

The Bittersweet Dilemma

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I take a bite into a cashew Nature Valley bar. I naturally go for another bite and then another and before I know it, I am left with a few crumbs and a crinkled wrapper. While the act of eating did not seem to require much thought, my brain was actively processing and responding to the cascade of signals detected with each sweet and salty bite. In particular, taste buds designed to detect sweetness initiated my brain to release dopamine, a hormone that stimulates the brain's pleasure and reward center (Wiss et al. 2018).

Sugar's ability to activate the dopamine reward system is an evolutionary advantage that originated from our successful nomadic ancestors. As sugary foods are rich in energy and calories, the body adapted to survive famine by positively reinforcing the consumption of sugar, enabling nomads to replenish energy stores and accumulate body fat. Over several million years, the primitive appeal of sugar in paleolithic nomads has evolved into strong sugar cravings in modern-day suburbanites and cosmopolitans. Likewise, the nature of sugar has also evolved. Rather than appearing only in fruits, grains, and honey, sugar presents itself in the modern world as refined sugar—it is the backbone of my granola bar and the cornerstone of the entire processed food industry. Although the dopamine reward system for natural sugars was essential for survival during times of sugar scarcity, it now serves to intensify America's sugar addiction as scientific advances and manufacturing make food abundant and refined sugar too accessible.

A lot has changed over these past million years, especially the modern world's access and relationship to food. While hunters and gatherers were at the mercy of nature, nature is now at

the mercy of the modern food industry. By processing and preserving nature's surplus, the food industry has created delicious ways to enjoy sweetened food all year round. Food has transformed from being a means of survival to being a source of pleasure, comfort, good health, identity, community, and more. As sweetness is one of the most pleasurable tastes experienced by humans, sugar is an essential ingredient used to flavor foods and enhance any dining experience. Sugar's popularity has influenced society to dedicate the last course of our meals to dessert, and its profitableness is what causes us to associate sweet foods with all occasions and a wide range of emotions. Cakes, cupcakes, and chocolates are just some of the ways that Americans celebrate large milestones, annual holidays, and birthdays. Meanwhile, we also turn to the comforts of ice cream after breakups or binge-eat sweets as a coping method during stressful experiences. However, sugar is not just limited to desserts and occasional guilty-pleasure treats but has fixed itself into almost every meal, snack, and drink. No longer coming and going with seasons, natural sugars in fruits and grains have been cultivated and processed into imperishable, highly concentrated refined sugars that are here to stay. Thus, understanding their presence in our diets is important for mitigating the health consequences associated with excessive sugar consumption.

When added to foods, refined sugars have versatile roles in sweetening and enhancing flavors, adding volume, modifying textures, and preserving freshness. Added sugars come in various forms and are disguised in ingredient lists by over 60 potential labels ranging from common names such as table sugar (sucrose), cane sugar, honey, and high-fructose corn syrup (HFCS) to more unfamiliar names such as erythritol, barley malt, xanthan gum, and treacle. Ingredients ending with "-ose" are usually sugar syrups, those ending with "-ol" are sugar

alcohols, and those including “malt” are sugars derived from grains (Harvard Health Publishing 2019). As consumers become more health-conscious, food manufacturers intentionally disguise sweetened products with complicated nutrition labels and countless obscure chemical names, hiding sugar in plain sight. While most consumers are aware that guilty pleasure desserts and pastries have high amounts of added sugar, “healthy” everyday items such as protein bars, yogurts, soups, and bread are also hidden sugar mines. Sugar entices America’s sweet tooth, creates irresistible flavor profiles, and helps companies sell more products, all at the consumer’s expense. Ultimately, we are paying for products that are harming our health.

Many people are not aware of the additives that control their eating and purchasing habits. Before a product is released on the market, thousands of product samples with varying sugar, salt, and fat ratios undergo countless consumer taste tests. Food companies use complex algorithms to fit the satisfactory ratings into a bell-shaped curve, with the top being the perfected “bliss point.” The “bliss point” is achieved when the perfect balance of sweetness, saltiness, and fat in food gives consumers the greatest pleasure without enough satisfaction. As a result, consumers continue desiring, buying, and eating more of that food to re-experience the bliss point. It is at this point that we physically cannot resist eating another chip or taking another bite of a cookie, causing us to impulsively and mindlessly eat until the food is finished (NPR 2015). Each product released on the market has been intentionally selected to be the most addictive and appealing product out of thousands of prototypes. Thus, the ten conglomerates dominating the global food and beverage industry, such as Nestle, PepsiCo, and Coca-Cola, make billions in revenue each year by taking advantage of the brain’s dopamine reward system to attract and control loyal consumers. Because a majority of calories in an American diet come from

processed foods, food manufacturers do not want consumers to realize how they are being exploited by sugar.

To help inform consumers of added sugars, the US Food and Drug Administration (U.S. FDA) announced that all packaged foods and drinks will be required to separately list the volume of total sugars and added sugars on nutrition labels by January 1, 2021 (U.S. Food and Drug Administration 2020). The updated nutrition label on my Nature Valley bar informed me that, along with the obvious cashews and oats I tasted, I unknowingly consumed nine total grams of sugar, seven grams of which were added sugars. Although the improved nutrition label creates a sense of transparency, food manufacturers have additional tactics to deceive consumers. It is commonly known that ingredients are listed on nutrition labels in a particular order, with ingredients in greater amounts at the beginning and trace amounts at the end. To positively portray processed foods with high amounts of added sugar, food manufacturers will often manipulate sugar's ranking on the ingredient list by adding smaller amounts of many obscurely named refined sugars so they are at the end of the ingredient list, ultimately deceiving consumers about how much sugar is in the product. This was true for my Nature Valley bar as most of the sugars were scattered at the end of the ingredient list. In briefly skimming the nutrition label, I easily identified five types of sugar out of the 30 ingredients, many of which were unfamiliar. After spending over ten minutes googling the 25 other ingredients, I was shocked to discover that my bar was a fusion of eight different added sugars: corn syrup, sugar, fructose, tapioca syrup, vegetable glycerin (a sugar alcohol), barley malt extract, honey, and maltodextrin. Had I not looked at the ingredients or calculated that sugar made up 25% of my bar, the deceptive wrapper displaying large cashews and the overpowering salty flavor would have successfully convinced

me that I did not consume a lot of sugar. Thus, food manufacturers create nutrition labels with dishonest intentions to protect themselves from being exposed for fortifying foods with cheap refined sugars instead of healthy nutrients and minerals.

Additionally, food manufacturers often distort our grasp of sugar intake by dividing a package into several servings to cut down the grams of sugar listed per serving on the nutrition label. Listing serving sizes in cups or grams instead of visibly quantifiable units such as cookies or chips can also hinder our perception of portion control, encouraging us to accidentally overeat. For example, the nutrition label for Honey Nut Cheerios says that one serving, one cup of cereal, contains 12 total grams of added sugar. Because people usually do not measure out a cup of their cereal, but rather instinctively pour enough to fill their bowl, consumers can be misled into thinking they ate roughly 12 grams of added sugar during breakfast, only to have eaten triple the amount. By forcing people to act like detectives in tracking their sugar intake, these strategies prevent people from making informed dietary decisions and abiding by sugar intake recommendations.

The American Heart Association (AHA) recommends that men consume no more than 150 calories, or 36 grams, of added sugar per day, equivalent to a 12-oz can of Coca-Cola or 60 strawberries. Additionally, women are advised to consume less than 100 calories of added sugar per day, about 25 grams, which roughly resembles a 6-oz container of Yoplait Original Strawberry Yogurt or 40 strawberries (Johnson et al. 2009). As people regularly and unknowingly consume more sugar than is recommended, annual per capita sugar consumption in the United States has almost tripled over this past century, exponentially increasing from 40 pounds in 1900 to over 150 pounds in 2020 (Lustig et al. 2012). The industrialized food

industry's success and the breakthrough of processed foods are largely responsible for this drastic rise, with the CDC's National Health and Nutrition Examination Survey from 2010 determining that about 90% of America's added sugar intake was attributed to ultra-processed foods like soft drinks, cereals, and packaged desserts (Huehnergath 2016).

While daily sugar intake comes from both natural and refined sugars, the amount of sugar consumed in the form of whole fruits and vegetables pales in comparison to the volume consumed in highly processed foods and beverages. Fruits and vegetables are loaded with fiber, an indigestible plant nutrient that helps us feel full faster and digest sugars slower. Fiber, nature's way of limiting sugar consumption in whole foods, is what makes us feel satisfied after eating 20 grams of sugar in an apple. However, most man-made food and beverages are designed fiber-free to promote sales through increased appetite and overeating, with sweetened beverages being the greatest offenders. CDC's National Health and Nutrition Examination Survey (NHANES) found that more than half of America's added sugar consumption was derived from beverages, specifically 42.2% in the form of sodas and 8.5% from fruit drinks (Harvard Health Publishing 2019). These shocking statistics can be explained by the fact that beverages contain no fiber but are saturated with added sugars, making it extremely easy for the average American to accidentally consume about 17 teaspoons, or 71 grams, of sugar every day (Johnson et al. 2009). A person can comfortably drink 71 grams of sugar in 20 ounces of Martinelli's Organic Apple Juice in one sitting and still crave more because they consumed 0 grams of fiber. However, when put in terms of natural sugar, that is similar to eating about 120 strawberries or 12 ears of corn per day! Yet people rarely eat this much naturally occurring sugar because the high volume of water and fiber accompanying it would leave them feeling too full. As fiber poses a challenge to

our limited appetites, food companies protect their sales by modifying foods to contain more sugar but less fiber. If food is meant to be filling, these delicious ultra-processed products fail as food because they arouse hunger and encourage overeating.

Consuming too much sugar over time can lead to metabolic syndrome, a name that encompasses several detrimental conditions such as type 2 diabetes, obesity, and non-alcoholic fatty liver disease, according to the World Health Organization (WHO) (World Health Organization 2019). Excessively high levels of fructose and glucose, sugar molecules that make up simple sugars, are responsible for these diseases. During metabolism, both natural and refined sugars are broken down into fructose and glucose constituents and processed similarly as they are chemically indistinguishable by the body (International Food Information Council Foundation, 2013). Glucose is absorbed into the bloodstream in the small intestine where it raises blood sugar levels, activating a hormone called insulin that transports glucose molecules to the cells for immediate energy use or long-term energy storage (Freeman et al. 2018). Because sugar is not capable of directly diffusing into cells, insulin functions as a key for the glucose transporters within cells so that sugar can enter cells and is vital in maintaining normal blood sugar levels. Additionally, insulin stimulates the leptin hormone to be secreted, which signals for the body to stop eating (Aprea 2019). In other words, glucose is the body's primary energy source and has been seen to improve satiety. In hunters and gatherers, insulin released from glucose replenished short-term energy stores and sustained laborious lifestyles. Now, insulin often promotes fat storage because our short-term energy stores are typically full from calorie-rich meals and untouched by our sedentary lifestyles.

When people consume more sugar than the body can utilize, the body releases high amounts of insulin to lower blood glucose levels, converting glucose into fat. However, when cells already have enough energy stored as fat, they do not want to accept more glucose from the bloodstream, becoming resistant to insulin. Insulin resistance can be compared to having a key for a book locker that is already full. Unlocking the locker will not help because there is no space to put more textbooks so we must continue carrying our textbooks around the hallway. Carrying a few extra textbooks is not too overwhelming, but if we continue increasing the number of textbooks, it can cause us to overwork our bodies, add unnecessary weight, prevent us from performing necessary tasks, and cause other injuries and health issues. In this case, the cells are the full lockers, glucose represents the textbooks, and the bloodstream is depicted by the person carrying the textbooks. Thus, consuming high amounts of sugar can lead to organ damage, weight gain, insulin resistance, and chronically high blood sugar levels, classified as type 2 diabetes (Lustig et al. 2012).

Compared to glucose, the body's primary source of energy, fructose is an indirect form of energy. Fructose metabolism does not raise blood sugar levels to release insulin and leptin hormones, which is why fructose consumption hinders the brain's ability to control hunger and suppress the appetite, contributing to obesity (Freeman et al. 2018). Unlike glucose metabolism which occurs in every cell in the body, fructose metabolism parallels alcohol metabolism as they both only occur in the liver, where they are primarily processed into fat (Lustig et al. 2012). Their metabolic pathways are essentially the same because alcohol is produced through the fermentation of sugar, such as fructose. When fat builds up in the liver, it impairs its function and

can lead to fatty liver disease. Therefore, excess fructose consumption can be just as harmful to the liver as alcohol.

Similar to frequent alcohol consumption, it is evident that the rewarding nature of sugar can also cause addictions. Animal studies have revealed that when given a choice, rats preferred sugar over cocaine, suggesting that the reward from consuming sugar can strongly influence the brain and be more addictive than drugs (Dinicolantonio et al. 2017). Table sugar, one of the most common forms of sugar, is created by extracting sugar cane juice, reducing this sugary solution into a thick syrup, and then purifying it into pure white crystals, a refining process similar to cocaine and opium (Dinicolantonio et al. 2017). Like drugs derived from plants, sugars become extremely addictive once they are refined into a highly concentrated powder.

Sugar encourages binge-eating, causes higher tolerance, produces signs of withdrawal, and arouses cravings when not consumed, which are all symptoms of addiction (Dinicolantonio et al. 2017). I personally experienced severe sugar withdrawals when I did the Whole30 program, a strict 30-day plan that promotes healthy eating by eliminating “trigger” foods such as common allergens (soy, dairy, grains, legumes), all forms of added sugar, alcohol, and all processed foods. During the first half of the program, I experienced the common symptoms of the “Keto Flu” such as minor headaches, intense sugar cravings, mood fluctuations, weakness, and fatigue, which are shared by people who abruptly transition to diets that cut out added sugar (Osborn, 2020). Despite eating generous portions of leafy greens, lean fish, and unprocessed food, I experienced intense cravings for sweet foods and desserts, specifically ice cream, brownies and cereal, the latter being something that I never craved before. Although most research studies have only investigated sugar’s addictive properties in mice, the prevalence of

withdrawal symptoms in people who stopped eating added sugars, including myself, strongly supports how refined sugars do have addictive effects that are capable of altering human brain chemistry, influencing habits, and affecting mood (Dinicolantonio et al. 2017).

However, these addictive symptoms can be reversed over time. After 30 days of Whole30, I enjoyed steady energy levels throughout the day as opposed to feeling tired after each meal, altered my brain's relationship with food, corrected my "bliss point" to be less sweet, and lost over seven pounds from entering ketosis, where my body burned fat for energy in place of glucose. It is important to note that glucose is the body's preferred energy source but not required for survival; thus, unlike essential vitamins and minerals, there is no perfect amount of sugar that can be consumed. The ideal sugar intake rests on each person's unique lifestyle pattern, daily activity level, and diet. Taking note of how much sugar is in food products and widely limiting sugar consumption can help reduce not only addiction, but also other negative health risks associated with sugar, such as type 2 diabetes and fatty liver disease.

Rather than cutting out all added sugars, which is nearly impossible given the ubiquity of sugar, consumers can slowly wean their sugar addictions by reducing sugar consumption by several grams each week over several months. Other small lifestyle changes can consist of eating sugar with fiber to reduce blood sugar spikes and hunger, putting food on small plates instead of eating from the bag to visualize the portion size, swapping out sweetened beverages for whole fruits and vegetables, and exercising after meals to use the energy in sugar before it can be stored as fat. During this period, consumers should reflect on how they feel with the amount of sugar they are consuming. When people are fueling their bodies with the proper amount of sugar, the rewards of eating should provide pleasure but also yield mental clarity, physical well-being,

steady moods, strength, satiety, and self-control. Thus, mindfully eating sugar in moderation, as nature intended for us, has long-term health benefits and can promote a fulfilling relationship with food rather than making us sick.

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