Executive Function and Negative Eating Behaviors in Severely Obese African Americans

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Objective: African Americans are disparately impacted by severe obesity. Low socioeconomic status and psychosocial risk factors help to explain this disparity; however, few studies have examined the role of negative eating behaviors or the influence of executive function on negative eating behaviors in this population. The objective was to examine the association between executive function (ie, inhibition and set shifting) and negative eating behaviors in severely obese African Americans.

Participants: Forty-seven African Americans who met criteria for severe obesity participated.

Design and Setting: Data were analyzed from a cross-sectional study entitled Stress and Psychoneuroimmunological Factors in Renal Health and Disease. The mean age of participants was 45.7 years (SD=10.8) and the mean educational attainment was 13 years (SD=2.1).

Main Outcome Measures: Participants completed the Wisconsin Card Sorting Task, the Stroop Color-Word Test, and the Eating Behavior Patterns Questionnaire.

Results: Correlation results suggested poorer inhibition was associated with greater self-reported emotional eating and snacking on sweets. Subsequent hierarchical regression analyses confirmed the inverse relations between inhibition, emotional eating, and snacking on sweets, after controlling for age, sex, years of education, and depression.

Conclusions: Reduced inhibition may be an important risk factor for negative eating behaviors and subsequent obesity in this population. Interventions aimed at increasing inhibition and self-regulation in this at-risk group are warranted. (*Ethn Dis*. 2014;24[3]: 328–334)

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Obesity is an epidemic in the United States, with an estimated 35.5% of adults classified as obese in 2009–2010.[1] The prevalence of severe obesity has also increased, with approximately 14.4% of the adult population meeting this criterion (body mass index ≥35 kg/m^2).[1] While rates of obesity have climbed for all racial/ethnic groups, African Americans are disproportionately impacted. Nearly 70% of African American men and over 82% of African American women are classified as overweight or obese,[1] and among obese African Americans, 26% are classified as severely obese.[1] Several factors that may account for this disparity include lower socioeconomic status (SES), sedentary lifestyle, chronic stress, psychological mood states, emotional eating, lack of access to quality medical care, and reduced availability of healthy food choices.[2–4]

Another risk factor for overweight and obesity is negative eating behavior.[5–9] Negative eating behaviors are loosely defined in the way they are operationalized – eating that is characterized by high fat, high sugar, and/or low nutrient-based consumption – and linked to weight gain. For example, mindless eating, where one overeats without awareness of satiety, is positively associated with obesity.[10] Fast food, increased consumption of simple sugars, skipping breakfast, and nighttime eating are also associated with increased weight as well as obesity.[7,11–13] Moreover, studies have suggested that other socioeconomic factors, such as increased access to fast foods, contribute to poorer eating behaviors, particularly among African Americans.[14–16] Other evidence has shown that biological factors, such as genetic susceptibility to obesity, are linked to emotional and uncontrolled eating.[17]

There is a paucity of research examining the influence of executive function on independent risk factors for obesity (eg, negative eating behaviors). Executive functions are higher order neurocognitive processes that enable individuals to initiate and arrest actions, inhibit and modify behaviors when necessary, and adapt to environmental changes.[18,19] The association between obesity and decrements in executive function has been well studied. Findings have suggested that obese individuals have reduced decision making and problem solving capacity, reduced mental flexibility, and poor inhibitory ability.[20–22] Furthermore, understanding the influence of executive function may elucidate how certain behavioral processes (eg, negative eating behaviors) increase the risk for obesity.[23,24] Specifically, executive inattention, impulsivity, and inflexibility may underlie the behavioral processes that increase the risk for becoming overweight or obese.

Previous research has found a relationship between executive function and impulsive behaviors, such as compulsive gambling, sex addiction, and substance abuse.[25–27] In addition, there have been documented associations between executive function and eating disorders. For example, the executive functions inhibition and set shifting play a critical role in negative eating behaviors prevalent in anorexia nervosa and bulimia.[28–30] Inhibition involves withholding an automatic or impulsive response to a stimulus to produce an alternative

response.[31,32] Set shifting involves switching attention between tasks.[33,34] It also involves the ability to refrain from perseveration of an ongoing behavior when a new stimulus requires attention to shift.[33,35] Taken together, these findings suggest that poor executive control is a dominant characteristic found in these psychiatric disorders and key to their behavioral expression.

Inhibition and set shifting have also been implicated in negative eating behaviors in non-psychiatric populations. Poor inhibition has not only been linked to impulsive eating,[24] it has also been associated with excessive snacking, emotional eating, and consumption of large portions of foods high in saturated fats and sugar.[23] Furthermore, overweight and obesity have been linked to poorer inhibitory control over food stimuli in children.[20] Deficits in set shifting have resulted in perseverative behaviors associated with overeating and inflexibility in adopting healthier patterns of behavior.[28] However, the role of decreased inhibition and set shifting in behaviors that characterize overweight and obese conditions is less understood, particularly in African Americans.

Expanding the conceptualization of disordered eating among obese African Americans to include novel risk factors such as poor executive function is warranted considering the excessive burden of obese conditions in this group. Greater risk for obesity underscores African Americans' higher rates of related detrimental health conditions including hypertension, diabetes, and cardiovascular disease. Filling the gap in the current body of literature will provide insight into neurocognitive (eg, executive function) and behavioral (eg, negative eating) processes that can be targeted for individualized treatment approaches to reduce weight as well as a better understanding of preventative measures.

The objective of our study was to examine relationships among the executive processes inhibition and set shifting and negative eating behaviors in severely obese African Americans. To our knowledge, there are no studies that have examined these phenomena in African Americans, and more specifically severely obese African Americans who may be more likely than lower weight individuals to engage in negative eating behaviors. It was hypothesized that lower inhibition and set shifting abilities would be associated with greater self-reported emotional eating and snacking on sweets.

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MATERIAL AND METHODS

Data Source

This study was conducted in conjunction with the National Minority Organ Tissue Transplant Education Program (MOTTEP) at the General Clinical Research Center (GCRC) at Howard University Hospital in Washington, DC from 2005 to 2007 and approved by the Howard University Institutional Review Board. Participants were recruited through local advertisement and screened by phone. Eligibility was based on self-report. All participants provided informed consent prior to participation. The study protocol took approximately four hours to complete and participants received monetary compensation. Details of the study protocol have been published elsewhere.[36,37]

Participants

A community-based sample of 214 African Americans participated in the parent study. Exclusion criteria included current physical, emotional, or drug abuse, and a previous psychiatric diagnosis. The inclusion criterion was a BMI >35 kg/m^2, for a final N of 47.

Measures

The Stroop Color and Word Test (Stroop) is a measure of inhibition.[38] The task consists of reading words in a list that are color names, naming the colors of Xs that are printed in another list, and for the color word task, naming the colors words are printed in while ignoring the color names written. The color word task tests inhibition, the ability to suppress the urge to perform a primary response in order to attend to a response that is secondary. The Stroop interference score reflects degree of inhibition and was calculated using the Golden method for use in the analyses.[39]

The Wisconsin Card Sorting Test (WCST) is a measure of set shifting. This test requires individuals to demonstrate cognitive flexibility to react to changing patterns in a set of displayed stimulus cards. The test requires individuals to adjust to a new pattern once it has changed. Individuals with greater set shifting ability are able to adjust to newly presented patterns and avoid perseverative errors.[40,41] A perseverative error occurs when an individual continues to sort cards based on a previously correct pattern.[42] In addition to perseverative errors, individuals must also avoid making non-perseverative errors, or errors that are unrelated to a pattern. For the current study, a computerized version of the WCST was administered. The number of perseverative and non-perseverative errors was utilized in the analysis.

The Eating Behavior Patterns Questionnaire (EBPQ) was designed to assess eating behaviors related to fat intake among African American women,[43] but has been administered to African Amer-

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ican men as well.[37] It is composed of items that make up five negative eating behavior domains and one positive domain: emotional eating, snacking on sweets, haphazard planning, meal planning, cultural/lifestyle behaviors, and low fat eating.[43] Internal consistency of the six EBPQ domains is sound, with Cronbach's alpha coefficients ranging from .70 to .88.[43] Construct validity was demonstrated with several domains correlating significantly with measures of total energy and total fat intake, and several macro- and micro-nutrients derived from the Meharry Food Frequency Questionnaire.[43,44] Examples of emotional eating items are "my emotions affect how and what I eat," and "I eat for comfort." Examples of snacking on sweets items are "I am a snacker" and "I eat cookies, cakes."[43] These two domains of the EBPQ were selected for the analysis.

Depressive symptoms were assessed as a covariate using the Beck Depression Inventory-II (BDI-II).[45] The BDI-II is a well-validated 21-item self-report measure used to determine the severity of depression with scores highly correlated with a clinical diagnosis of depression.[46]

Data Analysis

Data were analyzed using SPSS version 20.0. All variables in the analysis were checked for normality. The WCST non-perseverative errors variable was positively skewed and normalized using a log transformation. Initial associations between emotional eating, snacking on sweets, inhibition and set shifting variables were assessed with zero-order correlations. Significant zero-order pairs were then subjected to hierarchical linear regression. In order to account for multi-collinearity, separate hierarchical linear regression models were run to assess associations between executive function and eating behavior domains after controlling for age, sex, education, and depression. Covariates were selected based on their association with executive function. Predictors in the regression models were Stroop interference scores and WCST perseverative and non-perseverative error scores, and outcomes included emotional eating and snacking on sweets. In the first model of each regression, covariates were entered in order to account for their known association with executive function. In the second block, executive function variables were added to assess additional variance explained in eating behavior after accounting for covariates.

Table 1. Sample characteristics, *N*=47

	Mean	SD
Age, years	45.7	10.8
Education, years	13	2.1
Body mass index, kg/m^2	43.3	7.6
Beck Depression Inventory-II	11.70	10.24
Sex	*n*	%
Males	20	57.4
Females	27	42.6
Individual income		
<$10,000	16	34
$10,001–20,000	5	10.6
$20,001–30,000	12	25.5
$30,001–40,000	4	8.5
$40,001–50,000	3	6.4
$50,001–65,000	4	8.5
$65,001–80,000	1	2.1
>$80,000	1	2.1

RESULTS

The sample was 57.4% female and 42.6% male. The mean age of participants was 45.7 years (SD=10.8) with a mean of 13 years of education (SD=2.1). Mean BMI was 43.3 kg/m^2 (SD=7.6). Approximately 46% of participants had an income of ≤$20,000 per year, while 2% had an income ≥$80,000 per year. About 68% of the sample was unmarried. Depression within the sample, based on the BDI-II was relatively low. Sample characteristics are reported in Table 1. Descriptive statistics for study measures are summarized in Table 2.

Zero-order Correlations

Correlations revealed that emotional eating and snacking on sweets were inversely associated with Stroop interference. There were no statistically significant relationships between either WCST variable and the eating behavior variables. Zero-order correlations are summarized in Table 3.

Regression Analyses

Based on correlation findings, only two regressions were run, using Stroop interference score as the predictor variable. For emotional eating as an outcome, the first block of the regression that included age, sex, years of education, and depression was non-significant (F=1.452, *P*=.238) and accounted for 14.6% of the variance in emotional eating (Table 4). In the second block, the addition of the Stroop interference variable was again non-significant (F=2.194, *P*=.079) and explained an

Table 2. Descriptive statistics for executive functioning variables and eating behavior variables

	Mean (SD)	Range
Emotional eating	30.31 (6.65)	18–43
Snacking on sweets	16.81 (4.48)	6–26
WCST perseverative errors	22.06 (9.85)	4–44
WCST non-perseverative errors	23.19 (15.61)	3–91
Stroop interference score	−2.93 (12.92)	−28.11–36.10

WCST, Wisconsin Card Sorting Test.

additional 10.3% of the variance in emotional eating (R^2=.249). After accounting for covariates, the association between Stroop interference and emotional eating was significant and negative (β= −.376, *P*=.040), indicating that poorer inhibition was associated with greater self-reported emotional eating.

For snacking on sweets as an outcome, the first block of the regression that included age, sex, years of education, and depression was non-significant (F=.540, P=.707) and accounted for 6% of the variance in snacking on sweets (R^2=.06) (Table 5). In the second block, the addition of the Stroop interference variable was non-significant (F=1.429, P=.240) but explained an additional 11.8% of the variance in snacking on sweets (R^2=.178) After accounting for covariates, the association between Stroop interference and snacking on sweets was significant and negative (β=−.402, P=.037), indicating that poorer inhibition was associated with more snacking on sweets.

DISCUSSION

The objective of our study was to examine relations among inhibition, set shifting, and negative eating behaviors in severely obese African Americans. To our knowledge there were no prior studies that examined these relations in African Americans, a group disparately affected by obesity. Our results showed that poorer inhibition was associated with greater self-reported emotional eating and snacking on sweets. These findings are consistent with prior evidence that suggested executive processes play a role in negative eating behaviors and similar to findings for other impulsive behaviors such as compulsive gambling, sexual offenses, and substance abuse.[25–27]

Inhibition and Negative Eating Behaviors

Our findings linking inhibition to emotional eating and snacking on sweets were similar to prior evidence that found poorer inhibition contributes to impulsive eating[24] and negative eating behaviors, such as eating to assuage negative emotions, excessive consumption of snacks, and consumption of large quantities of high fat and high sugar foods.[23] These findings are particularly salient given that African Americans are more likely to reside in lower SES communities, experience unique chronic stressors, and emotional strain, which are risk factors that contribute significantly to emotional eating and obesity.[3,37,47–49]

Relatedly, reduced availability of healthy food options and poor neighborhood food environments contribute to greater consumption of unhealthy food.[2,50] In addition to these well-documented barriers to healthy eating for African Americans, our findings suggest that reduced inhibition may be a salient risk factor for negative eating behaviors and subsequent obesity in this at-risk population. Moreover, it is possible that reduced inhibition may compound the tendency to eat poorly in already compromised eating environments. An examination of the association between inhibition and negative eating behaviors in this population in various environments may help to elucidate the specific situational and contextual factors for which reduced inhibition contributes to poor eating. On the other hand, reduced inhibition may behave as a proxy for poor self-regulation among severely obese African Americans.

Potential Role of Self-regulation

Our findings linking inhibition to emotional eating and snacking on sweets were consistent with prior research that indicated negative eating behaviors may be avoided through increased self-regulation and ability to inhibit desires.[51] These findings are specifically related to the notion that individuals who are able to inhibit their urges to engage in negative behaviors may have adapted their own self-regulation techniques more efficiently.[52] Among severely obese African Americans in our sample, the association between inhibition and negative eating behaviors may be suggestive of limitations in effective self-regulation. This conclusion should be approached cautiously, however, because self-regulation was not directly assessed in the study.

Table 3. Zero-order correlations for executive function and eating behavior variables

	Emotional Eating	Snacking on Sweets
Stroop interference	−.336[a]	−.357[a]
WCST perseverative errors	−.159	.236
WCST non-perseverative errors	−.179	.036

WCST, Wisconsin Card Sorting Test.
[a] *P*<.05.

Table 4. Association of Stroop interference score with emotional eating

Emotional Eating	Beta	SE B	*P*	R^2	F	*P*
Model 1				.146	1.452	.238
Age	−.054	.104	.744			
Sex	−.368[a]	2.234	.034			
Education	.093	.571	.576			
BDI-II	.067	.655	.689			
Model 2				.249	2.194	.079
Age	−.154	.103	.353			
Sex	−.263	2.225	.123			
Education	.148	.550	.358			
BDI-II	−.009	.639	.956			
Stroop interference	−.376[a]	.096	.040			

BDI-II, Beck Depression Inventory-II.
[a] $P<.05$.

Further research is necessary to determine the relations among inhibition, self-regulation, and negative eating behaviors.

Non-significant Findings for Set Shifting

Inhibition was associated with emotional eating and snacking on sweets while set shifting was not. Poorer set shifting ability has previously been associated with overeating and inflexibility in adopting healthier patterns of behavior;[28] however, it was not related to negative eating behaviors in our sample. It is plausible that eating behavior is not influenced specifically by set shifting ability or that the measure of set shifting selected for this study was not ideal. Previous literature has identified that individuals with bulimia, another population with disordered eating, perform poorer on tasks of inhibition, but not set shifting.[53] Emotional eating and snacking on sweets represent impulsive behaviors, and as such, may be more automatic and not require the level of higher order processing that is characterized by set shifting.[53] Another explanation for non-significant findings may be a failure of the WCST to capture the type of attentional shifting that is required to shift from emotionally-driven eating behavior to more restrained eating, or from snacking on sweets to selection of healthier food options. The WCST requires immediate shifting of attention when a novel stimulus is presented. However, eating behaviors are driven by a number of variables in addition to attention, such as availability of healthy food options and hunger, that suggest a more complex system is at work. The WCST is a well-known measure of set shifting, however, several studies have questioned whether it is a pure measure of executive functioning. Imaging and event-related potential evidence has documented that the WCST activates areas of the brain outside of the traditional frontal areas (ie, parietal lobe) known to be associated with executive functioning[54] and may not reliably discriminate frontal lobe dysfunction.[55]

Table 5. Association of Stroop interference score with snacking on sweets

Snacking on Sweets	Beta	SE B	*P*	R^2	F	*P*
Model 1				.060	.540	.707
Age	.143	.072	.415			
Sex	−.148	1.544	.403			
Education	−.072	.394	.677			
BDI-II	.034	.452	.848			
Model 2				.178	1.429	.240
Age	.036	.071	.834			
Sex	−.036	1.533	.836			
Education	−.014	.379	.934			
BDI-II	−.048	.440	.780			
Stroop interference	−.402[a]	.066	.037			

BDI-II, Beck Depression Inventory-II.
[a] $P<.05$.

CONCLUSIONS AND LIMITATIONS

Little is known about the role that executive function plays in eating behaviors in African Americans, a high-risk population for obesity and related morbidities in the United States. Findings from our study are an early step in understanding these relations. In addition to the psychosocial and environmental factors that predispose African Americans to obesity, our findings suggest that a reduced ability to inhibit may promote negative eating behaviors and compound obesity risk. While cognitive training interventions have largely targeted memory improvement, a plausible next step is to determine if executive function can be enhanced within this population through cognitive training, and determine if any benefits translate to greater ability to inhibit negative eating. Moreover, interventions that help obese individuals to adapt their self-regulation techniques in unhealthy psychosocial and environmental contexts may provide additional benefits.

Our study was limited to self-reported eating behaviors. The addition of dietary recalls is needed to comple-

ment self-reports. Both food lists and qualitative narratives that detail daily food choices and eating behaviors would strengthen our understanding of this topic. Studies that incorporate experimental methods and imaging technology are also needed to help determine if frontal areas responsible for executive function are activated during specific eating behaviors. These methods will help to elucidate the role of executive function in emotional eating and snacking on sweets. Our study was also limited by its cross-sectional design, which did not allow us to examine causation. Additionally, the number of executive function measures available in the study limited the breadth of executive processes that could be examined. Inhibition is a multi-faceted construct, and only interference inhibition is assessed by the Stroop. Future studies should include a larger battery of executive measures.

REFERENCES

1. Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. *JAMA*. 2012;307(5): 491–497.
2. Baker EA, Shootman M, Barnidge E, Kelly C. The role of race and poverty in access to foods that enable individuals to adhere to dietary guidelines. *Prev Chronic Dis*. 2006;3:1–11.
3. Shepherd A. Obesity: prevalence, causes and clinical consequences. *Nurs Stand*. 2009; 23(52):51–57, quiz 58.
4. van Strien T, Cebolla A, Etchemendy E, et al. Emotional eating and food intake after sadness and joy. *Appetite*. 2013;66:20–25.
5. Colles SL, Dixon JB, O'Brien PE. Night eating syndrome and nocturnal snacking: association with obesity, binge eating, and psychological distress. *Int J Obes (Lond)*. 2007;31:1722–1730.
6. Maddock J. The relationship between obesity and the prevalence of fast food restaurants: state-level analysis. *Am J Health Promot*. 2004;19(2):137–143.
7. Bowman SA, Vinyard BT. Fast food consumption of US adults: Impact on energy and nutrient intakes and overweight status. *J Am Coll Nutr*. 2004;23(2):163–168.
8. Diliberti N, Bordi PL, Conklin MT, Roe LS, Rolls BJ. Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*. 2004;12(3):562–568.
9. Greenwood JL, Stanford JB. Preventing or improving obesity by addressing specific eating patterns. *J Am Board Fam Med*. 2008;21(2): 135–140.
10. Brewer EA, Kolotkin RL, Baird DD. The relationship between eating patterns and obesity in African American and Caucasian women. *Eat Behav*. 2003;4:159–171.
11. Raben A, Vasilaras TH, Moler AC, Astup A. Sucrose compared with artificial sweeteners: different effects on ad libitum food intake and body weight after 10 wk of supplementation in overweight subject. *Am J Clin Nutr*. 2002;75: 721–729.
12. Keski-Rahkonen A, Kaprio J, Rissanen A, Virkkunen M, Rose RJ. Breakfast skipping and health-compromising behaviors in adolescents and adults. *Eur J Clin Nutr*. 2003;57(7):842–853.
13. Andersen GS, Stunkard AJ, Sorensen TIA, Petersen L, Heitmann BL. Night eating and weight change in middle-aged men and women. *Int J Obes Relat Metab Disord*. 2004;28(10):1338–1343.
14. Booth SL, Sallis JF, Ritenbaugh C, et al. Environmental and societal factors affect food choice and physical activity: rationale, influences, and leverage points. *Nutr Rev*. 2001;59(3 Pt 2):S21–39; discussion S57–65.
15. Pereira MA, Kartashov AI, Ebbeling CB, et al. Fast-food habits, weight gain, and insulin resistance (the CARDIA study): 15-year prospective analysis. *Lancet*. 2005;365(9453): 36–42.
16. Odoms-Young AM, Zenk S, Mason M. Measuring food availability and access in African American communities: implications for intervention and policy. *Am J Prev Med*. 2009;36(4 Suppl):S145–150.
17. Cornelis M, Rimm E, Curhan G, et al. Obesity susceptibility loci and uncontrolled eating, emotional eating and cognitive restraint behaviors in men and women. *Obesity (Silver Spring)*. 2013 Aug 8 (Epub ahead of print).
18. Suchy Y. Executive functioning: overview, assessment, and research issues for non-neuropsychologists. *Ann Behav Med*. 2009; 37(2):106–116.
19. Friedman NP, Miyake A, Young SE, DeFries JC, Corley RP, Hewitt JK. Individual differences in executive functions are almost entirely genetic in origin. *J Exp Psychol Gen*. 2008; 137(2):201–225.
20. Nederkoorn C, Coelho JS, Guerrieri R, Houben K, Jansen A. Specificity of the failure to inhibit responses in overweight children. *Appetite*. 2012;59(2):409–413.
21. Boeka AG, Lokken KL. Neuropsychological performance of a clinical sample of extremely obese individuals. *Arch Clin Neuropsychol*. 2008;23(4):467–474.
22. Gunstad J, Paul RH, Cohen RA, Tate DF, Spitznagel MB, Gordon E. Elevated body mass index is associated with executive dysfunction in otherwise healthy adults. *Compr Psychiat*. 2007;48(1):57–61.
23. Elfhag K, Rossner S. Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obes Rev*. 2005;6(1):67–85.
24. Hofmann W, Friese M, Roefs A. Three ways to resist temptation: the independent contributions of executive attention, inhibitory control, and affect regulation to the impulse control of eating behavior. *J Exp Soc Psychol*. 2009;45(2):431–435.
25. Ferraro R, Gourneau M, Clow K, Erikson S, Anderson L. Impulse control, executive functioning and gambling in college students. *Psychol Jl*. 2008;5:212–214.
26. Dolan SL, Bechara A, Nathan PE. Executive dysfunction as a risk marker for substance abuse: the role of impulsive personality traits. *Behav Sci Law*. 2008;26(6):799–822.
27. Stone MH, Thompson EH. Executive function impairment in sexual offenders. *J Individ Psychol*. 2001;57:51–59.
28. Fagundo AB, de la Torre R, Jimenez-Murcia S, et al. Executive functions profile in extreme eating/weight conditions: from anorexia nervosa to obesity. *PLos One*. 2012;7(8):e43382.
29. Tchanturia KD, Davies H, Roberts M, et al. Poor cognitive flexibility in eating disorders: examining the evidence using the Wisconsin Card Sorting Rask. *PLos One*. 2012;7:e28331.
30. Brand M, Franke-Sievert C, Jacoby GE, Markowitsch HJ, Tuschen-Caffier B. Neuropsychological correlates of decision making in patients with bulimia nervosa. *Neuropsychology*. 2007;21(6):742–750.
31. Fisk JE, Sharp CA. Age-related impairment in executive functioning: updating, inhibition, shifting, and access. *J Clin Exp Neuropsychol*. 2004;26(7):874–890.
32. Pauli-Pott U, Albayrk O, Hebebrand J, Pott W. The Stroop task: the ''gold standard'' of attentional measures. *Eur Child Adolesc Psychiatry*. 2010;19(2):135–141.
33. Monsell S. Task switching. *Trends Cogn Sci*. 2003;7(3):134–140.
34. Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A. The unity and diversity of executive functions and their contributions to complex frontal lobe tasks: A latent variable analysis. *Cogn Psychol*. 2000;41:49–100.
35. Salthouse TA, Atkinson TM, Berish DE. Executive functioning as a potential mediator of age related cognitive decline in normal adult. *J Exp Psychol Gen*. 2003;132:566–594.
36. Mwendwa DT, Sims RC, Madhere S, et al. The influence of coping with perceived racism and stress on lipid levels in African Americans. *J Natl Med Assoc*. 2011;103(7):594–601.
37. Sims R, Gordon S, Garcia W, et al. Perceived stress and eating behaviors in a community-

based sample of African Americans. *Eat Behav*. 2008;9(2):137–142.
38. Stroop J. Studies of interference in serial verbal reactions. *J Exp Psychol Gen*. 1935;18:643–662.
39. Golden CJ. *The Stroop Color and Word Test: A Manual for Clinical and Experimental Uses*. Chicago: Stoelting Co; 1978.
40. Barcelo F. Does the Wisconsin Card Sorting Test measure prefrontal function? *Span J Psychol*. 2001;1:79–100.
41. Barcelo F, Munoz-Cespedes JM, Pozo MA, Rubia FJ. Attentional set-shifting modulates the target P3b response in the Wisconsin card sorting test. *Neuropsychologia*. 2000;38:1342–1355.
42. Hartman M, Bolton E, Fehnel SE. Accounting for age differences on the Wisconsin Card Sorting Test: decreased working memory, not inflexibility. *Psychol Aging*. 2001;16:385–399.
43. Schlundt DG, Hargreaves MK, Buchowski MS. The Eating Behavior Patterns Questionnaire predicts dietary fat intake in African American women. *J Am Diet Assoc*. 2003;103(3):338–345.
44. Schlundt DG, Hargreaves MK, Buchowski M. Questionnaires to measure barriers to dietary change in African American women. *Ann Behav Med*. 2000;22:S107.
45. Beck AT, Steer RA, Brown GK. *Manual for the Beck Depression Inventory-II*. San Antonio: Psychological Corporation; 1996.
46. Beck AT, Steer RA, Ball R, Ciervo CA. Use of the Beck anxiety and depression inventories for primary care with medical outpatients. *Assessment*. 1997;4:211–219.
47. Andersen GS, Stunkard AJ, Sorensen TI, Petersen L, Heitmann BL. Night eating and weight change in middle-aged men and women. *Int J Obes Relat Metab Disord*. 2004;28(10):1338–1343.
48. Clark RA, Norman B, Clark V, Williams R. Racism as a stressor for African Americans: a biospychosocial model. *Am Psychol*. 1999;54: 805–816.
49. Mwendwa DT, Gholson G, Sims RC, et al. Coping with perceived racism: a significant factor in the development of obesity in African American women? *J Natl Med Assoc*. 2011;103(7):602–608.
50. Grigsby-Toussaint DS, Zenk SN, Odoms-Young A, Ruggiero L, Moise I. Availability of commonly consumed and culturally specific fruits and vegetables in African American and Latino neighborhoods. *J Am Diet Assoc*. 2010;110(5):746–752.
51. Appelhans BM. Neurobehavioral inhibition of reward-driven feeding: implications for dieting and obesity. *Obesity*. 2009;17(4):640–647.
52. Pelletier L, Dion S, D'Angelo M, Reid R. Why do you regulate what you eat? Relationships between forms of regulation, eating behaviors, sustained dietary behavior change, and psychological adjustment. *Motiv Emot*. 2004;28(3): 245–276.
53. Siervo M, Arnold R, Wells JCK, et al. Intentional weight loss in overweight and obese individuals and cognitive function: a systematic review and meta-analysis. *Obes Rev*. 2011;12(11):968–983.
54. Barcelo F, Rubia FJ. Non-frontal P3b-like activity evoked by the Wisconsin Card Sorting Test. *Neuroreport*. 1998;9(4):747–751.
55. Nyhus E, Barcelo F. The Wisconsin Card Sorting Test and the cognitive assessment of prefrontal executive functions: a critical update. *Brain Cogn*. 2009;71(3):437–451.

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