

Food Addiction

An Examination of the Diagnostic Criteria for Dependence

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Abstract: The evidence for food's addictive properties is steadily growing. In addition to clinical and evolutionary plausibility, the possibility of addiction to food is supported by animal model research and increasingly by research with humans. Much as classic drugs of abuse "hijack" the brain, accumulating evidence with food suggests a similar impact, but with weaker effects. Although neurobiological evidence for food addiction is compelling, dependence as conceptualized with respect to alcohol and other drugs of abuse is fundamentally a behavioral disorder. Thus, we review the current state of food addiction research in the context of each of the diagnostic criterion for dependence (ie, tolerance, withdrawal, loss of control) and briefly explore other relevant addiction topics such as expectancies, reinforcement, and incentive salience. There is substantial evidence that some people lose control over their food consumption, suffer from repeated failed attempts to reduce their intake, and are unable to abstain from certain types of food or reduce consumption in the face of negative consequences. Although there is some evidence for other dependence criterion, further research is needed to examine tolerance and withdrawal to high-fat sweets, time spent in obtaining, using, and recovering from excess food consumption and the degree to which important activities are given up due to overconsumption. As science continues forward and both the public and elected leaders become aware that food may trigger an addictive process, this information will likely be used to inform policy. Thus, researchers need to carefully consider the implications of their work and the way in which the results may be interpreted.

Key Words: food, addiction, overeating, obesity

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Obesity is a pressing public health concern in all parts of the world¹ and obesity has now become the second leading preventable cause of death in the United States.² The picture is most dire for children, where estimates suggest that the current generation of children may be the first to have a lower life expectancy than their parents.³

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It is essential to identify the factors causing the increased rates of obesity in hopes that more effective prevention and treatment approaches can be developed. Recent work with both animals and humans has raised the potentially important possibility that foods can trigger biologic and psychologic processes similar to those seen with classic drugs of abuse. The potential scientific, policy, and legal implications are striking. Thus, it is important to get a clear view of the state of the science and to help cultivate the next generation of work in the field. The aim of this article was to review the available science, to highlight gaps in knowledge, and to discuss the implications of the food addiction concept.

Clinical and Evolutionary Plausibility

Clinical observations and even popular culture have long hinted at the idea that food might have addictive properties. Individuals with a variety of eating disturbances speak of cravings, symptoms they experience as withdrawal, and escalating patterns of eating that might be viewed as evidence of tolerance.⁴ In addition, treatments have been derived from these observations, most notably Overeaters Anonymous. In popular culture, people use terms like food addict and chomoholic, and refer to symptoms including carbohydrate cravings.⁴ Popular diets have also been based on the idea that food is addictive. Even the food industry has used the concept of food addiction in their advertisements, with suggestions that cravings must be satisfied or that "you cannot eat just one."

From an evolutionary perspective, one can build a case for why humans would crave energy-dense foods and engage in behaviors such as binge eating. Seeking out energy-dense foods and eating beyond immediate hunger serves to increase energy stores and provide protection against famine.⁵ Historically, food was not as abundant and was not processed in ways that manipulated sugar, fat, and salt, so the biologic propensity to seek out food high in energy density was seldom maladaptive. In contrast, the availability of inexpensive and highly palatable foods in industrialized countries seems to have contributed to the escalating rates of obesity. The mechanisms through which these foods have led to excessive food consumption likely involve reward centers in the brain (eg, dopamine and opiate systems) that create powerful incentives for eating.^{6,7}

Biologic and Animal Model Evidence

Many of the studies on food addiction have emphasized underlying biology, particularly the shared activation of the dopamine and opiate systems by both food and drugs of

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abuse.^{8–10} Neuroimaging research has found that the reward values of both food and substances of abuse are associated with the level of extracellular dopamine released in the nucleus accumbens.⁶ Positron emission tomographic imaging studies have provided evidence that reduced levels of dopamine receptors are related to both obesity and drug dependence.¹¹ In addition, consumption of certain foods and other substances can cause changes in the opiate system. For example, both alcohol and high-fat sweets can cause the release of endogenous opioids in the brain.⁷ Further the administration of an opiate blocker, such as naloxone, reduces the reinforcement value of alcohol for individuals with alcohol dependence¹² and high-fat sweets for binge eaters.⁷

Although research with humans has largely focused on brain activity rather than behavioral indicators of food addiction, animal models have explored both biologic and behavioral indicators of addiction to food.^{13–18} For example, Rada et al¹⁸ found that rats fed an intermittent diet of sucrose tripled their daily sugar consumption, possibly exhibiting a tolerance to the effects of sugar-rich foods. Another study found that when access to sugar was removed from animals on a high-sugar diet, body temperature dropped and there were behavioral changes typically associated with withdrawal, such as agitated and anxious movements.^{19,20} Other research has demonstrated that sugar-binging rats exhibit both increased motivation to consume ethanol and locomotor cross-sensitization with amphetamines and cocaine.^{14,16}

Diagnostic Criteria for Dependence

In light of the growing biologic evidence in humans and behavioral indicators observed in animal research, it is important to determine the extent to which behavioral indicators of food addiction are present in humans. According to the Diagnostic and Statistical Manual-IV-TR,²¹ substance dependence is defined as a “cluster of cognitive, behavioral, and physiological symptoms associated with the continued use of the substance despite significant substance-related problems.” A diagnosis of substance dependence is given when 3 or more of the 7 criteria are met and result in clinically significant impairment or distress. In the following section of the article, we will discuss the current state of research for each of the 7 diagnostic criteria in relation to “food addiction,” and briefly consider areas where further exploration is warranted. Table 1 provides a complete listing of the diagnostic criteria outlined in the remainder of the article.

Tolerance

Tolerance occurs when one needs to consume greater quantities of a substance to achieve a desired effect or the substance has a diminished effect after continued use.²¹ Although tolerance or withdrawal is necessary for a diagnosis of physical dependence, it is possible to meet criteria for substance dependence without having either of these physiologic symptoms.²¹ Little research has been conducted on either tolerance or withdrawal in relation to food consumption. This may be, at least in part, due to methodological difficulties of conducting this type of research. Unlike substances such as alcohol and nicotine where initial consumption frequently begins during adolescence, high-fat/sugar

TABLE 1. Diagnostic Criteria for Substance Dependence as Stated by the DSM-IV-TR²¹

1. Tolerance, as defined by either of the following:
 - The need for markedly increased amounts of the substance to achieve intoxication or desired effect.
 - Markedly diminished effect with continued use of the same amount of the substance.
2. Withdrawal, as manifested by either of the following:
 - The characteristic withdrawal syndrome for the substance.
 - The same (or closely related) substance is taken to relieve or avoid withdrawal symptoms.
3. Taking the substance often in larger amounts or over a longer period than was intended.
4. There is a persistent desire or unsuccessful effort to cut down or control substance use.
5. Spending a great deal of time in activities necessary to obtain or use the substance or to recover from its effects.
6. Giving up social, occupational, or recreational activities because of substance use.
7. Continuing the substance use with the knowledge that it is causing or exacerbating a persistent or recurrent physical or psychological problem.

foods are initially ingested for most people during infancy or early childhood. With a few exceptions, food intake patterns during this time of life have not been examined with the concept of tolerance in mind, but some research suggests the possibility that tolerance may develop during the early years. Harrison²² found that sucrose is an effective analgesic for minor pains in young infants (similar to traditional opiates), but this effect is no longer evident after 18 months of age when many children have already begun to regularly consume high-sugar foods.²³ Because of the possibility of early tolerance, the optimal time to conduct studies on this issue may be during infancy or early childhood.

In adult populations, there have been few direct studies on tolerance, but studies on anticipatory responses to food may be informative. The anticipation of food intake, and the preabsorptive signals generated by the body's first indication that food has been consumed, set into motion a series of biologic responses designed to ready the body for metabolic work. To help prepare the body for incoming nutrients, food-related stimuli trigger a compensatory response of cephalic insulin secretion, which is similar to compensatory responses to drugs of abuse. The compensatory cephalic insulin secretion reduces the level of glucose in the blood stream (for a review of this concept see Ref. 24), which may result in the need for increased consumption of sugar to achieve desired effects. Some behavioral evidence has also been found to indicate the development of food tolerance in patients with bulimia nervosa (BN). Brown et al²⁵ found that as illness duration increases binges become more frequent and the quantity of food consumed during binges increases. Participants in their study also spent longer periods of time binging and felt more out of control as time increased. Although existing evidence is intriguing, additional studies are needed to determine if tolerance is specific to certain types of foods that have been hypothesized to have addictive qualities (eg, high-sugar foods). If tolerance is shown to other

foods (eg, fruits and vegetables) it would suggest that these effects may not be particularly relevant to an addictive process. It is also important to determine if reduced effects of certain foods over time serve as a motivator of increased consumption of these foods.

Withdrawal

Withdrawal is defined as the development of physiological or cognitive symptoms in response to periods of abstinence or reduced consumption of a substance.²¹ Withdrawal can also be indicated by the consumption of a substance to prevent these symptoms from arising.²¹ The animal studies described earlier do suggest that withdrawal can occur,^{15,20} but to date the only evidence in humans is from anecdotal reports discussing how people feel when dieting. For example, in his popular low carbohydrate diet book, Atkins²⁶ warned that an abrupt decline in carbohydrates could provoke “fatigue, faintness, palpitations, headaches, and cold sweats.” Similar to research on tolerance, metabolic processes have also been examined for signs of withdrawal. When either obese or lean humans restrict their food consumption, cephalic responses are exaggerated.²⁷ These exaggerated responses may result in reactive hypoglycemia, in which excess insulin is secreted in response to food-related cues or food consumption. When this occurs, the level of sugar in the blood becomes too low and symptoms of discomfort or fainting may arise. This drop in blood sugar is also associated with intense cravings and hunger. This process is analogous to the development of withdrawal in drug-addicted individuals, for whom anticipatory responses to drug cues result in physiologic changes that trigger cravings and sometimes relapse (for a review of this concept see Ref. 24). Although this evidence is intriguing, it is obvious that this area is in need of additional empirical research.

Loss of Control

Loss of control is indicated by the frequent consumption of a substance in greater amounts or over longer periods of time than was initially intended.²¹ Loss of control becomes part of a diagnosis in the case of binge-eating disorder (BED) and BN. Binges are characterized by eating much more rapidly than normal, eating until uncomfortably full, eating outside of hunger, eating alone due to embarrassment and having feelings of disgust, depression, or guilt after periods of overeating.²¹ Binges can be triggered by the consumption of a “forbidden food” which is often high in fat and/or sugar.²⁸ This results in uncontrolled consumption of food in quantities as high as 5000 calories.²⁹ Although only 1–4% of the population meets diagnostic criteria for BED or BN,²¹ episodes of uncontrolled eating are also seen in nonclinical populations. Approximately 9% of normal weight and 21% of overweight women report occasionally binge eating.³⁰ Thus, the existence of a loss of control over food consumption for a substantial proportion of the population is well documented.

A greater concern, because of sheer numbers, may be the normative overconsumption of calories that place individuals at risk for weight gain. Despite widespread concern with nutrition and weight, eating is difficult to control for vast numbers of people. There are a host of possible contributing

factors beyond the physical properties of food (eg, large portions, pervasive marketing), but any role played by addictive processes that may be triggered by environmental factors needs careful examination.

A Desire or Repeated Failed Attempts to Reduce or Stop Consumption

The desire to cut down or stop consuming certain foods is pervasive in our society. Dieting is frequently directed at abstaining from certain types of food and restricting overall food consumption and is the basis for \$33 billion dollars spent annually on dieting products and programs.³¹ There is also evidence that the desire to cut-down begins early in life with 37% of elementary school children reporting dieting in an attempt to become thin.³² The repeated failure of such attempts is evident in even the most empirically validated treatments with approximately 83% of participants regaining their lost weight within 5 years.³³ Thus, there is substantial evidence that this criterion is frequently met.

A Great Deal of Time Spent in Activities Necessary to Obtain, Use, or Recover

Because calorie-dense, nutrient poor foods are so easily and inexpensively obtained, it has been argued that this criterion for substance dependence cannot be met for food consumption.³⁴ In many ways this may not be a relevant criterion for the issue of food addiction because, of course, it is possible for addiction to occur with something that is legal, readily available, and socially acceptable to obtain. Nicotine is a prime example. A great deal of time has been spent in activities by the food industry to make their products as readily available, desirable, and easily consumed as possible. Although unhealthy food is highly available, there may still be instances in which people will go out of their way to obtain favored foods, even when they have abundant sources of other food immediately available. In other words, a person might drive across town to a fast food restaurant to fulfill a craving even though they have other foods available. Although anecdotal reports of this type of behavior are common, we are not aware of any empirical studies documenting such behaviors. Thus, this subject also requires further attention.

Certainly, the time spent trying to recover is relevant because of the vast amounts of time people spend on diets, buying diet foods, being concerned with their weight, etc. In addition, people with BN or BED spend a great deal of time dealing with the emotional consequences of excess food consumption, much of it in secret, and much of it producing physical and psychologic distress.²¹

Giving up Other Important Activities

Being overweight is associated with decreased involvement in important life activities. Low rates of physical activity would be one example of giving up important activities, but there are many more. Excessive food consumption and obesity may lead to less engagement in social activities, including dating or marriage. This may be due in part to the experience of weight bias.^{35,36} Laboratory-based studies have also found that participants will choose to consume unhealthy

snack foods over healthy food alternatives or participation in pleasurable sedentary activities. When the work necessary to obtain the unhealthy food increases, participants will eventually shift their choice to other available alternatives.³⁷ In contrast, obese individuals will work significantly harder to acquire unhealthy snack foods than lean participants, even when the alternative is a pleasurable sedentary activity.³⁸ Thus, it is possible that the drive to consume high-fat sweets may become so appealing that it is frequently chosen over other important activities, especially for those who are prone to overconsumption. Further research is needed to explore the extent to which excess food consumption may begin to replace other important life activities.

Continued Use Despite Physical or Psychologic Problems

The association of high-calorie consumption and obesity with a host of serious health problems, such as heart disease and diabetes, provides some indication of continued use in the face of dire consequences. These health consequences are joined by significant stigma and social costs associated with obesity. A recent study unwittingly highlighted the difficulty of abstaining from certain foods even in the face of explicit negative consequences. In the context of a large clinical trial on heart health, participants were instructed to abstain from chocolate during the course of the study or they would no longer be able to participate. Of the 1200 participants, 139 participants were dropped from the study because they were incapable of abstaining from chocolate.³⁹ The criterion of continued use despite physical and psychologic problems is clearly met.

Diagnostic Threshold and Clinically Significant Impairment or Distress

Some criteria, such as a desire to cut down on food consumption, may be frequently endorsed, but the existence of any one criterion is not sufficient to constitute dependence. It is important to note that it is necessary to have a cluster of 3 or more symptoms, and clinically significant impairment or significant distress to meet the diagnostic threshold for substance dependence.²¹ The examination of clinically significant impairment or distress may be especially important when evaluating whether something is potentially addictive, as there is concern that considering overeating (as well as compulsive gambling and sexual behavior) as an addiction will trivialize the meaning of this concept.⁴⁰ Thus, if excessive food consumption causes little impairment or distress it may not be appropriate to label it as an addiction. Although research has not directly addressed the extent to which food-dependence criteria occur together or the level of distress or impairment caused by these symptoms, some indication of the distress caused by problems controlling eating and weight is evident from existing research. For instance, Schwartz et al⁴⁰ studied 4283 individuals and found that 46% would give up a year of their life instead of being obese; 15% would give up 10 years of life, 30% would rather be divorced; 25% would rather not be able to have children, and 14% would rather be alcoholic. In addition, it makes intuitive sense that many of the criteria,

such as repeated failed attempts, loss of control, and continued use despite negative consequences, would naturally occur together and would significantly impact life quality. Nonetheless, it is important to empirically evaluate the frequency with which these criteria appear together, and the degree of impairment and/or distress, to appropriately explore the prevalence of “food addiction.”

Additional Components of Addiction

In addition to further exploration of the diagnostic criteria for dependence, other areas of addiction research may also be beneficial in understanding excess food consumption. An essential first step to furthering the research in this area is the development of valid assessment tools. One limitation in the past is the absence of a scale to identify those likely to be exhibiting signs of “food addiction.” Previous research has relied on self-identification to study addiction to food.⁴¹ This reduces methodological certainty that the study truly captures food addiction for 2 reasons: (1) addicts traditionally lack insight into the extent of their problems⁴² and (2) “food addiction” is a term that is frequently used in popular culture and therefore may result in over self-identification of those who are not truly addicted. For instance, approximately half of participants in a nonclinical sample reported being addicted to chocolate.⁴³

Gearhardt et al⁴⁴ have recently developed the Yale Food Addiction Scale (YFAS) to identify those exhibiting signs of addiction toward food high in fat and/or sugar. The YFAS content was developed to examine the severity and frequency with which participants experienced symptoms of dependence in relation to their food consumption. The YFAS exhibited adequate internal reliability, and demonstrated good convergent validity with other measures of eating problems, and showed good discriminant validity relative to related but dissimilar constructs, such as alcohol consumption and impulsivity. Additionally, the YFAS predicted binge-eating behavior above and beyond existing measures of eating pathology, demonstrating incremental validity. In this nonclinical population, 11.4% of participants indicated that they had experienced 3 or more criteria in the past 12 months accompanied by clinically significant impaired and/or distress. The development of the YFAS provides a sound tool for identifying eating patterns that are most related to food addiction and may assist in identifying relevant samples in future research.

Another important area to examine may be the role that expectancies and motives play in food consumption. It is evident that people have many thoughts and feelings in regard to their consumption of food. In research with addictive substances such as alcohol, expectancies of the drug's effects and motives for use play an important role in how the drug will be experienced. Certain types of expectancies, such as increased expectations of social and sexual prowess, are predictive of substance-related problems.⁴⁵ Similarly, coping motives for use are a consistent predictor of the development of alcohol-related problems.⁴⁶ Understanding expectancies and motives for foods with addictive properties may help identify early cognitive indicators of risk.

Although explicit expectancies and motives for the use of addictive substances have been found to be important, there is also considerable evidence for the role of implicit cognition in addiction. Attentional biases toward drug-related cues have been identified and found to operate at an implicit level.⁴⁷ According to Robinson and Berridge⁴⁸ incentive salience begins to drive drug-taking behavior as the user develops experience with the drug. In other words, consumption becomes uncoupled from the pleasurable aspects of the substance and is instead driven by craving brought on by cues associated with the availability or consumption of the substance. This may be especially relevant to food, as food-related cues are omnipresent because of frequent advertising and high accessibility.

Consistent with the incentive salience model suggesting that pleasurable effects are not an important factor in more-advanced substance use, Koob⁴⁹ has suggested that a behavioral and neurological switch may take place from the positively reinforcing aspects of a substance (ie, greater sociability) to the negatively reinforcing components (ie, stress relief) as substance use transitions to substance dependence. Understanding what motivational forces drive excessive eating may provide important information for both behavioral and pharmacological treatments.

What Might Be Addictive?

If food can trigger an addictive process, it is essential to learn what constituents of foods might be responsible. Processed foods can have dozens of ingredients, so this will not be an easy task. Work thus far has focused on one macronutrient (sugar), so an obvious extension of the science would be to examine fat. Also, worthy of future study are substances added to food such as high fructose corn syrup and a long list of flavoring agents and preservatives. When such substances are added to food and consumption increases, they get labeled as “flavor enhancers” by the food industry. Central to the issue of food and addiction, and to the important legal question of how ingredients are intentionally manipulated, will be separating the extent to which added substances simply make a food more pleasurable or affect the brain in ways that products effects such as tolerance and withdrawal.

Conclusions, Risks, and Opportunities

The metaphor that drugs of abuse “hijack” the brain is now in wide use but only recently has food been considered in this context.⁵⁰ The science to date is relatively new, and as we note below, there are many important questions to be addressed. Nonetheless, results thus far have painted a consistent and increasingly compelling picture. Certain foods, with sugar being the most thoroughly studied, activate the brain in ways similar to classic drugs of abuse. Animal research further suggests that tolerance and withdrawal are exhibited by rats consuming sugar. Although there is some evidence for tolerance and withdrawal to high fat sweets in humans, further research is needed. Further research is also needed to examine time spent in obtaining, using, and recovering from excess food consumption and the degree to which important activities are given up due to overconsumption, especially in light of food’s socially acceptable and highly

accessible nature. There is clear evidence that some people lose control over their food consumption, suffer from repeated failed attempts to reduce their intake and are unable to abstain from certain types of food or reduce consumption in the face of negative consequences. The compilation of this evidence provides a strong case that food may be addictive and further highlights the need for further research in this area.

Given the evidence, it is also important to think about the implications of “food addiction” for both prevention and treatment. One potential outcome of demonstrating the existence of food addiction would be to further underscore the role the environment plays in encouraging excess food consumption. A host of factors drive the population toward calorie-dense foods including the existence of an inexpensive sweetener (high fructose corn syrup); increasing portion sizes; heavy marketing of fast foods, sugared beverages and cereals, and snacks; food technology that maximizes palatability; heavy consumption of calories connected with a known addictive substance (caffeine); and lower costs for energy-dense, nutrient poor foods than for healthier options. If these food products are found to be addictive, there may be a shift in thinking about corporate and personal responsibility, especially regarding children. Evidence of food addiction may also support legislation, litigation, and regulation efforts to increase access to healthy foods while reducing the availability of high-fat/-sugar foods. These combined efforts may help readjust the food environment to encourage the maintenance of a healthy weight.

Lessons Learned from Alcohol and Tobacco

Although there are ways that the validation of “food addiction” might assist in battling the obesity epidemic, there are also some risks involved. Examination of the way in which addiction to alcohol and nicotine have been treated in the United States provides a case in point. Alcoholism is widely conceptualized in American culture as a disease that resides within the individual.⁵¹ Although the disease model of alcoholism has helped to reduce stigma associated with alcoholism by taking blame away from the individual, it simultaneously takes away some of the responsibility from the drug itself. From the disease-model perspective, alcohol can be safely used by most of individuals and is only problematic for the relatively smaller number of individuals with the disease of alcoholism. This conceptualization has largely taken away responsibility from the alcoholic beverage industry leading to the acceptance of advertising for alcohol products on television and other medium, and sponsorship of sporting events by major distributors.⁵² Treatment is advocated for those suffering from alcoholism, but relatively few resources are devoted to prevention of alcohol-related problems.⁵³ The failure to take a public health approach to alcohol-related problems in the United States may have contributed to the relatively stable rates of alcoholism in recent decades.

In contrast to alcohol, nicotine has recently been characterized as a highly addictive drug that will lead to dependence in most users who use tobacco products.²¹ Thus, any use of the substance is seen as hazardous and the tobacco industry has been restricted from advertising on television

and has lost sponsorship for major sporting events.⁵⁴ In terms of treatment, tobacco cessation has made its way into primary care settings as a way to prevent future health problems.⁵⁵ This approach has the potential to reach far more individuals than the treatment approach typically advocated for alcoholism. The public health approach that has been taken with respect to tobacco has also led to a dramatic shift in public opinion regarding the tobacco industry and to substantial decreases in rates of smoking.⁵⁶

The different histories of alcohol and nicotine dependence in this country demonstrate that all addictions are not treated in the same way. With respect to food dependence, the alcoholism approach could lead to reduced culpability of the food industry. Producers of highly palatable and unhealthy foods would simply claim that most people can consume these products safely and that we need only concentrate our efforts on the small proportion of individuals with a food addiction. The industry could make the appearance of doing good by contributing money to treatment programs or more likely, to education programs, while simultaneously continuing to flood the market with unhealthy products. In contrast, the public health approach used with respect to nicotine dependence would have the potential to affect wide-spread changes in the food supply. Public support and legal pressure on the food industry might lead to the increased availability and reduced cost of healthy foods and reduced availability of unhealthy and highly palatable foods. Such efforts targeting youth might have the greatest potential to impact rates of obesity.

In sum, there is considerable evidence suggesting that some foods may trigger an addictive process. Under such conditions, the brain behaves much as it does when exposed to classic drugs of abuse. The importance of this issue argues for an aggressive research agenda that addresses key unanswered questions. As this work moves forward, it is important that the information be used responsibly and that public policy be developed in ways that create healthful food environments.

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AUTHOR QUERIES

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1

A—Kindly note that the short head has been shortened further.

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