Understanding and Managing Food Addiction

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Institute of Human Nutrition

Outline of the presentation

- The problem of obesity
- Our modern food landscape
- Some factors contributing to the obesity epidemic
- Background on food-reward and some of its associated brain systems
- Defining an addiction and contrasting it with “normal” rewarding experiences
- Assessment of “food addiction” in studies
- Managing “food addiction”: where should we look?
Obesity in the World

- Obesity prevalence as % of total population:
  - United Arab Emirates
  - United States
  - South Africa
  - Britain
  - Brazil
  - China
  - India

Source: Gretchen Siegner and Majid Ezzati, *Population Health Metrics*

*The Economist (2012)*

Obesity in the US

- ~65% of adults in the U.S. are overweight, of which ~36% are obese.
- Being obese or overweight is associated with multiple comorbid health concerns (e.g., heart disease, diabetes).
- Increased body weight can also have psychological, economical, and social consequences.
Why are so many people overweight or obese?

Portion size and portion creep

Twenty years ago
577 calories

Today's Burger
360 calories

Original 8-ounce bottle
37 calories

12-ounce can
45 calories

20-ounce bottle
370 calories
Food Acquisition is Easier Than it Used to Be

Added Sugar Consumption in the United States

<table>
<thead>
<tr>
<th>Age, y</th>
<th>n</th>
<th>Mean</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–3</td>
<td>1515</td>
<td>12.2</td>
<td>0.33</td>
</tr>
<tr>
<td>4–8</td>
<td>1701</td>
<td>21.0</td>
<td>0.54</td>
</tr>
<tr>
<td>Males 0–13</td>
<td>1061</td>
<td>29.2</td>
<td>0.92</td>
</tr>
<tr>
<td>Males 14–18</td>
<td>1424</td>
<td>34.3</td>
<td>1.03</td>
</tr>
<tr>
<td>Males ≥19</td>
<td>4650</td>
<td>25.4</td>
<td>0.48</td>
</tr>
<tr>
<td>Females 9–13</td>
<td>1112</td>
<td>23.2</td>
<td>0.82</td>
</tr>
<tr>
<td>Females 14–18</td>
<td>1362</td>
<td>25.2</td>
<td>0.71</td>
</tr>
<tr>
<td>Females ≥19</td>
<td>5063</td>
<td>18.3</td>
<td>0.37</td>
</tr>
<tr>
<td>All persons ≥1</td>
<td>17 888</td>
<td>22.2</td>
<td>0.29</td>
</tr>
</tbody>
</table>

Added sugar, as measured here, includes: white, brown and raw sugar, syrup, honey, and molasses that were eaten separately or used as ingredients in processed or prepared foods such as breads, cakes, soft drinks, jams, and ice cream.

The National Cancer Institute (2010)
Consumption of Added Sugars in Children and Adolescents

Added sugars have been reported to constitute approximately 16% of children and adolescents’ daily caloric intake.

Ervin et al. (2012)

Obesity is an endpoint, with multiple contributing factors

- Sedentary lifestyle
- Genetic vulnerability
- Food accessibility
- Genes (Prader-Willi syndrome)
- Increases in portion sizes
- Stress and endocrine factors
- Social norms regarding food
- Food reward (addiction?)
Hedonic eating vs. caloric need

- People sometimes eat because they want to eat, not because they have to eat (people may eat because of boredom, stress, etc.)
- Foods that are rich in fats and sugars, and consequently calories, taste good.
- Palatable food is ubiquitous for most people in our society.
- Food is a part of our social lives.

Who thinks food can be addictive?
Food Addiction in Food Advertising

Food Addiction in Popular Media
What kinds of foods may be addictive?

Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil

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doi: 10.1017/S1366659900010002
Variety and hyperpalatability: are they promoting addictive overeating?
Nicole M Arena and Mark S Gold

The hypothesis that food has evolved from a necessity and a boring staple to an object of desire and a substance of abuse has been debated for decades (1). However, over the past 10 years, empirical studies have revealed overlaps between maladaptive food intake patterns, which are sometimes seen in obesity, and drug addiction (2). As a result, “addiction” to palatable food has been suggested, with neurochemical and behavioral similarities seen in both human studies and in animal models (2, 3). In laboratory animals, signs of opiate-like withdrawal can be seen after administration of naloxone in cases in which the animals have a history of chronic overconsumption of sucrose. Furthermore, cross-tolerance and sensitization have been reported between alcohol, amphetamine, or cocaine and the overconsumption of sucrose. With these behaviors are concomitant changes in the mesolimbic dopamine and opioid daily presentation group than in the groups exposed to the palatable food weekly (6).

The findings of Epstein et al (6) provide support and guidance in developing dietary advice, such as the suggestion that people try to eat the same food each day, in which case habituation may develop that would reduce the likelihood of overeating and subsequent obesity. However, previous work has shown that having a variety of taste available can actually promote energy intake (8). Thus, variety in palatable food choices appears to be important in determining whether or not habituation or perhaps tolerance to food can develop. In our modern-day food environment, monotony and similarity in meals are rare. The variety of ethnic foods, multiple fast-food restaurants on virtually every corner, and the many choices of highly palatable food that these establishments...
What happens in the brain when we eat?

- Drugs that are abused act on brain systems that evolved to reinforce natural behaviors (e.g., sex, feeding).
- There are overlaps in the brain pathways activated by palatable foods and drugs of abuse.
Could some people be “addicted” to eating highly-palatable foods rich in sweets and fats in ways that resemble drug addiction?

Could such out-of-control eating result in increased body weight and obesity in some individuals?
Comparing and contrasting normal feeding and drug addiction

<table>
<thead>
<tr>
<th>Normal Feeding</th>
<th>Drug Addiction</th>
</tr>
</thead>
<tbody>
<tr>
<td>• We need food to survive (but not hyperpalatable foods).</td>
<td>• We don’t need drugs of abuse to survive.</td>
</tr>
<tr>
<td>• Food is not regulated, eating is socially accepted and encouraged, and food is readily available.</td>
<td>• Drugs of abuse are illegal, discouraged by society, and hard to procure.</td>
</tr>
<tr>
<td>• Food cues are everywhere (sights, smells, even sounds).</td>
<td>• Drug cues and advertisements are not common.</td>
</tr>
</tbody>
</table>

Assessing Addiction Using Animal Models

![Diagram showing the process of cross-sensitization and withdrawal](image-url)
Evidence for sugar addiction: Behavioral and neurochemical effects of intermittent, excessive sugar intake

Nicole M. Avena, Pedro Rada, Bartley G. Hoebel
Department of Psychology, Princeton University, Princeton, NJ 08544, USA

Table 1
Summary of findings in support of sugar addiction in rats using an animal model of sucrose or glucose bingeing.

<table>
<thead>
<tr>
<th>Substance dependence</th>
<th>Animal model of sugar dependence</th>
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<tbody>
<tr>
<td>A. DOM IV-TR</td>
<td></td>
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<tr>
<td>Tolerance</td>
<td></td>
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<tr>
<td>Signs of withdrawal</td>
<td></td>
</tr>
<tr>
<td>Consuming more than intended</td>
<td></td>
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<tr>
<td>B. Behavioral sign</td>
<td></td>
</tr>
<tr>
<td>Cocaine cross-sensitivity</td>
<td></td>
</tr>
<tr>
<td>Probability to consume other drugs of abuse</td>
<td></td>
</tr>
<tr>
<td>C. Neurochemical changes in the N/Nc</td>
<td></td>
</tr>
<tr>
<td>Repeated intake of EN</td>
<td></td>
</tr>
<tr>
<td>D1 receptor binding</td>
<td></td>
</tr>
<tr>
<td>D2 receptor binding</td>
<td></td>
</tr>
<tr>
<td>Guam rats</td>
<td></td>
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<tr>
<td>Sucrose intake</td>
<td></td>
</tr>
<tr>
<td>Somaic signs (weight-loss, tremor)</td>
<td></td>
</tr>
<tr>
<td>Anxiety measured by plus-maze</td>
<td></td>
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<tr>
<td>Ultrasonic distress vocalizations</td>
<td></td>
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<tr>
<td>Depression effect (Avena et al., 2005)</td>
<td></td>
</tr>
<tr>
<td>Alcohol (Avena et al., 2004)</td>
<td></td>
</tr>
<tr>
<td>Amphetamine (Avena and Hoebel, 2003)</td>
<td></td>
</tr>
</tbody>
</table>


Bingeing/Tolerance

Rada, Avena, and Hoebel (2005)
Alterations in Brain Dopamine Levels

- Increases in dopamine release wane with repeated exposure to chow, however, these increases continue in response to sugar.
  - This effect is only seen in sugar-bingeing rats, not control rats.
  - This effect is also seen in response to fat (Liang, Hajnal, & Norgren, 2006).
  - Rats are not overweight.

Withdrawal

- Sugar bingeing rats show signs of anxiety when given an opioid antagonist (naloxone), or when fasted from all food for 36 h.
- Opioid systems are perturbed by overeating, as revealed by increased mu-opioid receptor binding in these animals prior to withdrawal.

Rada, Avena and Hoebel (2005)

Colantuoni et al. (2001); Avena, Bocarsly, et al. (2008)
Craving

- Rats prone to overeat are more likely to cross a shock grid to get access to palatable food (Oswald, Murdaugh, King & Boggiano, 2011).

- Rats that overeat sugar daily show an increase in intake following a period of abstinence (Avena et al., 2005), and will work harder to get access to sugar-associated cues (Grimm et al., 2005).

Cross-sensitization to drugs of abuse

- Sugar-bingeing rats are hyperactive in response to a low dose of amphetamine.

- Sugar-bingeing rats consume more alcohol.

Avena and Hoebel (2003); Avena et al. (2004)
Food variety attenuates habituation to food in humans.....when you have variety, you eat MORE.

- Rats with access to a cafeteria-style diet are hyper-responsive to amphetamine in terms of dopamine release.

- However, they do not respond to a lab chow meal. These rats need “junk food” to release accumbens dopamine.

Geiger et al. (2009)
Assessing Addiction-like Responses to Palatable Food in Humans

- The Yale Food Addiction Scale has been created to study food addiction by applying the DSM-IV criteria for substance dependence to eating behaviors.

**Sample items:**

- “I find myself continuing to consume certain foods even though I am no longer hungry”
- “I eat to the point where I feel physically ill”
- “I find that when I start eating certain foods, I end up eating much more than planned”

- The items are answered using a Likert type scale (i.e., Never, Once a month, 2-4 times a month, 2-3 times a week, 4 or more times or daily)

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**Neural Correlates of Food Addiction**

Ashley N. Gearhardt, MS, MPhil; Sonja Yekum, PhD; Patrick T. Orr, MS, MPhil; Eric Stice, PhD; William R. Corbin, PhD; Kelly D. Brownell, PhD

Arch Gen Psychiatry (Reprinted) 2011 April 4

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This page contains educational content on assessing addiction-like responses to palatable food in humans, including the Yale Food Addiction Scale and neural correlates of food addiction. The content is designed to provide insights into the addictive behaviors associated with food consumption and the neurological aspects underlying these behaviors.
### Select Findings from Studies using the Yale Food Addiction Scale

- In a group of about 200 undergraduate students, **11.4%** met the criteria for food addiction (Gearhardt et al., 2009)

- Among **72 obese** participants, **25%** met the criteria for food addiction (Davis et al., 2011)

- Two studies assessing food addiction symptoms in obese individuals with binge eating disorder reported that **42-57%** met the criteria for food addiction (Gearhardt et al., 2012; 2013)

- Recently, this scale has been adapted to use in children and adolescents. A preliminary study using the YFAS-C found **7.2%** of the **72 children and adolescents** met the criteria for food addiction (Gearhardt et al., 2013)

### Food addiction has been associated with:

- Binge eating disorder (BED) / binge eating
- Depression
- Impulsivity
- Lower self-esteem
- Emotional eating
- Food cravings
- Snacking on sweets
- Mixed evidence regarding weight loss outcomes
Summary

Table 1

<table>
<thead>
<tr>
<th>DSM IV criteria</th>
<th>Animal model</th>
<th>Humans model</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tolerance</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>2. Withdrawal</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>3. Use more than intended in longer periods of time</td>
<td>✓</td>
<td>✓</td>
<td>Hypothalamus, hypothalamic suppression, hypothyroidism, stress, depression, anxiety, sleep disturbances, eating disorders, addiction, substance use disorders</td>
</tr>
<tr>
<td>4. Attempts to cut back</td>
<td>✓</td>
<td></td>
<td>Dietary restraint, participation in weight-loss programs</td>
</tr>
<tr>
<td>5. Spend time in the pursuit/ recovery of the substance</td>
<td>✓</td>
<td></td>
<td>Anticipation and preoccupation, cravings, food thoughts, increased brain dopamine levels in response to anticipation and consumption, negative food triggers, cue-induced behaviors, change of eating patterns and meal frequency, increase in habitual vs. physical hunger</td>
</tr>
<tr>
<td>6. Mixed important activities</td>
<td>✓</td>
<td>✓</td>
<td>Social &amp; emotional activities given up, social marginalization, psychological distress, discrimination</td>
</tr>
<tr>
<td>7. Persistent behavior in spite of knowledge of consequences</td>
<td>✓</td>
<td>✓</td>
<td>Lack of diet compliance, failure to achieve long-term weight loss, hyperphagia resistant to exercise or medication</td>
</tr>
</tbody>
</table>

(From Allen et al. (2012))

How might we manage food addiction?
Managing Food Addiction

1. One step to managing food addiction is to assess and try to alter certain **social norms** surrounding food, such as...

   - Using food as reinforcements in children
   - Having food as the central part of most social gatherings
   - Including popular toys in unhealthy food packages to market toward children

   As a society, we have to stop being “food pushers”.

2. We have to become **savvy food consumers**

   - Understanding nutrition labels
   - Know where sugars are hidden
   - Following new research to learn the latest

3. **Pharmacological approaches**.

   - Researchers are currently studying pharmacological agents known to target brain regions associated with reward (i.e., dopaminergic and opioiodergic systems) in order to identify possible drug treatments that may suppress overeating, particularly of highly-palatable foods.
Managing Food Addiction

In addition to the social and neurochemical aspects of food addiction, there may also be important psychological reasons that people may develop an unhealthy attachment to food. In order to address these factors, it may be helpful to recognize:

- When we typically overeat (when we are bored? Stressed? Depressed? Lonely? In groups?)
- When we first began this pattern of overeating
- What function overeating may serve for us

We have a lot more work to do to understand how to manage food addiction

Thank you!

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Monica Gordillo
Eric Su
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