieve sodium depletion. Because of this, however, this sodium depleted state seems not to be representative for the average individual who exhibits dietary restraint or engages in weight-loss dieting. As none of these studies imposed a restriction on any foods other than the avoided foods or on total caloric intake, it seems that perceived deprivation—a feeling of not eating what or as much as one would like, despite being in energy balance [51]—plays a larger part in generating food cravings than actual nutrient deficiencies.

### Effects of Energy-Restricting Diets

Another type of studies that is relevant to consider when examining whether food restriction causes food cravings are weight-loss interventions. As opposed to selective food deprivation studies, weight-loss interventions aim to create an energy deficit, which is primarily achieved by a reduction of energy intake (although they may also involve physical activity to increase energy expenditure). Importantly, results from these studies are opposite to the findings from selective food deprivation studies. A meta-analysis by Kahathuduwa and colleagues [52] which investigated eight studies in which caloric restriction was used as part of a weight-loss intervention found that food cravings actually decrease from pre- to post-intervention. Another systematic review that examined similar studies came to the same conclusion [53].

### Table 1 Experimental studies on the effects of selective food deprivation on food craving in humans

| Reference           | n     | Participants                      | Avoided foods                                    | Length of deprivation period | Findings                                                                 |
|---------------------|-------|-----------------------------------|-------------------------------------------------|-----------------------------|-------------------------------------------------------------------------|
| Beauchamp et al. [44]| 10    | University students (40% women)   | Sodium-rich foods                                | 10 days                     | Deprivation-induced increase in desire to eat salty foods               |
| Blechert et al. [45]| 29    | University students (100% women)  | Chocolate-containing foods                       | 7 days                      | Deprivation-induced increase in desire to eat chocolate-containing foods|
| Coelho et al. [46] | 77    | University students (100% women)  | Carbohydrate-rich or protein-rich foods          | 3 days                      | Deprivation-induced increase in carbohydrate-rich food craving frequency or protein-rich food craving frequency |
| Komatsu et al. [47] | 51    | University students (84% women)   | Rice                                             | 1 day or 3 days             | Deprivation-induced increase in rice craving frequency                  |
| Komatsu et al. [47] | 28    | University students (57% women)   | Bread                                            | 3 days                      | Deprivation-induced increase in bread craving frequency                 |
| Moreno et al. [48] | 58    | University students (100% women)  | Chocolate-containing foods                       | 14 days                     | Deprivation-induced increase in desire to eat chocolate-containing foods |
| Polivy et al. [49] | 103   | University students (100% women)  | Chocolate-containing or vanilla-containing foods | 7 days                      | No effects of deprivation on food cravings                              |
| Richard et al. [50] | 60    | University students (75% women)   | Chocolate-containing foods                       | 14 days                     | Deprivation-induced increase in desire to eat chocolate-containing foods in high trait chocolate cravers (but not in low trait chocolate cravers) |
Table 2 lists the most recent studies between 2017 and 2020 that were not included in the meta-analysis by Kahathuduwa and colleagues [52]. Intervention periods ranged between 4 weeks and 2 years and all studies investigated overweight or obese adults. An exception is the study by Dorling and colleagues [58] which also included normal-weight participants. This is also the study for which results were not entirely clear as the changes in food cravings were moderated by sex. Yet, findings from all other studies are in line with the meta-analytical results by Kahathuduwa and colleagues [52] as food cravings decreased during the caloric restriction period. These decreases seem to occur primarily during the first weeks of caloric restriction and do not seem to rebound at later follow-up measurements [60,62,63].

In sum, results from caloric restriction studies again speak against the notion that nutrient deficiencies or an energy deficit cause food cravings and instead favor psychological explanations. For example, decreases in food cravings during caloric restriction may be due to extinction of previously acquired conditioned responses [23*,26*]. In line with this is that a reduced frequency (but not the amount) of consuming craved foods related to reductions in cravings for these foods in the study by Apolzan and colleagues [55*]. That is, not eating certain foods over a period of at least several weeks may decouple learned associations (e.g., between evening time and chocolate consumption) so that certain cues (e.g., evening time) do no longer trigger a conditioned response (e.g., craving for chocolate).

### Conclusions

At first glance, it appears that the literature on the effects of food restriction on food cravings produced ambiguous findings. While selective food deprivation seems to increase food cravings,
caloric restriction seems to decrease them. However, these contradictory findings may be explained by several methodological differences between these studies. First, selective food deprivation studies have exclusively been conducted in university students, most of them normal-weight women (Table 1). In contrast, caloric restriction studies have almost exclusively been conducted in overweight persons (Table 2). Thus, it cannot be excluded whether different types of food restriction have different effects on craving as a function of sample characteristics such as body weight. Second, selective food deprivation studies included deprivation periods of few days up to 2 weeks, while caloric restriction studies included periods of several weeks and months. Thus, it may be that avoiding certain foods may increase cravings in the first few days but that they may have decreased if the selective food deprivation studies would have been conducted over longer periods of time. This interpretation is in line with the fact that extinction learning takes longer than acquisition [23].

In conclusion, a nutrient deficiency or an energy deficit brought about by food restriction can rarely explain the emergence of a food craving (although this may be true in some rare cases [64, 65] or if food intake is completely terminated [66, 67]). Instead, food craving can rather be understood as a conditioned response that emerges because internal or external cues associated with intake of certain foods. Restrained eaters, dieters, and study volunteers that are instructed to refrain from eating certain foods report more cravings for these foods over short periods of several days. However, weight-loss studies in overweight individuals consistently show that caloric restriction leads to decreases in food cravings, which may be due to extinction processes when certain foods are avoided and substituted with healthier alternatives. Thus, the wide-held notion that dieting inevitably leads to food cravings is strongly oversimplified as the relationship between food restriction and food craving is more complex.

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