



### Food Addiction: A Short Review

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#### Abstract

Neurotransmitters are essential for humans' body to work properly. There is a hedonic brain circuit composed of centers that work together to enable these neurotransmitters to control the state of pleasure: dopamine and serotonin. All drug abuse increases dopamine levels in the extracellular medium. Several times dependence occur behaviorally, and in a less proportion by substance. On this review is going to be approached food addiction.

#### Keywords

Food addiction, Highly palatable foods, Sugar and fat, Reward

#### Introduction

Some basic researches using humans and animals as models have shown that certain foods, especially very palatable, have addictive properties. Exposure to food or drugs may stimulate opioid and dopaminergic systems, which are related to the release of neurotransmitters and sensation of pleasure. The objective of this review is to analyze some concepts and researches related to food addiction.

#### Dependence on Pleasure

The essential neurotransmitters for human's body to operate normally are: dopamine and serotonin, precursors that come from external substances from the high-quality nutrients such as protein. For a long time in our history, these foods were not consumed in large quantities due to the scarcity or difficulty in storing them. As a consequence of it people had deficits of neurotransmitters regularly. Depletions of these substances tend to cause adverse effects on behavior and emotions, including motor skills, cognitive abilities and mood. Some plants such as *Erythroxylum* (coca) are capable of producing neurotransmitter substitutes when ingested, toxic effect produced as defense mechanism from the plant against mammals. From this discovery, humans were able to purify the psychoactive substances of plant and modify the route of administration, making it the most potent effect on brain stimulation [1].

According to Kringelbach and Berridge [2], researchers of neuroanatomy of pleasure, there is a hedonic brain circuit composed of brain centers that work together activating neurotransmitters controlling the state of pleasure.

The nucleus accumbens, the orbitofrontal cortex, insula, dorsal striatum, substantia nigra, among others, are part of the brain centers

responsible for various actions such as: memory of food rewarding, taste of food, searching palatable foods, reward or pleasure after ingestion, and opportunistic ingestion. In other words, when certain food is available there is a need to have it even in the absence of hunger, and several other reactions mediated by brain centers [3].

The limbic system located in the central nervous system region with regions of the cerebral cortex keep many of these brain centers controlling sensations such as "like", located in the nucleus accumbens region. An experiment with animals has showed an increase of this feeling when the neurons on this region were stimulated by sweet substances and neurochemical modulators. As a result, the elements mentioned produced endogenous pleasure stimulators; feelings of learning and feelings of "wanting" activated by the neurohormone dopamine in the limbic system [3,4].

All drugs abuse increase dopamine levels in the extracellular medium into regions associated with the striatum and mesolimbic. Some neuroimaging studies have shown that our brain responds similarly in the presence of food and drug abuse, increasing cell activation in the nucleus accumbens [5].

Clinicians and researchers understand addictions in many different forms, drug addiction has been defined as a chronically relapsing disorder characterized by compulsion to seek and take the drug; loss of control in limiting drug intake, and emergence of a negative emotional state (e.g, dysphoria, anxiety and irritability), reflecting on the motivational withdrawal syndrome when access to drug is prevented. And Sussman [6] identified five elements of food addiction that recur in the scientific literature: engagement in the behavior to achieve appetitive effects; preoccupation with the behavior; temporary satiation; loss of control; and negative consequences suffering [7].

#### The Perception of Dependence

About 60 years ago, Randolph defined addiction to food as a specific adaptation to one or more foods eaten regularly, which food the person has high sensitivity, producing a common pattern of symptoms described in a similar way to those and other processes in addiction [8]. Due to the increase of obesity in recent decades, the concept of food addiction has become popular with researchers, and it is possible to understand the impact of physiological factors with weight gain [7]. This concept is also presented very strong among the general population, 86% of Australians and Americans believe that certain foods have an addictive potential and 72% relate obesity with food addiction [9,10].

Food dependency is detected by using the YFAS (Yale Food Addiction Scale). It is used a questionnaire with 27 items to determine an eating pattern over a period of 12 months, it translates the DSM-IV TR (Diagnostic and Statistical Manual IV TR) which defines dependence criteria for substances related to eating behavior, including tolerance, symptoms, vulnerability in social activities, control and etc. Then, the test food addiction, at YFAS is 3 or more when symptoms are presented at 12 months [11].

Hardman *et al.* [10], summoned up 60 students at the University of Liverpool (UK), 72% women and 28% men. Participants were divided randomly into two groups: real and myth, in which they had to read newspaper articles that showed the existence of food addiction and the nonexistence. And in a second time the groups were exposed to permissive food addiction, as cookies and tortillas, and not permissive foods, like grapes and bread, followed by questionnaire (YFAS). The researchers found that exposure to the articles influenced participants' own perception about having food addiction, 57% (real group) compared to 27% (myth group), this exhibition has also influenced food ingestion. This result contrasts to the dates from the questionnaire, where only 8 % of respondents fit on the food dependency criteria. Thus, the environment and the own perception can influence the eating behavior. Corroborating the findings of Hardman *et al.* (2015) [10], Sawaya [12] shows that the power of advertising on food and sugary drinks generates a conditioned reflex causing a momentary reward after ingestion, and consequently generates pleasure.

Toral *et al.*, Yoshida and Prochaska *et al.* [13-15] developed a tool to identify the desire to change an individual's addiction, called Model Transtheoretical, which has five stages.

The pre-contemplation stage is characterized by the unwillingness to change and there is a resistance to recognize the problem and modify it [14,15].

In the second stage of contemplation, the individual has awareness of the problem and think about initiating a change. The individual who is in the preparation stage want to change their behavior in a near future. The action stage is characterized by visible changes in behavior requiring efforts to prevent relapse, because the changes are recent, less than six months. And the maintenance stage, the individual has changed the behavior for a period longer than six months, need to keep the acquired eating habits so that there is no relapse and the individual does not return to gain weight, for example [13,15-21].

## Highly Palatable Foods

Glycolysis sugars are conducted to produce pyruvate in all cells aerobic, being the key substrate for energy. Sugars such as mono-, di- e polysaccharides are essential substances to our diet. Generally, animals have a more specialized taste detection, are able to perceive compounds mono- and disaccharides as a potential food source, different from humans who simply recognize how sweet [7,22].

Schulte, Avena e Gearhardt [23] developed two studies with 120 participants in the first and 384 in the second, with the aim to evaluate and compare the pharmacokinetic properties of highly processed foods addicted with refined carbohydrates and fats to drug abuse. In the first study, the researchers have shown that foods high in fat and refined carbohydrates were often associated with behavior similar to food addiction. In the second study, processing is a positive predictor of this problem, concluding that these foods share characteristics with drug and food addiction.

Keser *et al.* [24] evaluated 100 overweight children and with obesity. He found out that 71% had food addiction and the most consumed foods were the fries, ice cream, soft drinks, candies, breads, rice, chocolate and pasta.

However, many studies show that in these cases the dependence occurs frequently behaviorally, and in a less extent on food substance [7]. In humans, behavioral addiction is accompanied by psychological and psychiatric complex as: shame, anxiety, depression and impulsivity [25].

A study was conducted with rats fed with sugar, and was observed that they had binge eating, increased consumption after private periods and signs of abstinence similar to drug after administration of high doses of opioids hormone inhibitors, such as teeth beating, trembling legs and head shaking. It is also noticed that mice that became obese by eating foods rich in sugars, showed a decrease in dopaminergic activity in the limbic system in relation to rats that were fed with a balanced diet for an average weight, similar effect to that described for drug addicts. The study's researcher realized that image of humans 'brains have shown that food and drugs stimulate the same brain regions and there is a decrease in cellular uptake of dopamine receptors in obese people and drug addicts [26].

Several studies have also associated the consumption of fat with food addiction, especially with processed food. In order to make these foods more palatable, industries add fat food composition to improve flavor, appearance and consistency to be accepted by consumers who generally prefer high fat food to low-fat. The reason for this preference is not clear yet, the chemoreception has been observed in humans [27].

Due to the central effects involved in several signaling in energy homeostasis, including hormones such as leptin, ghrelin, MCH and GLP-1, which are essential in food intake regulation, they are also influenced by the ingestion of diets rich in fatty acids. Exposure of animals to these diets, signaled an anxious behavior and endured an aversive environment in order to get high-fat foods, and neurochemical changes; mice exposed to these diets decreased sensitivity to stress, however, the removal of these foods increased stress and reduced the state of the reward system [7,28,29].

## Epigenetics and Food Addiction

Spangler *et al.* [30], showed that changes in gene expression with rearrangements in the neural circuits of reward and pleasure happen when there is consumption of sugars for weeks due to the change in neural plasticity, so there are not only functional changes but losses even deeper.

Robison e Nestler [31] and others proposed that changes in the transcriptional potential of genes, through actions in transcription factors, changes in chromatin and RNA noncoding, contribute to many neuroadaptations that result from chronic exposure to drug abuse. Many mRNAs have the ability to change reward regions in the brain after chronic exposure. From the modulation, they are able to induce or repress the genetic response in the next exposure to drugs or other environmental stimuli.

There is some evidence that stress in adolescence increases the risk of addiction; and that exposure to intrauterine drug increases the risk of it in adolescence and adulthood [32,33].

Sawaya [12] showed in his study that certain foods can cause neuroanatomical changes that can be transmitted from mothers to children, corroborating the study Spangler *et al.*, Andersen and Teicher, e Malanga and Kosofsky [29,33].

## Conclusion

In conclusion, the society as a whole has difficulty on separating substance and behavioral dependence, depending on situations and environments. As we pointed out in this review, there is a little evidence to indicate that humans can develop or acquire dependence of highly palatable foods. The dates from rodent and humans are consistent with the existence of addictive eating behavior.

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