

See discussions, stats, and author profiles for this publication at: <http://www.researchgate.net/publication/266401437>

Dopamine and glucose, obesity, and reward deficiency syndrome

ARTICLE in FRONTIERS IN PSYCHOLOGY · SEPTEMBER 2014

Impact Factor: 2.8 · DOI: 10.3389/fpsyg.2014.00919 · Source: PubMed

CITATIONS

5

DOWNLOADS

67

VIEWS

115

3 AUTHORS:



Kenneth Blum

University of Florida

301 PUBLICATIONS **5,321** CITATIONS

SEE PROFILE



Panayotis Thanos

Brookhaven National Laboratory

119 PUBLICATIONS **3,366** CITATIONS

SEE PROFILE



Mark S Gold

Washington University in St. Louis

529 PUBLICATIONS **8,141** CITATIONS

SEE PROFILE

betes. SPRINT will couple a somewhat more extensive cognitive assessment with brain magnetic resonance imaging, including assessments of blood flow and neural networks. The results are expected during early 2017.

Jeff D. Williamson, MD, MHS

Lenore J. Launer, PhD

Michael E. Miller, PhD

For the ACCORD MIND Investigators

Author Affiliations: Roena B. Kulynych Center for Memory and Cognition Research, Department of Internal Medicine, Wake Forest University, Winston-Salem, North Carolina (Williamson); Intramural Research Program, National Institute on Aging, National Institutes of Health, Bethesda, Maryland (Launer); Division of Public Health Sciences, Department of Biostatistical Sciences, Wake Forest School of Medicine, Winston-Salem, North Carolina (Miller).

Group Information: Members of the ACCORD MIND Study Group have been published in the article by Williamson et al.¹

Corresponding Author: Jeff D. Williamson, MD, MHS, Director, Roena B. Kulynych Center for Memory and Cognition Research, Department of Internal Medicine, Wake Forest School of Medicine, Medical Center Boulevard, Winston-Salem, NC 27157 (jwilliam@wakehealth.edu).

Conflict of Interest Disclosures: None reported.

1. Williamson JD, Launer LJ, Bryan RN, et al; Action to Control Cardiovascular Risk in Diabetes Memory in Diabetes Investigators. Cognitive function and brain structure in persons with type 2 diabetes mellitus after intensive lowering of blood pressure and lipid levels: a randomized clinical trial. *JAMA Intern Med.* 2014;174(3):324-333.

Why Are We Consuming So Much Sugar Despite Knowing Too Much Can Harm Us?

To the Editor In the article by Yang et al,¹ a relationship between intake of added sugars and risk of cardiovascular disease was demonstrated. The study revealed that almost 75% of the US population consumes more than 10% of calories from added sugars. Despite it becoming increasingly known that added sugars can have detrimental effects on health, people persist in consuming them in excess.

How the intake of highly palatable foods (ie, those with added sugars) influences reward-related brain regions and behaviors is being actively investigated. In light of the findings reported by Yang et al,¹ we think it important to emphasize that one potential cause of excessive sugar intake may relate to findings from laboratory animal and human studies, which suggest that addiction-like behaviors and related brain changes may perpetuate overeating highly palatable foods.²

Animal models indicate that excess sugar intake produces signs of tolerance, druglike withdrawal when sugar is unavailable, and craving-like behaviors. Concomitantly, changes occur in dopamine and opioid systems in reward-related brain regions, similar to animals using substances like alcohol or nicotine. In humans, studies of obese individuals show that brain areas associated with drug reward are activated by anticipation and receipt of food, with favorite food-related craving and associated brain-reward responses linked to insulin resistance in obesity.³ To study further addiction-like characteristics as related to food, the Yale Food Addiction Scale, which is adapted from the substance dependence disorder criteria in the *Diagnostic and Statistical Manual of Men-*

tal Disorders (Fourth Edition, Text Revision), was recently used in the Nurses' Health Study II cohort, showing an 8.4% prevalence of addiction-like responses to food.⁴ Moreover, the prevalence of addiction-like responses to food is greater in participants with binge-eating disorder or obesity⁵ and in those with greater impulsivity or emotional reactivity. Finally, functional magnetic resonance imaging studies correlate higher food addiction scores with greater activation of brain regions associated with addiction and craving during food anticipation and consumption.

From these clinical studies and observed neurochemical changes in reward systems in humans and laboratory animals, addictive behaviors associated with food intake very likely contribute to rising obesity rates and subsequent comorbidities (eg, cardiovascular disease). The high prevalence of added-sugar consumption found in the study by Yang et al¹ is very likely influenced by and a result of addictive behaviors incited by reward system activation after overeating highly palatable foods. Considering the impact of food addiction and the findings by Yang et al¹ could advance treatment, prevention, and policy initiatives.

Nicole M. Avena, PhD

Marc N. Potenza, PhD

Mark S. Gold, MD

Author Affiliations: New York Obesity Research Center, Department of Medicine, Columbia University College of Physicians and Surgeons, New York, New York (Avena); Department of Psychiatry, College of Medicine, University of Florida, Gainesville (Avena, Gold); Department of Psychiatry, Yale University School of Medicine, New Haven, Connecticut (Potenza); Department of Neurobiology, Yale University School of Medicine, New Haven, Connecticut (Potenza); Child Study Center, Yale University School of Medicine, New Haven, Connecticut (Potenza).

Corresponding Author: Nicole M. Avena, PhD, New York Obesity Research Center, Department of Medicine, Columbia University College of Physicians and Surgeons, 1111 Amsterdam Ave, 10th Floor, Room 1020, New York, NY 10025 (NA2574@columbia.edu).

Conflict of Interest Disclosures: Dr Avena has received research funding from Gilead Sciences and Bioprojet, the National Institutes of Health, and the National Eating Disorders Association; has consulted for groups and legal entities on issues related to diet and nutrition; has edited journals and journal sections; has given academic lectures in grand rounds, CME events, and other clinical or scientific venues; and has generated books or book chapters for publishers health-related texts. Dr Potenza has consulted for Ironwood and Lundbeck pharmaceuticals; has received research support from the National Institutes of Health, Mohegan Sun Casino, and the National Center for Responsible Gaming; has participated in surveys, mailings, or telephone consultations related to drug addiction, impulse-control disorders, or other health topics; has consulted for gambling and legal entities on issues related to impulse-control/addictive disorders; provides clinical care in a problem gambling services program; has performed grant reviews for the National Institutes of Health and other agencies; has edited journals and journal sections; has given academic lectures in grand rounds, CME events, and other clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts. No other disclosures are reported.

1. Yang Q, Zhang Z, Gregg EW, Flanders WD, Merritt R, Hu FB. Added sugar intake and cardiovascular diseases mortality among US adults. *JAMA Intern Med.* 2014;174(4):516-524.

2. Avena NM, Gearhardt AN, Gold MS, Wang GJ, Potenza MN. Tossing the baby out with the bathwater after a brief rinse? the potential downside of dismissing food addiction based on limited data [letter]. *Nat Rev Neurosci.* 2012;13(7):514.

3. Jastreboff AM, Sinha R, Lacadie C, Small DM, Sherwin RS, Potenza MN. Neural correlates of stress- and food cue-induced food craving in obesity: association with insulin levels. *Diabetes Care.* 2013;36(2):394-402.

4. Flint AJ, Gearhardt AN, Corbin WR, Brownell KD, Field AE, Rimm EB. Food-addiction scale measurement in 2 cohorts of middle-aged and older women. *Am J Clin Nutr*. 2014;99(3):578-586.

5. Gearhardt AN, Corbin WR, Brownell KD. Preliminary validation of the Yale Food Addiction Scale. *Appetite*. 2009;52(2):430-436.

In Reply We appreciate the suggestion by Avena and colleagues that addiction-like behaviors and related brain changes may perpetuate overeating highly palatable foods that tend to contain high amounts of added sugars. This interesting hypothesis needs to be tested in well-designed interventions and mechanistic studies. Although the high consumption of added sugars in the US population (on average, approximately 22 teaspoons per day) is possibly related to the “addictive” property of the palatable foods and the reward system in the brain, the abundance of added sugars in the current food environment and influential advertising by the food industry may also play an important role.¹

Our data indicate that the majority of US adults consumed more added sugars than is recommended for a healthy diet. Our results, along with the findings of many other studies,²⁻⁵ support current recommendations to reduce the intake of added sugars in US diets.⁶

Quanhe Yang, PhD

Zefeng Zhang, MD, PhD

Frank B. Hu, MD, PhD

Author Affiliations: Division for Heart Disease and Stroke Prevention, Centers for Disease Control and Prevention, Atlanta, Georgia (Yang, Zhang); Department of Nutrition, Harvard School of Public Health, Boston, Massachusetts (Hu); Department of Epidemiology, Harvard School of Public Health, Boston, Massachusetts (Hu).

Corresponding Author: Zefeng Zhang, MD, PhD, Division for Heart Disease and Stroke Prevention, Centers for Disease Control and Prevention, 4770 Buford Hwy, MS F-72, Atlanta, GA 30033 (hww0@cdc.gov).

Conflict of Interest Disclosures: None reported.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

1. Chandon P, Wansink B. Does food marketing need to make us fat? a review and solutions. *Nutr Rev*. 2012;70(10):571-593.

2. Malik VS, Popkin BM, Bray GA, Després JP, Willett WC, Hu FB. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: a meta-analysis. *Diabetes Care*. 2010;33(11):2477-2483.

3. Welsh JA, Sharma A, Abramson JL, Vaccarino V, Gillespie C, Vos MB. Caloric sweetener consumption and dyslipidemia among US adults. *JAMA*. 2010;303(15):1490-1497.

4. Malik VS, Popkin BM, Bray GA, Després JP, Hu FB. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation*. 2010;121(11):1356-1364.

5. de Koning L, Malik VS, Kellogg MD, Rimm EB, Willett WC, Hu FB. Sweetened beverage consumption, incident coronary heart disease, and biomarkers of risk in men. *Circulation*. 2012;125(14):1735-1741, S1.

6. US Dept of Health and Human Services, US Dept of Agriculture, US Dietary Guidelines Advisory Committee. *Dietary Guidelines for Americans, 2010*. 7th ed. Washington, DC: US Government Printing Office; 2010.